UNIVERZA V LJUBLJANI
FPP
Fakulteta za pomorstvo in promet

ŠOLSKI CENTER CELJE
Srednja šola za storitvene dejavnosti in logistiko

XV. mednarodni simpozij

INTERDISCIPLINARNOST LOGISTIKE IN PROMETA

ZBORNIK PRISPEVKOV

Portorož, 25. – 27. september 2025

XV. MEDNARODNI SIMPOZIJ

XV. INTERNATIONAL SYMPOSIUM

INTERDISCIPLINARNOST LOGISTIKE IN PROMETA

INTERDISCIPLINARITY OF LOGISTICS AND TRAFFIC

ZBORNIK PRISPEVKOV

PROCEEDINGS

Portorož, 25. – 27. september 2025

Uredil/Edited by: Zoran Jazbinšek

Izdal in založil /Published by: Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko

Sedež/Address: Ljubljanska cesta 17, 3000 Celje, Slovenija

Oblikovanje in prelom/DTP: Zoran Jazbinšek

1. elektronska izdaja

Celje, november 2025

Avtorji jamčijo za avtorstvo in prevzemajo vso odgovornost za objavljene prispevke ter prevode.

Authors pledge for authorship and take full responsibility for published proceedings and translations.

Kataložni zapis o publikaciji (CIP) pripravili v Narodni in univerzitetni knjižnici v Ljubljani

COBISS.SI-ID 259206403

ISBN 978-961-6871-34-1 (PDF)

Organizatorji

ŠOLSKI CENTER CELJE, SREDNJA ŠOLA ZA STORITVENE DEJAVNOSTI IN LOGISTIKO

UNIVERZA V LJUBLJANI, FAKULTETA ZA POMORSTVO IN PROMET

Programski odbor

mag. Roman Krajnc predsedujoči	Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko, Celje, Slovenija
Darja Lužnik univ. dipl. ped.	Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko, Celje, Slovenija
doc. dr. sci. Kemal Jaganjac dip. ing. saob.	JU Srednja škola za saobraćaj i komunikacije, Sarajevo, Bosna in Hercegovina
Nikolče Spasovski dipl. saob. inž.	ASUC Boro Petruševski, Skopje, Severna Makedonija
m-r. Snezana B. Risteska dipl. saob. inž.	ASUC Boro Petruševski, Skopje, Severna Makedonija
Tomislav Kučina dipl. ing. prometa	Škola za cestovni promet, Zagreb, Hrvaška
Nemanja Radović dipl. inž. saob.	Zavod za unapređivanje obrazovanja i vaspitanja, Beograd, Srbija
mr. Srećko Kljajić dip. ing. saob.	Srednja stručna škola “Ivan Uskoković”, Podgorica, Črna Gora

Organizacijski odbor

mag. Andreja Jelen Mernik predsedujoča	Šolski center Celje, Višja strokovna šola, Celje, Slovenija
Darja Rebevšek prof.	Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko, Celje, Slovenija

Ksenja Rožanski Fidler univ. dipl. inž.	Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko, Celje, Slovenija
Rosana Jordan prof.	Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko, Celje, Slovenija
Zoran Jazbinšek dipl. inž.	Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko, Celje, Slovenija
Petra Selič prof.	Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko, Celje, Slovenija
Polona Lešar	Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko, Celje, Slovenija
Alina Slatinek dipl. inž.	Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko, Celje, Slovenija
Mr. sci. Emilija Martinčević dipl. ing. saob.	JU Srednja škola za saobraćaj i komunikacije, Sarajevo, Bosna in Hercegovina
Zoki Stojmirov dipl. saob. inž.	ASUC – „Boro Petruševski'', Skopje, Severna Makedonija
Tomislav Ćurković dipl. ing. prometa	Škola za cestovni promet, Zagreb, Hrvaška
Svetlana Veličković dipl. inž. saob.	Saobraćajno tehnička škola, Beograd, Srbija
mr. Srećko Kljajić dip. ing. saob.	Srednja stručna škola – „Ivan Uskoković'', Podgorica, Črna Gora

Kazalo

PRIMENA ITS KOMPONENTI I SAVREMENI TRENDOVI (APPLICATION OF ITS COMPONENTS AND MODERN TRENDS)

Nataša Sretenović, Tanja Arsić, Sabahudin Solak

1

STANDARDI GS1 KOT VEZ MED GOSPODARSTVOM, PRAKSO IN IZOBRAŽEVANJEM (GS1 STANDARDS AS A BRIDGE BETWEEN INDUSTRY, PRACTICE AND EDUCATION)

Gregor Belcijan, Dr. Mateja Podlogar

17

SLEDENJE Z UVAJANJEM DIGITALNIH POTNIH LISTOV IZDELKOV (TRACKING BY DIGITAL PRODUCT PASSPORTS IMPLEMENTATION)

Bogomir Brečko

39

SIGURNO PRUGOM – UGROŽENOST ADOLESCENATA PRI KRETANJU ŽELJEZNIČKOM PRUGOM (KEEP SAFE WHILE MOVING CLOSE TO THE RAILWAY TRACKS – THE THREATS ADOLESCENTS FACE WHILE WALKING IN THE VICINITY OF RAILWAY TRACKS)

Maja Šajn, Svjetlana Glad, Tanja Burić

55

ZIMI SAMO VLAKOM (IN WINTER ONLY BY TRAIN)

Maja Šajn, Svjetlana Glad, Tanja Burić

71

EKOLOŠKO OZAVEŠČANJE DIJAKOV SKOZI IGRO NA PROGRAMU LOGISTIČNI TEHNIK (ENVIRONMENTAL AWARENESS OF STUDENTS THROUGH GAME-BASED LEARNING IN THE LOGISTICS TECHNICIAN PROGRAM)

Haris Ćordić

84

VIRTUALNA STVARNOST U NASTAVI STRUKOVNIH PREDMETA (VIRTUAL REALITY IN TEACHING VOCATIONAL SUBJECTS)

Igor Jelić, Tomislav Ćurković

96

MODERNIZACIJA KURIKULA VOZAČ MOTORNOG VOZILA I NJEGOVO UVOĐENJE U OBRAZOVNI SUSTAV REPUBLIKE HRVATSKE KROZ MODULARNU NASTAVU (MODERNIZATION OF THE MOTOR VEHICLE DRIVER CURRICULUM AND ITS INTRODUCTION INTO THE EDUCATIONAL SYSTEM OF THE REPUBLIC OF CROATIA THROUGH MODULAR TEACHING)

Tomislav Kučina, Tomislav Ćurković

110

МОГУЋНОСТИ УНАПРЕЂЕЊА НАСТАВНО-ОБРАЗОВНОГ ПРОЦЕСА У ВОЈНОМ ВИСОКОШКОЛСКОМ ОБРАЗОВАЊУ (POSSIBILITIES OF IMPROVING THE TEACHING AND EDUCATIONAL PROCESS IN MILITARY HIGHER EDUCATION)

Momčilo Đorđević, Srđan Ljubojević, Sreten Perić, Milan Bukvić, Saša Milojević

131

PRIKAZ STUDIJE SLUČAJA PROJEKTNOG PRISTUPA VISOKOŠKOLSKOJ NASTAVI U OBLASTI SAOBRAĆAJA I TRANSPORTA (REVIEW OF THE CASE STUDY OF THE PROJECT APPROACH TO HIGHER EDUCATION TEACHING IN THE FIELD OF TRANSPORT AND TRANSPORT)

Dr. Srđan Ljubojević, Momčilo Đorđević, Dr. Srđan Dimić

144

PERCEPCIJA UČENIKA SREDNJE STRUČNE VOJNE ŠKOLE O VIENNA TEST SYSTEM-U KAO DELU PROCESA SELEKCIJE (STUDENTS' PERCEPTION OF THE VIENNA TEST SYSTEM AS PART OF THE SELECTION PROCESS)

Jelena Trifunović, Maja Đorđević

167

ZNAČAJ PSIHIČKE PRIPREME UČENIKA ZA UPIS NA FAKULTET (THE IMPORTANCE OF MENTAL PREPARATION OF STUDENTS FOR ENROLLMENT IN COLLEGE)

Maja Đorđević, Jelena Trifunović

180

PROJEKT IZGRADNJE VAROVANEGA PARKIRIŠČA V SODELOVANJU S PODJETJEM FRBEJZAR d. o. o. (PROJECT FOR THE CONSTRUCTION OF A SECURED PARKING LOT IN COLLABORATION WITH THE COMPANY FRBEJZAR d. o. o.)

Tjaša Gerič

195

OSIGURANJE KVALITETE U SUSTAVU ODGOJA I OBRAZOVANJA U REPUBLICI HRVATSKOJ (QUALITY ASSURANCE OF THE EDUCATION SYSTEM IN THE REPUBLIC OF CROATIA)

Renata Heljić, Tomislav Kučina

215

OD INFRASTRUKTURE ZA AUTOMOBILE KA ULICAMA ZA LJUDE (FROM INFRASTRUCTURE FOR CARS TO STREETS FOR PEOPLE)

Alija Šoljić, Arnela Mujić, Dr.sc. Kemal Jaganjac

238

OBNOVA IN PREDELAVA PITBIKE MOTOCIKLA (RESTORATION AND MODIFICATION OF A PITBIKE MOTORCYCLE)

Zoran Jazbinšek

258

AVTOSERVISNA STROKA NA POKLICNI MATURI IZ ANGLEŠČINE (AUTOMOTIVE PROFESSION AT THE VOCATIONAL MATURA IN ENGLISH (3RD SUBJECT))

Rosana Jordan

275

SOOBRAĆAJNA I URBANA MOBILNOST

Sekuloska Violeta, Jošeski Borče, Pipidjanoska Irena

294

ПРИМЕР ДОБРЕ ПРАКСЕ ЗА ПРИМЕНУ САВРЕМЕНИХ МЕТОДА И ТЕХНИКА УЧЕЊА КРОЗ ТЕМАТСКУ И ПРОЈЕКТНУ НАСТАВУ (EXAMPLE OF GOOD PRACTICE FOR THE APPLICATION OF MODERN LEARNING METHODS AND TECHNIQUES THROUGH THEMATIC AND PROJECT-BASED TEACHING)

Olivera Prvić Erac, Sanja Milojević, Knez Alexandar Karađorđević

319

MATERIJALI ZA ODRŽAVANJE PUTEVA U ZIMSKIM USLOVIMA (MATERIALS FOR ROAD MAINTENANCE IN WINTER CONDITIONS)

Biljana Kljajić, Srečko Kljajić

335

STRUČNO USAVRŠAVANJE NASTAVNIKA IZ OBLASTI SAOBRAĆAJA KROZ PROGRAME USAVRŠAVANJA (PROFESSIONAL TRAINING OF TEACHERS IN THE FIELD OF TRAFFIC THROUGH TRAINING PROGRAMS)

Srečko Kljajić, Vesko Rašković

363

UTJECAJ ERGONOMIJE NA SIGURNOST MLADIH VOZAČA U CESTOVNOM PROMETU (THE INFLUENCE OF ERGONOMICS ON THE SAFETY OF YOUNG DRIVERS)

Karlo Klobučar, Stefanija Malović Žmegač

389

KORELACIJA MED IZVAJANJEM PRAKTIČNEGA POUKA IN STROKOVNIMI MODULI V PROGRAMU AVTOSERVISNI TEHNIK (CORRELATION BETWEEN PRACTICAL TRAINING AND PROFESSIONAL MODULES IN THE CAR SERVICE TECHNICIAN PROGRAM)

Aleš Kos

403

POMEN ERASMUS+ IZMENJAV ZA IZOBRAŽEVANJE DIJAKOV LOGISTIKE (THE IMPORTANCE OF ERASMUS+ EXCHANGES FOR THE EDUCATION OF LOGISTICS STUDENTS)

Jasmina Kovač

415

VPLIV MASE TOVORNEGA VOZILA NA ZAVORNO POT: ZAKAJ JE PREOBREMENITEV VOZILA NEVARNA (IMPACT OF TRUCK WEIGHT ON BRAKING DISTANCE: WHY OVERLOADING A VEHICLE IS DANGEROUS)

Danica Kozel

429

VPLIV UPORABE PROGRAMOV UMETNE INTELIGENCE PRI POUČEVANJU VSEBIN TRAJNOSTNE MOBILNOSTI IN TRAJNOSTNEGA RAZVOJA (THE IMPACT OF ARTIFICIAL INTELLIGENCE APPLICATIONS ON TEACHING SUSTAINABLE MOBILITY AND SUSTAINABLE DEVELOPMENT)

Metka Kruič

442

ODPORNOST TRANSPORTNE INFRASTRUKTURE NA NARAVNE NESREČE V SLOVENIJI: PRIMER SEVESO OBRATOV (RESILIENCE OF TRANSPORT INFRASTRUCTURE TO NATURAL DISASTERS IN SLOVENIA: THE CASE OF SOVESO PLANTS)

Martin Fale, dr. Borut Jereb, Mirjana Lazarević, dr. Matevž Obrecht, doc. dr. Maja Rosi, Bojana Slomšek Šlamberger

454

ERASMUS + PROJEKT COMPETENCE+ D/I: RAZVOJ KOMPETENCIJA U JAVNOM PRIJEVOZU ZA VIŠE RAZNOLIKOSTI I UKLJUČIVOSTI (ERASMUS + PROJECT COMPETENCE+ D/I: DEVELOPING COMPETENCES IN PUBLIC TRANSPORT FOR MORE DIVERSITY AND INCLUSION)

Lončar Kočić Darinka, Slunjski Piskač Vlatka

470

LOGISTIKA ODNOSOV: UČINKOVITA KOMUNIKACIJA KOT TEMELJ USPEŠNEGA SODELOVANJA (RELATIONS LOGISTICS: EFFECTIVE COMMUNICATION AS THE FOUNDATION OF SUCCESSFUL COOPERATION)

Darja Lužnik

488

DIGITALIZACIJA IN TRAJNOST V ŠPEDICIJI: IZZIVI IN PRILOŽNOSTI SODOBNEGA LOGISTIČNEGA SEKTORJA (DIGITALIZATION AND SUSTAINABILITY IN FREIGHT FORWARDING: CHALLENGES AND OPPORTUNITIES OF THE MODERN LOGISTICS SECTOR)

Patricija Majcen

502

MODELIRANJE CITY LOGISTIKE ZA PODRUČJE GRADA SARAJEVA (MODELING URBAN LOGISTICS FOR THE CITY OF SARAJEVO)

Emilija Martinčević, Solak Sabhudin

526

TRAJNOSTNA MOBILNOST NA PROMETNI ŠOLI MARIBOR (SUSTAINABLE MOBILITY AT THE MARIBOR SCHOOL OF TRANSPORT AND TRAFFIC)

Izidor Mandl

542

VAROVANJE Z DRONI (DRONES IN SECURITY)

Mateja Mazgan Senegačnik

566

ANALIZA USPEŠNOSTI UKREPOV ZA IZBOLJŠANJE VARNOSTI OTROK STARIH OD 6 DO 11 LET (ANALYSIS OF THE EFFECTIVENESS OF MEASURES TO IMPROVE THE SAFETY OF CHILDREN AGED 6 TO 11 YEARS)

Nevenka Ozebek

584

VARNOST V PREDORIH NA CESTNEM OMREŽJU (SAFETY IN TUNNELS ON THE ROAD NETWORK)

Rajko Palčar

600

ВЛИЈАНИЕТО НА ЕДУКАЦИЈА НА МАТУРАНТИТЕ ЗА БЕЗБЕДНОСТА ВО СООБРАКАЈОТ (THE IMPACT OF EDUCATION OF HIGH SCHOOL STUDENTS ON TRAFFIC)

Zoki Stojmirov, Antea Pašoska

622

OGLJIKOVI KREDITI

Andrej Prašnikar

638

PONOVNA UPORABA TEKSTILNIH MATERIALOV V AVTOMOBILSKI INDUSTRIJI (REUSE OF TEXTILE MATERIALS IN THE AUTOMOTIVE INDUSTRY)

Tjaša Rozman

646

VLOGA UMETNE INTELIGENCE PRI IZBOLJŠANJU VARNOSTNIH SISTEMOV V VOZILIH (THE ROLE OF ARTIFICIAL INTELLIGENCE IN IMPROVING VEHICLE SAFETY SYSTEMS)

Igor Skukan

661

SLOVENSKA SODNA PRAKSA NA PODROČJU ŽELEZNIŠKEGA PREVOZA POTNIKOV, PRTLJAGE IN TOVORA (SLOVENIAN CASE LAW IN THE FIELD OF RAIL TRANSPORT OF PASSENGERS, LUGGAGE AND FREIGHT)

Alina Slatinek

674

БЕЗБЕДНОСТА ВО СООБРАКАЈОТ НА УЧЕНИЦИТЕ КАКО ДЕЛ ОД ОБРАЗОВНИОТ СИСТЕМ (STUDENT TRAFFIC SAFETY AS PART OF THE EDUCATION SYSTEM)

Zoki Stojmirov, Dalior Stojanov, Aneta Pashoska

688

ALI JE VODIK PRAVA ALTERNATIVA ELEKTRIČNEMU IN KONVENCIONALNEMU POGONU VOZIL (IS HYDROGEN A REAL ALTERNATIVE TO ELECTRIC AND CONVENTIONAL VEHICLE PROPULSION)

Matic Turnšek

704

PROJEKTNA NASTAVA: „KAKO OTPADNI MATERIJAL ISKORISTITI ZA POBOLJŠANJE I ZAŠTITU ZDRAVLJA VOZAČA?“ (PROJECT TEACHING: „HOW TO USE WASTE MATERIAL TO IMPROVE AND PROTECT THE HEALTH OF DRIVERS?”)

Sanja Tirić, Lovorka Vidić,

724

ANALIZA TRŽIŠTA OSIGURANJA OD AUTOODGOVORNOSTI U CRNOJ GORI U PERIODU OD 2000. DO 2025.GODINE (ANALYSIS OF THE MOTOR THIRD-PARTY LIABILITY INSURANCE MARKET IN MONTENEGRO FROM 2000 TO 2025)

Gordana Vuksanović, Radoš Zuković,

742

IMPLEMENTACIJA DUALNOG OBRAZOVANJA - TEORIJA I PRAKSA (IMPLEMENTATION OF DUAL EDUCATION – THEORY AND PRACTICE)

Milica Vukašinović

762

MARKETING I LOGISTIKA – SINERGIJA ZA USPJEH (MARKETING AND LOGISTICS – SYNERGY FOR SUCCESS)

Ivana Zagrajski

776

UPORABA SODOBNIH MATERIALOV V AVTOMOBILSKI INDUSTRIJI (USE OF MODERN MATERIALS IN THE AUTOMOTIVE INDUSTRY)

Uroš Zajec

790

KROŽNO GOSPODARSTVO V LOGISTIKI (CIRCULAR ECONOMY IN LOGISTICS)

Klavdija Živko Pal

806

TRAJNOSTNA REŠITEV ZA DELOVANJE SKLADIŠČA PODJETJA BTC D.D. (A SUSTAINABLE SOLUTION FOR THE OPERATION OF BTC D.D.’S WAREHOUSE)

Matej Žunko

824

Primena ITS komponenti i savremeni trendovi

Nataša Sretenović (nastavnik), Saobraćajno-tehnička škola, Zemun

Tanja Arsić (nastavnik), Saobraćajno-tehnička škola, Zemun

Sabahudin Solak (nastavnik), Srednja škola za saobraćaj i komunikacije, Sarajevo

Rezime

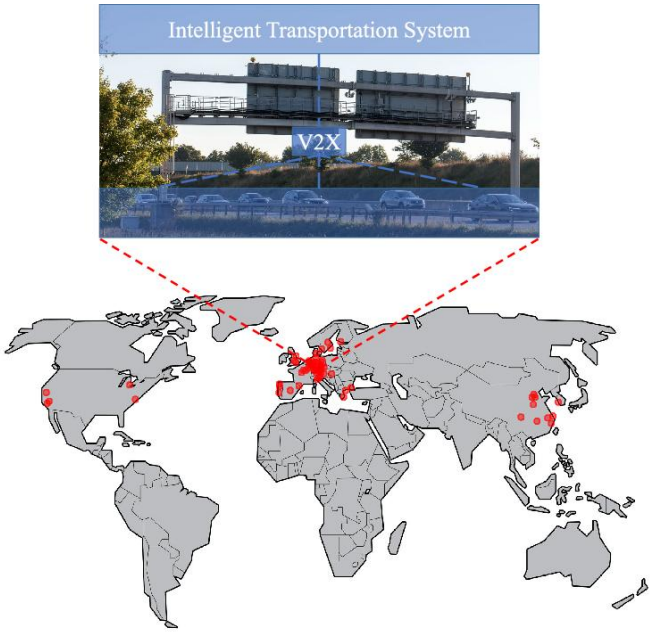
Inteligentni transportni sistemi (ITS) predstavljaju ključni element u transformaciji saobraćajne infrastrukture kroz primenu savremenih informacionih i komunikacionih tehnologija. Integracijom savremenih tehnologija ITS optimizuje složenu interakciju između korisnika, infrastrukture i vozila, čime se uspostavlja transportna mreža prilagodljivija zahtevima koji se postavljaju pred nju i efikasnije zadovoljava rastuće potrebe mobilnosti. Glavni problemi u oblasti saobraćaja su saobraćajne nezgode, sve izraženije usporavanje saobraćajnog toka i zagađenje životne sredine. ITS zasnovani na inteligentnoj infrastrukturi mogu da doprinesu rešavanju ovih problema. Sa porastom urbanizacije ekološki problemi postaju sve izraženiji, zbog čega uloga ITS-a postaje sve značajnija u njihovom rešavanju.

Kroz rad smo želeli da prikažemo kako pametna saobraćajna rešenja redefinišu budućnost mobilnosti i doprinose stvaranju održivih gradova. Trudićemo se da otkrijemo inovacije koje pokreću ITS revoluciju.

1. Uvod

Glavni problem u saobraćaju su saobraćajne nezgode, usporavanje saobraćajnog toka i zagađenje. Ovi problemi posebno su izraženi u gradovima, gde trenutno živi polovina svetske populacije. Ključno je sprovesti i razviti napredna rešenja za optimizaciju saobraćaja u urbanim sredinama, sa ciljem povećanja bezbednosti, efikasnosti i održivosti saobraćajnog sistema

Najveća koncentracija ITS-a je u Severnoj Americi, Evropi i Aziji.



Slika 1. Lokacija inteligentih transportnih sistema u svetu

Kako bi se postigli ciljevi ITS-a primenjuju se različite komponente iz oblasti detektora, telekomunikacija, obrade informacija i kontrole. Važno je naglasiti da su komponente međusobno umrežene i funkcionišu u kordinaciji, zbog čega se ovi sistemi nazivaju kooperativni ITS (C-ITS). Komponetne ITS mogu biti prostorno raspoređene - na primer mogu se nalaziti u vozilima, na semaforima, nadvožnjacima ili drugim infrastrukturnim elementima. Ova inovativna tehnologija prikuplja podatke sa detektora, iz vozila ili centralne upravljačke jedinice i omogućava dvosmernu komunikaciju između vozila, infrastrukture i centra za upravljanje saobraćajem.

Trenutni trendovi u ITS tehnologiji obuhvataju integraciju 5G mreža, napredak u razvoju autonomnih vozila, poboljšanje sistema upravljanja saobraćajem, razvoj pametne infrastrukture, širenje mobilnosti kao usluge (MaaS), unapređenje sajber bezbednosti i zaštite podataka i primenu veštačke inteligencije i mašinskog učenja. U ovom radu pažnja je posvećena konceptu „pametnog“ vozila i razvoju tehnologije komunikacije vozilo-ka-svemu (V2X) sa posebnim osvrtom na bezbednost ranjivih učesnika u saobraćaju VRU (Vulnerable Road Users).

2. Autonomna vozila i V2X komunikacija

Autonomna vozila (AV) sve više postaju deo svakodnevnog saobraćaja, a mnoge zemlje planiraju njihovu integraciju u sisteme javnog prevoza u narednim godinama. Pametna vozila omogućavaju komunikaciju sa okruženjem i objektima putem savremenih telekomunikacionih sistema. Postoje različiti oblici V2X komunikacije:

- vozilo–vozilo (vehicle-to-vehicle, V2V),
- vozilo–infrastruktuara (vehicle-to-infrastructure, V2I),
- vozilo–pešak (vehicle-to-pedestrian, V2P),
- vozilo–uređaj (vehicle-to-device, V2D),

- vozilo–mobilna mreža (vehicle-to-network, C-V2X),
- i vozilo–elektroenergetska mreža (vehicle-to-grid, V2G).

Aspekti bezbednosti u okviru komunikacije između vozila (V2V) i komunikacije vozila sa infrastrukturom (V2I) do sada su detaljno istraživani. Ipak, bezbednost ranjivih učesnika u saobraćaju (VRU) – kao što su pešaci, biciklisti i korisnici električnih trotineta – i dalje predstavljaju oblast koja traži dodatnu pažnju. Senzorski sistemi koji se trenutno implementiraju u autonomnim vozilima omogućavaju širok spektar funkcionalnosti, uključujući pokrivanje mrtvih uglova, detekciju objekata na većim rastojanjima i otpornost na nepovoljne vremenske uslove. Ove funkcionalnosti su posebno značajne u kontekstu V2V i V2I komunikacije. Međutim, fokus postojećih tehnologija je primarno usmeren na identifikaciju i komunikaciju sa drugim vozilima, oslanjajući se na naprednu komunikacionu infrastrukturu radi efikasne razmene informacija o statusu učesnika u saobraćaju.



V2V (vozilo–vozilo)

Komunikacija između vozila (V2V) omogućava razmenu podataka u realnom vremenu, čime se vozilima pruža mogućnost međusobnog deljenja ključnih informacija, poput brzine, trenutne pozicije i pravca kretanja.Tehnologija V2V doprinosi u smanjenju broja saobraćajnih nezgoda, ublažavanju saobraćajnih zagušenja i povećanju energetske efikasnosti.

Kao osnovna komponenta naprednih sistema asistencije vozaču (ADAS) i autonomne vožnje (AD), V2V tehnologija omogućava vozilima donošenje odluka u realnom vremenu na



Komunikacija vozilo-infrastruktura (V2I) omogućava vozilima interakciju sa različitim elementima saobraćajne infrastrukture, kao što su saobraćajna signalizacija, saobraćajni znakovi i senzori na putu. Integracijom ovih podataka, V2I komunikacija može doprineti smanjenju saobraćajnih zagušenja, optimizaciji trajanja ciklusa i poboljšanju efikasnosti celokupnog saobraćajnog sistema.

Pored toga, V2I komunikacija pruža značajne informacije za sisteme asistencije vozaču



Komunikacija tipa vozilo-pešak (V2P) fokusira se na interakciju između vozila i ranjivih učesnika u saobraćaju, uključujući pešake, bicikliste i ostale ranjive učesnike u saobraćaju. Ova tehnologija se oslanja na upotrebu pametnih telefona, nosivih uređaja ili drugih mobilnih sredstava koja korisnici poseduju, s ciljem prenošenja informacija o njihovom položaju i kretanju.

Vozila opremljena V2P tehnologijom koriste ove informacije kako bi pravovremeno idetifikovala prisustvo ranjivih učesnika u saobraćaju i izbegla potencijalne saobraćajne nezgode, čime se povećava nivo bezbednost u saobraćaju. Na primer, u situaciji kada pešak prelazi ulicu, vozilo sa V2P može da primi obaveštenje u realnom vremenu da uspori ili

V2N (vozilo–mreža)



Komunikacija tipa vozilo-mreža (V2N) omogućava povezivanje vozila sa širom komunikacionom infrastrukturom, uključujući mobilne mreže ili Wi-Fi mreže. Ova povezanost omogućava vozilima pristup informacijama u realnom vremenu, kao što su podaci o saobraćaju, vremenska prognoza, preporučene rute i drugi relevantni podaci koji doprinose efikasnijem i bezbednijem putovanju.

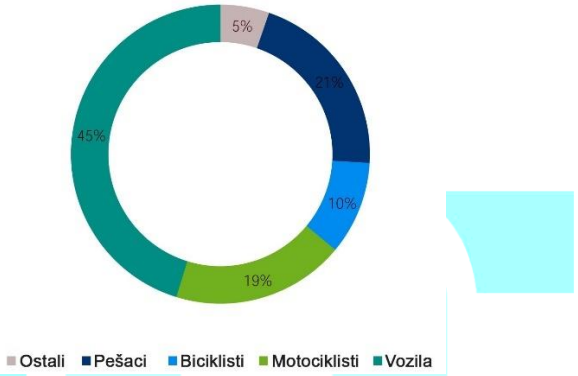
Pored toga V2N omogućava daljinsku dijagnostiku i ažuriranja softvera, što proizvođačima vozila omogućava da detektuju tehničko stanje vozila i obezbede nadogradnju softvera. Takođe, V2N komunikacija podržava izgradnju pametnih gradova i povezanih saobraćajnih ekosistema primenjujući podatke dobijene od vozila sa drugim izvorima informacija, kao što su sistemi javnog prevoza i urbana infrastruktura.

U kontekstu autonomnih vozila i V2X tehnologija, VRU predstavljaju poseban izazov jer ih je teže detektovati i pratiti u realnom vremenu, posebno u uslovima slabe vidljivosti, nepovoljnih vremenskih uslova ili loše pokrivenosti telekomunikacionom mrežom.

3. V2X bezbednosni sistemi za ranjive učesnike u saobraćaju (VRU)

Pojam ranjivih učesnika u saobraćaju (VRU) odnosi se na nemotorizovane učesnike, kao što su pešaci i biciklisti, ali i na osobe sa invaliditetom, koje su dodatno izložene riziku usled odsustva fizičke zaštite u saobraćajnom okruženju. Sa razvojem novih oblika individualnog prevoza, kao što su električni trotineti, ova kategorija se dodatno proširuje i obuhvata širi spektar učesnika koji zahtevaju posebne mere zaštite.

Prema podacima iz 2020. godine, ranjivi učesnici u saobraćaju - uključujući pešake, bicikliste i motocikliste - činili su približno 50% stradalih u saobraćajnim nezgodama na području Evropske unije.



Slika 2. Broj saobraćajnih nezgoda sa smrtnim ishodom u 2020. u Evropskoj uniji

Prema podacima Instituta za osiguranje u oblasti bezbednosti na putevima (Insurance Institute of Highway Safety – IIHS), poginuli pešaci čine 17% svih smrtnih slučajeva u saobraćajnim nezgodama, dok biciklisti čine dodatna 2% (Users, 2022). Uprkos značajnom napretku u razvoju sistema napredne asistencije vozaču (ADAS), uključujući sisteme za detekciju pešaka i druge bezbednosne sisteme, broj smrtno stradalih pešaka u poslednjih deset godina nastavlja da raste.

Uvođenje pouzdanih i bezbednijih navigacionih sistema za autonomna vozila (AV) postaje od ključnog značaja u urbanim sredinama, gde je interakcija između AV i ranjivih učesnika u saobraćaju učestala. Savremena rešenja u dizajnu autonomnih vozila uključuju modelovanje obrazaca kretanja i ponašanja VRU sa ciljem povećanja bezbednosti svih učesnika u saobraćaju. Na primer, razdvajanje saobraćajnih traka za bicikliste, jer njihova veća brzina zahteva bržu reakciju autonomnog vozila nego u slučaju pešaka.

Pored toga, biciklisti često ispoljavaju nepredvidive obrasce ponašanja, kao što je iznenadni prelazak na pešačku stazu kako bi izbegli raskrsnicu. Ovakve situacije predstavljaju ozbiljan izazov za bezbednosne sisteme, jer generišu veliki broj graničnih slučajeva (edge cases) koje sistem za planiranje putanje AV mora uzeti u obzir kako bi se izbegli sudari.

Prema izveštaju organizacije *Brake* (2018), više od 1,3 miliona ljudi godišnje strada u saobraćajnim nezgodama, pri čemu svaka druga žrtva pripada kategoriji VRU, a čak 80% ovih žrtava potiče iz zemalja u razvoju i brzo motorizovanih ekonomija (Radjou i Kumar, 2018).

U poslednjim godinama, urbanistički savetnici i donosioci politika primenili su progresivne mere za povećanje bezbednosti VRU, kao što su: smanjenje ograničenja brzine, izgradnja posebnih biciklističkih traka, inteligentne pešačke zone sa naprednom signalizacijom i poboljšane mere vidljivosti. Ove mere pomažu vozačima da u realnom vremenu dobiju informacije i vizuelne signale, čime se povećava pažnja u zonama sa visokom frekvencijom kretanja VRU.

Tradicionalno, vozač se oslanjaju na čula za prepoznavanje rizičnih situacija, kao što je kretanje pešaka. Međutim V2X tehnologije značajno unapređuju ovu percepciju - sistem za prijem V2X komunikacije u vozilu može da prati putanju pešaka i predvidi potencijalno opasnu situaciju. Na sličan način, V2X sistemi emituju upozorenja o prisustvu biciklista ili riziku od sudara, čak i u tzv. mrtvim uglovima vozila.

Komunikacija između vozila i pešaka (V2P – Vehicle-to-Pedestrian) predstavlja specifičan segment šireg sistema komunikacije vozilo-sa-svime (V2X–Vehicle-to-Everything), omogućavajući bežičnu i neprekidnu razmenu informacija između vozila i pešaka. Ova tehnologija omogućava precizno i pravovremeno prenošenje podataka o lokaciji i kretanju pešaka vozilima u okruženju. Iako su sistemi V2P slični V2V i V2I, poseduju specifične tehničke i funkcionalne karakteristike koje ih izdvajaju. Uspostavljanje V2X komunikacionog čvora zahteva prisustvo jedinica za povezivanje na oba kraja komunikacionog linka. U tipičnom V2P scenariju, uređaj instaliran u vozilu uspostavlja vezu sa pametnim telefonom pešaka - bilo direktno ili posredstvom mreže. Razmena podataka odvija se kroz tri definisana režima (Malik, 2020).

U okviru V2X komunikacionih sistema, različiti scenariji koji definišu stepen i modalitet interakcije između vozila i njihovog okruženja. Ovi protokoli imaju ključnu ulogu u određivanju efikasnosti, bezbednosti i prostorne pokrivenosti sistema. Tri osnovna protokola, prikazana u nastavku, opisuju različite pristupe i izazove u razmeni informacija, sa direktnim uticajem na bezbednost saobraćaja.

Scenario 1 – Detekcija zasnovana na infrastrukturi

U ovom scenariju, komunikacija između vozila i pešaka ostvaruje se putem senzora postavljenih duž saobraćajnica. Iako je implementacija ovakve infrastrukture skupa, naročito u kontekstu široke primene, koristi se u zonama visokog rizika, kao što su semaforizovane raskrsnice i pešački prelazi. Ovaj pristup omogućava sintezu senzorskih podataka svih relevantnih učesnika u saobraćaju u neposrednom okruženju, što je posebno značajno u složenim ili otežanim uslovima odvijanja saobraćaja.

Scenario 2 – Detekcija zasnovana na vozilu

U ovom modelu, komunikacija se oslanja isključivo na senzorske sisteme koji se nalaze na vozilu. Ovaj pristup je ograničen prostornom pokrivenošću, naročito u oblastima sa tzv. ”mrtvim uglovima”, gde je smanjena preciznost pozicioniranja usled nedostupnosti GNSS signala, što je čest slučaj u gustim urbanim sredinama. Dodatno ograničenje predstavlja nedostupnost mobilne mreže u udaljenim ili ruralnim područjima.

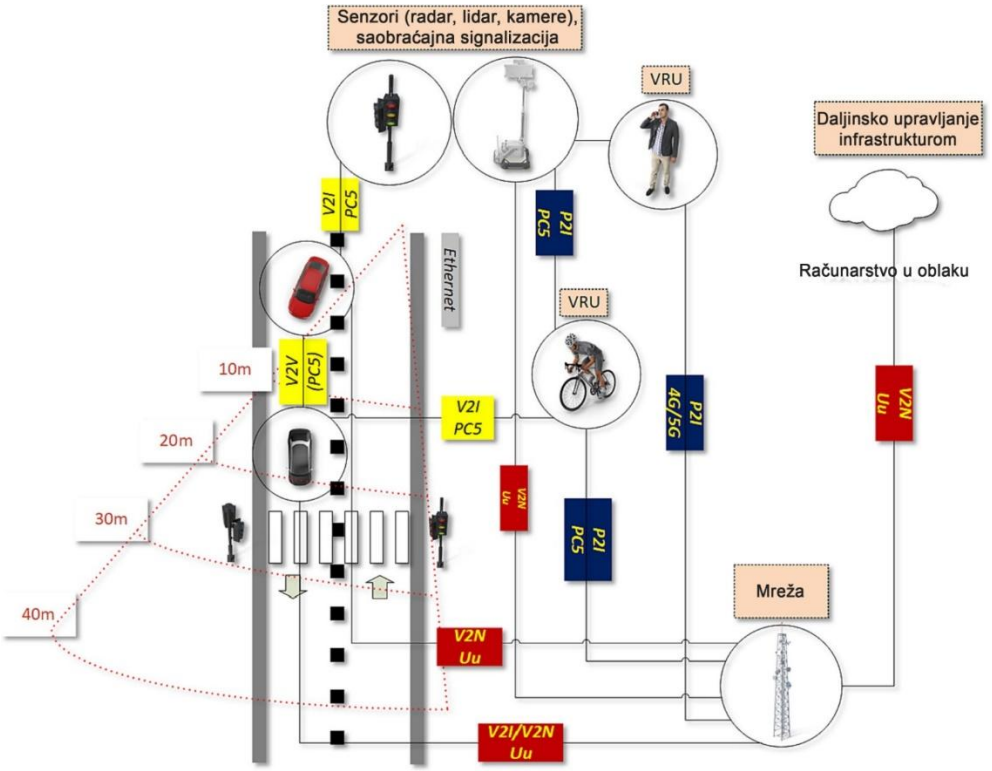
Kao posledica toga, u situacijama kada vozilo nije povezano na komunikacionu mrežu (npr. u okviru C-V2X sistema) - čak i visoko automatizovano vozilo nije u stanju da detektuje objekte koji se nalaze izvan njegove linije vidljivosti (NLOS – Non-Line of Sight).

Scenario 3 – Detekcija zasnovana na ranjivim učesnicima u saobraćaju (VRU)

U ovom pristupu detekcija ranjivih učesnika u saobraćaju podrazumeva upotrebu pametnih

telefona ili uređaja sa V2X komunikacionim sposobnostima koje korisnici nose sa sobom. Na taj način, VRU samostalno šalje podatke o svojoj lokaciji, brzini i pravcu kretanja omogućavajući vozilima u neposrednom okruženju da pravovremeno detektuju njihovo prisustvo i blagovremeno reaguju.

U poređenju sa prethodnim modelima detekcija, ovaj pristup se odlikuje manjom infrastrukturnom složenošću i predstavlja glavni fokus većine istraživanja u oblasti V2X komunikacija. Efikasnost primene ovog sistema u velikoj meri zavisi od pouzdanosti i kvaliteta komunikacione mreže koja se koristi za razmenu podataka. Međutim, sa porastom broja VRU i vozila u gusto naseljenim urbanim područjima, rastu i zahtevi u pogledu obrade podataka i upravljanja mrežnim resursima, što dodatno komplikuje primenu ovog modela u realnim uslovima.



Slika 3.V2X protokoli za ranjive učesnike u saobraćaju i načini razmene podataka

4. Zaključak

Uvođenje tehnologija komunikacije vozilo-sa-svime V2X predstavlja značajan korak ka unapređenju bezbednosti saobraćaja. Ova tehnologija nudi brojne prednosti, ali se suočava i sa određenim izazovima tokom svog daljeg razvoja i implementacije. V2X komunikacija omogućava prevenciju saobraćajnih nezgoda obezbeđujući informacije u realnom vremenu o drugim vozilima, pešacima i uslovima na putu. Takve informacije omogućavaju vozačima donošenje pravovremenih odluka, čime se unapređuje funkcionalnost sistema za naprednu asistenciju vozaču (ADAS).

Zahvaljujući razmeni podataka sa saobraćajnom infrastrukturom i drugim vozilima, V2X tehnologija može doprineti optimizaciji saobraćajnog toka, smanjenju zagušenja i povećanju efikasnosti transportnog sistema. Ova se odražava kroz kraće vreme putovanja, manju

potrošnju goriva i nižu emisiju štetnih gasova. V2X omogućava vozačima viši stepen percepcije okruženja, upozoravajući ih na potencijalne opasnosti koje su teško uočljive, kao što su pešaci u uslovima slabe vidljivosti ili predstojeće saobraćajne gužve.

Komunikacija putem V2X predstavlja ključnu komponentu tehnologije autonomne vožnje, jer omogućava autonomnim vozilima navigaciju u složenim saobraćajnim sitauacijama i bezbednu interakciju sa ostalim učesnicima u saobraćaju.

Bezbedno učešće svih učesnika u saobraćaju, a naročito ranjivih učesnika (VRU), jedan je od ključnih izazova savremenog transportnog sistema. Iako V2X tehnologija ima izuzetno veliki potencijal, njena puna implementacija zahteva rešavanje izazova u vezi sa standardizacijom, bezbednošću i zaštitom privatnosti, kao i regulativnim i pravnim aspektima.

Materijal je primenjen u nastavi predmeta **Regulisanje i bezbednost saobraćaja** kao i u okviru predmeta **Inteligentni transportni sistemi**.

U okviru predmeta *Bezbednost i regulisanje saobraćaja*, učenici su upoznati sa načinima na koje ITS doprinosi smanjenju broja saobraćajnih nezgoda (V2V komunikacija, inteligentni semafori, sistemi za detekciju ranjivih učesnika u saobraćaju). Kao praktičan zadatak, učenicima je dato da identifikuju ITS rešenja u svom gradu i analiziraju njihov uticaj na bezbednost saobraćaja. U okviru nastavne teme *„Čovek kao faktor bezbednosti saobraćaja“*, na jednom od časova organizovana je debata na temu: **„Da li su ITS sistemi zamena ili podrška ljudskom faktoru u bezbednosti saobraćaja?“**

U okviru teorijske nastave predmeta *Inteligentni transportni sistemi*, učenici su upoznati sa definicijama i osnovnim komponentama ITS-a (senzori, komunikacione mreže, centri za upravljanje, softverska rešenja za obradu podataka). Tokom nastave korišćene su šeme, dijagrami i kratki video-materijali koji prikazuju primenu ITS projekata. Učenicima je zatim dodeljen praktični zadatak da pronađu i analiziraju realne primere primene ITS tehnologija u našoj zemlji i u državama u okruženju.

Evaluacija znanja učenika sprovedena je putem kratkih testova, praktičnih zadataka i diskusionih aktivnosti.

Literatura

1. https://www.usiglobal.com/public/en/blog/solutions-and-services-in-v2x-area
2. https://ieeexplore.ieee.org/document/1001277
3. https://webresource.joynext.com/uploadfile/2023/0307/20230307025851861.pdf
4. https://ieeexplore.ieee.org/document/10012775
5. https://www.sciencedirect.com/science/article/pii/S2590198223002270#f0010
6. https://www.traffictechnologytoday.com/news/autonomous-vehicles/vitronic-announces-launch-of-worlds-first-project-for-managed-automated-driving.html
7. https://www.fic.com.tw/v2i_v2v
8. https://blog.rgbsi.com/defining-vehicle-to-pedestrian-v2p
9. https://www.emqx.com/en/blog/what-is-v2x-and-the-future-of-vehicle-to-everything-connectivity
10. https://www.forbes.ru/mneniya/497186-bespilotnye-masiny-i-umnye-dorogi-kakie-riski-

Application of ITS components and modern trends

Nataša Sretenović (nastavnik), Saobraćajno-tehnička škola, Zemun

Tanja Arsić (nastavnik), Saobraćajno-tehnička škola, Zemun

Sabahudin Solak (nastavnik), Srednja škola za saobraćaj i komunikacije, Sarajevo

Summary

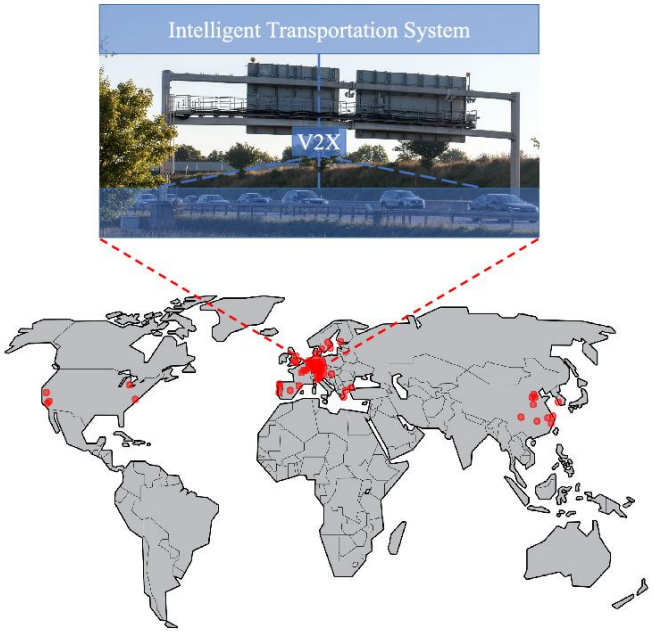
Intelligent Transport Systems (ITS) are a key element in the transformation of transport infrastructure through the application of modern information and communication technologies. By integrating modern technologies, ITS optimizes the complex interaction between users, infrastructure and vehicles, thus establishing a transport network that is more adaptable to the demands placed on it and more efficiently meets the growing needs of mobility. The main problems in the field of traffic are traffic accidents, increasing slowdown of traffic flow and environmental pollution. ITS based on intelligent infrastructure can help solve these problems. With the increase in urbanization, environmental problems are becoming more pronounced, which is why the role of ITS is becoming increasingly important in solving them.

Through this paper, we wanted to show how smart transport solutions are redefining the future of mobility and contributing to the creation of sustainable cities. We will strive to discover the innovations that drive the ITS revolution.

1. Introduction

The main problems in traffic are traffic accidents, slowing down traffic flow and pollution. These problems are especially pronounced in cities, where half of the world's population currently lives. It is crucial to implement and develop advanced solutions for traffic optimization in urban areas, with the aim of increasing the safety, efficiency and sustainability of the transport system

The largest concentrations of ITS are in North America, Europe and Asia.



Picture 1. The Location of Intelligent Transport Systems in the World

2. The Location of Intelligent Transport Systems in the World

In order to achieve the goals of ITS, various components are applied in the field of detectors, telecommunications, information processing and control. It is important to emphasize that the components are interconnected and function in coordination, which is why these systems are called cooperative ITS (C-ITS). Component ITS can be spaced - for example, they can be located in vehicles, traffic lights, overpasses or other infrastructure elements. This innovative technology collects data from detectors, vehicles or central control units and enables two-way communication between the vehicle, the infrastructure and the traffic management center.

Current trends in ITS technology include the integration of 5G networks, advances in the development of autonomous vehicles, the improvement of traffic management systems, the development of smart infrastructure, the expansion of mobility as a service (MaaS), the advancement of cybersecurity and data protection, and the application of artificial intelligence and machine learning. In this paper, attention is paid to the concept of a "smart" vehicle and the development of vehicle-to-everything (V2X) communication technology with special emphasis on the safety of vulnerable road users (VRUs).

3. Autonomous vehicles and V2X communication

Autonomous vehicles (AVs) are increasingly becoming part of everyday transport, and many countries are planning to integrate them into public transport systems in the coming years. Smart vehicles enable communication with the environment and objects through modern telecommunication systems. There are different forms of V2X communication:

- vehicle-to-vehicle, V2V,
- vehicle-to-infrastructure, V2I,
- vehicle-to-pedestrian, V2P,
- vehicle-to-device (V2D),

- vehicle-to-network (C-V2X),
- and vehicle-to-grid (V2G).

The security aspects of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication have been thoroughly researched so far. Nevertheless, the safety of vulnerable road users (VRUs) – such as pedestrians, cyclists and e-scooter users – remains an area that requires additional attention. Sensor systems currently being implemented in autonomous vehicles enable a wide range of functionalities, including blind spot coverage, object detection at greater distances, and resistance to adverse weather conditions. These functionalities are especially important in the context of V2V and V2I communication. However, the focus of existing technologies is primarily on identification and communication with other vehicles, relying on advanced communication infrastructure for the efficient exchange of information on the status of participants in the vehicle. saobraćaju.



V2V (vozilo–vozilo)

Vehicle-to-vehicle (V2V) communication enables real-time data exchange, giving vehicles the ability to share key information with each other, such as speed, current position and direction of travel. V2V technology contributes to reducing the number of traffic accidents, alleviating traffic congestion and increasing energy efficiency.

As a core component of Advanced Driver Assistance (ADAS) and Autonomous Driving (AD) systems, V2V technology enables vehicles to make real-time decisions based on available information and react appropriately according to current road conditions.



V2I (vozilo–infrastruktura)

Vehicle-to-infrastructure (V2I) communication allows vehicles to interact with various elements of traffic infrastructure, such as traffic signals, road signs and road sensors. By integrating this data, V2I communication can contribute to reducing traffic congestion, optimizing cycle times and improving the efficiency of the entire transport system.

In addition, V2I communication provides important information for driver assistance systems (ADAS) and autonomous vehicles (AD).



V2P (vozilo–pešaci)

Vehicle-to-pedestrian (V2P) communication focuses on the interaction between vehicles and vulnerable road users, including pedestrians, cyclists, and other vulnerable road users. This technology relies on the use of smartphones, wearables, or other mobile devices that users own, in order to transmit information about their location and movements.

Vehicles equipped with V2P technology use this information to identify the presence of vulnerable road users in a timely manner and avoid potential traffic accidents, thus increasing the level of traffic safety. For example, in a situation where a pedestrian is crossing the street, a vehicle with V2P can receive a real-time notification to slow down or stop, allowing the driver or autonomous driving system to take an appropriate response.



V2N (vozilo–mreža)

Vehicle-to-network (V2N) communication allows vehicles to be connected to a wider communication infrastructure, including mobile networks or Wi-Fi networks. This connectivity allows vehicles to access real-time information, such as traffic data, weather forecasts, recommended routes and other relevant data that contribute to more efficient and safe travel.

In addition, V2N enables remote diagnostics and software updates, allowing vehicle manufacturers to detect the technical condition of vehicles and provide software updates. Also, V2N communication supports the construction of smart cities and connected transport ecosystems by applying data obtained from vehicles with other sources of information, such as public transport systems and urban infrastructure.

In the context of autonomous vehicles and V2X technologies, VRUs pose a particular challenge because they are more difficult to detect and monitor in real time, especially in conditions of poor visibility, adverse weather conditions or poor telecommunications network coverage.

4. V2X security systems for vulnerable road users (VRU)

The term vulnerable road users (VRU) refers to non-motorized road users, such as pedestrians and cyclists, but also to people with disabilities, who are further exposed to risk due to the absence of physical protection in a traffic environment. With the development of new forms of individual transport, such as e-scooters, this category is further expanding to include a wider range of participants who require special protection measures.

According to 2020 data, vulnerable road users - including pedestrians, cyclists and motorcyclists - accounted for approximately 50% of road accident deaths in the European Union.

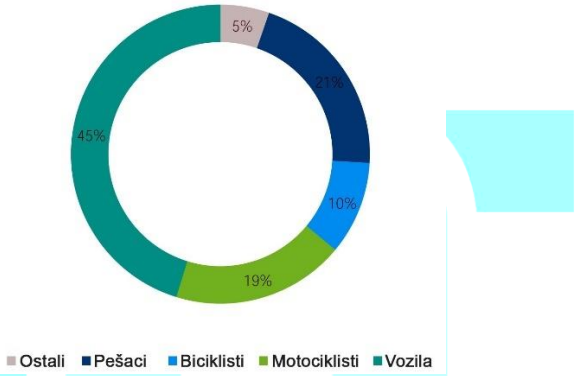


Figure 2. Number of fatal road accidents in the European Union in 2020

According to the Insurance Institute of Highway Safety (IIHS), pedestrian deaths account for 17% of all road accident fatalities, while cyclists account for an additional 2% (Users, 2022). Despite significant progress in the development of Advanced Driver Assistance (ADAS) systems, including pedestrian detection systems and other safety systems, the number of pedestrian fatalities has continued to rise over the past decade.

The introduction of reliable and safer navigation systems for autonomous vehicles (AVs) is becoming crucial in urban areas, where interaction between AVs and vulnerable road users is frequent. Modern solutions in the design of autonomous vehicles include the modeling of movement patterns and behavior of VRU with the aim of increasing the safety of all road users. For example, the separation of traffic lanes for cyclists, because their higher speed requires a faster reaction of an autonomous vehicle than in the case of pedestrians.

In addition, cyclists often exhibit unpredictable patterns of behavior, such as abruptly switching to a footpath to avoid an intersection. Such situations pose a serious challenge to security systems, as they generate a large number of edge cases that the AV path planning system must take into account in order to avoid collisions.

According to a report by *Brake* (2018), more than 1.3 million people die annually in road accidents, with one in two victims belonging to the VU category, and as many as 80% of these victims come from developing countries and fast-motorized economies (Radjou and

Kumar, 2018).

In recent years, urban planning consultants and policymakers have implemented progressive measures to increase the safety of the VRU, such as: reducing speed limits, building special bicycle lanes, intelligent pedestrian zones with advanced signage, and improved visibility measures. These measures help drivers to receive real-time information and visual signals, thereby increasing attention in high-frequency VRUs.

Traditionally, drivers have relied on their senses to recognize risky situations, such as pedestrian movement. However, V2X technologies significantly improve this perception - the vehicle's V2X communication reception system can follow the path of pedestrians and anticipate a potentially dangerous situation. Similarly, V2X systems emit warnings about the presence of cyclists or the risk of collision, even in the so-called blind spots of vehicles.

Vehicle-to-Pedestrian (V2P) is a specific segment of the wider vehicle-to-everything (V2X) system, enabling wireless and continuous exchange of information between vehicles and pedestrians. This technology enables accurate and timely transmission of data on the location and movement of pedestrians to vehicles in the environment. Although V2P systems are similar to V2V and V2I, they have specific technical and functional characteristics that set them apart. Establishing a V2X communication node requires the presence of connection units at both ends of the communication link. In a typical V2P scenario, a device installed in the vehicle establishes a connection to the pedestrian's smartphone - either directly or via a network. Data exchange takes place through three defined modes (Malik, 2020).

Within V2X communication systems, different scenarios that define the degree and modality of interaction between vehicles and their environment. These protocols play a key role in determining the efficiency, safety, and spatial coverage of a system. The three basic protocols, presented below, describe different approaches and challenges in information exchange, with a direct impact on traffic safety.

Scenario 1 – Infrastructure-based detection

In this scenario, communication between vehicles and pedestrians is achieved through sensors placed along the roads. Although the implementation of such infrastructure is expensive, especially in the context of widespread deployment, it is used in high-risk zones, such as traffic lights and pedestrian crossings. This approach enables the synthesis of sensor data of all relevant traffic participants in the immediate environment, which is especially important in complex or difficult traffic conditions.

Scenario 2 – Vehicle-based detection

In this model, communication relies solely on on-board sensor systems. This approach is limited by spatial coverage, especially in areas with so-called "blind spots", where positioning accuracy is reduced due to the unavailability of GNSS signals, which is often the case in dense urban areas. An additional limitation is the unavailability of the mobile network in remote or rural areas.

As a consequence, in situations where the vehicle is not connected to the communication network (e.g. within the C-V2X system) - even a highly automated vehicle is not able to detect objects outside its line of sight (NLOS - Non-Line of Sight).

Scenario 3 – Vulnerable Road User (VRU) Based Detection

In this approach, the detection of vulnerable road users involves the use of smartphones or devices with V2X communication capabilities that users carry with them. In this way, the VRU independently sends data on its location, speed and direction of movement, enabling vehicles in the immediate vicinity to detect their presence in a timely manner and react in a timely manner.

Compared to previous detection models, this approach is characterized by less infrastructure complexity and is the main focus of most research in the field of V2X communications. The effectiveness of the implementation of this system depends to a large extent on the reliability and quality of the communication network used for data exchange. However, with the increase in the number of VRUs and vehicles in densely populated urban areas, the requirements for data processing and management of network resources are also increasing, further complicating the application of this model in real-world conditions.

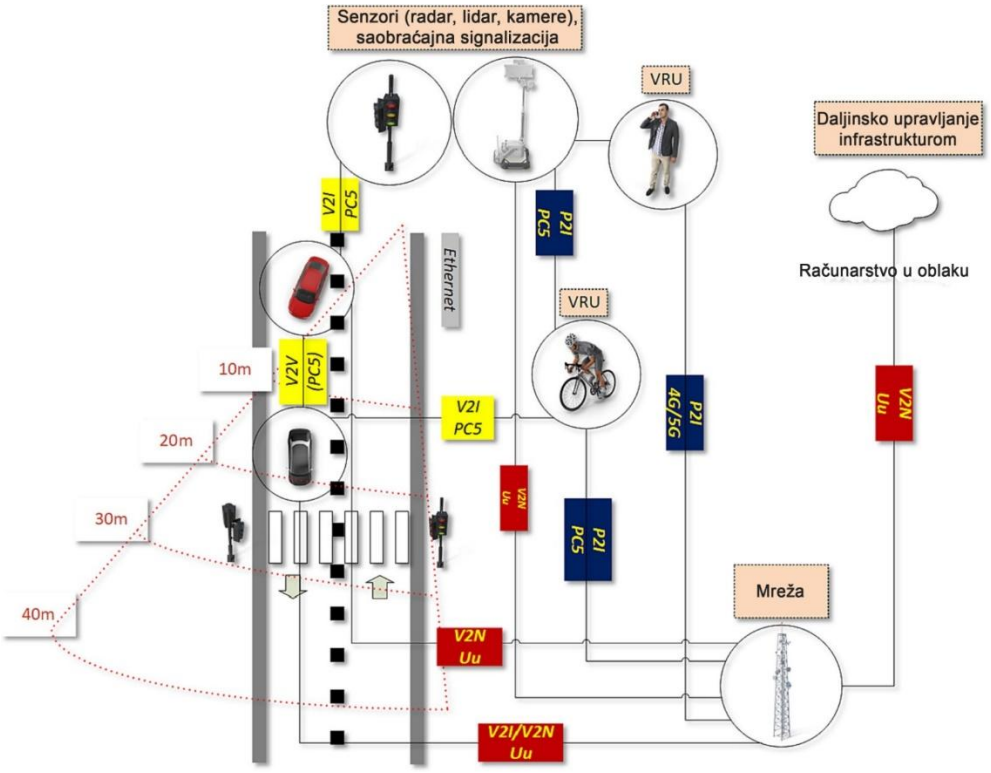


Figure 3.V2X protocols for vulnerable road users and methods of data exchange

5. Conclusion

The introduction of V2X vehicle-to-everything communication technology is a significant step towards improving traffic safety. This technology offers many advantages, but it also faces certain challenges during its further development and implementation. V2X communication enables the prevention of traffic accidents by providing real-time information about other vehicles, pedestrians and road conditions. Such information enables drivers to make timely decisions, thus improving the functionality of the Advanced Driver Assistance System (ADAS).

Thanks to the exchange of data with transport infrastructure and other vehicles, V2X technology can contribute to optimizing traffic flow, reducing congestion and increasing the

efficiency of the transport system. This is reflected in shorter travel times, lower fuel consumption and lower emissions. V2X allows drivers to have a higher level of perception of their surroundings, alerting them to potential hazards that are difficult to see, such as pedestrians in poor visibility conditions or impending traffic jams.

V2X communication is a key component of autonomous driving technology, as it allows autonomous vehicles to navigate complex traffic situations and interact safely with other road users.

The safe participation of all road users, especially vulnerable participants (VRUs), is one of the key challenges of the modern transport system. While V2X technology has enormous potential, its full implementation requires addressing challenges related to standardization, security and privacy protection, as well as regulatory and legal aspects.

The material was applied in the teaching of **the subject Traffic Regulation and Safety,** as well as within the subject **Intelligent Transport Systems**.

Within the course *Safety and Traffic Regulation*, students are introduced to the ways in which ITS contributes to the reduction of the number of traffic accidents (V2V communication, intelligent traffic lights, systems for detecting vulnerable road users). As a practical task, students were given to identify ITS solutions in their city and analyze their impact on traffic safety. Within the teaching topic *"Man as a factor of traffic safety"*, a debate was organized on the topic: **"Are ITS systems a replacement or support for the human factor in traffic safety?"**

As part of the theoretical teaching of the *subject Intelligent Transport Systems*, students are introduced to the definitions and basic components of ITS (sensors, communication networks, control centers, software solutions for data processing). During the course, diagrams, diagrams and short video materials were used to show the implementation of ITS projects. The students were then assigned a practical task to find and analyze real examples of the application of ITS technologies in our country and in the neighboring countries.

Evaluation of students' knowledge was carried out through short tests, practical tasks and discussion activities.

Sources

1. https://www.usiglobal.com/public/en/blog/solutions-and-services-in-v2x-area
2. https://ieeexplore.ieee.org/document/1001277
3. https://webresource.joynext.com/uploadfile/2023/0307/20230307025851861.pdf
4. https://ieeexplore.ieee.org/document/10012775
5. https://www.sciencedirect.com/science/article/pii/S2590198223002270#f0010
6. https://www.traffictechnologytoday.com/news/autonomous-vehicles/vitronic-announces-launch-of-worlds-first-project-for-managed-automated-driving.html
7. https://www.fic.com.tw/v2i_v2v
8. https://blog.rgbsi.com/defining-vehicle-to-pedestrian-v2p
9. https://www.emqx.com/en/blog/what-is-v2x-and-the-future-of-vehicle-to-everything-connectivity
10. https://www.forbes.ru/mneniya/497186-bespilotnye-masiny-i-umnye-dorogi-kakie-riski-

Gregor Belcijan, tehnični svetovalec

Dr. Mateja Podlogar, vodja Akademije GS1 Slovenija GS1 Slovenija

Standardi GS1 kot vez med gospodarstvom, prakso in izobraževanjem

Povzetek

Standardi GS1 predstavljajo temelj sodobne logistične infrastrukture in omogočajo enotno identifikacijo, označevanje, sledenje ter elektronsko izmenjavo podatkov v globalnih, odprtih preskrbovalnih verigah. V prispevku izpostavljamo njihovo pomembnost kot vsebino, ki povezuje gospodarstvo, prakso in izobraževanje. Predstavljeni so ključni elementi standardov GS1 in njihova vloga v logistiki, delovanje organizacije GS1 Slovenija in njene Akademije kot nosilke prenosa znanja ter konkretne oblike sodelovanja z izobraževalnimi ustanovami, med katerimi je poseben poudarek namenjen srednjim in višjim strokovnim šolam, katerih analize učnih načrtov kažejo skladnost obstoječih izobraževalnih programov z vsebinami standardov GS1. Prispevek vključuje tudi primere dobre prakse sodelovanja s šolami, razvojem učnih modulov, izvedbo seminarjev in certificiranjem znanja. S tem Akademija GS1 Slovenija prispeva k večji povezanosti izobraževalnega sistema z gospodarstvom in razvoja praktičnih kompetenc dijakov, študentov, profesorjev in strokovnjakov iz gospodarstva.

1 Uvod

Logistika danes ni več zgolj operativna funkcija, temveč tudi strateški element preskrbovalnih verig, ki pomembno vpliva na učinkovitost, kakovost in odzivnost celotnega gospodarstva. Sodobni logistični sistemi temeljijo na podatkovni povezanosti, sledljivosti, avtomatizaciji in globalni interoperabilnosti – kar zahteva nove kompetence in sodobna znanja, ki morajo biti vključena tudi v formalne oblike izobraževanja.

Globalni standardi GS1 so temeljni del infrastrukture sodobne logistike. Omogočajo enotno identifikacijo prodajnih in logističnih enot, standardizirano označevanje izdelkov in lokacij, avtomatski zajem podatkov ter strukturirano elektronsko izmenjavo informacij. Prav z njimi podjetja zagotavljajo sledljivost, zmanjšujejo napake, izboljšujejo pretočnost blaga in zanesljivost podatkov – od pridobivanja surovin, proizvodnje ter na koncu do končnega potrošnika (GS1 AISBL, GS1 General Specifications, 2025a).

Čeprav so standardi GS1 v različnih gospodarskih panogah že široko uveljavljeni, jih v formalnem izobraževanju pogosto še ne obravnavamo kot celovito vsebino. V logističnih in sorodnih programih se pojavljajo s temami, kot so označevanje, skladiščenje, transportna dokumentacija ali informacijska podpora, vendar brez enotne rdeče niti, ki bi dijakom in študentom omogočila razumeti širši pomen standardizacije (GS1 Slovenija, Analiza izobraževalnih programov SSI, SPI, VSI, 2024b).

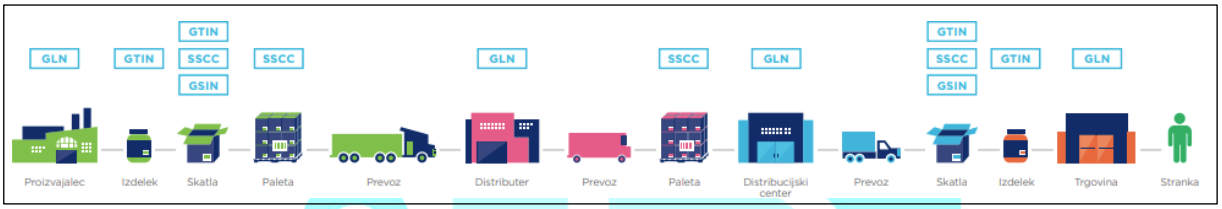
V tem prispevku zato predstavljamo pomen standardov GS1 kot vsebino, ki povezuje gospodarstvo, prakso in izobraževanje. Najprej bomo predstavili standarde in njihovo

pomembnost v gospodarstvu s poudarkom na logistiki, nato predstavimo organizacijo GS1 Slovenija in Akademijo GS1 kot prenašalko znanja ter njene aktivnosti. V zadnjem delu izpostavimo pomen vključevanja teh vsebin v srednješolsko in višješolsko izobraževanje.

2 Globalni standardi GS1

Globalni standardi GS1 so eden od ključnih temeljev za zagotavljanje enotnosti, učinkovitosti in sledljivosti v preskrbovalnih verigah (slika 1). Predstavljajo nabor mednarodno priznanih standardov, ki omogočajo enotno identifikacijo izdelkov, lokacij, logističnih enot, sredstev in dokumentov ter standardizirano označevanje in elektronsko izmenjavo podatkov. V logistiki, kjer so podatkovni tokovi tesno prepleteni s fizičnim gibanjem blaga, so standardi GS1 ključni za brezhibno povezovanje vseh deležnikov v preskrbovalnih verigah (GS1 AISBL, GS1 General Specifications, 2025a).

Slika 1: Standardi GS1 v preskrbovalni verigi (vir: lasten)



Standardi GS1 so prisotni v več kot 25 panogah in jih uporablja več kot 2 milijona podjetij po vsem svetu. Z več kot 1 milijardo izdelkov, označenih s črtnimi kodami GS1, vsak dan podpirajo več kot 10 milijard transakcij v globalnih preskrbovalnih verigah (GS1 AISBL, GS1 Overview Presentation, 2025b). Njihova univerzalnost omogoča, da delujejo ne glede na velikost organizacije, uporabljeno programsko opremo ali državo – kar jih postavlja v središče globalne interoperabilnosti. V praksi to pomeni, da lahko npr. izdelek, označen z unikatnim standardom za označevanje izdelkov GS1 GTIN – globalno trgovinsko številko izdelka (Global Trade Item Number), takoj prepoznajo vsi partnerji preskrbovalne verige: trgovci, distributerji in logistični centri ter ostali, kjerkoli na svetu (GS1 Slovenija, GTIN - Globalna trgovinska številka izdelka, 2025a).

V logistiki so standardi GS1 posebej pomembni pri identifikaciji in sledenju transportnih in logističnih enot z GS1 SSCC – zaporedno kodo zabojnika (Serial Shipment Container Code)[1], upravljanju lokacij z GS1 GLN – globalno lokacijsko številko (Global Location Number)[2], nadzoru in vodenju sredstev z GS1 GRAI – globalnim identifikatorjem vračljivega sredstva (Global Returnable Asset Identifier)[3], sledenju dogodkom z GS1 EPCIS – zaznavanjem in beleženjem dogodkov v realnem času (Electronic Product Code Information Services)[4] in povezovanju z informacijskimi sistemi podjetij (slika 2).

1 GS1 Slovenija (2025b, 22. julij). *SSCC – Zaporedna koda zabojnika* https://www.gs1si.org/standardi/sscc

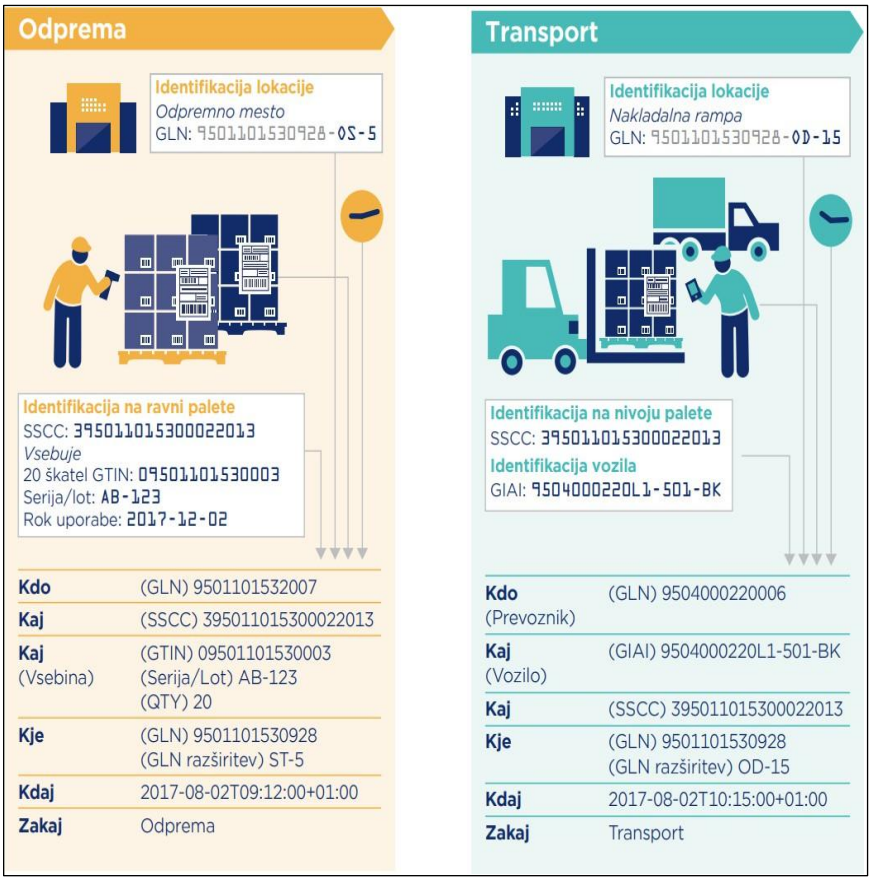
2 GS1 Slovenija (2025c, 22. julij. *GLN – Globalna lokacijska številka* https://www.gs1si.org/standardi/gln

[3] GS1 Slovenija (2025d, 22. julij). *Identifikacijski ključi GS1* https://www.gs1si.org/standardi/stevilke- gs1/id-kljuci

[4] GS1 Slovenija (2025e, 22. julij). *EPCIS* https://www.gs1si.org/standardi/EPCIS

Uporaba standardov GS1 omogoča hitrejši pretok blaga, zmanjšuje število napak, izboljšuje sledljivost ter omogoča večjo skladnost z zakonskimi zahtevami in digitalnimi poslovnimi modeli (GS1 AISBL, EPCIS and CBV Implementation Guideline 2.0, 2023).

Slika 2: Uporaba identifikatorjev GS1 v logistiki (vir: lasten)



Poleg identifikacije in označevanja standardi GS1 zajemajo tudi standarde za izmenjavo matičnih podatkov: GDM – globalni podatkovni model (Global Data Model) in GDSN – globalna sinhronizacija podatkov (Global Data Synchronization Network), transakcijskih podatkov RIP – računalniška izmenjava standardiziranih sporočil (EDI – Electronic Data Interchange) in podatkov o dogodkih, EPCIS, ki je posebej uporaben v kompleksnih logističnih verigah z večjim številom vključenih partnerjev ter omogoča poleg sledenja tudi vidnost enot (izdelkov, škatel, palet …) preskrbovalne verige[5]. Vse te komponente delujejo kot skladen ekosistem, ki organizacijam omogoča, da upravljajo tako fizične tokove blaga

[5] GS1 Slovenija (2025f, 23. julij). *Matični podatki* https://www.gs1si.org/standardi/izmenjava-podatkov/maticni-podatki

[6] GS1 Slovenija (2025g, 24. julij). *Digitalni potni list izdelka* https://www.gs1si.org/trajnost/dpp

kot pripadajoče podatke skozi celoten življenjski cikel izdelka ali storitve (GS1 AISBL, GS1 General Specifications, 2025a).

Zaradi vse večje potrebe po digitalizaciji logistike, trajnostnih rešitvah in podatkovni sledljivosti so standardi GS1 ključni pri razvoju novih modelov, kot je na primer DPP – digitalni potni list izdelkov (Digital Product Passport)[6].

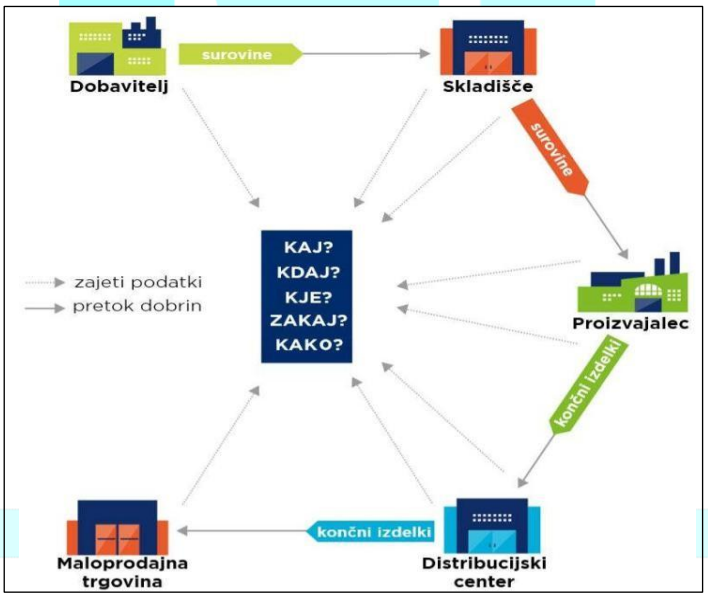
Njihovo razumevanje in uporaba zato nista več izključno domena podjetij, temveč postajata tudi ključna vsebina v strokovnem izobraževanju – še posebej v srednjih in višjih šolah z logističnim ali tehnično-ekonomskim programom. Z vključevanjem standardov GS1 v predmete, kot so logistični procesi, skladiščenje, digitalna

podpora logistiki in preskrbovalne verige, dijaki in študenti razvijajo praktične kompetence, ki jih pričakujejo delodajalci v gospodarstvu. S tem postaja standardizacija ne le vsebina, temveč tudi konkretno orodje povezovanja med gospodarstvom, prakso in šolstvom (GS1 Slovenija, Analiza izobraževalnih programov SSI, SPI, VSI, 2024b).

2.1 Vidnost (EPCIS) in 2D v logistiki

Vse večje zahteve po transparentnosti, digitalizaciji in trajnostnih rešitvah v logistiki narekujejo uporabo sodobnejših pristopov k zajemu in deljenju podatkov. Med najnaprednejšimi standardi GS1 na tem področju sta EPCIS in GS1 Digital Link v kombinaciji z 2D-kodami, kot sta GS1 QR ali GS1 DataMatrix (GS1 AISBL, EPCIS and CBV Implementation Guideline 2.0, 2023).

Slika 3: Zajem in izmenjava podatkov z uporabo EPCIS v preskrbovalni verigi (vir: lasten)



EPCIS omogoča beleženje in izmenjavo podatkov o dogodkih, povezanih z izdelkom ali logistično enoto skozi celoten proces – kdaj, kje, kaj in zakaj se je nekaj zgodilo (slika 3). V

logistiki to pomeni možnost spremljanja in dokumentiranja premikov izdelkov in logističnih enot, skeniranja v skladiščih, prevzema pri kupcu in povezovanja z drugimi sistemi za nadzor, varnost in kakovost podatkov. Ključnega pomena za vzpostavitev takega sistema v odprtem okolju je, da se podatki o poslovnih dogodkih (praviloma logističnih transakcijah) beležijo na standardiziran način in da je omogočen dostop do teh podatkov preko standardiziranih vmesnikov. Podatki EPCIS omogočajo celovito dokumentacijo poti blaga, kar je ključno za področja, kot so prehrana, zdravstvo in farmacija ter tehnično blago (GS1 AISBL, EPCIS and CBV Implementation Guideline 2.0, 2023).

V kombinaciji z 2D-kodami, kot je npr. GS1 QR, se odpira možnost, da vsak izdelek ali logistična enota že na embalaži nosi povezavo do strukturiranih podatkov v digitalni obliki. Tako lahko na enem mestu združimo informacije za notranjo logistiko (SSCC, GTIN, LOT …) in hkrati omogočimo dostop do javnih informacij za potrošnika, carino ali trgovca ipd. (GS1 AISBL, EPCIS and CBV Implementation Guideline 2.0, 2023).

Uporaba dvodimenzionalnih kod v logistiki omogoča:

- zapis večje količine informacij na manjši površini,
- hitrejše in zanesljivejše skeniranje,
- podporo avtomatizaciji in robotizaciji skladišč in logističnih centrov ter

izpolnjevanje zahtev evropskih regulativ, kot sta ESPR – Uredba o okoljsko primerni zasnovi trajnostnih izdelkov (Ecodesign for Sustainable Products Regulation) in DPP – digitalni potni list izdelkov.

Standarda EPCIS in GS1 Digital Link se medsebojno dopolnjujeta: EPCIS omogoča strukturirano beleženje in izmenjavo podatkov o dogodkih v preskrbovalni verigi, medtem ko GS1 Digital Link omogoča enostaven dostop do podatkov prek fizičnega nosilca podatkov, kot je 2D-koda. Skupaj tvorita temelj sodobne podatkovne infrastrukture v logistiki prihodnosti (GS1 AISBL, EPCIS and CBV Implementation Guideline 2.0, 2023).

Zato je ključno, da se tudi te vsebine postopoma uvajajo v izobraževanje – kot osnova za razumevanje delovanja digitalne infrastrukture preskrbovalnih verig na ravni posameznega izdelka, logistične enote in celotnega logističnega ali informacijskega sistema podjetja (GS1 Slovenija, Analiza izobraževalnih programov SSI, SPI, VSI, 2024b).

3 Akademija GS1 Slovenija

GS1 Slovenija je nacionalna organizacija, ki je del mednarodne organizacije GS1, v kateri je povezanih že 118 nacionalnih organizacij po svetu. Pooblaščena je za upravljanje in razvoj standardov GS1 v Sloveniji. Deluje kot neodvisna, nepridobitna in strokovna organizacija. Ima več kakor 3800 članov oziroma uporabnikov, predvsem iz predelovalne in trgovske dejavnosti, logistike in zdravstva. Njeno poslanstvo je podpirati gospodarstvo pri izboljševanju sledljivosti, učinkovitosti, interoperabilnosti in kakovosti podatkov v poslovnih procesih preskrbovalnih verig z uporabo standardov in rešitev GS1 (GS1 Slovenija, Strategija GS1 Slovenija 2025-2028 - dejavnost Akademija GS1 Slovenija, 2024a).

S tem namenom GS1 Slovenija že vrsto let ne le razvija in podpira uporabo standardov GS1 v praksi, temveč tudi aktivno gradi sistem prenosa znanja, zlasti na področju logističnega

inženirstva, informatike, ekonomije ter živilstva in prehrane ter v različnih panogah: v trgovini, zdravstvu in tudi na železnicah, v gradbeništvu in bančništvu (GS1 Slovenija, Strategija GS1 Slovenija 2025-2028 - dejavnost Akademija GS1 Slovenija, 2024a). Ključni korak v tej smeri je bila vzpostavitev Akademije GS1 Slovenija, ki deluje kot specializiran izobraževalni center za vse deležnike preskrbovalnih verig – med njimi tudi za dijake, študente, učitelje, profesorje in strokovnjake iz gospodarstva (slika 4).

Akademija GS1 je zasnovana kot strukturiran model prenosa znanja, razdeljen v štiri stebre delovanja, ki skupaj omogočajo celovit pristop k razvoju kompetenc:

- 1. steber: Izobraževanje, strokovno usposabljanje in izpopolnjevanje (uvodni seminar, specialistični seminar, izobraževanje po meri naročnika …).
- 2. steber: Sodelovanje s sekundarnim in terciarnim izobraževanjem, kjer se standardi GS1 uvajajo v kurikulume in učne module v sodelovanju s srednjimi in višjimi šolami ter visokimi šolami in fakultetami.
- 3. steber: Certificiranje strokovnih kvalifikacij s pomočjo strukturiranega sistema preverjanja kompetenc, razdeljenega na več zahtevnostnih stopenj (Razume; Uporablja in Implementira standarde GS1).
- 4. steber: Center znanja kot stičišče različnih deležnikov za kreiranje idej, mreženje, izmenjavo praks, razvoj vsebin in vključevanje zunanjih strokovnjakov (raziskave trga, strokovni posveti delovnih skupin, interno usposabljanje …).

Slika 4: Akademija GS1 Slovenija (vir: GS1 Slovenija, Strategija GS1 Slovenija 2025-2028 - dejavnost Akademija GS1 Slovenija, 2024a)



Akademija GS1 Slovenija izvaja širok nabor dejavnosti, kot so seminarji, delavnice, e-izobraževanja, individualna svetovanja, priprava učnih gradiv ipd.

Poseben poudarek je namenjen vsebinam s področja logistike, saj ravno tukaj standardi GS1 najhitreje pokažejo svojo uporabno vrednost – pri označevanju, sledljivosti in vidnosti logističnih enot, upravljanju skladiščnih procesov, digitalni dokumentaciji in usklajevanju podatkovnih tokov itd. Znanje, ki ga Akademija prenaša, ni namenjeno le podjetjem, temveč je vse bolj pomembno tudi za izobraževalne ustanove, ki želijo svojim dijakom in študentom približati realna orodja, s katerimi se bodo srečevali v praksi (GS1 Slovenija, Strategija GS1 Slovenija 2025-2028 - dejavnost Akademija GS1 Slovenija, 2024a).

3.1 Vključevanje vsebin standardov GS1 v izobraževalne programe

Standardi GS1 niso le teoretični okvir sodobne logistike, temveč tudi konkretna vsebina, ki jo v slovenskih izobraževalnih programih že danes najdemo v različnih oblikah. V GS1 Slovenija smo zato v letu 2024 v okviru Akademije GS1 izvedli sistematično analizo srednješolskih strokovnih in tehniških programov (SSI, SPI) ter višješolskih strokovnih programov (VSI), da bi prepoznali stične točke med zahtevami učnih načrtov in vsebinami, ki jih razvijamo in izvajamo v okviru izobraževanj Akademije GS1 Slovenija (GS1 Slovenija, Analiza izobraževalnih programov SSI, SPI, VSI, 2024b).

Analiza je pokazala, da se vsebine, kot so unikatna identifikacija izdelkov in logističnih enot, sledenje blaga, avtomatski zajem podatkov ter elektronsko poslovanje, že pojavljajo v večini učnih načrtov. Zlasti so prisotne na področju logistike, skladiščnega poslovanja, oskrbovalnih verig in informacijske podpore. To pomeni, da je vključevanje vsebin o standardih GS1 v kurikulume v skladu z obstoječimi učnimi cilji, ne pa dodatek ali odmik od ciljev programov (GS1 Slovenija, Analiza izobraževalnih programov SSI, SPI, VSI, 2024b).

Še posebej so standardi GS1 skladni s programi, kot so:

- logistični tehnik: poznavanje označevanja blaga, standardizacije, sledljivosti, uporabe različnih simbologij, upravljanje skladišč in globalnih oskrbovalnih verig,
- logistično inženirstvo: označevanje transportno-skladiščnih enot, tehnologije za zajem podatkov, uporaba standardov pri skladiščnem poslovanju in digitalizaciji logistike,
- živilstvo in prehrana, ekonomski tehnik, računalništvo ipd., kjer se pojavljajo vsebine, kot so klasifikacija izdelkov, sledljivost, deklariranje, elektronsko poslovanje, kakovost podatkov in označevanje živil.

Poleg vsebinske usklajenosti z učnimi cilji je pomembno poudariti, da so dijaki, študenti in profesorji že večkrat izkazali zanimanje za vključevanje vsebin s področja standardov GS1 ter konkretnih primerov in orodij iz prakse ter gradiv, kot sta učbenik in delovni zvezek Upravljanje globalnih preskrbovalnih verig. Skladno s tem smo v Akademiji GS1 razvili izobraževalne module, ki omogočajo praktično razumevanje in uporabo vsebin v kontekstu realnega logističnega okolja.

Podpisali smo pismo o sodelovanju s CPI - Centrom Republike Slovenije za poklicno izobraževanje in izobraževalnimi ustanovami, kjer se osredotočamo na prilagajanje in razvijanje učnih gradiv, modulov in seminarjev, ki podpirajo te vsebine in omogočajo lažje vključevanje v izobraževalni proces – brez potrebe po spremembi kurikuluma.

4 Sodelovanje z izobraževalnimi institucijami

Vključevanje standardov GS1 v izobraževalne vsebine ni zgolj teoretična možnost, temveč že danes realnost na številnih srednjih in višjih strokovnih šolah v Sloveniji. Akademija GS1 Slovenija si prizadeva, da vsebine, povezane s standardi GS1, ne ostanejo omejene le na poslovno okolje, temveč postanejo tudi sestavni del izobraževalnega procesa – in sicer s konkretnim sodelovanjem z izobraževalnimi ustanovami, profesorji ter dijaki in študenti (GS1 Slovenija, Strategija GS1 Slovenija 2025-2028 - dejavnost Akademija GS1 Slovenija, 2024a).

Ena od ključnih oblik tega sodelovanja so izobraževalni seminarji, ki jih Akademija GS1 izvaja posebej za profesorje. Ti seminarji ponujajo profesorjem strukturiran vpogled v svet standardizacije, identifikacije, označevanja in digitalne sledljivosti, hkrati pa jim omogočajo, da pridobljeno znanje samostojno prenašajo svojim dijakom in študentom. V sodelovanju s Centrom RS za poklicno izobraževanje (CPI) v Akademiji GS1 izvajamo strokovna usposabljanja za člane študijskih skupin, ki sodelujejo pri pripravi in prenovi izobraževalnih programov.

Akademija GS1 izvaja tudi certificiranje znanja o standardih GS1, ki temelji na jasno strukturiranem sistemu s tremi stopnjami: razumevanje, uporaba in implementacija standardov GS1. Udeleženci po uspešno opravljenem preverjanju pridobijo mednarodni certifikat GS1, ki služi kot dokazilo o usposobljenosti za delo s standardi GS1. Certifikacijski sistem je enoten za vse ciljne skupine – od profesorjev, študentov in dijakov do zaposlenih v gospodarstvu – in se izvaja v okviru organiziranih terminov ali v sodelovanju s posameznimi šolami in izobraževalnimi institucijami (GS1 Slovenija, Strategija GS1 Slovenija 2025-2028 - dejavnost Akademija GS1 Slovenija, 2024a).

V sodelovanju s profesorji nastajajo tudi praktična učna gradiva in moduli, ki jih je mogoče neposredno vključiti v redni pouk. Gradiva zajemajo vsebine od osnovnih konceptov identifikacije izdelkov do konkretnih primerov označevanja, razumevanja logističnih nalepk in uporabe podatkovnih nosilcev v praksi. Moduli so pripravljeni tako, da jih profesorji lahko uporabijo samostojno ali v kombinaciji z drugimi vsebinskimi sklopi rednega kurikuluma.

Na posameznih šolah so potekali tudi projektni dnevi in strokovni obiski, kjer so dijaki aktivno sodelovali pri reševanju konkretnih izzivov iz prakse, spoznavali uporabo standardov GS1 v skladiščih, trgovinah ali proizvodnji ter se seznanjali z digitalnimi trendi, kot so dvodimenzionalne kode, sledljivost in vidnost, digitalni potni list izdelka ipd. Te izkušnje predstavljajo pomembno dopolnilo učnemu načrtu in prispevajo k večji motivaciji dijakov in študentov za pridobivanje tovrstnega znanja. Predvsem pa vidijo, kako pomembno je osvojiti to znanje, brez katerega v praksi, ko se enkrat zaposlijo, ne bo šlo.

Preglednica 1: Primeri dobrih praks prenosa vsebin GS1 v srednje in višje šole

Aktivnost	Vsebina/poudarek	Sodelujoča institucija/e
Mednarodno študentsko tekmovanje v študiji primera	Uporaba standardov GS1 v praksi, reševanje primerov	FOV UM, GS1 Slovenija
Projektni dan na Fakulteti za logistiko	Strokovne usmeritve za pravilno in učinkovito delo s podatki	Fakulteta za logistiko UM
Teden vseživljenjskega učenja – strokovno predavanje	Brez GTIN, črtne kode in kakovostnih podatkov ne gre več	Višja šola ŠC Kranj
Inovativne metode izobraževanja	Pilotni primer vsebin GS1 v simulaciji VR	GS1 Slovenija, VIAR, Spar Slovenija
Projektni dan v okviru podjetniškega tedna na Vegovi gimnaziji	»Šolska spletna prodajalna« in GS1 Slovenija	Fakulteta za organizacijske vede UM in Elektrotehniško-računalniška šola in gimnazija Ljubljana
Gostujoče predavanje (UGPV0, UGPV1)	Uvod v standarde GS1 za srednješolce (1.–3. letnik)	ŠC Nova Gorica – Strojna, prometna in lesarska šola

Izpostavili bi primer dobre prakse, izobraževalni dan na Strojni, prometni in lesarski šoli v sklopu Šolskega centra Nova Gorica, ki smo ga izvedli letos pomladi. Namenjen je bil dijakom programa Logistični tehnik od 1. do 3. letnika. V okviru dveh šolskih ur je 75 dijakov sodelovalo v kombiniranem formatu predavanj in delavnic. V prvem delu so dijaki 1. letnika s predavateljem spoznavali osnove standardov GS1 preko praktičnih primerov iz vsakdanjega življenja in gospodarstva, medtem ko so dijaki

2. in 3. letnika z drugim predavateljem utrjevali že osvojeno znanje v diskusiji in reševanju primerov iz prakse. V drugem delu so se vsi dijaki združili in skozi primere dobre in slabe prakse v logistiki aktivno sodelovali pri razumevanju označevanja logističnih enot, uporabe dvodimenzionalnih kor, elektronskih dobavnic in druge logistične dokumentacije. Dijaki so bili z izvedbo predavanja zelo zadovoljni, aktivno so sodelovali pri razlagi in razpravah, še posebej pa so jih pritegnili interaktivni kvizi. Tudi profesorica je izrazila zadovoljstvo nad izvedbo in predlagala nadaljevanje sodelovanja v prihodnjem šolskem letu.

Na ta način Akademija GS1 aktivno podpira izobraževalne institucije pri uvajanju vsebin, ki so skladne z učnimi cilji, hkrati pa povezuje teorijo z realnimi procesi v gospodarstvu. Tako nastaja živ most med izobraževanjem in prakso, ki ne prispeva le k večji usposobljenosti dijakov in študentov, temveč tudi k dolgoročni konkurenčnosti slovenskega logističnega sektorja.

5 Sklep

Logistika kot panoga se razvija z izjemno hitrostjo, kar od izobraževalnega sistema zahteva nenehno prilagajanje vsebin in pristopov, ki odražajo dejanske potrebe gospodarstva. Standardi GS1 predstavljajo temelj sodobne logistične infrastrukture in digitalne preskrbovalne verige. Njihovo poznavanje, razumevanje in uporaba pa postajajo ključne kompetence, ki jih pričakujejo delodajalci v različnih panogah.

V tem kontekstu je pomembno, da se izobraževalne ustanove povezujejo s podjetji in strokovnjaki iz prakse, ki lahko prispevajo k večji aktualnosti in uporabnosti učnih vsebin. Akademija GS1 Slovenija s svojim delovanjem omogoča ravno to: strukturiran in strokovno podprt prenos znanja iz prakse v učilnice.

Srednjim in višjim strokovnim šolam nudimo strokovno podporo pri vključevanju vsebin globalnih standardov GS1 v izobraževalni proces. To dosegamo z razvojem modulov, izvajanjem izobraževanj in sistemom certificiranja, ki so usklajeni z učnimi cilji in dijakom ter študentom omogočajo pridobiti znanje, ki je neposredno uporabno v njihovem prihodnjem poklicu.

S povezovanjem gospodarstva, šolstva in standardizacije tako gradimo most med teorijo in prakso ter prispevamo k dolgoročni konkurenčnosti slovenskega logističnega sektorja – z znanjem, razumevanjem in uporabo mednarodnih standardov GS1.

6 Viri in literatura

1. GS1 AISBL (2025a). *GS1 General Specifications*, Version 25.0 https://ref.gs1.org/standards/genspecs/ (nazadnje dostopano 24. julij 2025)
2. GS1 AISBL (2025b). *GS1 Overview Presentation* https://mozone.gs1.org/docs/GS1_overview_slides.pptx (nazadnje dostopano 23. julij 2025)
3. GS1 AISBL (2023). *EPCIS and CBV Implementation Guideline*, Release 2.0 https://ref.gs1.org/guidelines/epcis-cbv/2.0.0/
4. GS1 Slovenija (2025a). GTIN – Globalna trgovinska številka izdelka https://www.gs1si.org/standardi/gtin (nazadnje dostopano 23. julij 2025)
5. GS1 Slovenija (2025b). SSCC – Zaporedna koda zabojnika https://www.gs1si.org/standardi/sscc (nazadnje dostopano 22. julij 2025)
6. GS1 Slovenija (2025c). GLN – Globalna lokacijska številka https://www.gs1si.org/standardi/gln (nazadnje dostopano 22. julij 2025)
7. GS1 Slovenija (2025d). Identifikacijski ključi GS1 https://www.gs1si.org/standardi/stevilke-gs1/id-kljuci (nazadnje dostopano 22. julij 2025)
8. GS1 Slovenija (2025e, 22. julij). *EPCIS* https://www.gs1si.org/standardi/EPCIS

9. GS1 Slovenija (2025f). *Matični podatki* https://www.gs1si.org/standardi/izmenjava-podatkov/maticni-podatki (nazadnje dostopano 23. julij 2025)

10. GS1 Slovenija (2025g). *Digitalni potni list izdelka* https://www.gs1si.org/trajnost/dpp (nazadnje dostopano 24. julij 2025)

11. GS1 Slovenija (2024a). Strategija GS1 Slovenija 2025–2028 – dejavnost Akademija GS1 Slovenija, Ljubljana

12. GS1 Slovenija (2024b). Analiza izobraževalnih programov SSI, SPI, VSI.

Gregor Belcijan, Technical Advisor

Dr. Mateja Podlogar, Head of GS1 Slovenia Academy GS1 Slovenia

GS1 Standards as a Bridge Between Industry, Practice and Education

Summary

GS1 standards form the foundation of modern logistics infrastructure by enabling consistent identification, labelling, traceability and electronic data exchange across global, open supply chains. This paper highlights the role of GS1 standards as a bridge between industry, practical application and education. It outlines the core components of GS1 standards and their relevance in logistics, presents the role of GS1 Slovenia and its Academy as key drivers of knowledge transfer, and describes specific forms of collaboration with educational institutions. Particular attention is given to secondary and higher vocational schools, where curriculum analysis shows strong alignment with GS1-related content. The paper includes examples of good practices such as collaboration with schools, development of teaching modules, delivery of seminars and certification of knowledge. Through these efforts, the GS1 Slovenia Academy strengthens the connection between the education system and the business sector, supporting the development of practical competencies among students, teachers and industry professionals.

Introduction

Logistics today is no longer merely an operational function – it has become a strategic component of supply chains, significantly influencing efficiency, quality and responsiveness across the entire economy. Modern logistics systems rely on data connectivity, traceability, automation and global interoperability – all of which require new competencies and up-to-date knowledge that must also be integrated into formal education.

Global GS1 standards are a fundamental part of the infrastructure behind modern logistics. They enable the unified identification of trade and logistics units, standardized product and location labelling, automatic data capture and structured electronic data exchange. These standards help companies ensure traceability, reduce errors, improve the flow of goods and increase data reliability – from sourcing raw materials to manufacturing and ultimately reaching the end consumer (GS1 AISBL, GS1 General Specifications, 2025a).

Although GS1 standards are widely adopted across various industries, they are still not consistently addressed as a comprehensive topic in formal education. In logistics and related study programmes, they typically appear in the context of labelling, warehousing, transport documentation or IT support, but without a unified thread that would help students understand the broader value of standardization (GS1 Slovenia, Analysis of Educational Programmes – Secondary and Short-Cycle Tertiary, 2024b).

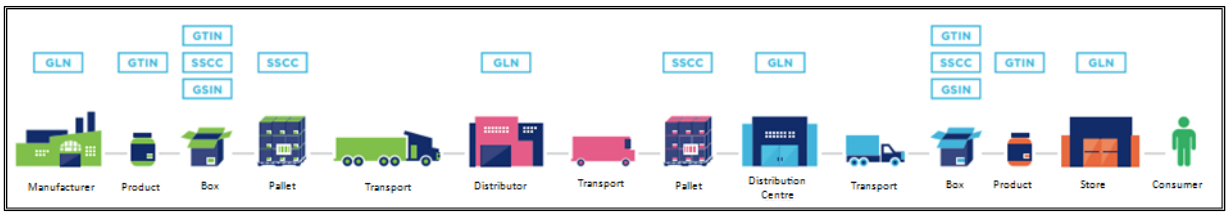
This paper therefore presents the role of GS1 standards as a connecting element between business, practical application and education. We begin by introducing the standards and their importance in the economy, with an emphasis on logistics. We then present the organization GS1 Slovenia and its Academy as a hub for knowledge transfer and outline its activities.

Finally, we highlight the importance of integrating this content into secondary and higher vocational schools.

GS1 Global standards

GS1 global standards are one of the key foundations for ensuring consistency, efficiency and traceability within supply chains (Figure 1). They represent a set of internationally recognized standards that enable the unique identification of products, locations, logistics units, assets and documents, as well as standardized labelling and electronic data exchange. In logistics – where data flows are closely intertwined with the physical movement of goods – GS1 standards are essential for seamless integration and collaboration among all stakeholders in the supply chain (GS1 AISBL, GS1 General Specifications, 2025a).

Figure 1: GS1 standards in the supply chain (source: internal)



GS1 standards are used in more than 25 industries and adopted by over 2 million companies worldwide. With more than 1 billion products labelled with GS1 barcodes, they support over 10 billion transactions every day in global supply chains (GS1 AISBL, GS1 Overview Presentation, 2025b). Their universality allows them to function regardless of the size of the organization, the software used or the country – placing them at the core of global interoperability. In practice, this means that a product marked with the unique GS1 GTIN (Global Trade Item Number) can be instantly recognized by all supply chain partners – retailers, distributors, logistics centres and others – anywhere in the world (GS1 Slovenia, GTIN – Global Trade Item Number, 2025a).

In logistics, GS1 standards play a crucial role in the identification and tracking of transport and logistics units via GS1 SSCC (Serial Shipping Container Code)[1], location management via GS1 GLN (Global Location Number)[2], asset control using GS1 GRAI (Global Returnable Asset Identifier)[3], and real-time event tracking through GS1 EPCIS (Electronic Product Code Information Services)[4], all while integrating with enterprise information systems (Figure 2).

[1] GS1 Slovenija (2025b, 22. July). *SSCC – Zaporedna koda zabojnika* https://www.gs1si.org/standardi/sscc

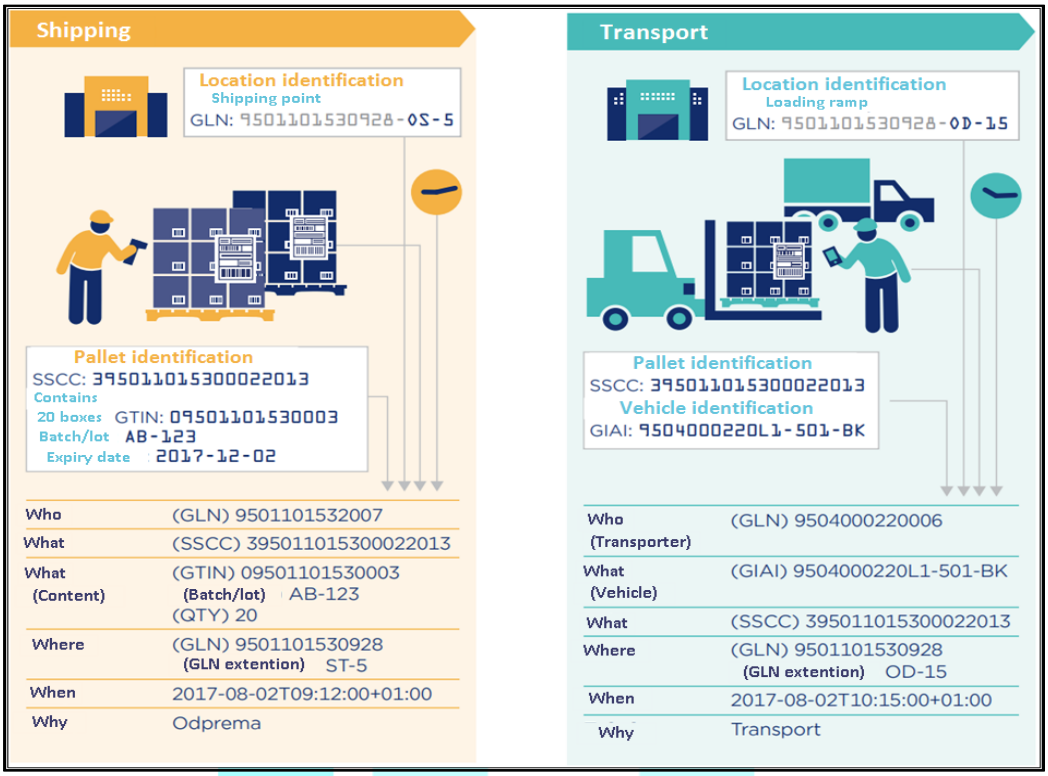
[2] GS1 Slovenija (2025c, 22. July. *GLN – Globalna lokacijska številka* https://www.gs1si.org/standardi/gln

[3] GS1 Slovenija (2025d, 22. July). *Identifikacijski ključi GS1* https://www.gs1si.org/standardi/stevilke- gs1/id-kljuci

[4] GS1 Slovenija (2025e, 22. July). *EPCIS* https://www.gs1si.org/standardi/EPCIS

The use of GS1 standards accelerates the movement of goods, reduces errors, enhances traceability and ensures greater compliance with legal requirements and digital business models (GS1 AISBL, EPCIS and CBV Implementation Guideline 2.0, 2023).

Figure 2: Usage of GS1 Identifiers in Logistics (source: internal)



In addition to identification and labelling, GS1 standards also encompass standards for master data exchange, such as GDM – the Global Data Model – and GDSN – the Global Data Synchronization Network; for transactional data exchange via EDI (Electronic Data Interchange); and for event data via EPCIS, which is particularly useful in complex logistics chains involving many partners. EPCIS enables not only traceability but also real-time visibility of units (products, boxes, pallets, etc.) within the supply chain[5]. Together, these components function as a coherent ecosystem that allows organizations to manage both the physical flow of goods and the associated data throughout the entire product or service lifecycle (GS1 AISBL, GS1 General Specifications, 2025a).

Due to the increasing need for logistics digitalization, sustainable solutions and data-driven traceability, GS1 standards are playing a key role in the development of new models such as the Digital Product Passport (DPP)[6]. Their understanding and application are therefore no longer exclusive to businesses – they are becoming a vital part of professional education, especially in secondary and higher vocational school programmes focused on logistics or technical-economics. By integrating GS1 standards into subjects such as logistics processes, warehousing, digital support in logistics and supply chain

[5] GS1 Slovenija (2025f, 23. July). *Matični podatki* https://www.gs1si.org/standardi/izmenjava- podatkov/maticni-podatki

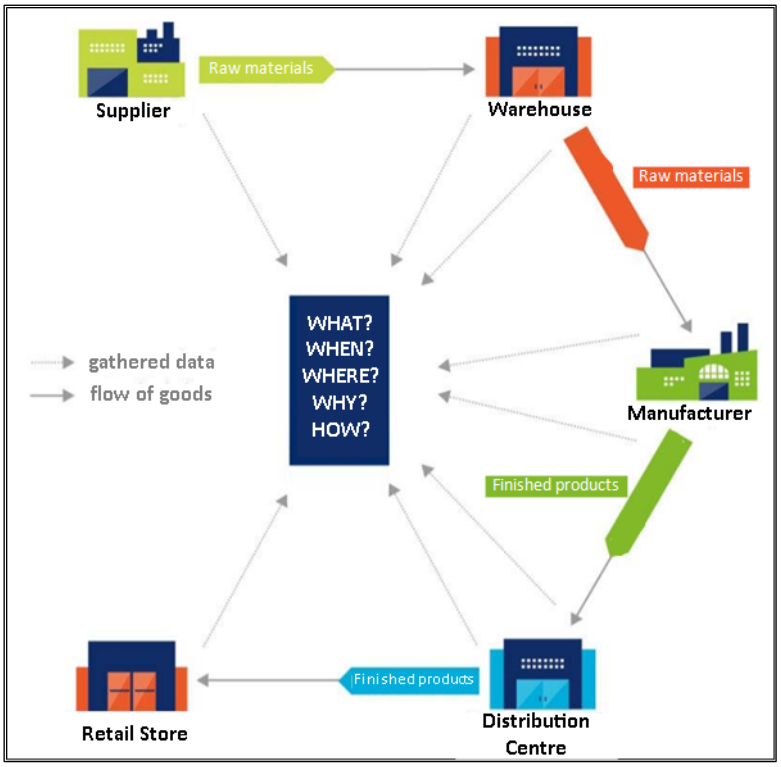
[6] GS1 Slovenija (2025g, 24. July). *Digitalni potni list izdelka* https://www.gs1si.org/trajnost/dpp

management, students develop practical competencies that are highly valued by employers. In this way, standardization becomes not only a topic of instruction, but also a concrete tool for connecting industry, practice and education (GS1 Slovenia, Analysis of Educational Programmes – Secondary and higher vocational schools, 2024b).

Visibility (EPCIS) and 2D in Logistics

Increasing demands for transparency, digitalization and sustainable solutions in logistics are driving the adoption of more advanced approaches to data capture and sharing. Among the most cutting-edge GS1 standards in this area are EPCIS and GS1 Digital Link, combined with 2D barcodes such as GS1 QR and GS1 DataMatrix (GS1 AISBL, EPCIS and CBV Implementation Guideline 2.0, 2023).

Figure 3: Data capture and Exchange using EPCIS in the supply chain (source: internal)



EPCIS enables the recording and exchange of event data related to a product or logistics unit throughout the entire process – what happened, when, where and why (Figure 3). In logistics, this means the ability to monitor and document the movement of products and logistics units, scanning in warehouses, receipt at the customer, and integration with other systems for control, security and data quality. A critical requirement for such a system in an open environment is that business event data (typically logistics transactions) is recorded in a standardized format and made accessible through standardized interfaces. EPCIS data enables comprehensive documentation of the product journey, which is essential in sectors such as food, healthcare, pharmaceuticals and technical goods (GS1 AISBL, EPCIS and CBV Implementation Guideline 2.0, 2023).

Combined with 2D codes, such as the GS1 QR code, each product or logistics unit can carry a link on its packaging to structured data in digital form. This enables the integration of

information for internal logistics (SSCC, GTIN, LOT, etc.) with access to public data for consumers, customs authorities, retailers and others (GS1 AISBL, EPCIS and CBV Implementation Guideline 2.0, 2023).

The use of two-dimensional codes in logistics enables:

encoding more data in a smaller space,

faster and more reliable scanning,

support for warehouse and logistics centre automation and robotics,

compliance with European regulations such as the Eco-design for Sustainable Products Regulation (ESPR) and the Digital Product Passport (DPP).

EPCIS and GS1 Digital Link complement each other: EPCIS provides structured recording and exchange of event data in the supply chain, while GS1 Digital Link enables simple access to that data via a physical data carrier such as a 2D code. Together, they form the foundation of a modern data infrastructure for the logistics of the future (GS1 AISBL, EPCIS and CBV Implementation Guideline 2.0, 2023).

It is therefore essential that this content is gradually integrated into education – as a basis for understanding the operation of digital supply chain infrastructure at the level of individual products, logistics units and the broader logistics or information systems of companies (GS1 Slovenia, Analysis of Educational Programmes – Secondary and higher vocational schools, 2024b)..

GS1 Slovenia Academy

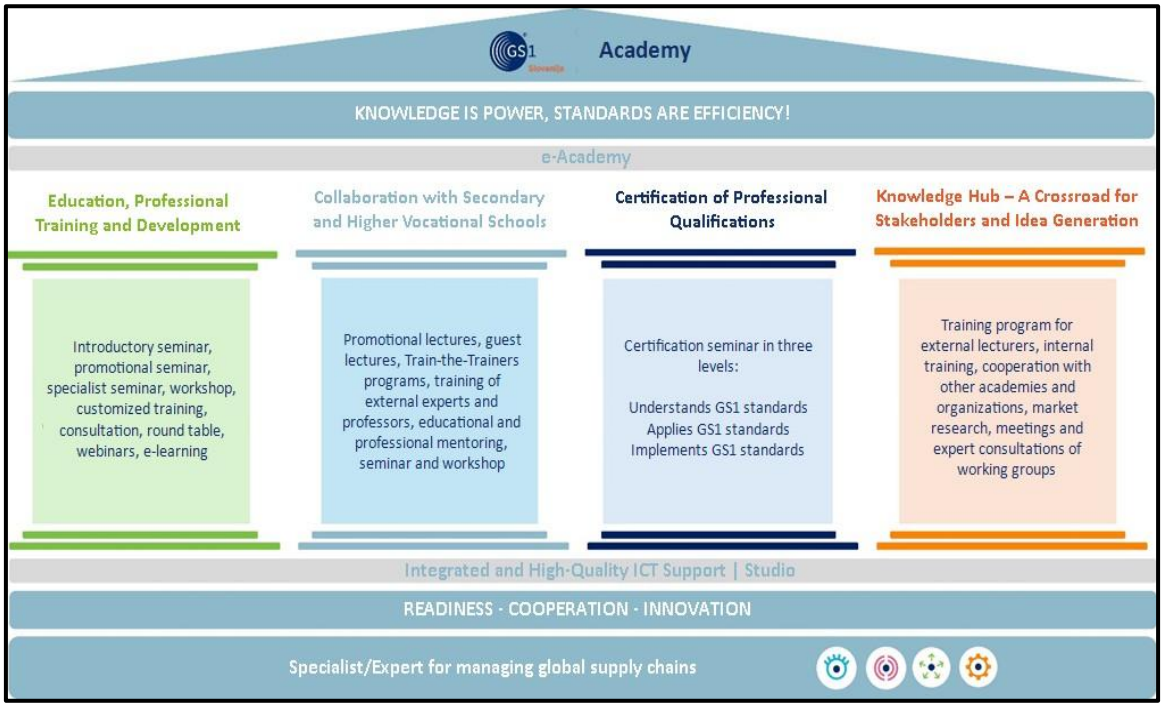
GS1 Slovenia is a national organization and member of the international GS1 network, which brings together 118 national organizations around the world. It is authorized to manage and develop GS1 standards in Slovenia and operates as an independent, non-profit and expert organization. GS1 Slovenia has over 3,800 members or users, primarily from the manufacturing and retail sectors, logistics and healthcare. Its mission is to support businesses in improving traceability, efficiency, interoperability and data quality in supply chain processes using GS1 standards and solutions (GS1 Slovenia, Strategy 2025–2028 – GS1 Slovenia Academy Activities, 2024a).

To achieve this, GS1 Slovenia has for many years not only supported the implementation of GS1 standards in practice, but also actively built a knowledge transfer system – especially in the fields of logistics engineering, IT, economics and food sciences – and across various industries, including retail, healthcare, railways, construction and banking (GS1 Slovenia, Strategy 2025–2028 – GS1 Slovenia Academy Activities, 2024a). A key step in this direction was the establishment of the GS1 Slovenia Academy, which acts as a specialized educational centre for all supply chain stakeholders – including students, teachers, professors and industry professionals (Figure 4).

The GS1 Academy is designed as a structured knowledge transfer model, divided into four pillars that together enable a comprehensive approach to competency development:

- Pillar 1: Education, professional training and improvement (introductory seminar, specialist seminar, tailored training for companies, etc.).
- Pillar 2: Cooperation with secondary and higher vocational schools and higher education institutions, where GS1 standards are integrated into curricula and learning modules in collaboration with secondary schools, higher vocational schools, colleges and universities.
- Pillar 3: Certification of professional qualifications through a structured system for assessing competencies, divided into multiple levels of complexity (Understands; Applies and Implements GS1 standards).
- Pillar 4: Knowledge Centre as a hub for stakeholders to co-create ideas, network, exchange practices, develop content and engage external experts (e.g. market research, expert group consultations, internal training, etc.).
-

Figure 4: GS1 Slovenia Academy (Source: (GS1 Slovenia, Strategy 2025–2028 – GS1 Slovenia Academy Activities, 2024a)



The GS1 Slovenia Academy delivers a wide range of activities, including seminars, workshops, e- learning courses, one-on-one consulting, the development of educational materials and more. Special emphasis is placed on logistics-related content, as this is where GS1 standards most clearly demonstrate their practical value – in labelling, traceability and visibility of logistics units, warehouse process management, digital documentation and data flow synchronization. The knowledge transferred by the Academy is not only intended for companies but is increasingly relevant for educational institutions that aim to equip their students with real-world tools they will encounter in practice (GS1 Slovenia, Strategy 2025–2028 – GS1 Slovenia Academy Activities, 2024a).

Integrating GS1 Standards into Educational Programmes

GS1 standards are not just a theoretical framework for modern logistics – they also represent concrete content that already appears in various forms within Slovenian educational programmes. In 2024, GS1 Slovenia, through its Academy, conducted a systematic analysis of secondary vocational and technical programmes (SSI, SPI) and higher vocational programmes (VSI), with the goal of identifying intersections between curriculum requirements and the content developed and delivered through the GS1 Slovenia Academy's educational offerings (GS1 Slovenia, Analysis of Educational Programmes – SSI, SPI, VSI, 2024b).

The analysis revealed that topics such as the unique identification of products and logistics units, goods traceability, automatic data capture and electronic business processes already appear in most curricula. These topics are especially prevalent in areas related to logistics, warehouse operations, supply chains and IT support. This confirms that integrating GS1 standards into curricula aligns with existing learning objectives – it is not an add-on or a diversion from programme goals (GS1 Slovenia, Analysis of Educational Programmes – SSI, SPI, VSI, 2024b).

GS1 standards are particularly well aligned with programmes such as:

- Logistics technician: understanding of goods labelling, standardization, traceability, use of different symbologies, warehouse management and global supply chains;
- Logistics engineering: labelling of transport and storage units, data capture technologies, and the application of standards in warehouse operations and logistics digitalization;
- Food science and nutrition, economics technician, computer science, etc., where topics such as product classification, traceability, labelling, electronic business, data quality and food labelling are addressed.

In addition to content alignment with learning objectives, it is important to note that students, teachers and professors have repeatedly expressed strong interest in integrating GS1-related content, real-life examples and practical tools, such as the textbook and workbook Managing Global Supply Chains. In response, the GS1 Slovenia Academy has developed educational modules that support practical understanding and application of these concepts in the context of real-world logistics environments.

We have signed a letter of intent with CPI – the Institute of the Republic of Slovenia for Vocational Education and Training – as well as with educational institutions, with a focus on adapting and developing teaching materials, modules and seminars that support these topics and make them easier to integrate into the educational process – without requiring changes to existing curricula.

Cooperation with Educational Institutions

Integrating GS1 standards into educational content is not just a theoretical possibility – it is already a reality at many secondary and higher vocational schools in Slovenia. The GS1 Slovenia Academy is committed to ensuring that GS1-related topics do not remain confined to the business environment but become an integral part of the educational process – through concrete collaboration with educational institutions, professors and both secondary school

and university-level students (GS1 Slovenia, Strategy 2025–2028 – GS1 Slovenia Academy Activities, 2024a).

One of the key forms of such collaboration are training seminars specifically designed for teachers. These seminars provide professors with a structured overview of standardization, identification, labelling and digital traceability, and equip them to independently transfer this knowledge to their students. In cooperation with the Institute of the Republic of Slovenia for Vocational Education and Training (CPI), the Academy also conducts expert training for members of curriculum working groups involved in the development and renewal of educational programmes.

The GS1 Academy also offers certification of knowledge related to GS1 standards through a clearly structured three-level system: understanding, applying and implementing GS1 standards. Upon successful completion, participants receive an international GS1 certificate as proof of their qualification to work with GS1 standards. The certification system is unified across all target groups – from professors, students and pupils to professionals in industry – and is conducted either during scheduled sessions or in collaboration with individual schools and institutions (GS1 Slovenia, Strategy 2025–2028 – GS1 Slovenia Academy Activities, 2024a).

Together with professors, the Academy also co-develops practical teaching materials and modules that can be directly integrated into regular lessons. These materials cover content ranging from the basic concepts of product identification to real-world examples of labelling, interpreting logistics labels and using data carriers in practice. The modules are designed to be used independently by teachers or in combination with other regular curriculum content.

Some schools have also hosted project days and professional site visits, during which students actively engaged in solving real-world challenges, explored the use of GS1 standards in warehouses, retail or production environments, and learned about emerging digital trends such as 2D barcodes, traceability and visibility, and the Digital Product Passport. These experiences are a valuable complement to the standard curriculum and contribute to greater student motivation to acquire this type of knowledge. Most importantly, they realize how essential this knowledge is – and that without it, they will not be fully prepared for the demands of the workplace.

Table 1: Examples of Good Practices in Integrating GS1 Content into Secondary and Higher Vocational Schools

Activity	Focus/Content	Participating Institution(s)
International Student Case Study Competition	Applying GS1 standards in practice, case-solving	Faculty of Organizational Sciences, University of Maribor (FOV UM), GS1 Slovenia
Project Day at the Faculty of Logistics	Professional guidance on proper and efficient data handling	Faculty of Logistics, University of Maribor
Lifelong Learning Week – Expert Lecture	"Without GTIN, barcodes and quality data, things no longer work"	Higher Vocational College, School Centre Kranj
Innovative Teaching Methods	Pilot GS1 content in a VR simulation	GS1 Slovenia, VIAR, Spar Slovenia
Project Day during Entrepreneurship Week at Vegova Gymnasium	"School Online Store" and GS1 Slovenia	Faculty of Organizational Sciences UM and Vegova Ljubljana – Secondary School for Electrical Engineering and Computer Science
Guest Lecture (UGPV0, UGPV1)	Introduction to GS1 standards for secondary students (Years 1–3)	Nova Gorica School Centre – School of Mechanical Engineering, Transport and Woodworking

One example of good practice we would like to highlight is an educational day held this spring at the School of Mechanical Engineering, Transport and Woodworking, part of the Nova Gorica School Centre. The event was designed for students of the Logistics Technician programme from years 1 to 3. During two school hours, a total of 75 students participated in a blended format of lectures and workshops.

In the first part, year 1 students explored the basics of GS1 standards with a lecturer through practical examples from everyday life and industry, while year 2 and 3 students worked with another lecturer to reinforce their existing knowledge through discussion and real-life case studies. In the second part of the session, all students came together and actively engaged in analysing good and poor practices in logistics – including the labelling of logistics units, the use of 2D barcodes, electronic delivery notes and other logistics documentation.

Students responded very positively to the session, participating actively in discussions and especially enjoying the interactive quizzes. The teacher also expressed great satisfaction with the session and proposed continuing the collaboration in the following school year.

Through this type of activity, the GS1 Slovenia Academy actively supports educational institutions in introducing content that aligns with curriculum objectives while also connecting theoretical knowledge with real-world industry processes. In doing so, it builds a living bridge between education and practice – one that contributes not only to greater competence among students but also to the long-term competitiveness of Slovenia's logistics sector.

Conclusion

The logistics sector is evolving at a rapid pace, requiring the education system to continuously adapt its content and approaches to reflect the real needs of industry. GS1 standards represent the foundation of modern logistics infrastructure and the digital supply chain. Knowledge, understanding and application of these standards are becoming key competencies that employers across various sectors increasingly expect.

In this context, it is essential for educational institutions to collaborate with companies and practitioners who can contribute to the relevance and applicability of teaching content. The GS1 Slovenia Academy supports exactly this – a structured and professionally guided transfer of knowledge from practice into the classroom.

We provide secondary and higher vocational schools with expert support for integrating global GS1 standards into their educational processes. This is achieved through the development of learning modules, the delivery of training and a certification system aligned with curriculum objectives – enabling students to acquire knowledge that is directly applicable in their future careers.

By connecting business, education and standardization, we are building a bridge between theory and practice and contributing to the long-term competitiveness of Slovenia's logistics sector – through the knowledge, understanding and use of international GS1 standards.

References and Literature

1. GS1 AISBL (2025a). *GS1 General Specifications*, Version 25.0 https://ref.gs1.org/standards/genspecs/ (last accessed 24. July 2025)
2. GS1 AISBL(2025b). GS1Overview Presentation

https://mozone.gs1.org/docs/GS1_overview_slides.pptx (last accessed 23. July 2025)

3. GS1 AISBL (2023). *EPCIS and CBV Implementation Guideline*, Release 2.0 https://ref.gs1.org/guidelines/epcis-cbv/2.0.0/
4. GS1 Slovenija (2025a). GTIN – Globalna trgovinska številka izdelka

https://www.gs1si.org/standardi/gtin (last accessed 23. July 2025)

5. GS1 Slovenija (2025b). SSCC – Zaporedna koda zabojnika

https://www.gs1si.org/standardi/sscc (last accessed 22. July 2025)

6. GS1 Slovenija (2025c). GLN – Globalna lokacijska številka

https://www.gs1si.org/standardi/gln (last accessed 22. July 2025)

7. GS1 Slovenija (2025d). Identifikacijski ključi GS1

https://www.gs1si.org/standardi/stevilke-gs1/id-kljuci (last accessed 22. July 2025)

8. GS1 Slovenija (2025e, 22. July). *EPCIS* https://www.gs1si.org/standardi/EPCIS
9. GS1 Slovenija (2025f). *Matični podatki* https://www.gs1si.org/standardi/izmenjava- podatkov/maticni-podatki (last accessed 23. July 2025)
10. GS1 Slovenija (2025g). *Digitalni potni list izdelka* https://www.gs1si.org/trajnost/dpp (last accessed 24. July 2025)
11. GS1 Slovenija (2024a). Strategija GS1 Slovenija 2025–2028 – dejavnost Akademija GS1 Slovenija, Ljubljana
12. GS1 Slovenija (2024b). Analiza izobraževalnih programov SSI, SPI, VSI.

Prometna šola Maribor Preradovičeva 33
2000 Maribor

Bogomir Brečko, dipl. inž. prom.

SLEDENJE Z UVAJANJEM DIGITALNIH POTNIH LISTOV IZDELKOV

TRACKING BY DIGITAL PRODUCT PASSPORTS IMPLEMENTATION

Povzetek:

V prispevku je predstavljeno sledenje z uvajanjem digitalnih potnih listov izdelkov. V času, ko trajnost, transparentnost in sledljivost postajajo ključni dejavniki konkurenčnosti, se podjetja vse bolj obračajo k digitalnim rešitvam za upravljanje življenjskega cikla izdelkov. Ena izmed najobetavnejših inovacij na tem področju je digitalni potni list izdelka (DPP – Digital Product Passport), ki omogoča celovito sledenje podatkov o izdelku od zasnove do konca njegove življenjske dobe.

Ključne besede: *sledenje, digitalni potni list izdelka, DPP – Digital Product Pasport, trajnost.*

Summary:

This article presents tracking with the introduction of digital product passports. At a time when sustainability, transparency and traceability are becoming key factors in competitiveness, companies are increasingly turning to digital solutions for product lifecycle management. One of the most promising innovations in this area is the Digital Product Passport (DPP), which enables comprehensive tracking of product data from design to the end of its life.

Keywords: *tracking, digital product passport, DPP – Digital Product Passpor, sustainability.*

1 UVOD

Digitalni potni list izdelka (DPP, angl. **Digital Product Passport**) je pomembno orodje za prehod v krožno in trajnostno gospodarstvo. Podjetjem omogoča preverjanje, upravljanje in izboljšanje trajnosti svojih izdelkov. Je digitalna identiteta fizičnega izdelka, ki omogoča dostop do ključnih informacij o izdelku skozi njegov celotni življenjski cikel.

Potni list izdelka je strukturiran dokument, ki vsebuje ključne informacije o izdelku, kot so:

- sestava in materiali,
- poreklo surovin in kraji proizvodnje,
- proizvajalec in odgovorne osebe,
- navodila za uporabo in vzdrževanje,
- možnosti popravila in reciklaže,
- vplivi na okolje,
- certifikati in skladnosti z zakonodajo.

Gre za orodje, ki povečuje preglednost v celotni dobavni verigi in je pogosto zahtevan v kontekstu **trajnostne proizvodnje** ali **zakonodaje EU** (npr. digitalni potni list izdelka – *Digital Product Passport* – kot del Zelenega dogovora).

2 PRAVNA UREDITEV DPP

Pravna ureditev se nanaša na sistem zakonov, pravil in institucij, ki urejajo družbeno življenje z določenim pravnim redom. V Sloveniji **ni posebne nacionalne zakonodaje**, ki bi neposredno urejala digitalni potni list izdelka (DPP). Pravna ureditev za DPP izhaja iz zakonodaje EU, ki se v Sloveniji uporablja neposredno kot del pravnega reda.

Temeljno pravno ogrodje EU za digitalni potni list izdelka (DPP) vključuje:

- **Uredbo o okoljsko primerni zasnovi trajnostnih izdelkov (**angl. **Ecodesign for Sustainable Products Regulation (ESPR)** – glavni regulatorni okvir, sprejet v letu 2024 (Regulacija (EU) 2024/1781), ki vzpostavlja osnovne zahteve za uvedbo DPP za trajnostne izdelke.
- **Construction Products Regulation (CPR)** – (Regulacija (EU) 2024/1305), kjer so specifike DPP vključene za gradbeni sektor.
- **General Product Safety Regulation (GPSR)** – (Regulacija (EU) 2023/988), ki sicer ureja splošno varnost izdelkov, dopušča pa tudi digitalni format tehnične dokumentacije (tehnični dosje), ki je v nekaterih primerih lahko DPP.

3 KAJ JE POTNI LIST IZDELKOV (DPP)

Digitalni potni list izdelka je elektronski dokument, ki vsebuje podrobne in standardizirane informacije o izdelku skozi celoten njegov življenjski cikel. Cilj je omogočiti večjo sledenje, transparentnost, krožnost in trajnost izdelkov v EU in širše.

Je digitalna identiteta fizičnega izdelka, ki omogoča dostop do ključnih informacij o izdelku

skozi njegov celotni življenjski cikel. Je pomembno orodje za prehod v krožno in trajnostno gospodarstvo, saj podjetjem omogoča preverjanje, upravljanje in izboljšanje trajnosti svojih izdelkov.

Primer videoposnetka je dostopen na https://www.youtube.com/watch?v=pB-ryTwPrKU (20.3.2025)

3. 1 Ključne značilnosti DPP

Potni list je dostopen prek QR kode ali druge oblike digitalne identifikacije na izdelku (Slika 1).

Vsak izdelek ima preko digitalnega potnega lista svojo edinstveno in globalno identiteto, ki je povezana z enim ali več standardiziranimi viri podatkov. Ti vključujejo informacije o sestavi, izvoru, trajnosti, popravljivosti, navodilih za uporabo, garanciji, recikliranju in drugih vidikih izdelka.

Potni list izdelka je strukturiran dokument, ki vsebuje ključne informacije o izdelku, kot so:

- Sestava in materiali
- Poreklo surovin in kraji proizvodnje
- Proizvajalec in odgovorne osebe
- Navodila za uporabo in vzdrževanje
- Možnosti popravila in reciklaže
- Vplivi na okolje
- Certifikati in skladnosti z zakonodajo

Gre za orodje, ki povečuje preglednost v celotni dobavni verigi in je pogosto zahtevan v kontekstu **trajnostne proizvodnje** ali **zakonodaje EU** (npr. kot del Zelenega dogovora).

Digitalni potni list je pomemben ker:

- **Podpira krožno gospodarstvo**

  Omogoča ponovno uporabo, recikliranje in popravilo izdelkov.

- **Izboljšuje informiranost potrošnikov**

  Kupci lahko preverijo sestavo, trajnost in izvor izdelka.

- **Skladnost z zakonodajo EU**

  Postaja zakonsko obvezen za določene vrste izdelkov.

- **Učinkovitejše ravnanje z odpadki**

  Olajša razvrščanje in recikliranje izdelkov na koncu njihove življenjske dobe.



Slika 1: Primer DPP

Vir: https://racunalniske-novice.com/od-preproste-crtne-kode-do-digitalnega-potnega-lista/

3. 2 Primer uporabe DPP

Primer osnovnega potnega lista izdelka (Slika 2)

Podatek	Vsebina
Ime izdelka	Npr. Pametni telefon X100
Model/Serijska št.	X100-BL-2025
Proizvajalec	Tehno d.o.o., Ljubljana, Slovenija
Datum izdelave	12. april 2025
Materiali in komponente	Aluminij, litij-ionska baterija, steklo, plastika
Poreklo komponent	Litij iz Čila, aluminij iz Norveške, sestavljanje v Sloveniji
Certifikati	CE, RoHS, ISO 14001
Navodila za uporabo	Priložena knjižica / QR koda
Vzdrževanje in popravila	Možna menjava baterije in zaslona, rezervni deli na voljo 5 let
Možnosti reciklaže	Reciklažni centri, program vračila izdelka
Okoljski vpliv	CO_2 odtis 12,3 kg / izdelek, energijska učinkovitost razred A



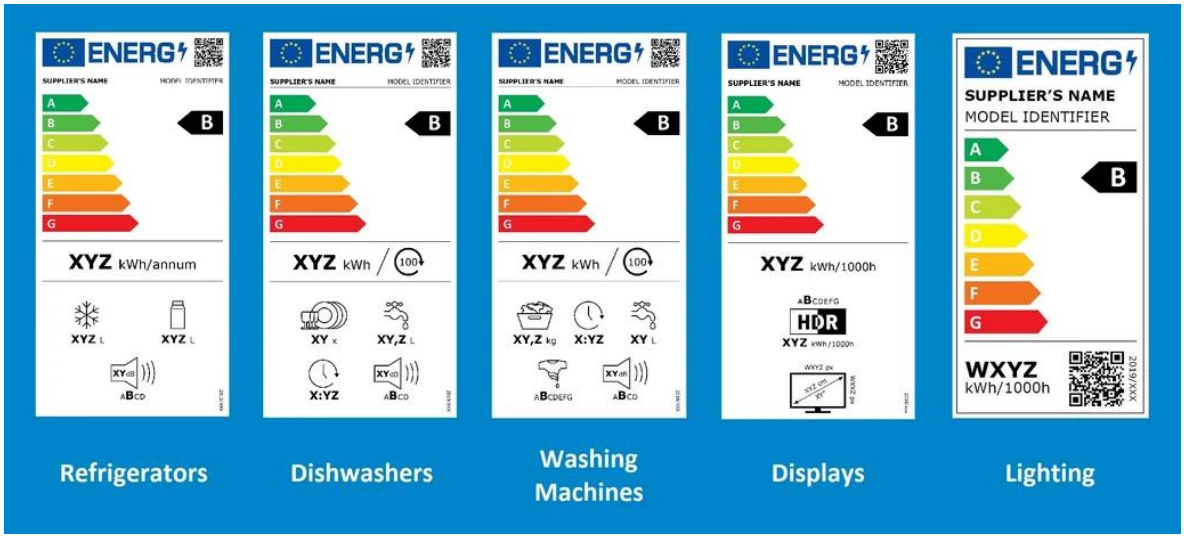
Slika 2: Pametni telefon x100

Vir: https://www.ceneje.si/Izdelek/46128553/telefonija/mobilni-telefoni-oprema/mobilni-telefoni/vivo-pametni-telefon-x100-pro-16gb512gb-asteroid-black

3. 3 Tveganje za poslovanje – katere panoge so zajete?

Obveznost uvedbe DPP se postopoma širi:

- Baterije – posebni "Battery Passport" bo obvezen od februarja 2027.
- Tekstil, oblačila, obutev, elektronika (Slika 4), gradbeni material, barve, detergenti, železo, jeklo, pohištvo, gume, maziva, kemikalije upoštevanje DPP bo postopno uvedeno med 2026 in 2030.
- DPP je že zdaj obvezen za določene baterije (Battery Passport).
- Načrtujejo se obsežnejši seznam – predvideva se, da bo vključenih približno 30 kategorij izdelkov do 2030.
-



Slika 4: Energijske nalepke EU za različne vrste elektronike

Vir: https://www.plytix.com/blog/digital-product-passport-dpp

3. 4 Tehnične zahteve in standardi

- DPP mora biti strogo berljiv, strukturen in interoperabilen – z uporabo odprtih standardov. (Slika 3).
- Podatki vključujejo: **unikaten identifikator**, TARIC / GTIN kode, dokumentacijo o skladnosti, sestavo, navodila za uporabo, varnost, navodila za popravljanje, recikliranje itd.
- Standardizacijska telesa **CEN, CENELEC, ETSI** pripravljajo konzistentne norme, ki jih morajo nacionalna telesa prenesti v zakonodajo.
- GS1 igra ključno vlogo pri identifikaciji in izmenjavi podatkov.



Slika 3: Primer berljivosti DPP

Vir: https://www.femmeactuelle.fr/mode/news-mode/eco-score-quelle-est-cette-nouvelle-note-que-lon-retrouvera-bientot-sur-les-etiquettes-de-nos-vetements-2171037

4 ZAKLJUČEK

Digitalni potni list izdelka predstavlja pomemben korak k bolj trajnostni, transparentni in pametni industriji. Čeprav je pot do popolne implementacije še dolga, je jasno, da bo **DPP** (Slika 5) igral ključno vlogo pri oblikovanju prihodnosti proizvodnje in potrošnje. Podjetja, ki se bodo pravočasno prilagodila, bodo imela pomembno prednost v novem digitalnem ekosistemu.

Kljub številnim prednostim uvajanje digitalnih potnih listov ni brez izzivov. Potrebno bo zagotoviti:

- **standardizacijo podatkov,**
- **zaščito podatkov** (zagotovljena morata biti varnost in zasebnost podatkov),
- **tehnično infrastrukturo** (podjetja bodo morala investirati v digitalne platforme in usposabljanje kadrov),
- **sodelovanje deležnikov** (uspešna implementacija zahteva sodelovanje med proizvajalci, dobavitelji, regulatorji in potrošnik).



Slika 5: Promocija DPP

Vir: https://www.ebc-construction.eu/news/digitalisation-ebc-responds-to-consultation-on-requirements-for-digital-product-passport-service-providers/

5 REFERENCE

[1] Digitalisation: EBC responds to consultation on requirements for Digital Product Passport service providers

Dostopno na: https://www.ebc-construction.eu/news/digitalisation-ebc-responds-to-consultation-on-requirements-for-digital-product-passport-service-providers/ (10.2.2025)

[2] Digital Product Passport: What You Need to Know About the DPP

Dostopno na: https://www.plytix.com/blog/digital-product-passport-dpp

[3] GS1 Slovenija

Dostopno na: https://www.gs1si.org/iskalnik?query=digitalni%20potni%20list&tab=articles-novice [25.3.2025]

[4] Zdaj bodo celo izdelki imeli potne liste - digitalne.

Dostopno na:

https://www.gzs.si/Portals/SN-informacije-Pomoc/Vsebine/GG/2022/november/23-24.pdf [26.3.2025]

prometna šola maribor
srednja prometna šola

Traffic School Maribor Preradovičeva 33

2000 Maribor

Bogomir Brečko, BSc. Eng. Prom.

TRACKING BY DIGITAL PRODUCT PASSPORTS IMPLEMENTATION

Summary:

This paper presents tracking with the introduction of digital product passports. At a time when sustainability, transparency and traceability are becoming key factors in competitiveness, companies are increasingly turning to digital solutions for product lifecycle management. One of the most promising innovations in this area is the Digital Product Passport (DPP), which enables comprehensive tracking of product data from design to the end of its life.

***Keywords** : tracking, digital product passport, DPP – Digital Product Passport, sustainability.*

1 INTRODUCTION

The Digital Product Passport (DPP) is an important tool for the transition to a circular and sustainable economy. It allows companies to check, manage and improve the sustainability of their products. It is the digital identity of a physical product that provides access to key information about the product throughout its entire life cycle.

A product passport is a structured document that contains key information about a product, such as:

- sixth in materials,
- origin of raw materials and places of production,

- the manufacturer and responsible persons,
- instructions for use and maintenance,
- repair and recycling options,
- environmental impacts,
- certifications and legal compliance.

It is a tool that increases transparency throughout the supply chain and is often required in the context **of sustainable production** or **EU legislation** (e.g. *the Digital Product Passport* as part of the Green Deal).

2 LEGAL REGULATION OF THE DPP

Legal regulation refers to a system of laws, rules and institutions that govern social life with a specific legal order. There **is no specific national legislation in Slovenia** that directly regulates the Digital Product Passport (DPP). The legal regime for DPP derives from EU legislation, which is directly applicable in Slovenia as part of the acquis.

The EU's basic legal framework for the Digital Product Passport (DPP) includes:

- **The Ecodesign for Sustainable Products Regulation (**ESPD) **Ecodesign for Sustainable Products Regulation (ESPR)** – the main regulatory framework adopted in 2024 (Regulation (EU) 2024/1781), which establishes the basic requirements for the introduction of DPPs for sustainable products.
- **Construction Products Regulation (CPR)** – (Regulation (EU) 2024/1305), where the specifics of the DPP are included for the construction sector.
- **General Product Safety Regulation (GPSR)** – (Regulation (EU) 2023/988), which, while regulating the general safety of products, also allows for a digital format of technical documentation (technical dossier), which in some cases may be a DPP.

3 WHAT IS A PRODUCT PASSPORT (DPP)

A digital product passport is an electronic document that contains detailed and standardized information about a product throughout its entire life cycle. The aim is to enable greater traceability, transparency, circularity and sustainability of products in the EU and beyond.

It is the digital identity of a physical product that provides access to key information about the product throughout its entire life cycle. It is an important tool for the transition to a circular and sustainable economy, as it allows companies to verify, manage and improve the sustainability of their products.

An example video is available at https://www.youtube.com/watch?v=pB-ryTwPrKU (20.3.2025

3. 1 Key features of DPP

The passport is accessible via a QR code or other form of digital identification on the product (Figure 1).

Through a digital passport, each product has its own unique and global identity, which is linked to one or more standardized data sources. These include information on the

composition, origin, durability, reparability, instructions for use, warranty, recycling and other aspects of the product.

A product passport is a structured document that contains key information about a product, such as:

- Sexuera in materials
- Origin of raw materials and places of production
- Manufacturer and responsible persons
- Instructions for use and maintenance
- Repair and recycling options
- Environmental impacts
- Certifications and legal compliance

It is a tool that increases transparency throughout the supply chain and is often required in the context **of sustainable production** or **EU legislation** (e.g. as part of the Green Deal).

A digital passport is important because:

- Supports the circular economy

Allows products to be reused, recycled and repaired.

- Improves consumer information

Customers can check the composition, durability and origin of the product.

- Compliance with EU legislationIt remains

Legally mandatory for certain types of products.

- More efficient waste management

Makes it easier to sort and recycle products at the end of their life.



Figure 2: First DPP

Source: https://racunalniske-novice.com/od-preproste-crtne-kode-do-digitalnega-potnega-lista/

3. 2 Example of the use of DPP

Example of a basic product passport (Figure 2)

Information	Content
Product Name	E.g. X100 smartphone
Model/Serial No.	X100-BL-2025
Manufacturer	Tehno d.o.o., Ljubljana, Slovenija
Date of manufacture	April 12, 2025
Component materials	Aluminum, lithium-ion battery, glass, plastic
Origin of components	Lithium from Chile, aluminium from Norway, assembly in Slovenia
Certificates	CE, RoHS, ISO 14001
Instructions for use	Booklet / QR code included
Maintenance and repairs	Battery and screen replacement possible, spare parts available for 5 years
Recycling options	Recycling centers, product return program

Information	Content
Environmental impact	CO_2 footprint 12.3 kg / product, energy efficiency class A



Figure 2: Smartphone x100

Source: https://www.ceneje.si/Izdelek/46128553/telefonija/mobilni-telefoni-oprema/mobilni-telefoni/vivo-pametni-telefon-x100-pro-16gb512gb-asteroid-black

3. 3 Business risk – which industries are covered?

The obligation to introduce a DPP is gradually expanded:

- **Batteries** – a special "Battery Passport" will be mandatory from February 2027.
- Textiles, clothing, footwear, electronics (Figure 3), building materials, paints, detergents, iron, steel, furniture, rubbers, lubricants, chemicals compliance with the DPP will be phased in between 2026 and 2030.
- DPP is already mandatory for certain batteries (Battery Passport).
- A more extensive list is planned – it is envisaged that around 30 product categories will be included by 2030.

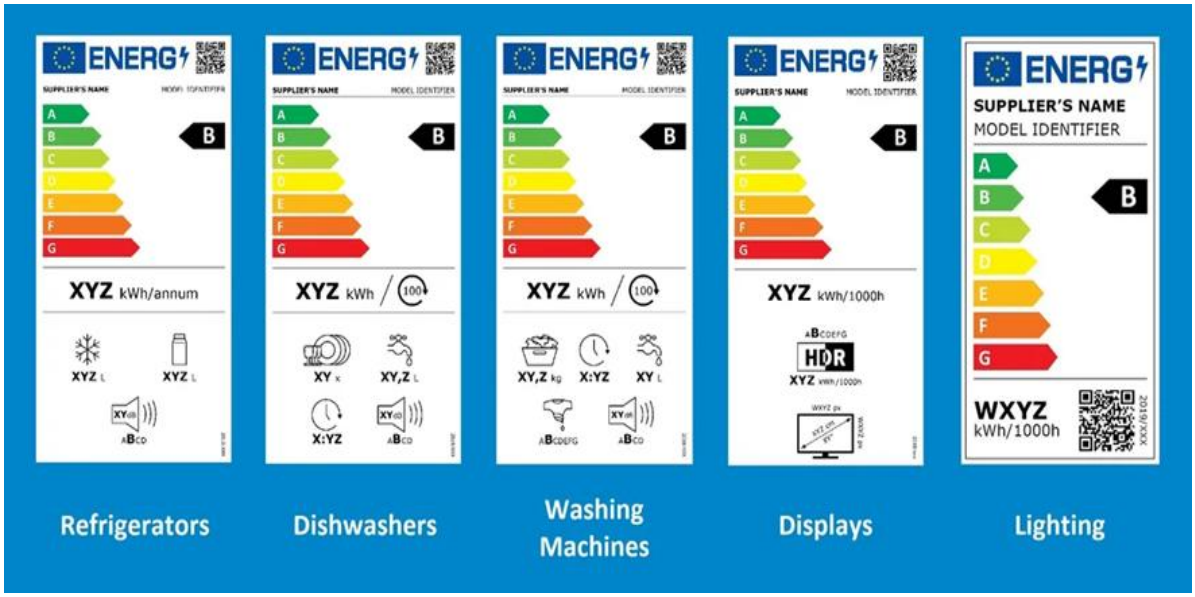


Figure 3: EU energy labels for different types of electronics

For: https://www.plytix.com/blog/digital-product-passport-dpp

3. 4 Technical requirements and standards

- The DPP must be strictly readable, structural and interoperable – using open standards. (Figure 4).
- Data includes: **unique identifier**, TARIC/GTIN codes, compliance documentation, composition, instructions for use, safety, repair instructions, recycling, etc.
- The standardisation bodies **CEN, CENELEC, ETSI** draw up consistent norms that national authorities have to transpose into law.
- GS1 plays a key role in identifying and exchanging data.

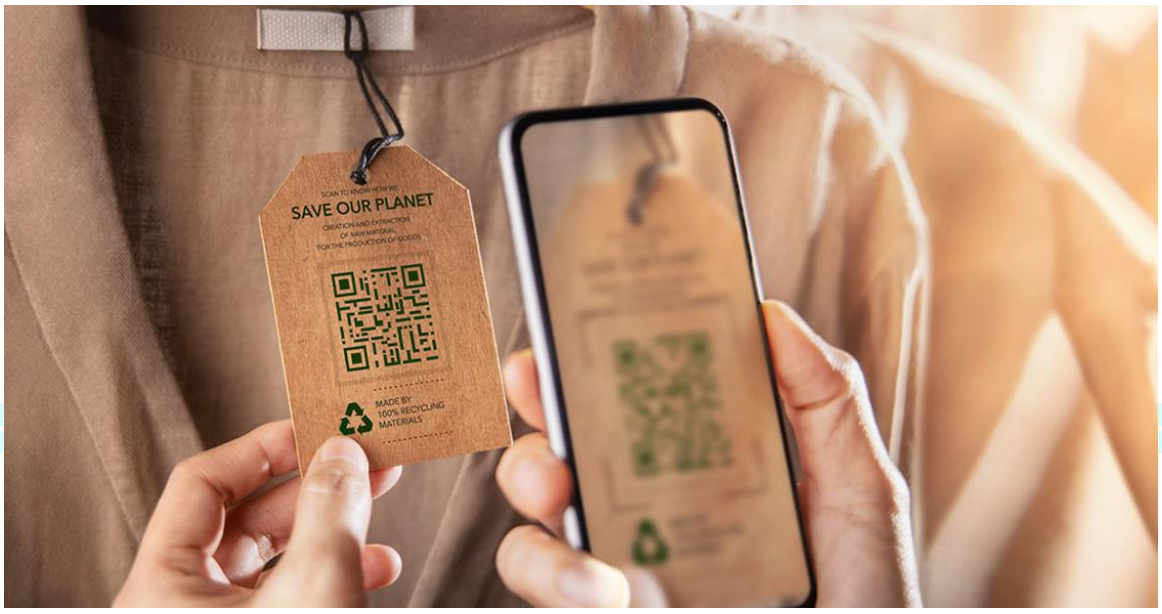


Figure 4: Example of readability of DPP

Vir: https://www.femmeactuelle.fr/mode/news-mode/eco-score-quelle-est-cette-nouvelle-note-que-lon-retrouvera-bientot-sur-les-etiquettes-de-nos-vetements-2171037

4 CONCLUSION

The Digital Product Passport represents an important step towards a more sustainable, transparent and smart industry. Although there is still a long way to go for full implementation, it is clear that the **DPP** (Figure 5) will play a key role in shaping the future of production and consumption. Companies that adapt in a timely manner will have an important advantage in the new digital ecosystem.



Figure 5: Promotion of the DPP

Vir: https://www.ebc-construction.eu/news/digitalisation-ebc-responds-to-consultation-on-requirements-for-digital-product-passport-service-providers/

Despite its many benefits, the adoption of digital passports is not without its challenges. It will be necessary to provide:

- **standardisation of data**;
- **data protection** (data security and privacy must be ensured),
- **technical infrastructure** (companies will have to invest in digital platforms and staff training);
- **stakeholder engagement** (successful implementation requires collaboration between manufacturers, suppliers, regulators and the consumer).

5 REFERENCE

[5] Digitalisation: EBC responds to consultation on requirements for Digital Product Passport service providers

Available at: https://www.ebc-construction.eu/news/digitalisation-ebc-responds-to-

consultation-on-requirements-for-digital-product-passport-service-providers/ [10.2.2025]

[6] Digital Product Passport: What You Need to Know About the DPP

Available at: https://www.plytix.com/blog/digital-product-passport-dpp [3.3.2025]

[7] GS1 Slovenija

Available at: https://www.gs1si.org/iskalnik?query=digitalni%20potni%20list&tab=articles-novice [25.3.2025]

[8] Now even products will have passports - digital.

Available at:

https://www.gzs.si/Portals/SN-informacije-Pomoc/Vsebine/GG/2022/november/23-24.pdf [26.3.2025]

Maja Šajn , dipl. ing.
Obrtnička i tehnička škola Ogulin
Svjetlana Glad , dipl. ing.
Tanja Burić , dipl. ing.
Željeznička tehnička škola Moravice

SIGURNO PRUGOM – UGROŽENOST ADOLESCENATA PRI KRETANJU ŽELJEZNIČKOM PRUGOM

Sažetak

Svako kretanje uz željezničku prugu ili prelazak preko željezničke pruge može predstavljati izvor opasnosti.

Najveći rizik predstavljaju željezničko cestovni prijelazi koji su izgrađeni u istoj razini s željezničkom prugom. S obzirom na način osiguranja željezničko cestovnih prijelaza u istoj razini veliku opasnost predstavljaju neosigurani prijelazi.

Nepažnja pri kretanju cestovnim vozilima preko željezničko cestovnih prijelaza kao i kretanje pješaka mogu izazvati teške posljedice (ozljede i smrtnost).

Izvor opasnosti predstavlja i namjerni kontakt s izvorima električnog napona na željezničkim prugama. Važno je educirati adolescente u cilju sprečavanja možebitno nastalih nezgoda i nesreća.

U ovom radu dati ćemo osvrt na vrste željezničko cestovnih prijelaza u RH kao i na izvore opasnosti koji prijete adolescentima pri prijelazu istih.

Ključne riječi: pruga, sigurnost, željezničko cestovni prijelazi, osigurani prijelazi , neosigurani prijelazi, adolescenti.

1. Željezničko – cestovni prijelazi u razini

Željezničko-cestovnim prijelazom u razini naziva se mjesto prijelaza cestovne prometnice preko željezničke pruge ili industrijskoga kolosijeka, odnosno, građevinski gledano, mjesto križanja kolnika i gornjega ruba tračnice. Iz toga proizlazi kako je željezničko-cestovni prijelaz mjesto neposrednoga sučeljavanja željezničkoga i cestovnoga prometa pa s gledišta sigurnosti predstavlja potencijalnu točku visokoga rizika. Kako bi se osiguralo nesmetano odvijanje prometa željezničko-cestovni prijelazi moraju biti propisno osigurani. Osnovna podjela osiguranja željezničko-cestovnih prijelaza podrazumijeva pasivno i aktivno osiguranje (slika 1).

Aktivnim se osiguranjem željezničko-cestovnih prijelaza smatra svaki način osiguranja koji reagira promjenom svoga stanja (svjetlosno-zvučnoga ili zaštitnoga) pri nailasku željezničkoga vozila.

Pasivnim osiguranjem smatra se svaki prijelaz koji je opremljen bilo kojim znakom upozorenja, uređajima ili nekom drugom zaštitnom opremom koja je stalna i koja se ne mijenja u ovisnosti o bilo kojoj prometnoj situaciji.



Slika 1: Podjela osiguranja željezničko-cestovnih prijelaza

1.1.Aktivno osigurani željezničko-cestovni prijelazi

Aktivno osiguranim ŽCP-ima se smatraju prijelazi koji su osigurani nekom vrstom svjetlosne, zvučne ili mehaničke signalizacije koja mijenja svoje stanje s obzirom na utjecaj prometa, odnosno koja mijenja svoje stanje s obzirom na približavanje vlaka samom prijelazu. U aktivna tehnička sredstva spadaju svjetlosni uređaji, zvučna signalizacija, polubranici i branici, odnosno bilo koja kombinacija navedenih (slika 2).



Slika 2: Aktivno osigurani željezničko-cestovni prijelaz

1.2.Pasivni željezničko-cestovni prijelazi

Pasivni željezničko-cestovni prijelazi su prijelazi bez ikakvog sustava upozorenja i/ili zaštite koji se aktivira kada prijelaz preko njega nije siguran za korisnike (slika 3).



Slika 3: Pasivni željezničko cestovni prijelaz

2.Vrste osiguranja na željezničko-cestovnim prijelazima

Od ukupno 1521 prijelaza njih 897 (oko 60 %) osigurano je prometnim znakovima (Andrijinim križem i znakom STOP), 71 mehaničkim branicima (oko 5 %), 140 svjetlosnim i zvučnim signalima (oko 9 %), a 341 svjetlosnim i zvučnim signalima i polubranicima (oko 23 %). Preostala 72 prijelaza su pješački prijelazi osigurani mimoilaznim ogradama među kojima je njih 11 osigurano i svjetlosnim i zvučnim signalima za pješake (gotovo 5 %).

3.Analiza incidenata na željezničko-cestovnim prijelazima

Rezultati analiza incidenata na željezničko - cestovnim prijelazima HŽ Infrastrukture upućuju na zaključak kako modernizacija osiguranja ne implicira i nužno smanjenje broja nesreća odnosno povećanje tehničke razine osiguranja, nažalost, ne rezultira i proporcionalnim smanjenjem broja nesreća. Naime, od ukupno 29 ozbiljnih nesreća/nesreća u 2013. njih čak 14 dogodilo se na ŽCP-ima osiguranima signalno – sigurnosnim uređajima (ima ih 552), a 15 na prijelazima osiguranima Andrijinim križem i znakom STOP (njih 897).

4.Stanje sigurnosti na željezničko-cestovnim prijelazima u republici hrvatskoj

HŽ Infrastruktura d.o.o. kao upravitelj željezničkom infrastrukturom u Republici Hrvatskoj odgovorna je za organiziranje i reguliranje željezničkog prometa, a njegova sigurnost osnovno je opredjeljenje cijeloga sustava. Cjelokupni sustav sigurnosti kontinuirano se prati, analiziraju se uzorci i posljedice izvanrednih događaja, a provodi se i niz drugih aktivnosti propisanih politikom sigurnosti HŽ infrastrukture.

Nesreća na željezničko-cestovnom prijelazu je svaka nesreća u kojoj sudjeluje najmanje jedno željezničko vozilo te jedno ili više vozila koja prelaze preko prijelaza, drugi korisnici prijelaza, kao što su pješaci, ili drugi objekti koji se privremeno nalaze na pruzi ili u njezinoj blizini, ako su ispali iz vozila ili su ih izgubili korisnici tijekom prelaska preko prijelaza. Ujedno je nesreća i izvanredni događaj u željezničkome prometu sa štetnim posljedicama kao što su teške tjelesne ozljede do četiriju osoba te materijalna šteta koja se može procijeniti na vrijednost do dva milijuna eura .

Tablica 1. prikazuje broj ozbiljnih nesreća na željezničko-cestovnim prijelazima u razdoblju od 2016. do 2021.

OZBILJNE NESREĆE		2016.	2017	2018	2019	2020.	2021	*prosjek 2016.-2020.*
NA ŽCP	a) promet osiguran SS uređajem	0	5	5	3	2	3	*3,00*
	b) promet osiguran prometnim znacima	2	1	2	2	2	2	*1,80*
	c) pješački prijelaz	0	0	0	1	0	1	*0,20*
Ukupno ŽCP (a+b+c):		2	6	7	6	4	6	*5,00*

Tablica 1: Broj ozbiljnih nesreća na željezničko-cestovnim prijelazima u razdoblju od 2016. do 2021. Izvor: Analiza izvanrednih događaja u 2021. godini – HŽ Infrastruktura d.o.o.

Pružni prijelazi predstavljaju značajan sigurnosni izazov i za cestovni i za željeznički promet, iako je željeznički promet među najsigurnijim načinima prijevoza. Iako postoji trend smanjenja broja nesreća i smrtnih slučajeva na pružnim prijelazima u Republici Hrvatskoj, statistika nesreća i dalje pokazuje vrlo lošu prometnu kulturu.

5.Mjere za suzbijanje stradavanja adolescenata na prugama u Republici Hrvatskoj

1. HŽ Infrastruktura 23. godinu zaredom provodi edukativno-preventivnu akciju »Vlak je uvijek brži«, ponavljajući i ističući informacije za koje će mnogi reći da ih znaju, ali praksa potvrđuje da ih treba stalno ponavljati.(Slika 4). Akcija je namijenjena djeci osnovnoškolskoga uzrasta te vozačima i drugim sudionicima u cestovnome prometu kojom ih se upozorava na opasnosti koje prijete prilikom neopreznoga prelaženja preko pruge ili boravka uz prugu.



Slika 4: Preventivna akcija „Vlak je uvijek brži“

Zadnjih nekoliko godina bilježi se, nažalost, sve veći broj nesreća do kojih dolazi zbog korištenja mobitela i/ili slušalica tijekom kretanja ulicom ili prilikom prelaženja preko pruge. Korištenje mobitela i slušalica znatno utječe na koncentraciju, ali i na sposobnost praćenja zvukova iz okoline. Suvremena komunikacijska tehnologija pruža neizmjerno dobre mogućnosti, ali nosi i ozbiljne prijetnje ako se neprikladno koristi. Zato je važno osvijestiti to da sigurnost započinje s poštivanjem prometnih znakova i izbjegavanjem nepoželjnih i opasnih ponašanja. Opasnost od strujnog udara koja prijeti prilikom penjanja na vagone možda je i najdrastičniji primjer kako igra ili bezazleni nestašluk dovode do strašnih nesreća. Zabrane koje su izrečene treba poštivati jer one služe za zaštitu ljudi. Naime, električni vodovi iznad vagona „živi“ su i opasni zbog izrazito visokoga nazivnog napona od 25 000 V. Zato penjanje na vagone zbog jednog selfija često završi strujnim udarom koji je smrtonosan ili ostavlja teške doživotne posljedice unatoč dugotrajnome liječenju.



Slika 5: Preventivna akcija „Vlak je uvijek brži“ uz slogan „Stani, gledaj, slušaj“

2. Abeceda prevencije je nacionalni program koji pomaže školama da lakše osmisle i primijene svoje školske preventivne strategije koje povezuju međupredmetne teme i školske preventivne programe, a u sklopu tog programa jedna od tema je i „Sigurno uz prugu - prevencija stradavanja djece i mladih“ gdje se djeci ukazuje na opasnosti od visokog napona i gdje im se kroz primjere stardavanja ukazuje na opasnosti koje prijete za vrijeme kretanja prugom.

U posljednih 10 godina, od strujnog udara u pružnom pojasu poginulo je sedam osoba, a 22 su teže ozlijeđene. Prosjek godina nastradalih je ispod 17.

3. U sklopu Nacionalnog plana sigurnosti cestovnog prometa niz je preventivnih mjera

upravo na temu sigurnog prelaska željezničke pruge.

4. Rješavanje problema sigurnosti ŽCP-a i PP-a utvrđeno je Strategijom prometnog razvoja Republike Hrvatske 2017.-2030. kao jedna od mjera povećanja sigurnosti željezničkog i cestovnog prometa. Ovim Programom rješavanja željezničko cestovnih i pješačkih prijelaza preko pruge za razdoblje od 2018. do 2022. godine utvrđuje se lista prioriteta rješavanja željezničko-cestovnih i pješačkih prijelaza preko pruge. Programom su obuhvaćeni prijelazi koji su u postupku rješavanja, zatim prijelazi koji su u obuhvatu projektnih prijava kojima su osigurana sredstva kao i oni koji nisu u obuhvatu postojećih investicijskih programa, a nužno ih je osigurati.

Namjena Programa je poboljšanje razine osiguranosti željezničko-cestovnih i pješačkih prijelaza i uspostava dodatnih mjera u cilju povećanja sigurnosti željezničkog i cestovnog prometa.

6.Modernizacija željezničko-cestovnih prijelaza

Budući da sigurnost ima i svoju cijenu, HŽ Infrastruktura ulaže znatna sredstva u modernizaciju pruga i uređaja. No zbog važnosti problematike sigurnosti na željezničko-cestovnim prijelazima (ŽCP) HŽ Infrastruktura provodi i projekte koji su posvećeni isključivo modernizaciji željezničko-cestovnih prijelaza. Jedan od njih jest Nabava i ugradnja opreme za osiguranje 49 željezničko-cestovnih prijelaza i jednog pješačkog prijelaza preko pruge na 50 lokacija diljem hrvatske željezničke mreže vrijednosti 9,8 milijuna eura, a koji se financira u sklopu projekta Svjetske banke „Održive hrvatske željeznice u Europi“. Drugi je Projekt osiguranja i modernizacije željezničko-cestovnih prijelaza, u sklopu kojeg će se modernizirati 94 željezničko-cestovna prijelaza i jedan pješački prijelaz. Njegova ukupna vrijednost iznosi 27,7 milijuna eura, za što je osigurano 85-postotno sufinanciranje prihvatljivih troškova iz EU-ovih fondova. Najveći dio obuhvaćenih prijelaza nalazi se u Bjelovarsko-bilogorskoj, Požeško-slavonskoj, Osječko-baranjskoj, Virovitičko-podravskoj i Varaždinskoj županiji te su na prugama i za međunarodni i za regionalni, ali i lokalni promet. Tijekom 2023. započeli su radovi na dijelu projekta koji se odnosi na modernizaciju 69 željezničko-cestovnih prijelaza, a u pripremi su radovi za dodatnih 26 prijelaza. Osim toga HŽ Infrastruktura d.o.o. provodi još jedan projekt kojim se modernizira 26 ŽCP-ova vrijednih šest milijuna eura iz Državnog proračuna RH. Kada budu završeni svi trenutačno započeti projekti modernizacije željezničke infrastrukture diljem Hrvatske, broj novo moderniziranih prijelaza na cijeloj željezničkoj mreži bit će viši za 300. Prijelazi obuhvaćeni tim projektima bit će opremljeni suvremenim signalno-sigurnosnim uređajima koji za siguran tijek prometa upotrebljavaju svjetlosne signale u LED tehnologiji i jakozvučna zvona, a na velikoj većini bit će ugrađeni i polubranici. Nekoliko će prijelaza biti i denivelirano. Pješački prijelaz iz drugoga spomenutog projekta imat će i mimoilaznu ogradu.

Literatura

Program rješavanja željezničko-cestovnih i pješačkih prijelaza preko pruge za razdoblje od 2018.do 2022.

Pravilnik o načinu osiguravanja prometa na željezničko-cestovnim prijelazima i pješačkim prijelazima preko pruge (NN 111/15)

3. Analiza izvanrednih događaja u 2021. godini – HŽ Infrastruktura d.o.o.

4. https://npscp.hr/

5. https://www.hzinfra.hr/oprezno-na-pocetku-skolske-godine/

6. https://mmpi.gov.hr/UserDocsImages/arhiva/PROG%20RJESAVANJA%20ZCP-PP%202018-2022%203-5_18.pdf

Maja Šajn , mag. ing. traff.
Obrtnička i tehnička škola Ogulin
Svjetlana Glad , mag. ing. traff.
Tanja Burić , mag. ing. traff.
Željeznička tehnička škola Moravice

KEEP SAFE WHILE MOVING CLOSE TO THE RAILWAY TRACKS – THE THREATS ADOLESCENTS FACE WHILE WALKING IN THE VICINITY OF RAILWAY TRACKS

Summary

Each movement close to railway track or the crossing of the railway tracks is a potential source of danger to pedestrians.

The most serious life-threatening spots are the road-railway crossings which are constructed on the same level as the railway tracks. Unsecured crossings represent especially great danger regarding the method of securing road-railway crossings on the same level.

The carelessness of road vehicles drivers while moving across the railway-road crossings, as well as moving of pedestrians across the same place can cause some grave consequences (injury and death).

A deliberate contact with the sources of electric voltage on the railway tracks can be extremely dangerous too. Therefore, it is immensely important to educate adolescents with the aim of preventing potential accidents and tragedies.

This paper will provide a review of the types of railway-road crossings in RH and also of the sources of danger threatening adolescents while crossing them.

1.Railway-road crossing on the same level

What is called railway-road crossing at the same level is the place where a road crosses railway tracks or an industrial track, or, in the construction sense, the place where the road and the upper part of the track cross. It means that the railway-road crossing is the place where railway and road traffic directly meet so, from the standpoint of safety, it represents the potential point of a high risk. In order to ensure seamless operating of the traffic those railway-road crossing have to be properly secured. The basic division of railway-road security methods implies passive and active safety measures (Figure 1).

Active protecting of level crossing implies every method od securing which reacts by the change of its state (either illuminate-acoustic or user-side protective) when a railway vehicle approaches.

Passive protection is the protection of each crossing which is equipped by warning signs, devices or some other kind of protective equipment which are constant and do not change depending on any traffic situation.



Figure 1: The division on level crossing protection

1.1.Actively secured level crossings

Actively protected level crossings are the crossing protected by a kind of light, sound or mechanic signals which change in accordance to traffic, or, in other words, changes their condition when a train approaches the crossing itself. Active technical means imply light devices, sound signals, half or full barriers, or any combination of the above. (Figure 2)



Figure 2: Actively secured level crossing

1.2.Passively secured level crossings

Passive level crossings are crossings without any warning system and/or protection which is activated when the crossing is not safe for users (Figure 3).



Figure 3: Passive level crossing

2.The types of security measures on the level crossings

Out of total of 1521 level crossings 897 (about 60%) are secured by the traffic signs (Saltire St. Andrew's cross and the stop sign), 71 by mechanical barriers (about 5%), 140 by light and sound signals (about 9%), and 341 by light and sound signals and half-barriers (about 23%). The remaining number of 72 crossings are pedestrian crossings secured by bypass fences, and, among those, there are 11 which are secured by light and sound signals for pedestrians (almost 5%).

3.The analysis of the accidents on the level crossings

The results of the accidents analysis on the level crossings which are the part of HŽ infrastructure lead to the conclusion that the modernisation of security systems does not necesarrily imply the decrease in the number of accidents, that is, that the increase of technical level of security does not result in proportional decrease in the number of accidents. Namely, out of 29 serious accidents in 2013, 14 occured on the level crossings secured by signal – safety devices (there are 552 of such), and 15 on the crossings secured by St. Andrew's cross and the STOP sign (897 of them).

4.The state of security on the level crossings in the republic of croatia

HŽ Infrastruktura l.t.d. as a body managing the railway infrastructure in the Republic of Croatia is responsible for the organisation and regulation of railway transport, and its safety represents the basic direction of the whole system.

The entire security sistem is constantly checked, the causes and consequences of some extraordinary events are analysed. What is more, a whole list of other statutory activities defined by the security policy of HŽ infrastructure is regulary implemented.

The accident on the level crossing is each accident in which at least one railway vehicle and one or more road vehicles riding across it participate. It could also be caused by some other

users of the crossing such as pedestrians, or some objects that temporarily end up on the railway tracks or their vicinity being dropped from a vehicle or lost by the passengers during their crossing. At the same time, an accident is an extraordinary occurence in railway traffic with harmful consequences such as grave body injuries of up to four persons and a material damage that can be estimated at €2 million. Chart 1. shows the number of serious accident on level crossings from 2016 to 2021.

OZBILJNE NESREĆE		2016.	2017	2018	2019	2020.	2021	*prosjek 2016.-2020.*
NA ŽCP	a) promet osiguran SS uređajem	0	5	5	3	2	3	*3,00*
	b) promet osiguran prometnim znacima	2	1	2	2	2	2	*1,80*
	c) pješački prijelaz	0	0	0	1	0	1	*0,20*
Ukupno ŽCP (a+b+c):		2	6	7	6	4	6	*5,00*

Chart 1: The number of serious accidents on level crossings during the period between 2016 and 2021.

Source: The analysis of some extraordinary occurences in 2021 – HŽ Infrastruktura L.t.d.

Level crossings represent an important safety challenge for both the road and railway traffic, despite the fact that railway transport is one of the safest means of transport. Although there is a trend of decrease of accidents and fatalities on the level crossings in the Republic of Croatia, the analysis and statistics of the accients still show a very poor traffic culture.

5.The measures to prevent casualties involving adolescents on the railways in the Republic of Croatia

1. HŽ Infrastruktura has been carrying out the educational-preventive action "The train is always faster" continuously, for 23 years, repeating and emphasising information which the majority of adolescents are allegedly familiar with. However, the reality proves that it should be continuously pointed out (Figure 4). The activity is created for the primary school children and the drivers, as well as other participants in the road traffic and it warns them about the dangers they are exposed to during a careless crossing of the railway tracks or when keeping close to the railway tracks.



Figure 4: The preventive activity "The train is always faster"

In the recent few years it has been noticed that the increasing number of accidents was caused by the use of mobile phones and/or headphones while walking along the street or during the crossing of the railway. The use of mobile phones and headphones significantly influence not only concentration, but also the perception of the surrounding sounds. Modern communication technology offers immensely useful applications, but also represent a serious threat if not used properly. Therefore, it is vital to emphasize the importance of safety which begins with the following of traffic signs and with avoiding inapropriate and dangerous behaviour. The danger of electric shock which threatens while climbing on the railway wagon is probably the most extreme example of the play or an inocent mischief turning into a horrible tragedy. The prohibitions that have been imposed should be obeyed because they serve to protect people. Namely, the electric cables above the wagons are "alive" and dangerous due to an extremely high voltage of 25,000 V. Because of that, the climbing in order to make a selfie ends up with an electric shock that is deadly or leaves serious lifelong consequences despite a long medical treatment.



Figure 5: Preventive activita "The train is always faster" with the slogan "Stop, watch, listen!"

2. The Alphabet of prevention is a national programme which helps schools create and apply their preventive strategies by connecting some interdisciplinary topics and school preventive programmes more easily. A part of this programe is a topic "Safely near the railway – the prevention of children and teenagers' casualities where the young people are taught about the dangers of high voltage, and where, through the examples of casualities, they are warned about the dangers of approaching and moving along the railway tracks.

In the last 10 years period 7 people suffered deadly consequences and 22 had a serious injuries caused by electric shock in the railway tracks zones. The age average of the victims is below 17.

3. As a part of national road safety plan, a number of preventive measured dealing with safe crossing of the railway tracks have been applied too.

4. The dealing with the problem of safety of RRC and PC is regulated by the Traffic development strategy of the Republic of Croatia from 2017 to 2030, as a measure of railway and road safety increase. This Programme of solving level crossings problem for the period between 2018 and 2022 defines the prioriy list for solving level and pedestrian crossings issue. The programme encompasses the crossings that are still in the process of tackling, then the crossings that are included in the project applications with the funds previously secured, as well as those that are not included in the existent investment programmes, but which should be secured.

The purpose of the programme is the level of security on the road-railway and pedestrian crossings increase and the introduction of supplementaryy measures which would help raise the safety of railway and road traffic.

6.The modernisation of level crossings

Since the safety costs, HŽ Infrastuktura invests considerable financial resources into modernisation of the railways and equipment. However, due to the importance of the security on level crossings issue (RRC) HŽ Infrastruktura is also implementing projects dedicated solely to the modernization of level crossings. One of them is the aquisition and installation of safety equipment for 49 level crossings and one pedestrian crossing on 50 locations all over the Croatian railway network worth €9.8 million, financed from the World Bank's project called "Sustainable Croatian Railways in Europe" The other is "The security and modernisation of level crossings project" which includes the modernization of 94 level crossings and one pedestrian crossing. Its total worth is €27.7 million, and the 85% acceptable costs co-financing has been secured from the European funds. The majority of those level crossings on the railways of both international and regional or local significance are in the following counties: Bjelovarsko-bilogorska, Požeško-slavonska, Osječko-baranjska, Virovitičko-podravska, and Varaždinska. The implementation of a part of the project related to the modernization of 69 level crossings began during 2023. Also, the reconstruction of additional 26 crossing is being prepared. Apart from this, HŽ Infrastruktura L.t.d. si implementing one more project with the aim to modernize 26 RRCs worth six million Euros from the national budget of the Republic of Croatia. When all the above mentioned projects of railway infrastructure all over Croatia are finished, the number of modernised level crossings on the entire railway network will be higher by 300. The crossings included in those projects will be equiped by modern signal-security devices which use light signals in LED technology and very loud sound signals, and on the majority of them there will also be half barriers. Several of those crossings will be unleveled. Pederstrian crossings from the secondly mentioned project will have bypass fences.

Sources:

1. Program rješavanja željezničko-cestovnih i pješačkih prijelaza preko pruge za razdoblje od 2018.do 2022.
2. Pravilnik o načinu osiguravanja prometa na željezničko-cestovnim prijelazima i pješačkim prijelazima preko pruge (NN 111/15)

3. Analiza izvanrednih događaja u 2021. godini – HŽ Infrastruktura d.o.o.
4. https://npscp.hr/
5. https://www.hzinfra.hr/oprezno-na-pocetku-skolske-godine/
6. https://mmpi.gov.hr/UserDocsImages/arhiva/PROG%20RJESAVANJA%20ZCP-PP%202018-2022%203-5_18.pdf

Svjetlana Glad , dipl. ing.

Tanja Burić , dipl. ing.

Željeznička tehnička škola Moravice

Maja Šajn , dipl. ing.

Obrtnička i tehnička škola Ogulin

ZIMI SAMO VLAKOM

Sažetak

Na mreži pruga Hrvatskih željeznica, dvije pruge su posebno kritične za odvijanje prometa u zimskom periodu.

To su pruge: Zagreb-Rijeka (dionica od Ogulina do Rijeke) i pruga Oštarije-Split (dionica od Oštarija do Knina).

Najviše snijega može napadati na području od Ogulina do Delnica na riječkoj pruzi, te od

Ogulina do Vrhovina na ličkoj pruzi. Radi se o velikim količinama snijega čija visina može doseći 80 pa čak i 100 centimetara u vrlo kratkom periodu.

Uz velike količine snijega posebne probleme može izazivati jaka bura stvarajući smetove čija visina može doseći i nekoliko metara.

Pored snijega i bure u tim predjelima, temperatura se preko noći spušta ponekad i preko – 20 stupnjeva što uzrokuje stvaranje leda i dodatne probleme.

Unatoč takvim vremenski neprilikama željeznički promet se rijetko prekida ili ti prekidi traju kraće vrijeme, to pokazuje snagu i važnost željezničkog prometa.

1.Propisane mjere za zimske uvijete na prugama

Prije početka zimskog razdoblja moraju se propisati sve mjere za obavljanje prometa u zimskim uvjetima.

Zimsko razdoblje započinje 15. studenog, a završava 15. ožujka.

Upravitelj infrastrukture dužan je općim aktom propisati mjere za čišćenje snijega i leda u kolodvorima i na otvorenoj pruzi najkasnije do 15. listopada za sljedeće zimsko razdoblje.

Svake godine određene službe donose svoje operativne planove za obavljanje prometa u zimskim uvjetima. Na sastancima ti se planovi međusobno usklađuju kako bi u datom trenutku borba protiv snijega i drugih zimskih neprilika dala zadovoljavajuće rezultate.

Operativne planove izrađuju građevinski poslovi, poslovi vuče i poslovi signalno-sigurnosnih i telekomunikacijskih postrojenja.

Određuju se prioritetni kolodvori za čišćenje snijega, određuje se koji će radnici učestvovati

u čišćenju snijega, napravi se pregled skretnica s ugrađenim grijačima, odredi se određeni broj vagona za odvoz snijega, predvidi se način predgrijavanja putničkih vagona.

Kod električnih lokomotiva najosjetljiviji su vučni motori jer vlaga i snijeg ulaze u kučište elektromotora i dolazi do probijanja izolacije pa se oni dodatno pregledavaju. Isto tako obavlja se preventivni pregled pantografa.

Određuju se radnici koji obavljaju odleđivanje kočnog polužja.

Poslovi signalno-sigurnosnih i telekomunikacijskih uređaja Ogulin formiraju posebnu skupinu radnika koja prije zime pregledava skretničke grijače na potezu od Karlovca do Drivenika na 122 skretnice.

Ustanovljuju se zalihe plina, koje moraju biti dostatne do mjeseca ožujka. Također se pregledaju agregati za proizvodnju struje i količine nafte kao pogonskog goriva. Pregledaju se i burobrani u kolodvorima Plase i Škrljevo. Iznad brzine od 175 km/h obustavlja se sav promet.

Određen je i raspored rada mehaničkih sredstava za čišćenje snijega i leda po domovnim kolodvorima i vučnim relacijama.

2. Sredstva za čišćenje snježnih nanosa

Domovni kolodvor Ogulin:

a) Vrsta sredstva: Rolba RR 6000 – COOP-D-S

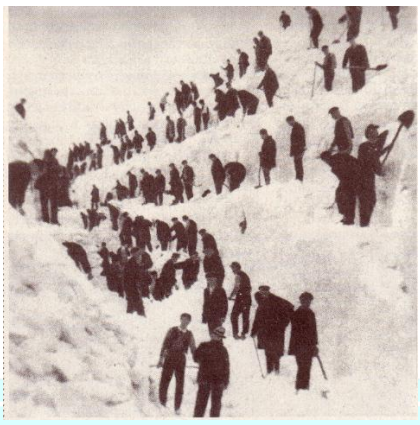
- područje rada: Ogulin-Oštarije-Knin-Martin Brod i Moravice-Ogulin-Zagreb

b) Vrsta sredstva: Rolba RR 2000

- područje rada: Ogulin-Oštarije-Knin-Martin Brod i Moravice-Ogulin-Zagreb

3.Zimski uvijeti nekada i sada

Nekada je čišćenje pruge od snijega izgledalo ovako:



Slika 1: Ručno čiščenje snijega

Danas se pruge čiste rolbama što je vidljivo na slikama 3., 4.

Rolbe su švicarski samohodni strojevi koji razgrću i bacaju na stranu snijeg s pruge. Mogu

se podići i na mjestu okrenuti za 360 stupnjeva. Njihova puna učinkovitost dolazi do izražaja u usjecima iz kojih izbacuju snijeg za razliku od ralica koje samo razgrću snijeg na stranu.

Rolba RR 2000 može očistiti dvije tisuće tona snijega na sat, a rolba RR 6000 deset tisuća tona snijega na sat.



Slika 3: Čišćenje kolosijeka u kolodvoru



Slika 4: Rolba RR 2000

Na elektrificiranim prugama u slučaju potrebe skidanja leda s kontaktne mreže rabe se električne lokomotive s metalnim klizačem na strujnom oduzimaču.

Metalni klizači smješteni su u Vuči vlakova – Rijeka i u Vuči vlakova – Za

4.Kako je to izgledalo na terenu u praksi

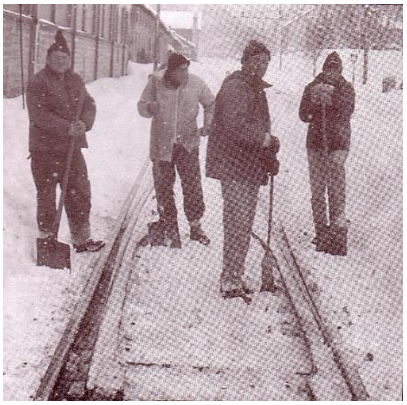
U mjesecu siječnju 2004. godine u Gorskom kotaru snijeg je pao u dva navrata. Napadalo ga je više od pola metra.

Prometna sigurnost bila je ugrožena samo jednom, i to onda kada je na prugu između Moravica i Vrbovskog odnosno na vozni vod kontaktne mreže pala velika grana. Tada je promet bio obustavljan gotovo deset sati.

U noći između 28. i 29. veljače 2004. u kolodvoru Moravice vladala je snježna mećava i palo je 80 cm snijega.

Lokomotive su na plugovima dovozile smetove snijega koji su se dijelom istresali na skretnicama.

Plugovi su se morali ručno čistiti lopatama kako bi se izvršila zamjena lokomotiva. Isto tako lopatama su se čistile i skretnice.



Slika 7: Čišćenje kolosijeka

Snijeg je najjače padao od 25. do 27. siječnja 2005. godine. Rolba RR 6000 čistila je prugu od Ogulina prema Gračacu, a rolba RR 2000 prema Moravicama.

Visina snijega kod Ličke Jesenice, Javornika i Rudopolja bila je 130 cm.

Vlakovi su vozili cijelo vrijeme. Najdulje kašnjenje bilo je 60 minuta zbog kvara teretnog vlaka. Istovremeno kamionski promet stajao je tri dana.

Na raščišćavanju snijega bilo je angažirano oko 200 željezničara. Rolbe su vozile iste posade puna 24 sata.



Slika 9: Čišćenje na ličkoj pruzi

Po prestanku padanja snijega došlo je do iznimno niskih temperatura i do –25 stupnjeva. Tako niske temperature dovele su do pucanja tračnica, kvarili su se uređaji na cestovnim prijelazima i uređaji automatskog pružnog bloka.

I jedan slučaj iz ne tako daleke prošlosti koji još jednom pokazuje kako teški uvjeti u zimskom periodu mogu vladati na našim prugama.

Zbog jako lošeg vremena u veljači 2018 godine kada je visina snijega u Gorskom kotaru dosezala i 80 cm, temperatura padala do –18 stupnjeva uz brzinu bure koja je u Primorju dosezala 150 km/h i ledenu kišu došlo je do kvara na lokomotivama.

Putnički vlakovi ukupno su kasnili 2327 minuta ili 39 sati, a u 11 slučajeva došlo je do padanja zaleđenih stabala na kontaktnu mrežu što je uzrokovalo puknuće kontaktne mreže i isključenje struje.

5.Potencijali željezničkog prometa

U zimskim uvijetima željeznica pokazuje svoju važnost i snagu. Uz još dodatna ulaganja trebala bi pokazati svoj puni potencijal tijekom cijele godine, a osobito u zimskom periodu.

U medijima često čitamo naslove : „Kada ne ide cestom tu je željeznička pruga“, „Zimi samo vlakom“, „ Radila je jedna prometna žila kucavica – željeznica“. Često je zimi bio slučaj da su zbog snježnog nevremena Dalmacija i jug bili odsječeni od ostatka Hrvatske. Bile su zatvorene i zametene ceste i autoceste, brojni putnici su zapeli u vozilima, a jedino su vlakovi gotovo pod gotovo nemogućim uvjetima probijali se od unutrašnjosti do obale (Zagreb-Split). To su upravo omogućili snjegočistači HŽ Infrastrukture koji su neprestano radili čisteći snijeg s tračnica kao i mnogobrojni radnici koji su ručno čistili snijeg po kolodvorima.

Potrebno je bilo napraviti raspored radnika za čišćenje snijega po kolodvorima, pratila se je prognoza vremena te su se radnici do kolodvora prebacivali vlakovima što je i bila dobra i jedina opcija jer su ceste bile neprohodne.

Primjer iz kolodvora Gospić pokazuje kako su radnici ručno čistili snijeg cijeli dan kako bi putnici mogli proći kroz pothodnik i na perone, ali i kako bi vlakovi nesmetano prelazili preko skretnica.



Slika 10: Snijegom okovan kolodvor Gospić

Kako se nije prekidalo odvijanje putničkog prometa bilo je potrebno osigurati i otpremu teretnih vlakova kako ne bi došlo do otkazivanja vlakova iz međunarodnog prometa prema Austriji i Italiji.

Kao što je navedeno u prethodnim primjerima kada su snježni nanosi vrlo visoki u takvim situacijama ne pomaže ništa drugo osim ručnog čišćenja snijega. Uz ručno čišćenje neophodne su i rolbe koje raščišćavaju otvorenu prugu i kolosijeke u kolodvoru.

Uz velike količine snijega poteškoće u odvijanju željezničkog prometa stvaraju i jaki udari bure u priobalnom području. Najkritičnija je dionica pruge na relaciji Plase – Rijeka (riječka pruga) , a snaga bure mjeri se u kolodvoru Škrljevo. Iz tog kolodvora podaci o snazi bure šalju se u kolodvor Moravice u kojem se sukladno tim podacima formiraju sastavi vlakova kako bi se osigurao siguran promet.

6. Promidžbena akcija - zimi samo vlakom

Još 2005 godine Hrvatske željeznice pokrenule su promidžbenu akciju pod nazivom “ZIMI SAMO VLAKOM”.

Unatoč problemima koji se pojavljuju u tako teškim vremenskim neprilikama, vlakovi su ipak prijevozna sredstva koja zimi pružaju najviše povjerenja. Naravno da u takvim uvjetima ne možemo niti od željeznice očekivati besprijekornu redovitost vlakova.

Tu se može navesti cijeli niz opravdanih razloga: od lokomotiva starih četrdeset i više godina, nedostatka pričuvnih dijelova za signalno-sigurnosne uređaje, uređaje za grijanje vagona itd.

Postoje i drugi problemi kao naprimjer nedostatak skretničara u manjim kolodvorima i ukrižnicama. U nastojanju smanjenja broja zaposlenih ukinuti su skretničari što se upravo u zimskim uvjetima pokazuje kao promašaj.

Naime, skretnički grijači ne mogu kod jačih snježnih padalina održati skretnicu uporabljivom bez pomoći metle i lopate. Zbog nemogućnosti prebacivanja skretnica, kolodvori postaju stajališta bez mogućnosti obavljanja križanja vlakova što izaziva dosta velika zakašnjenja.

Sa još boljom i kvalitetnijom organizacijom, željeznica bi mogla biti još učinkovitija što bi joj donijelo veliku prednost pred cestovnim prometom posebice u zimskom period.

I snježni pozdrav iz Gorkog kotara od snješko prometnika iz Delnica !



Literatura

1. https://narodne-novine.nn.hr/clanci/sluzbeni/2016_11_107_2273.html
2. Željezničar – list HŽ Infrastrukture d.o.o. broj 854 / siječanj 2017.
3. Zeljeznicar-831 vlakom kroz gorski kotar.pdf
4. 865-Zeljeznicar-prosinac-2017.pdf
5. https://www.hzinfra.hr/kada-ne-ide-cestom-tu-je-pruga/

Svjetlana Glad , mag. ing. traff.

Tanja Burić , mag. ing. traff.

Željeznička tehnička škola Moravice

Maja Šajn , mag. ing. traff.

Obrtnička i tehnička škola Ogulin

IN WINTER ONLY BY TRAIN

Summary

On the entire network of Croatian Railways (HŽ), there are two sections especially demanding when dealing with traffic operation during winter period.,3

These are Zagreb-Rijeka (from Ogulin to Rijeka section) and Oštarije-Split railway line (Oštarije to Knin section).

The deepest accumulation of snow can be created between Ogulin and Delnice on the Rijeka Railway line, and from Ogulin to Vrhovine on the Lika line. It is usually a huge quantity of snow with the depth of 80, even100 centimetres, accumulated in a very short time.

Apart from a great quantity of snow, a particular problem can be caused by a strong North wind (bura) which sometimes creates a few metres deep snow drifts .

In addition to snow and North wind, there is a problem of temperature which sometimes plummets to -20 ° C during the night and creates ice and some other problems.

Despite such weather extremes, the railway traffic is rarely interrupted and those delays do not last long, which shows the strength and importance of railway traffic.

1.The established measures for winter conditions on the railway lines

All the measures for traffic operating in winter conditions should be established before the beginning of the winter period.

Winter period begins on the 15th November and finishes on the 15th March.

I accordance with the general act, an infrastructure manager must establish measures for cleaning of snow and ice on the railway stations and open railways for the next winter period no later than the 15th November.

Each year certain bodies make their operational plans for traffic operation in winter conditions. Those plans are coordinated on their meetings so that the battle against the snow and other troubles caused by winter could yield favourable results when necessary.

Operational plans are also made by the teams employed in the building, traction, signal-

safety and telecommunication facility field.

It is established which stations have priority and which workers will be employed in the cleaning of snow. Switches with built-in heaters are inspected, a certain number of wagons are repurposed for transporting snow, plans for the ways of pre-heating of the passenger cars made.

The most sensitive parts of electric locomotives are their traction engines since moisture and snow enter the electric motor casing which causes insulation breakthrough. Therefore they should be aditionally inspected. The preventive inspection of pantographs is also necessary.

The workers who will do the job of de-icing breaking rods are assigned.

Signal-safety and telecommunication facilities jobs section in Ogulin assigns a special group of workers who inspect switch heaters on the strip between Karlovac and Drivenik on 122 switches before winter.

The reserves of gas, that need to last until March, are secured. Electricity generating sets and the quantities of oil needed as motor fuel are also checked. Employees inspect windbreak on the Plase and Škrljevo railway stations. If North wind strength exeeds 175 km/h all the traffic is interrupted.

Work schedule of the snow and ice-cleaning mechanical devices used on home stations and towing relations are determined.

2.Snow drift cleaning equipment

Main station Ogulin:

a) Type of equipment: Rolba RR 6000 – COOP-D-S

- the area of work: Ogulin-Oštarije-Knin-Martin Brod i Moravice-Ogulin-Zagreb

b) Type of equipment: Rolba RR 2000

- the area of work: Ogulin-Oštarije-Knin-Martin Brod i Moravice-Ogulin-Zagreb

3.Winter conditions then and now

There were times when snow cleaning looked like this:

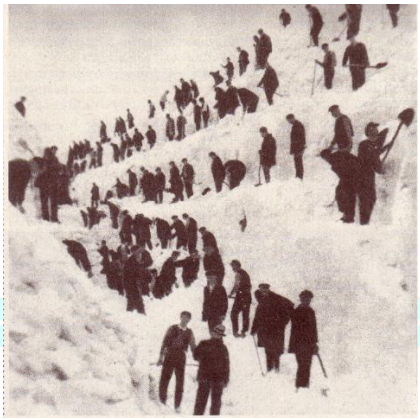


Figure 1: Cleaning snow manually

Today, railway tracks are cleaned by snow plougs and blowers as shown in the photos 3, 4.

Snow ploughs and blowers are Swiss self-propelled machines that rake up and throw snow at the side of the railway track. They can rise up and make a full turn. Their full effectiveness can be best seen when operating in rifts from which they throw snow away, compared to iron wedges that only clear snow off the tracks.

Snow plough RR 2000 can remove two thousand tonnes of snow per hour, and snow plough RR 6000 ten thousand tonnes of snow per hour.



Figure 4: The use of machinery



Figure 5: Snow plough RR 2000

Electric locomotives with metal scroll bar on the electric current pantograph are used on electrified railways if removal of the ice from the contact network is required

Metal scroll bars are stored in the Train traction department Rijeka, and Train traction department in Zagreb.

4.What it looked like on the site, in practice

It was January 2004 and it was snowing twice in Gorski Kotar.The snow was over half a metre deep.

Traffic safety was endangered only once, and it was when a massive branch fell onto the tracks, that is, onto the running cable of the contact network between Moravice and Vrbovsko. The traffic was delayed for almost ten hours.

During the night between the 28th and 29th of February 2004. the railway station in Moravice was blocked by a snowstorm and 80 cm of snow.

The locomotives pushed the snow drifts with the iron wedges and left some of the snow on the switches

The wedges had to be cleaned manually, by shovels so that locomotives replacement can be done. The swithes were cleand by shovels too,

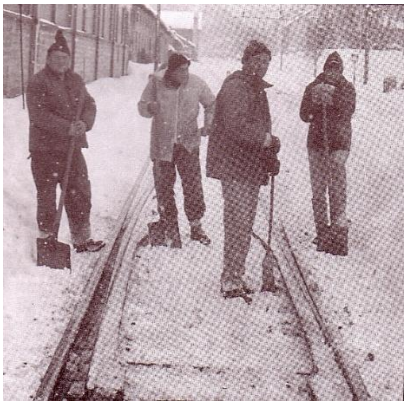


Figure 7: The cleaning of tracks

The snow was particularly heavy from the 25th to 27th January 2005. The snow plough RR 6000 was cleaning the railway from Ogulin toward Gračac, and snow plough RR 2000 towards Moravice.

The depth of the snow near Lička Jesenica, Javornik and Rudopolje was 130 cm.

The trains ran all the time. The longest delay was 60 minutes due to a freight train breakdown. At the same time, the trucks were stuck for tree days.

200 railway workers took part in the clearing of snow. The snow plough had the same crews for 24 hours.



Figure 9: The snow cleaning on the Lika railway

After the snow had stopped, the temperatures plummeted to – 25ºC. These extreme temperatures lead to tracks cracking, the devices on the level crossings and the devices of automatic railway tracks block started do break down.

One case from the recent past proves one more time how difficult the winter conditions on our railways can be.

Because of a very harsh weather in February 2018 when the depth of snow in Gorski Kotar reached 80 cm, the temperature fell to -18ºC, the speed of the North wind in Primorje exeeded 150 km/h, and the icy rain persisted, the locomotives broke down.

The total delay of the passenger trains was 2327 minutes, or 39 hours. In eleven cases the delay was caused by falling of the frozen trees onto the contact network which resulted in its breakage and the electric current shutdown.

5.The potential of the railway traffic

Railways shows their importance and strength in winter conditions. With some additional funding, it could show its full potential throughout the year and especially in the winter period.

Media is full of headliness such as: "When the road lets you down you have the railways", "In winter only by train", "Once upon a time there was a traffic artery – the railways". It has been common that, due to snowstorms, Dalmatia and South regions were cut off the rest of Croatia in winter. Roads and highways were closed, numerous passengers got stuck in their cars, and only the trains managed to pull through from inland to the coast (from Zagreb to Split) in almost impossible conditions. This was possible thanks to HŽ Infrastruktura's snow ploughs and to numerous workers who were cleaning the snow on the railvay stations manually.

It was necessary to make a schedule for workers who would clean the snow on the railway stations, the weather report was closely monitored, and the workers commuted to the stations by trains which was good and only option since the roads were blocked.

The example from the railway station in Gospić where the workers cleaned the snow manually all day long, so that the passengers could go to the platforms by underpass, and also that the trains could run over the switches seamlessly.



Figure 10: The snowbound station of Gospić

Since the running of passenger transport was not to be interrupted, the same rule applied for the freight trains. It was necesarry to let them pass so that the cancelations of trains in international traffic towards Austria and Italy would not occur.

As it was described in the above examples, in the situations when the show drifts are very high, nothing helps as efficiently as manual cleaning. Apart from manual cleaning, the snow plougs help enormously when open railway and railway station tracks cleaning is required.

Strong gusts of North wind in the coastal region, apart from huge quantities of snow, represent serious traffic difficulties. The most critical stretch of the railway is between Plase and Rijeka (Rijeka railway line). The strength of wind is measured on the station Škrljevo. From that station, the data are sent to the Moravice station where, according to the data, compositions of the trains are formed to secure a safe traffic.

6.Promotional campaign – in winter only by train

Back in 2005 Croatian Railways started a promotional campaign called 'In Winter Only by Train'

Despite the problems that occur in winter, the trains are the means of transport that inspire a lot of confidence in difficult weather conditions. Certainly, in such circumstances we should not expect impossible from the railway. However, it is understandable that trains cannot be perfectly punctual.

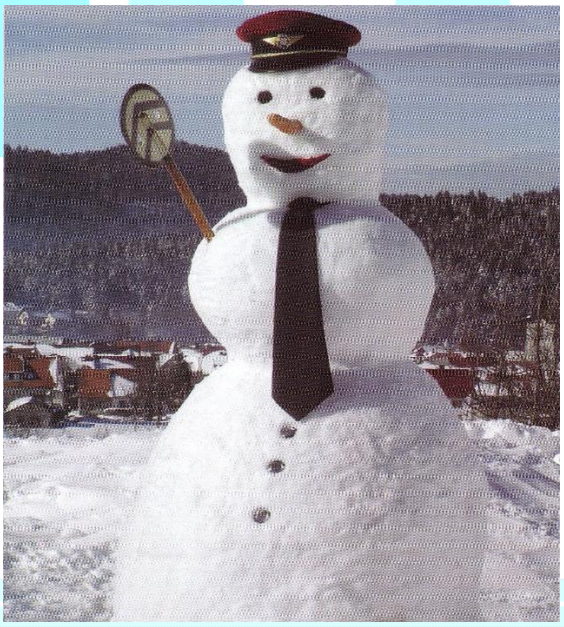
There is a whole list of justifiable grounds: from the locomotives which are forty years old, the lack of spare parts for signal-safety equipment to the wagon heating devices.

There are also some other problems such as the lack of switchmen on smaller stations and crossing points. In attempt to reduce workforce those switchmen have been removed which has proved to be a mistake in winter conditions.

Namely, switch heaters cannot keep the switch in function during heavy snow by themselves. In such a case, nothing is more useful than the broom and shovel. It is not posible to move the switch and the stations become mere stops without the possibilities for the trains to pass one another which results in relatively long delays.

With better, high quality organisation, railway traffic could be even more efficient which may become a huge precedence ovet road transport, especially during winter period.

And finally, a snowy greetings from Gorski Kotar from a traffic controller, the snowman from Delnice!



Sources

1. https://narodne-novine.nn.hr/clanci/sluzbeni/2016_11_107_2273.html
2. Željezničar – list HŽ Infrastrukture d.o.o. broj 854 / siječanj 2017.

3. Zeljeznicar-831 vlakom kroz gorski kotar.pdf
4. 865-Zeljeznicar-prosinac-2017.pdf
5. https://www.hzinfra.hr/kada-ne-ide-cestom-tu-je-pruga/

Ekološko ozaveščanje dijakov skozi igro na programu logistični tehnik

Avtor: Haris Ćordić, mag. inž. prom.

Povzetek

Ekološko izobraževanje v metaverzumu predstavlja inovativni pristop k razumevanju trajnostnih izzivov. Dijaki v interaktivnem okolju razvijajo okoljsko zavest, sistemsko razmišljanje in veščine sodelovanja. Projekt ClimaVerse*, v okviru Erasmus+ KA2, vključuje partnerje iz petih držav in razvija učni načrt po smernicah* GreenComp*. Mini igra znotraj metaverzuma zajema dve ravni: trajnostno kmetijstvo in gradnjo, kjer dijaki sprejemajo trajnostne odločitve. Igra temelji na principih t.i. »*game-based learning*« in je prilagojena tudi dijakom s posebnimi potrebami, s čimer spodbuja vključujoče, interaktivno in globalno primerljivo okoljsko izobraževanje.*

Ključne besede:

Trajnost, Izobraževanje, ClimaVerse, Prihodnost, Vključenost

Uvod

V času, ko se svet sooča z vedno bolj perečimi okoljskimi izzivi – od podnebnih sprememb, izgube biotske raznovrstnosti do prekomerne rabe naravnih virov – postaja ekološko izobraževanje ključno orodje za oblikovanje okoljsko odgovornih državljanov prihodnosti. Tradicionalni načini poučevanja pogosto ne zadostujejo več za učinkovito posredovanje kompleksnih okoljskih vsebin, ki zahtevajo interdisciplinarno razumevanje, kritično mišljenje in predvsem čustveno povezanost z naravo. V tem kontekstu se kot obetavno orodje za inovativno učenje vse bolj uveljavlja t. i. metaverzum – tridimenzionalno, imerzivno digitalno okolje, ki omogoča poglobljeno, izkustveno učenje skozi igro.

Metaverzum predstavlja nov mejnik v digitalni pedagogiki, saj združuje elemente navidezne resničnosti (VR), razširjene resničnosti (AR), umetne inteligence in interaktivne simulacije. Učenci lahko s pomočjo avatarjev raziskujejo ekosisteme, izvajajo virtualne eksperimente, opazujejo posledice podnebnih sprememb v realnem času ali se vključujejo v simulacije okoljskih odločitev. Po podatkih raziskave, objavljene v reviji Education and Information Technologies, se je pri dijakih, ki so sodelovali v ekoloških simulacijah v metaverzum okoljih, okrepila stopnja okoljske ozaveščenosti za 36 %, v primerjavi z dijaki, ki so prejemali izključno klasična predavanja (Radianti, 2022).

Poleg kognitivnih koristi pa metaverzum pomembno vpliva tudi na afektivno dimenzijo učenja. Raziskava Kye et al. (2021) v reviji Journal of Educational Technology & Society ugotavlja, da izkustveno učenje v metaverzum okolju povečuje motivacijo, občutek prisotnosti in empatijo do naravnega okolja. To je še posebej pomembno v kontekstu okoljskega izobraževanja, kjer je čustvena povezanost z naravo ključna za trajnostne vedenjske spremembe. Študija med srednješolci v Južni Koreji je pokazala, da so dijaki po udeležbi v VR-simulaciji degradiranega koralnega grebena kar 54 % pogosteje izražali pripravljenost za spremembo svojih potrošniških navad (Kye et al., 2021).

Metaverzum kot igralno učno okolje omogoča tudi uporabo principov t.i. »game-based learning«, ki vključujejo reševanje problemov, sodelovanje, sistemsko razmišljanje in povratne informacije v realnem času. Po podatkih UNESCO (2023) lahko tak pristop bistveno poveča angažiranost dijakov in spodbudi samostojno raziskovanje kompleksnih okoljskih izzivov. Vloga učitelja se pri tem preobrazi iz podajalca znanja v mentorja, ki usmerja dijake skozi personalizirano in participativno učno pot.

Integracija metaverzum tehnologij v učne procese torej ne pomeni zgolj tehnične posodobitve šolskega okolja, temveč paradigmo premik v smeri bolj angažiranega, trajnostno naravnanega izobraževanja. V času, ko se dijaki vse pogosteje srečujejo z digitalnimi mediji že izven učilnic, predstavlja metaverzum naraven most med njihovim digitalnim vsakdanjikom in šolskim kurikulumom. Uporaba metaverzuma v ekološkem izobraževanju tako odpira vrata k ustvarjanju generacije, ki bo ne le razumela okoljske izzive, temveč imela tudi orodja, znanje in motivacijo za aktivno sodelovanje pri njihovem reševanju.

Projekt ClimaVerse

Projekt ClimaVerse, spada pod ključno aktivnost 2, t.i. Eramus+ KA2 projekti, ki ga koordinira Strokovni izobraževalni center Ljubljana. Na projektu sodelujejo srednje šole in programerska podjetja:

- UpToEarth (Italija)
- CodeArrays (Ciper)
- Politeknika Ikastegia Txorierri S. Coop (Španija)
- Escola Secundaria Dr. Jose Afonso (Portugalska)



Slika 3: ClimaVerse projekt, vpogled v metaverzum, vir: lasten

Namen projekta je izboljšati zmogljivost formalnega izobraževanja za upravljanje metaverzuma in ga izkoristiti za razvoj ključnih kompetenc trajnostnega razvoja med učenci. Partnerji bomo razvili zeleni učni načrt, ki bo temeljil na »GreenComp-u«, tj. zelene kompetence, za ustvarjanje okoljskih scenarijev v metaverzumu, da bi spodbudili zeleno izobraževanje in podnebno odgovornost.

Cilji projekta:

- Ustvariti učni načrt za srednje šole, ki spodbuja izobraževanje o trajnostnem razvoju in bo repliciran v virtualnem okolju metaverzuma
- Učitelji bodo opravili mobilnost - usposabljanje in prejeli sorodna gradiva o metaverzumu in učnem načrtu
- Zagotovljene bodo tudi smernice za učitelje in učence za izboljšanje njihove učne izkušnje.

Eden od ciljev projekta je tudi vključevanje deklet v STEM ter prilagoditev vseh projektnih vsebin dijakom in dijakinjam s posebnimi potrebami, zato smo pripravili tudi strateški dokument s smernicami za vse naše dokumente oz. vsebine, ki jih objavljamo in izdelujemo na projektu. Smernice upoštevajo:

- Funkcije digitalne dostopnosti
- Jezikovna dostopnost in večjezična podpora
- Načela učenja, ki temeljijo na dokazih

- Raznolikost predstavnikov v digitalnih pripovedih
- Sodelovanje med vrstniki in skupinsko učenje
- Mentorstvo in zgledovanje
- Ustvarjanje varnih in spoštljivih učnih prostorov
- Vključujoča komunikacija in uporaba jezika

Partnerji pripravljamo tudi obdobno spremljanje upoštevanja zgoraj omenjenih smernic.



Slika 4: Svet metaversuma, vir: lasten, Spatial

»Mini igra« – vizija trajnostne prihodnosti

Del vsebin, ki bodo vključene v metaverzumu, smo pripravili tudi na Strokovnem izobraževanem centru Ljubljana. Avtorja koncepta »mini igre« sva Haris Ćordić in Mateja Vlašić-Crnolić. Projektna partnerja CodeArrays (CYP) in UpToEarth (ITA) pa bosta koncept spremenila v igro s pomočjo orodja Spatial.

Koncept je pripravljen na 12 straneh, zato v nadaljevanju podajam le povzetek koncepta.

Poglobljena (*ang. Immersive*) izobraževalna aktivnost v metaverzumu ponuja dijakom priložnost, da skozi sodelovalno igro razvijejo ključne kompetence za trajnostni razvoj, s poudarkom na trajnostnem kmetijstvu in gradbeništvu. Glavni cilj je ozaveščanje o vplivu izbire materialov in praks na okolje, v skladu s cilji trajnostnega razvoja OZN (cilji 11, 12 in 13).

Struktura učne aktivnosti

Aktivnost traja približno 45 minut in je razdeljena na dve učni ravni:

1. raven: Trajnostno kmetijstvo – učenci se naučijo osnov trajnostnega kmetovanja (npr. uporaba organskega gnojila, varčevanje z vodo) in nato sodelujejo v igri, kjer morajo skupaj izbrati ustrezne materiale za vzgojo vrta.

2. raven: Trajnostna gradnja – učenci spoznajo trajnostne in ne trajnostne gradbene materiale (npr. les, mineralna volna, stiropor) in jih v igri razporejajo med dve platformi: trajnostna in ne trajnostna prihodnost.

Učenci skozi igro pridobivajo točke za pravilne izbire in sodelujejo pri reševanju izzivov, ki

spodbujajo sistemsko razmišljanje, kritično presojo in t.i. »future literacy« – zmožnost predvidevanja in oblikovanja trajnostnih scenarijev prihodnosti.

Pedagoški pristop in dostopnost

Igra temelji na metodah t.i. »game-based learning« in sodelovalnem učenju. Vključuje tudi »informacijsko točko« z razlagami (pred vstopom v igro in med njo), ki dijakom omogoča sprotno učenje o trajnostnih praksah v kmetijstvu in gradbeništvu. Vsebina je na voljo v več jezikih (angleščina, slovenščina, portugalščina, španščina), kar omogoča mednarodno izvedbo.

Za dijake s posebnimi potrebami je predvidena prilagoditev časa in dodatna učiteljeva podpora za zagotavljanje enakovredne vključenosti.

Učni cilji

Dijaki bodo po izvedeni aktivnosti:

- razumeli povezave med praksami v kmetijstvu/gradnji in dolgoročnim vplivom na okolje,
- razvili sposobnost sodelovanja in prilagodljivosti pri reševanju okoljskih izzivov,
- izboljšali svojo sposobnost odločanja na osnovi trajnostnih meril.

S tem metaverzum postane orodje za globoko in vključujoče učenje o trajnostni prihodnosti skozi igro, pri čemer dijaki prevzamejo aktivno vlogo pri oblikovanju rešitev za resnične okoljske izzive.



Slika 5: Sortiranje odpadkov, vir: lasten, Spatial

Zaključek

Integracija tehnologije metaverzuma v okoljsko izobraževanje predstavlja prelomni korak za reševanje nujnih ekoloških izzivov današnjega časa. Tradicionalni načini poučevanja, ki so pogosto omejeni v svoji sposobnosti vključevanja dijakov v kompleksna, interdisciplinarna okoljska vprašanja, so dopolnjeni in nadgrajeni s poogloblјenimi digitalnimi okolji, ki spodbujajo izkustveno učenje. Edinstvena kombinacija virtualne resničnosti, umetne inteligence in interaktivnih simulacij v metaverzumu omogoča dijakom poglobljeno raziskovanje ekosistemov, opazovanje vplivov podnebnih sprememb v realnem času in aktivno sodelovanje pri odločanju, kar vodi do merljivih povečanj okoljske ozaveščenosti in motivacije. Projekti, kot je ClimaVerse, predstavljajo ta inovativen pristop z razvojem učnih načrtov in interaktivnih aktivnosti, ki spodbujajo kompetence trajnosti skladno z evropskimi okviri, kot je GreenComp. Vključevanje večjezičnih vsebin, funkcij dostopnosti in strategij za podporo raznolikim učencem — vključno z dekleti v STEM in dijaki s posebnimi potrebami — izkazuje zavezanost k pravičnosti in vključenosti. S preoblikovanjem učiteljev v mentorje ter spodbujanjem sodelovanja, sistemskega mišljenja in kritičnega odločanja ti izobraževalni pristopi pripravljajo dijake ne le na razumevanje okoljskih problemov, temveč tudi na aktivno vlogo pri njihovem reševanju. Metaverzum tako povezuje digitalne izkušnje dijakov z izobraževalnimi cilji ter ustvarja generacijo, opremljeno z znanjem, veščinami in motivacijo za učinkovito prispevanje k trajnostni prihodnosti.

Viri in literatura

- Radianti, J. et al. (2022). Virtual Reality for Environmental Education: A Comparative Study. Education and Information Technologies, 27(4), 5911–5930. https://doi.org/10.1007/s10639-021-10753-w
- Kye, B., Han, N., Kim, M., Park, Y., & Jo, S. (2021). Educational applications of metaverse: Possibilities and limitations. Journal of Educational Technology & Society, 24(1), 1–12.
- UNESCO (2023). Digital Learning and the Future of Education. Retrieved from: https://unesdoc.unesco.org/ark:/48223/pf0000384682

TECHNICAL EDUCATION CENTRE LJUBLJANA

Environmental Awareness of Students through Game-Based Learning in the Logistics technician program

Author: Haris Ćordić, Master's in Transport Engineering

Summary

Environmental education in the metaverse represents an innovative approach to understanding sustainability challenges. In this interactive environment, students develop environmental awareness, systems thinking, and collaboration skills. The ClimaVerse project, part of Erasmus+ KA2, brings together partners from five countries and develops a curriculum aligned with the GreenComp framework. A mini-game within the metaverse includes two levels—sustainable agriculture and construction, where students make sustainability-related decisions. The game is based on game-based learning principles and is adapted for students with special needs, promoting inclusive, interactive, and globally relevant environmental education.

Keywords

Sustainability, Education, ClimaVerse, Future, Inclusion

Uvod

At a time when the world is facing increasingly urgent environmental challenges—from climate change and biodiversity loss to the overexploitation of natural resources—environmental education is becoming a vital tool for shaping environmentally responsible citizens of the future. Traditional teaching methods often no longer suffice to effectively convey complex environmental content, which demands interdisciplinary understanding, critical thinking, and above all, an emotional connection with nature. In this context, the so-called metaverse—an immersive, three-dimensional digital environment that enables deep, experiential learning through play—is emerging as a promising tool for innovative education.

The metaverse represents a new milestone in digital pedagogy, combining elements of virtual reality (VR), augmented reality (AR), artificial intelligence, and interactive simulations. Students can use avatars to explore ecosystems, conduct virtual experiments, observe the real-time effects of climate change, or engage in environmental decision-making simulations. According to research published in Education and Information Technologies, students who participated in environmental simulations within metaverse environments increased their environmental awareness by 36% compared to peers who received only traditional lectures (Radianti, 2022).

Beyond cognitive benefits, the metaverse significantly impacts the affective dimension of learning. A study by Kye et al. (2021), published in the Journal of Educational Technology & Society, found that experiential learning in the metaverse enhances motivation, a sense of presence, and empathy for the natural environment. This is particularly important in environmental education, where emotional connection to nature is key to fostering sustainable behavioral change. In a study involving South Korean high school students, those who experienced a VR simulation of a degraded coral reef were 54% more likely to express willingness to change their consumption habits (Kye et al., 2021).

As a game-based learning environment, the metaverse also supports problem-solving, collaboration, systems thinking, and real-time feedback. According to UNESCO (2023), such approaches significantly increase student engagement and encourage independent exploration of complex environmental issues. In this model, the teacher's role shifts from knowledge transmitter to mentor, guiding students through a personalized and participatory learning journey.

Thus, integrating metaverse technologies into education is not merely a technical upgrade, but a paradigm shift toward more engaging, sustainability-oriented learning. As students increasingly interact with digital media outside the classroom, the metaverse provides a natural bridge between their digital everyday life and the school curriculum. Its use in environmental education opens the door to creating a generation that not only understands environmental challenges but also has the tools, knowledge, and motivation to actively participate in solving them.

Project ClimaVerse

The ClimaVerse project falls under Key Action 2, also known as Erasmus+ KA2 projects, and is coordinated by the Technical Education Centre Ljubljana (Strokovni izobraževalni center Ljubljana). The project brings together secondary schools and software development companies, including:

- UpToEarth (Italy)
- CodeArrays (Cyprus)
- Politeknika Ikastegia Txorierri S. Coop (Spain)
- Escola Secundária Dr. José Afonso (Portugal)



Slika 6: ClimaVerse project, insights of metaversum, source: own

The purpose of the project is to enhance the capacity of formal education to manage the metaverse and leverage it for the development of key sustainability competencies among students. The project partners will develop a green curriculum based on the GreenComp framework, i.e. the European sustainability competence framework, to create environmental scenarios within the metaverse, aiming to promote green education and climate responsibility.

Project objectives:

- To create a secondary school curriculum that promotes education for sustainable development and will be replicated in a virtual metaverse environment
- To enable teacher mobility for training, during which they will receive relevant materials on the metaverse and the curriculum
- To provide guidelines for teachers and students aimed at enhancing their learning experience

One of the project's goals is also to promote the inclusion of girls in STEM and to adapt all project content for students with special educational needs. To support this, a strategic document has been developed containing guidelines for all materials and documents produced and published within the project. These guidelines take into account:

- Digital accessibility features
- Language accessibility and multilingual support
- Evidence-based learning principles
- Diversity in digital storytelling representation
- Peer collaboration and group learning
- Mentorship and role modeling
- Creation of safe and respectful learning spaces
- Inclusive communication and language use

The project partners are also preparing periodic monitoring to ensure compliance with these guidelines.



Slika 7: Svet metaversuma, vir: lasten, Spatial

»Minigame« – Envisioning sustainable future

A portion of the content to be included in the metaverse was developed at the Techincal Education Centre Ljubljana. The authors of the mini-game concept are Haris Ćordić and Mateja Vlašić-Crnolić. Project partners CodeArrays (Cyprus) and UpToEarth (Italy) will transform the concept into a fully functioning game using the Spatial platform. The concept spans 12 pages, so the following is a brief summary.

This immersive educational activity within the metaverse offers students the opportunity to develop key competencies for sustainable development through collaborative gameplay, with a particular focus on sustainable agriculture and construction. The main goal is to raise awareness about the environmental impact of material and practice choices, in alignment with the United Nations Sustainable Development Goals (Goals 11, 12, and 13).

Structure of the Learning Activity

The activity is designed to last approximately 45 minutes and is divided into two levels, each addressing a key aspect of sustainability:

Level 1: Sustainable Agriculture - students are first introduced to the basics of sustainable farming practices (e.g., use of organic fertilizers, water conservation). They then engage in a cooperative mini-game where they must identify and select appropriate materials to successfully grow a virtual garden.

Level 2: Sustainable vs. Unsustainable Construction - in this level, students learn about sustainable and unsustainable building materials (e.g., wood and mineral wool vs. styrofoam). In the game, they categorize materials by placing them on platforms representing either a sustainable or an unsustainable future.

Throughout both levels, students earn points for correct choices and collaborate to solve challenges, promoting systems thinking, critical decision-making, and futures literacy—the ability to envision and plan for sustainable futures.

Pedagogical Approach and Accessibility

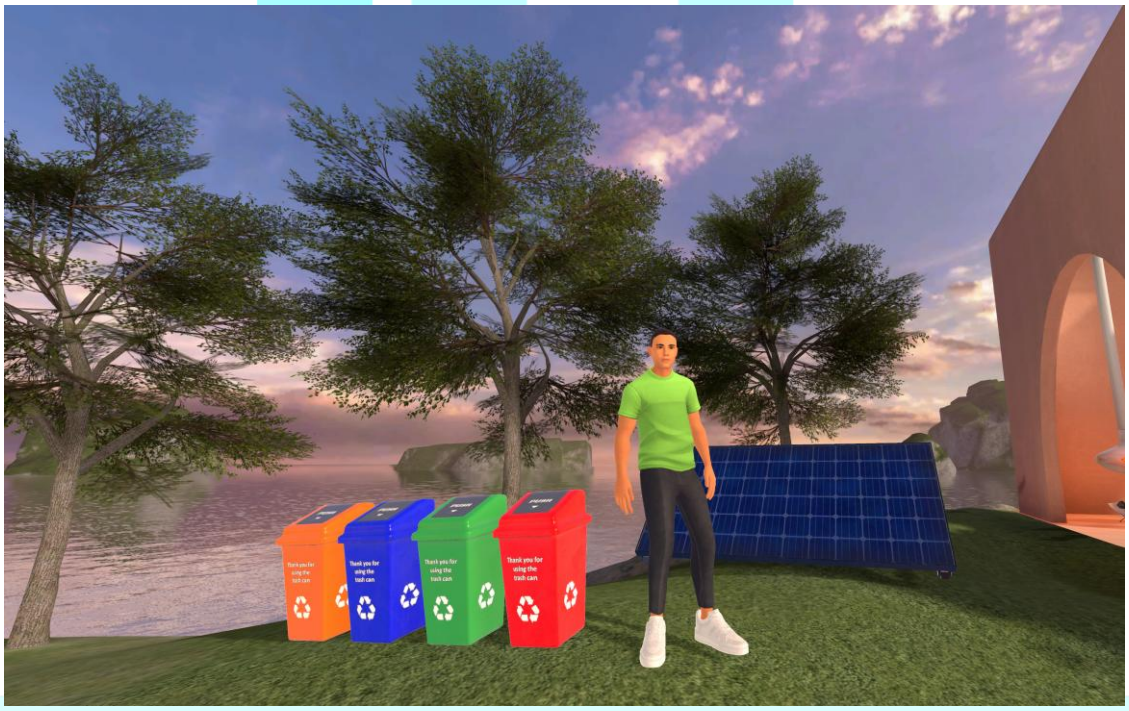
The game is based on game-based learning methods and collaborative learning. It also features an "information point", accessible both before and during gameplay, which provides explanations and real-time educational content on sustainable practices in agriculture and construction. The content is available in multiple languages—English, Slovene, Portuguese, and Spanish—enabling international implementation and cross-cultural learning. For students with special educational needs, the activity includes time adjustments and additional teacher support to ensure equitable participation and inclusion throughout the learning process.

Learning Objectives

After completing the activity, students will:

- Understand the connections between practices in agriculture/construction and their long-term environmental impact
- Develop collaboration and adaptability skills in addressing environmental challenges
- Improve their decision-making abilities based on sustainability criteria

Through this, the metaverse becomes a tool for deep and inclusive learning about a sustainable future, enabling students to take an active role in shaping solutions to real-world environmental challenges through play.



Slika 8: Waste managament, source: own, Spatial

Conclusion

The integration of metaverse technology into environmental education represents a transformative step toward addressing the urgent ecological challenges of our time. Traditional teaching methods, often limited in their capacity to engage students with

complex, interdisciplinary environmental issues, are complemented and enhanced by immersive digital environments that foster experiential learning. The metaverse's unique combination of virtual reality, artificial intelligence, and interactive simulations allows students to engage deeply with ecosystems, observe climate change impacts in real time, and participate actively in decision-making processes, leading to measurable increases in environmental awareness and motivation. Projects like ClimaVerse exemplify this innovative approach by developing curricula and interactive activities that promote sustainability competencies aligned with European frameworks such as GreenComp. The inclusion of multilingual content, accessibility features, and strategies to support diverse learners—including girls in STEM and students with special needs—demonstrates a commitment to equity and inclusion. By transforming teachers into mentors and encouraging collaboration, systems thinking, and critical decision-making, these educational innovations prepare students not only to understand environmental issues but also to become proactive agents of change. Ultimately, the metaverse bridges students' digital experiences with educational goals, cultivating a generation equipped with the knowledge, skills, and motivation necessary to contribute effectively to a sustainable future.

Sources

Radianti, J. et al. (2022). Virtual Reality for Environmental Education: A Comparative Study. Education and Information Technologies, 27(4), 5911–5930. https://doi.org/10.1007/s10639-021-10753-w

Kye, B., Han, N., Kim, M., Park, Y., & Jo, S. (2021). Educational applications of metaverse: Possibilities and limitations. Journal of Educational Technology & Society, 24(1), 1–12.

UNESCO (2023). Digital Learning and the Future of Education. Retrieved from: https://unesdoc.unesco.org/ark:/48223/pf0000384682

ŠKOLA ZA CESTOVNI PROMET
TRG J. F. KENNEDYJA 8
10000 ZAGREB



Autori:
Igor Jelić, mag. ing. traff.
Tomislav Ćurković, dipl. ing.

VIRTUALNA STVARNOST U NASTAVI STRUKOVNIH PREDMETA

Sažetak:

Projekt Vozi bez mobitela nastavak je uspješno provedenog projekta financiranog iz Nacionalnog programa sigurnosti cestovnog prometa Republike Hrvatske (NPSCP) "Uočljivost biciklista" vezan uz sigurnost i uočljivost kojim se i drugu godinu nakon završetka projekta provode edukacijske, preventivne i promidžbene aktivnosti. Također, kao rezultat provedenog projekta kreiran je te se uspješno provodi i u fakultativnom predmetu "Sigurnost pješaka u cestovnom prometu" u sklopu kojeg učenici Škole za cestovni promet educiraju učenike u osnovnim i srednjim školama o sigurnosti u prometu s ciljem povećanja svjesnosti i prometne kulture. Tijekom edukacija koriste se virtualne naočale kako bi opasne situacije u prometu približile učenicima i povećale svjesnost o mogućim posljedicama.

Glavni cilj projekta je preventivno-edukativnim aktivnostima povećati svjesnost mladih vozača o rizicima korištenja mobitela u vožnji te razvijati pozitivne stavove prema vožnji bez mobitela i odgovorno ponašanje u vožnji, što je u skladu s NPSCP RH 2021. - 2030. (do 2030. za 50 % smanjiti broj teških nesreća), a definirano je područjem djelovanja PD6 (Prevencija distrakcije vozača), mjerom 7.4. Prevencija distrakcije vozača, tip mjere Edukacija/Provođenje preventivno-edukativnih i promidžbenih aktivnosti.

Ukupni proračun projekta iznosi 57.142,86 eura, od čega se 70 % ili 40.000,00 eura financira iz NPSCP RH 2021. - 2030.

Ključne riječi:

sigurnost

distrakcija

mobitel

prometne nesreće

Uvod

Telefoniranje tijekom vožnje jedan je od najčešćih distraktora koji smanjuje sposobnost zadržavanja pažnje vozača na cestu i promet, jer skreće i zadržava pogled na mobitelu, a

kroz vođenje razgovora njegovi kognitivni zadaci se multipliciraju i on svoju mentalnu usmjerenost na vožnju mora dijeliti s denotativnim i konotativnim komponentama komunikacije koju vodi. Mobilni uređaji ne koriste se samo za telefoniranje već i za komunikaciju putem društvenih mreža, pretraživanje internetskih izvora te navigaciju što sve također učestalo koriste i vozači za vrijeme vožnje, što je dodatna opasnost za sigurnost prometa. Distrakcija je uzrok u 11% teških prometnih nesreća.

Glavni cilj projekta bio je preventivno-edukativnim te promidžbenim aktivnostima povećati svjesnost mladih vozača o rizicima korištenja mobitela u vožnji te razvijati pozitivne stavove prema vožnji bez mobitela. Projekt je provodila Škola za cestovni promet u suradnji s Fakultetom prometnih znanosti iz Zagreba. Aktivnosti su usmjerene prema učenicima završnih razreda srednjih škola u Zagrebu i 16 gradova u RH. U edukaciju je uključeno više od 1200 učenika odnosno direktnih korisnika. Rezultat projekta je edukacijski materijal u kojem je prezentiran scenarij poučavanja popraćen sa svim potrebnim materijalima u digitalnoj formi. Kreirani materijal ustupit će se nastavnicima srednjih škola kako bi edukaciju mogli samostalno provoditi i nakon završetka projekta.

Podciljevi projekta Vozi bez mobitela:

Ispitivanje stavova i ponašanje budućih i trenutnih vozača o korištenju mobitela za vrijeme vožnje te utjecaju distraktora na vozačevu pažnju i sigurnost prometa;

povećanje broja preventivnih aktivnosti kojima se prikazuje važnost nekorištenja mobilnih uređaja tijekom vožnje za sigurnost prometa;

povećanje broja vozača koji neće koristiti mobilni uređaj tijekom vožnje;

kreiranje scenarija poučavanja sa svim pratećim nastavnim materijalima i sadržajima koji će biti ustupljen nastavnicima/razrednicima srednjih škola i dostupan za samostalnu provedbu te tako osigurati održivost projekta;

izrada edukacijskog materijala s temom distrakcije vozača;

izrada simulacije distrakcije u vožnji za VR naočale.

Stručnjaci s Fakulteta prometnih znanosti izradili su simulaciju distrakcije u vožnji koja korisnicima projekta putem VR naočala dodatno približava potencijalne opasnosti i rizike vezane uz korištenje mobitela u vožnji.

Rezultati istraživanja, edukacije, prevencije i promidžbe prezentirani su učenicima srednjih škola u Gradu Zagrebu i u ostalim gradovima Republike Hrvatske (Split, Rijeka, Zadar, Šibenik, Gospić, Metković, Imotski, Sinj, Osijek, Beli Manastir, Konjščina, Đurđevac, Slavonski Brod, Varaždin i Čakovec) kako bi problematiku distrakcije usmjerili na veći broj trenutnih i budućih vozača kao i na veći broj ostalih sudionika prometa koji se s vozačima susreću u prometu na cestama.

Slika 1. Gradovi u kojima su provedene edukacije



Korisnici projekta su učenici srednjih i osnovnih škola koji su bili uključeni direktno ili indirektno sudjelujući na edukacijama o distrakciji u prometu. Broj direktnih korisnika je veći od 1200, a indirektnih veći od 10000. Također, za održivost projekta direktni i indirektni korisnici se svakako povećavaju jer se edukacije nastavljaju održavati u osnovnim i srednjim školama.

Distrakcija u prometu

Posjedovanje mobitela je uobičajeno među mladim ljudima čija primjena je poboljšala stil života mijenjajući izrazito fleksibilno način razvoja svakodnevnih aktivnosti. Mobilni uređaji ne koriste se samo za telefoniranje već i za komunikaciju putem društvenih mreža, pretraživanje internetskih izvora, slikanje, snimanje, slušanje glazbe te navigaciju. Iako primjena mobitela u vožnji ima određenih prednosti, uporaba tijekom vožnje smatra se najčešćom i najopasnijom distrakcijom. Važno je napomenuti da se distrakcije u prometu ne odnose samo na vozače motornih vozila nego i na vozače električnih romobila i bicikliste.

Distrakcija je od psihologa prihvaćen termin koji označava „smanjivanje sposobnosti zadržavanja pažnje, a obično se manifestira kao ekscesivno premještanje pažnje s jednog predmeta na drugi.“ Uporaba mobitela ometa vozača vizualno (vozač se ne fokusira na cestu ispred sebe jer miče pogled s ceste kako bi koristio mobilni uređaj), kognitivno (koncentracija i pažnja vozača su podijeljene između vožnje i uporabe mobitela), fizički (micanje ruke s upravljača kako bi se rukovalo mobitelom) i zvučno (zagušenje zvukova upozorenja). Najveći utjecaj na vozača ima kognitivna distrakcija što kao posljedicu ima nesvjesno davanje prednosti radnji na mobilnom uređaju nad vožnjom zbog čega

koncentracija i sposobnost prosuđivanja opadaju. Telefoniranje tijekom vožnje jedan je od najčešćih distraktora koji smanjuje sposobnost zadržavanja pažnje vozača na cestu i promet, jer skreće i zadržava pogled na mobitelu, a kroz vođenje razgovora njegovi kognitivni zadaci se multipliciraju i on svoju mentalnu usmjerenost na vožnju mora dijeliti s denotativnim i konotativnim komponentama komunikacije koju vodi. Iako su fokus vozača na vožnju i performanse vožnje manji uporabom hands-free funkcije ili držanjem mobitela u ruci, vozači smatraju da je uporaba hands-free funkcije u velikoj mjeri bezopasna iako pokretanje hands-free razgovora još uvijek često zahtijeva vizualno-ručne radnje. Jedna od najopasnijih radnji na mobitelu je pisanje poruka i pretraživanje interneta jer uključuje vizualno, kognitivno i fizičko ometanje.

Čimbenici koji pridonose vožnji bez pažnje, osobito među mladim vozačima, uključuju spremnost na rizik, stavove, društvene norme i utjecaje (npr. opaženo ponašanje roditelja i vršnjaka) i percipiranu kontrolu ponašanja (npr. povjerenje u vlastitu sposobnost sudjelovanja).

Mladi vozači su skupina koja ima najveću sklonost korištenja mobitela u vožnji u odnosu na ostale skupine vozača što smanjuje performanse mladog vozača. Istraživanje stavova i ponašanja mladih vozača provedeno 2019. godine na sveučilištima u nekoliko saveznih država SAD-a pokazalo je da tijekom vožnje 95 % ispitanika čita poruke, 86 % razgovara telefonom, 84 % šalje poruke, te 71 % koristi hands-free uređaj.

Negativni učinci uporabe mobitela tijekom vožnje ogledaju se kroz duže i češće skretanje pogleda s ceste, sporije reakcije i detekcije, više varijacija položaja u prometnom traku i udaljenosti praćenja, smanjenje brzine što dovodi do znatno povećanog rizika od sudara i smanjenja razine sigurnosti prometa. Vozač tri puta sporije reagira na prepreku kada piše SMS, a samo jedna sekunda nepažnje produljuje zaustavni put u normalnim uvjetima vožnje za više od 15 metara. Utjecaj mobilnog telefona na performanse vožnje nedvojbeno je negativan čime je uporaba mobitela u vožnji postala jedan od ključnih problema sigurnosti cestovnog prometa. U prilog tvrdnji ide podatak Svjetske zdravstvene organizacija (engl. World Health Organization) prema kojem je 150 od 175 država svijeta donijelo zakone protiv korištenja mobilnih uređaja u vožnji. U Belgiji i Njemačkoj zabrana uporabe mobitela odnosi se na vozila u pokretu, ali i na vozila koja stoje u prometnoj gužvi ili ispred crvenog svjetla. U SAD-u mnoge države zabranjuju sve oblike telefonske interakcije (uključujući hands-free) za vozače školskih autobusa i mlade vozače.

Prema podacima iz Biltena o sigurnosti cestovnog prometa u Republici Hrvatskoj 2024. godine tijekom nadzora prometa utvrđeno je ukupno 786.367 prekršaja, od čega 40.657 prekršaja korištenja mobitela za vrijeme vožnje

Za učinkovitu borbu protiv korištenja mobitela tijekom vožnje ključna je kombinacija stroge provedbe zakona, učinkovitih komunikacijskih kampanja i promjene u društvenoj percepciji vožnje bez pažnje. Za povećanje učinka važno je kontinuirano provođenje poruka specifičnih za ciljnu skupinu, a posebna pozornost treba se dati mladim ljudima koji imaju 'prirodni' refleks da dohvate svoj telefon kada prime poziv ili tekstualne poruke. Podizanje svijesti također bi trebalo biti uključeno u obrazovanje vozača i kontinuirano osposobljavanje za profesionalne vozače. Mjere provedbe, u kombinaciji s kontinuiranom edukacijom i podizanjem svijesti, mogu imati značajan utjecaj na ponašanje vozača i u konačnici spasiti živote.

Edukacija mladih i budućih vozača

Kontinuirana edukacija mladih i adolescenata na temu vožnje bez mobitela, posebno kroz radionički oblik rada, važna je zbog nekoliko ključnih razloga:

Korištenje mobitela tijekom vožnje drastično povećava rizik od prometnih nesreća. Mladi vozači često nemaju dovoljno vozačkog iskustva, a distrakcija u obliku slanja poruka, razgovora ili pregledanja društvenih mreža može biti fatalna. Edukacija može pomoći u razvijanju svijesti o opasnostima i ozbiljnim posledicama takvog ponašanja.

Upotreba mobitela prilikom vožnje stvara kognitivnu, vizualnu i manuelnu distrakciju. Adolescenti često nisu svjesni koliko je opasno kada im je pažnja skrenuta s puta, čak i na par sekundi. Edukacija pomaže da postanu svjesniji rizika povezanih s ovakvim ometanjima.

Adolescenti su u fazi razvoja kada usvajaju važne navike i obrasce ponašanja. Edukacije im omogućavaju da razumiju odgovornost koju preuzimaju kada sjednu za upravljač automobila i kako njihove odluke mogu uticati na njih, njihove putnike i ostale učesnike u prometu.

Mladi su često podložni grupnom pritisku i utjecaju vršnjaka, zbog čega je važno stvoriti kulturu sigurnog ponašanja u prometu. Radionice pružaju priliku da se kroz diskusiju, praktične primjere i simulacije vozačke situacije potakne sigurno i odgovorno ponašanje, što može postati pozitivan uzor u njihovim grupama.

Mnogi mladi nisu dovoljno informirani o zakonima koji reguliraju upotrebu mobitela tijekom vožnje. Edukativne radionice pomažu im da razumiju pravne aspekte i posljedice kršenja zakona, uključujući novčane kazne, oduzimanje vozačke dozvole ili čak zatvorske kazne u slučajevima ozbiljnih nesreća.

Nesreće uzrokovane korištenjem mobitela za vrijeme vožnje mogu imati trajne posljedice, uključujući teške povrede, invaliditet ili gubitak života. Mladima se putem radionica može objasniti kako jedan trenutak nepažnje može trajno promeniti njihov život i živote drugih.

Adolescencija je period kada se formiraju trajne životne navike. Edukacija i radionice mogu potaknuti promjenu ponašanja, kao što je razvijanje navike da se mobitel koristi samo kada je vozilo parkirano ili se koristi hands-free uređaj, čime se smanjuje rizik od distrakcije.

Kroz radionice, mladi mogu razviti kritičko razmišljanje i analizu rizika. Na ovaj način postaju sposobniji da prepoznaju rizične situacije i donesu odgovorne odluke, što je ključ za sigurnu vožnju i odgovorno sudjelovanje u prometu.

Kada educiramo mlade i potaknemo ih da izbjegavaju korištenje mobitela za vrijeme vožnje, oni postaju primjer i za druge vozače, uključujući članove njihove obitelji i prijatelje. To može stvoriti lančanu reakciju i pozitivno utjecati na širu društvenu zajednicu u smislu sigurnijeg ponašanja u prometu. Edukacije i radionice nisu samo sredstvo za smanjenje rizika od prometnih nesreća, već i način da se mladi osnaže kao odgovorni i svjesni sudionici u prometu, čime se stvara sigurnije okruženje za sve.

VR naočale u nastavnom procesu

Tehnologija virtualne stvarnosti donosi brojne prednosti koje unapređuju nastavni proces. Kao jedna od najčešći prednosti korištenja virtualne tehnologije u nastavi je bolja motiviranost i angažiranost učenika. Također, tehnologija virtualne stvarnosti omogućuje korisnicima zamjenu trenutne stvarnosti s virtualnim okruženjem koje može biti bilo koja

lokacija, stvarna ili zamišljena. Nastavnici mogu iskoristiti tu mogućnost kako bi postigli obrazovne ciljeve koji se ne mogu zadovoljavajuće postići unutar ograničenja nametnutih trenutnom fizičkom lokacijom.

Tijekom provedbe projektnih aktivnosti sudionici edukacije su uz pomoć predavača koristili VR naočale sa simulacijom naleta vozila na pješaka. Korisnik simulacije je u svojstvu vozača osobnog vozila koji ima mogućnost upravljanja istim. Tijekom vožnje u određenom trenutku vozač dobiva poziv na mobilnom uređaju koji se nalazi u predjelu mjenjača. S obzirom na dislociranost mobilnog uređaja vozač je primoran pažnju i pogled usmjeriti prema mobitelu kako bi ga uzeo i „javio“ se na mobitel. U trenutku kada je pažnja i pogled usmjerena na mobitel, ispred vozila se pojavljuju pješaci te nakon toga dolazi do prometne nesreće.

Uz pomoć VR naočala sudionici edukacija doživjeli su neke rijetke i opasne situacije bez stvarnog rizika od ozljeda ili oštećenja opreme. Sigurno okruženje omogućuje korisnicima stjecanje iskustva i znanja te im istodobno omogućuje učenje iz svojih pogrešaka i eksperimentiranje s različitim scenarijima bez potrebe za fizičkom prisutnošću u stvarnom opasnom okruženju.

Zaključak

Sigurnost cestovnog prometa u Republici Hrvatskoj jedan je od segmenta javne sigurnosti. Glavni cilj je svakako smanjenje broja prometnih nesreća i njihovih posljedica. Unazad dva desetljeća u Republici Hrvatskoj poduzimaju se brojne sigurnosne mjere regulirane prema svjetskim i europskim smjernicama zakonske regulative kako bi se povećala sigurnost u prometu na cestama kao što je kontrola brzine, preojekti za podizanje svijesti o sigurnosti u prometu, osuvremenjivanje prometne infrastrukture, educiranje osnovnoškoleske i srednjoškolske djece o prometnoj kulturi te razvoj novih tehnologija (autonomna vozila, napredni sustavi pomoći vozaču, inteligentni prometni sustavi, napredne tehnologije sigurnosnih pojaseva i zračnih jastuka, digitalne platforme i mobilne aplikacije). Primjena mjera i tehnološke inovacije uvelike doprinose povećanju sigurnosti na cestama, smanjenju broja nesreća i njihovih posljedica. Cilj svake zemlje je podići stanje sigurnosti u cestovnom prometu na što višu razinu, sa što manje poginulih i što manje prometnih nesreća s teškim posljedicama. Da bi se to postiglo, između ostalog, potrebno je podići svijest o značaju prometne kulture u cjelokupnom društvu. Kontinuirana edukacija djece i mladih o sigurnosti u cestovnom prometu i prometnoj kulturi od izuzetne je važnosti. Edukacije s novim tehnologijama kao što je primjena VR naočala u nastavi podiže se motivacija i zainteresiranost učenika. Takvim općim pristupom i novim tehnologijama cjelokupno bi društvo s vremenom dostiglo visoku razinu prometne kulture, povećala bi se sigurnost u prometu na cestama i spriječile prometne nesreće s tragičnim posljedicama.

Literatura:

1. Boets, S. (2022) „Road Safety Thematic Report – Driver distraction“, European Road Safety Observatory, European Commission, https://road-safety.transport.ec.europa.eu/document/download/662f244a-b3ad-442a-aa60-50f8437c86f2_en?filename=Road_Safety_Thematic_Report_Driver_Distraction_2022.pdf
2. Cerovac, Mirna (2016) „Povezanost stavova prema vožnji, poznavanja prometnih propisa i samoprocjene prometnog ponašanja mladih vozača“, https://urn.nsk.hr/urn:nbn:hr:142:968483
3. European Commission (2018) „Cell phone use while driving“, Summary, https://road-safety.transport.ec.europa.eu/system/files/2021-07/ersosynthesis2018-cellphone-summary.pdf
4. Ljubić Hinić, M., Šego, D. i Milošević., M (2023) „Stavovi i ponašanja mladih vozača u prometu na području Šibensko-kninske županije“, Zbornik Veleučilišta u Rijeci / Journal of the Polytechnic of Rijeka, 11(1); 313-330. https://doi.org/10.31784/zvr.11.1.17
5. Bilten o sigurnosti cestovnog prometa 2024., XLX izdanje, Zagreb 2025.
6. Mccartt, A.T., Hellinga, L.A. and Bratiman, K.A. (2006.) „Cell phones and driving: review of research“, Traffic Injury Prevention, 7(2), pp. 89–106. https://doi.org/10.1080/15389580600651103
7. Neuroth M.N. et al. (2021.) „Driving contradictions: behaviors and attitudes regarding handheld and handsfree cellphone use while driving among young drivers“, Injury Epidemiology (8), https://doi.org/10.1186/s40621-021-00312-2
8. Nijboer, M., Borst, J. P., i Rijn, H. and Taatgen, N. A. (2016.) „Driving and multitasking: the good, the bad, and the dangerous“.,Frontiers in Psychology. 7, 1718. https://doi.org/10.3389/fpsyg.2016.01718
9. Prelčec, Ivana (2020) „Utjecaj korištenja mobilnih uređaja na vozačevu percepciju prometne signalizacije“ https://urn.nsk.hr/urn:nbn:hr:119:412706

ŠKOLA ZA CESTOVNI PROMET, ZAGREB

Autori:

Igor Jelić, mag. ing. traff.

Tomislav Ćurković, dipl. ing. prometa

VIRTUAL REALITY IN TEACHING VOCATIONAL SUBJECTS

Summary:

The Drive without a mobile phone project is a continuation of the successfully implemented project financed by the National Road Safety Program of the Republic of Croatia (NPSCP) "Bicyclist Visibility" related to safety and visibility, which has been conducting educational, preventive and promotional activities for the second year after the project's completion. Also, as a result of the implemented project, an optional subject "Pedestrian safety in road traffic" was created and is being successfully implemented in which students of the School for road traffic educate students in primary and secondary schools about traffic safety with the aim of increasing awareness and traffic culture. During training, virtual reality glasses are used to bring dangerous traffic situations closer to students and increase awareness of possible consequences.

The main objective of the project is to increase awareness of young drivers about the risks of using mobile phones while driving through preventive and educational activities and to develop positive attitudes towards driving without a mobile phone and responsible driving behavior, which is in line with the NPSCP RH 2021 - 2030 (reduce the number of serious accidents by 50% by 2030), and is defined by the area of action PD6 (Prevention of driver distraction), measure 7.4. Prevention of driver distraction, measure type Education/Implementation of preventive and educational and promotional activities.

The total project budget is 57,142.86 euros, of which 70% or 40,000.00 euros is financed from the NPSCP RH 2021 - 2030.

Keywords:

- *safety*
- *distraction*
- *mobile phone*
- *traffic accidents*

Introduction

Talking while driving is one of the most common distractors that reduces the driver's ability to maintain attention on the road and traffic, because he turns away and keeps his eyes on the mobile phone, and through conducting a conversation his cognitive tasks multiply and

he has to share his mental focus on driving with the denotative and connotative components of the communication he conducts. Mobile devices are not only used for talking on the phone but also for communicating via social networks, searching for Internet resources and navigation, all of which are also frequently used by drivers while driving, which is an additional danger to traffic safety. Distraction is the cause of 11% of serious traffic accidents.

The main goal of the project was to increase awareness among young drivers about the risks of using mobile phones while driving through preventive, educational and promotional activities and to develop positive attitudes towards driving without a mobile phone. The project was implemented by the School of Road Traffic in cooperation with the Faculty of Transport Sciences in Zagreb. The activities are aimed at students in the final grades of secondary schools in Zagreb and 16 cities in the Republic of Croatia. More than 1,200 students, or direct users, were included in the education. The result of the project is educational material in which a teaching scenario is presented, accompanied by all the necessary materials in digital form. The material created will be provided to secondary school teachers so that they can independently conduct the education even after the project ends.

The sub-objectives of the project are:

- Examining the attitudes and behavior of future and current drivers regarding the use of mobile phones while driving and the impact of distractors on the driver's attention and traffic safety;
- increasing the number of preventive activities that demonstrate the importance of not using mobile devices while driving for traffic safety;
- increasing the number of drivers who will not use a mobile device while driving;
- creating a teaching scenario with all accompanying teaching materials and content that will be provided to secondary school teachers/classroom teachers and available for independent implementation, thus ensuring the sustainability of the project;
- creating educational material on the topic of driver distraction;
- creating a simulation of driving distraction for VR glasses.

Express from the Faculty od Transport Sciences will cerite a simulation of distraction while driving that will further familiarize project users with the potential dangers and risks associated with using a mobile phone while driving through VR glasses.

The results of research, education, prevention and promotion were presented to high school students in the City of Zagreb and other cities in the Republic of Croatia (Split, Rijeka, Zadar, Šibenik, Gospić, Metković, Imotski, Sinj, Osijek, Beli Manastir, Konjščina, Đurđevac, Slavonski Brod, Varaždin and Čakovec) in order to focus the issue of distraction on a larger number of current and future drivers, as well as on a larger number of other traffic participants who encounter drivers in road traffic.

Figure 1. Cities where training was conducted



The project beneficiaries are secondary and primary school students who were directly or indirectly involved in education on distraction in traffic. The number of direct beneficiaries is more than 1200, and indirect beneficiaries is more than 10000. Also, for the sustainability of the project, the number of direct and indirect beneficiaries will certainly increase because the education will continue to be held in primary and secondary schools.

Distraction in traffic

Owning a mobile phone is common among young people, whose use has improved their lifestyle by changing the way they carry out their daily activities in a very flexible way. Mobile devices are not only used for making calls, but also for communicating via social networks, searching for Internet resources, taking pictures, recording, listening to music and navigating. Although using a mobile phone while driving has certain advantages, using it while driving is considered the most common and dangerous distraction. It is important to note that distraction in traffic does not only apply to drivers of motor vehicles, but also to drivers of electric scooters and cyclists.

Distraction is a term accepted by psychologists to mean “a reduction in the ability to sustain attention, usually manifested as excessive shifting of attention from one object to another.” Using a cell phone distracts the driver visually (the driver does not focus on the road ahead because they take their eyes off the road to use the cell phone), cognitively (the driver's concentration and attention are divided between driving and using the cell phone), physically (taking their hands off the steering wheel to operate the cell phone), and aurally (the driver's warning sounds are drowned out). Cognitive distraction has the greatest impact on the driver, which results in unconsciously prioritizing actions on the cell phone over driving, which causes concentration and judgment to decline. Talking on the phone while driving is one of the most common distractors that reduces the driver's ability to keep his attention on the road and traffic, because he diverts and keeps his eyes on the mobile phone, and through conversation his cognitive tasks multiply and he has to share his mental focus on driving with the denotative and connotative components of the communication he leads. Although driver focus on driving and driving performance are reduced by using the hands-

free function or holding a mobile phone in hand, drivers consider the use of the hands-free function to be largely harmless, although initiating a hands-free conversation still often requires visual-manual actions. One of the most dangerous actions on a cell phone is texting and browsing the Internet because it involves visual, cognitive, and physical distraction.

Factors that contribute to distracted driving, especially among young drivers, include risk-taking, attitudes, social norms and influences (e.g., observed behavior of parents and peers), and perceived behavioral control (e.g., confidence in one's own ability to participate). Young drivers are the group most likely to use cell phones while driving compared to other driver groups, which reduces young driver performance. A 2019 survey of young driver attitudes and behaviors conducted at universities in several U.S. states found that 95% of respondents read text messages, 86% talk on the phone, 84% send text messages, and 71% use a hands-free device while driving.

The negative effects of using a mobile phone while driving are reflected in longer and more frequent looks away from the road, slower reactions and detection, more variations in lane position and following distance, and reduced speed, which leads to a significantly increased risk of collision and a reduced level of traffic safety. A driver reacts three times slower to an obstacle when texting, and just one second of inattention increases the stopping distance in normal driving conditions by more than 15 meters. The impact of a mobile phone on driving performance is undoubtedly negative, making the use of a mobile phone while driving one of the key problems in road safety. This claim is supported by data from the World Health Organization, according to which 150 out of 175 countries in the world have passed laws against the use of mobile devices while driving. In Belgium and Germany, the ban on the use of mobile phones applies to vehicles in motion, but also to vehicles stopped in traffic jams or at red lights. In the USA, many states prohibit all forms of telephone interaction (including hands-free) for school bus drivers and young drivers.

According to data from the Road Traffic Safety Bulletin in the Republic of Croatia 2024, a total of 786,367 violations were detected during traffic inspections, of which 40,657 were violations of using a mobile phone while driving

A combination of strict law enforcement, effective communication campaigns and changes in the social perception of distracted driving are key to effectively combating mobile phone use while driving. Continuous implementation of targeted messages is important to increase the impact, and special attention should be paid to young people who have a 'natural' reflex to reach for their phone when receiving a call or text message. Awareness-raising should also be included in driver education and continuous training for professional drivers. Enforcement measures, combined with continuous education and awareness-raising, can have a significant impact on driver behavior and ultimately save lives.

Education of young and future drivers

Continuous education of young people and adolescents on the topic of driving without a mobile phone, especially through workshops, is important for several key reasons:

- Using a cell phone while driving drastically increases the risk of traffic accidents. Young drivers often do not have enough driving experience, and distraction in the form of texting, chatting or browsing social networks can be fatal. Education can help in developing awareness of the dangers and serious consequences of such behavior.

- Using a cell phone while driving creates a cognitive, visual and manual distraction. Adolescents are often unaware of how dangerous it is when their attention is diverted, even for a few seconds. Education helps them become more aware of the risks associated with such distractions.

- Adolescents are in the phase of development when they adopt important habits and patterns of behavior. Education enables them to understand the responsibility they assume when they sit behind the wheel of a car and how their decisions can affect them, their passengers and other road users.

- Young people are often subject to group pressure and peer influence, which is why it is important to create a culture of safe behavior in traffic. The workshops provide an opportunity to encourage safe and responsible behavior through discussion, practical examples and simulations of driving situations, which can become a positive role model in their groups.

- Many young people are not sufficiently informed about the laws governing the use of mobile phones while driving. Educational workshops help them understand the legal aspects and consequences of breaking the law, including fines, loss of driving license or even imprisonment in cases of serious accidents.

- Accidents caused by using mobile phones while driving can have lasting consequences, including serious injury, disability or loss of life. Workshops can help young people understand how a moment of inattention can permanently change their lives and the lives of others.

- Adolescence is a period when lasting life habits are formed. Education and workshops can encourage behavioral changes, such as developing the habit of using a cell phone only when the vehicle is parked or using a hands-free device, which reduces the risk of distraction.

- Through workshops, young people can develop critical thinking and risk analysis. In this way, they become better able to recognize risky situations and make responsible decisions, which is the key to safe driving and responsible participation in traffic.

- When we educate young people and encourage them to avoid using a cell phone while driving, they become an example for other drivers, including their family members and friends. This can create a chain reaction and positively influence the wider social community in terms of safer traffic behavior. Education and workshops are not only a means of reducing the risk of traffic accidents, but also a way to empower young people as responsible and aware participants in traffic, thus creating a safer environment for everyone.

VR glasses in the teaching process

Virtual reality technology brings numerous advantages that improve the teaching process. One of the most common advantages of using virtual technology in teaching is better motivation and engagement of students. Also, virtual reality technology allows users to replace the current reality with a virtual environment that can be any location, real or imagined. Teachers can use this opportunity to achieve educational goals that cannot be satisfactorily achieved within the limitations imposed by the current physical location.

During the implementation of the project activities, the training participants, with the help of the lecturer, used VR glasses with a simulation of a vehicle hitting a pedestrian. The simulation user is the driver of a personal vehicle who has the ability to control it. While driving, at a certain moment the driver receives a call on a mobile device located in the gearshift area. Given the dislocation of the mobile device, the driver is forced to direct his attention and gaze towards the mobile phone in order to pick it up and "answer" the mobile phone. At the moment when his attention and gaze are focused on the mobile phone, pedestrians appear in front of the vehicle, and then a traffic accident occurs.

With the help of VR glasses, the training participants experienced some rare and dangerous situations without the real risk of injury or damage to the equipment. A safe environment allows users to gain experience and knowledge and at the same time allows them to learn from their mistakes and experiment with different scenarios without the need for physical presence in a real dangerous environment.

Conclusion

Traffic safety in the Republic of Croatia is a key aspect of public safety, with the aim of reducing the number of traffic accidents and their consequences. In recent years, numerous measures have been taken in accordance with global and European legal guidelines to improve road safety, such as increasing speed control, campaigns to raise awareness of traffic safety, improving traffic infrastructure, education on traffic culture and the development of new technologies (autonomous vehicles, advanced driver assistance systems (ADAS), connected vehicles, intelligent traffic systems, advanced seatbelt and airbag technologies, digital platforms and mobile applications). The implementation of measures and technological innovations greatly contribute to increasing road safety, reducing the number of accidents and their consequences. The goal of every country is to raise the state of road safety to the highest possible level, with as few fatalities and as few traffic accidents with serious consequences as possible. To achieve this, among other things, it is necessary to raise awareness of the importance of traffic culture in society as a whole. Continuous education of children and young people on road safety and traffic culture is of utmost importance. With such an approach, society as a whole would eventually reach a high level of traffic culture, road safety would increase, and traffic accidents with tragic consequences would be prevented.

Literature:

- Boets, S. (2022) „Road Safety Thematic Report – Driver distraction“, European Road Safety Observatory, European Commission, https://road-safety.transport.ec.europa.eu/document/download/662f244a-b3ad-442a-aa60-50f8437c86f2_en?filename=Road_Safety_Thematic_Report_Driver_Distraction_2022.pdf
- Cerovac, Mirna (2016) „Povezanost stavova prema vožnji, poznavanja prometnih propisa i samoprocjene prometnog ponašanja mladih vozača“, https://urn.nsk.hr/urn:nbn:hr:142:968483
- European Commission (2018) „Cell phone use while driving“, Summary, https://road-safety.transport.ec.europa.eu/system/files/2021-07/ersosynthesis2018-cellphone-summary.pdf

- Ljubić Hinić, M., Šego, D. i Milošević., M (2023) „Stavovi i ponašanja mladih vozača u prometu na području Šibensko-kninske županije“, Zbornik Veleučilišta u Rijeci / Journal of the Polytechnic of Rijeka, 11(1); 313-330. https://doi.org/10.31784/zvr.11.1.17
- Bilten o sigurnosti cestovnog prometa 2024., XLX izdanje, Zagreb 2025.
- Mccartt, A.T., Hellinga, L.A. and Bratiman, K.A. (2006.) „Cell phones and driving: review of research“, Traffic Injury Prevention, 7(2), pp. 89–106. https://doi.org/10.1080/15389580600651103
- Neuroth M.N. et al. (2021.) „Driving contradictions: behaviors and attitudes regarding handheld and handsfree cellphone use while driving among young drivers“, Injury Epidemiology (8), https://doi.org/10.1186/s40621-021-00312-2
- Nijboer, M., Borst, J. P., i Rijn, H. and Taatgen, N. A. (2016.) „Driving and multitasking: the good, the bad, and the dangerous“.,Frontiers in Psychology. 7, 1718. https://doi.org/10.3389/fpsyg.2016.01718
- Prelčec, Ivana (2020) „Utjecaj korištenja mobilnih uređaja na vozačevu percepciju prometne signalizacije“ https://urn.nsk.hr/urn:nbn:hr:119:412706

ŠKOLA ZA CESTOVNI PROMET, ZAGREB

Autori:

Tomislav Kučina, dipl. ing. prometa

Tomislav Ćurković, dipl. ing. prometa

MODERNIZACIJA KURIKULA VOZAČ MOTORNOG VOZILA I NJEGOVO UVOĐENJE U OBRAZOVNI SUSTAV REPUBLIKE HRVATSKE KROZ MODULARNU NASTAVU

Sažetak

Agencija za strukovno obrazovanje i obrazovanje odraslih je nositelj projekta "Modernizacija sustava strukovnog obrazovanja i osposobljavanja. Svrha projekta je razvoj strukovnog obrazovanja koje je privlačno, inovativno i povezano s tržištem rada, te jačanje kompetencija odgojno-obrazovnih djelatnika za uvođenje i provedbu kurikuluma.

Kroz nove kurikulume uvodi se i modularna nastava. Modul povezuje oblike učenja na radu, učioničko i izvanučioničko učenje i poučavanje u smislenu te međusobno povezanu i zaokruženu cjelinu, povećava se učinkovitost organizacije rada i smislenije učenje. Ovim pristupom omogućava se planiranje i organiziranje nastave usmjerene na učenika, primjenjivanje nastavnih metoda i strategija kojima se potiče samostalno, odgovorno i aktivno učenje, povezivanje potreba svijeta rada s ishodima učenja, problemsko, projektno i istraživačko učenje. Tijekom izrade novih kurikuluma stavljeno je težište na učenje temeljeno na radu.

Za zanimanje vozač motornog vozila se je pristupilo izradi standarda zanimanja Vozač motornog vozila u prijevozu putnika i Vozač motornog vozila u prijevozu tereta, Standarda kvalifikacije Vozač motornog vozila koji obuvača oba navedena standarda zanimanja i izradi Strukovnog kurikula Vozač motornog vozila koji se temelji na skupovima ishoda učenja koji se realiziraju kroz module u kurikulu.

Ključne riječi: Standard zanimanja, Standard kvalifikacija, Strukovni kurikul, Vozač motornog vozila

MODERNIZACIJA KURIKULA VOZAČ MOTORNOG VOZILA I NJEGOVO UVOĐENJE U OBRAZOVNI SUSTAV REPUBLIKE HRVATSKE KROZ MODULARNU NASTAVU

Modernizacija strukovnog obrazovanja u Republici Hrvatskoj

Agencija za strukovno obrazovanje i obrazovanje odraslih je nositelj projekta "Modernizacija sustava strukovnog obrazovanja i osposobljavanja", koji se je provodio od 2017. do 2024. godine. Cilj projekta je Modernizacija ponude strukovnog obrazovanja te podizanje njegove kvalitete u svrhu povećanja zaposlenosti učenika kao i mogućnosti za daljnje obrazovanje.

Svrha projekta je razvoj strukovnog obrazovanja i osposobljavanja koje je privlačno, inovativno, relevantno, povezano s tržištem rada te koje će omogućiti učenicima stjecanje kompetencija za osobni i profesionalni razvoj te nastavak obrazovanja i cjeloživotno učenje, a ostvaruje se kroz razvoj inovativnih i fleksibilnih sektorskih i strukovnih kurikula temeljenih na potrebama tržišta rada te jačanja kompetencija odgojno-obrazovnih djelatnika za uvođenje i provedbu kurikula. Izrađeno je 120 novih kurikula za strukovne škole te se radi na uvođenju modularne nastave. Modul povezuje oblike učenja na radu, učioničko i izvan učioničko učenje i poučavanje u smislenu te međusobno povezanu i zaokruženu cjelinu, povećava se učinkovitost organizacije rada (odgojno-obrazovnoga procesa) i smislenije učenje. Ovim pristupom omogućit će se planiranje i organiziranje nastave usmjerene na učenika, primjenjivanje nastavnih metoda i strategija kojima se potiče samostalno, odgovorno i aktivno učenje, povezivanje potreba svijeta rada s ishodima učenja, povezivanje informalnoga učenja i neformalnog obrazovanja s formalnim obrazovanjem, problemsko, projektno i istraživačko učenje.

Naglasak je na vertikalnoj i horizontalnoj prohodnosti kroz strukovno obrazovanje i kroz odgojno obrazovne cikluse. Odgojno-obrazovni ciklusi su odgojno-obrazovna razvojna razdoblja učenika koja čine jednu cjelinu. Obuhvaćaju jednu ili više godina obrazovanja, a određuju se prema zajedničkim odgojno-obrazovnim ciljevima i ishodima učenja koja učenik treba postići. U strukovnom obrazovanju odgojno-obrazovni ciklusi razlikuju se ovisno o razini kvalifikacije.

Kvalifikacije u strukovnom obrazovanju prema Hrvatskom kvalifikacijskom okviru (HKO):

- Kvalifikacija razine 3 – kvalifikacije stečene završetkom srednjoškolskog obrazovanja u trajanju kraćem od tri godine. Ukupno radno opterećenje za stjecanje kvalifikacije minimalno je 60 CSVET bodova na razini 3 ili višoj razini ishoda učenja.
- Kvalifikacija razine 4.1. – kvalifikacije stečene završetkom srednjoškolskog obrazovanja u trajanju od tri ili dužem od tri, a kraćem od četiri godine. Ukupno radno opterećenje za stjecanje kvalifikacije minimalno je 180 CSVET bodova, od kojih je najmanje 120 CSVET bodova na razini 4 ili višoj razini ishoda učenja.
- Kvalifikacija razine 4.2. – kvalifikacije stečene završetkom srednjoškolskog obrazovanja u trajanju od četiri ili više godina. Ukupno radno opterećenje za

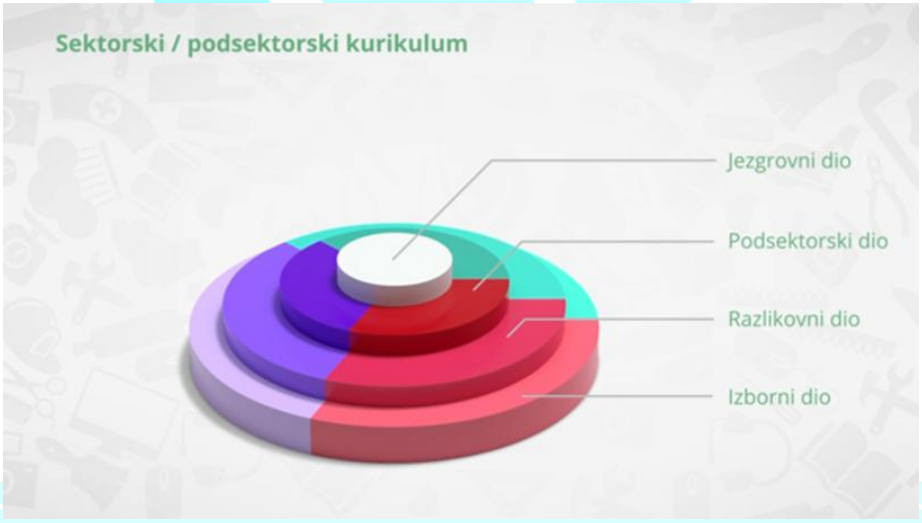
stjecanje kvalifikacije minimalno je 240 CSVET bodova, od kojih je najmanje 150 CSVET bodova na razini 4 ili višoj razini ishoda učenja

- Kvalifikacija razine 5. – kvalifikacije stečene završetkom stručnih studija kojima se stječe manje od 180 ECTS ili CSVET bodova; strukovnoga specijalističkog usavršavanja; programa za majstore uz najmanje dvije godine vrednovanoga radnog iskustva. Ukupno radno opterećenje za stjecanje kvalifikacije minimalno je 60 CSVET ili 120 ECTS bodova, od kojih je najmanje 30 CSVET ili 60 ECTS bodova na razini 6 ili višoj razini ishoda učenja. Uvjet je pristupanja posjedovanje prethodne kvalifikacije na razini 4.1 ili više.

Modernizaciji sustava strukovnog obrazovanja i osposobljavanja se pristupilo kroz nekoliko koraka u kojima su radne skupine formirane od Agencija za strukovno obrazovanje i obrazovanje odraslih izrađivale slijedeće dokumente:

- Standard zanimanja – koji se izrađuje u suradnji s poslodavcima a sadrži popis ključnih poslova na radnom mjestu i pripadajućih kompetencija potrebnih za rad na jednom ili više radnih mjesta.
- Standard kvalifikacija – izrađen na temelju Standarda zanimanja a sukladno s Hrvatskim klasifikacijskim okvirom i koji se temelji na kurikularnom pristupu i ishodima učenja.
- Sektorski i strukovni kurikul – izrađen na temelju Standarda kvalifikacije, a dovodi do racionalizacije broja kurikuluma, koji omogućavaju učenicima lakše uključivanje na tržište rada, bolju horizontalnu prohodnost, profesionalni razvoj ali i nastavak obrazovanja sa naglaskom na učenje temeljeno na radu.

Slika 1.: Struktura Sektorskog kurikula *– izvor: Agencija za strukovno obrazovanje i obrazovanje odraslih - https://www.asoo.hr/projekti-i-suradnja/esf-projekti/modernizacija-sustava-strukovnog-obrazovanja-i-osposobljavanja/*

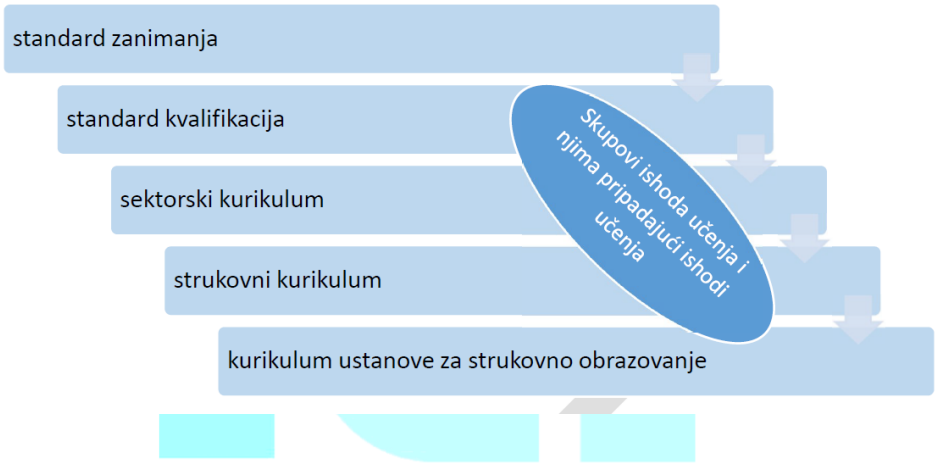


U sektoru Promet i logistika strukovni dio kurikuka koji čini jezgrovni dio se izvodi tijekom prvog polugodišta i u *svim* zanimanjima u sektoru Prometa i logistike je isti. Podsektorski dio se grana na cestovni promet, željeznički promet, zračni promet, vodni promet i logistiku, što znači sa sektor Promet i logistika ima 5 podsektora.

Standard zanimanja Vozač motornog vozila

Standard zanimanja je opis poslova koje pojedinac obavlja u određenom zanimanju te sadrži popis ključnih poslova i kompetencija, potrebna znanja i vještine, te razinu samostalnosti i odgovornosti koju učenik treba imati kako bi bilo sposoban raditi u navedenom zanimanju. Za izradu standarda zanimanja snovana je radne skupine iz redova nastavnika, poslodavaca i predstavnika poslodavaca te radnika u zanimanju. Izrađena su dva standarda zanimanja i to Vozač motornog vozila u prijevozu tereta i Vozač motornog vozila u prijevozu putnika Provedene su ankete poslodavaca o standardu zanimanja prema novoj Metodologiji izrade standarda zanimanja. Prilikom izrade Standarda zanimanja bilo je potrebno navesti dokaze utemeljenosti prijedloga standarda zanimanja i opisati stratešku, sektorsku i analitičku utemeljenost standarda zanimanja na temelju odabranih pokazatelja tržišta rada.

Slika 2.: Odnos standarda zanimanja, standarda kvalifikacija i kurikula u strukovnom obrazovanju – izvor Metodologija izrade sektorskog kurikuluma, strukovnog kurikuluma i kurikuluma ustanove za strukovno obrazovanje – Agencija za strukovno obrazovanje i obrazovanje odraslih



Standard zanimanja sadrži opis zanimanja ili skupa kompetencija, popis ključnih poslova na radnom mjestu i pripadajućih pojedinačnih kompetencija potrebnih za rad.

Vozač motornog vozila u prijevozu putnika je osoba koja samostalno ili u kao član posade obavlja poslove prijevoza putnika u domaćem i međunarodnom prijevozu putnika. Tijekom izvršenja prijevoznog procesa odgovoran je za sigurnost putnika i njihove prtljage, posebnu pozornost posvećuje djeci, starijim i invalidnim osobama. Mora biti psihički stabilan i sposoban samostalno donositi odluke u promjenjivim prometnim uvjetima, te rješavati izvanredne situacije. Obavlja administrativne poslove povezane s prijevozom (prodaja karata i obrada druge dokumentacije u skladu s vrstom prijevoza). Vozač motornog vozila u prijevozu putnika mora se kontinuirano stručno osposobljavati u svrhu stjecanja novih znanja i vještina potrebnih za obavljanje posla na radnom mjestu te mora znati uljudno komunicirati na hrvatskom i stranom jeziku. Poslove može obavljati u prijevozničkim tvrtkama, turističkim tvrtkama ili samostalno.

Vozač motornog vozila u prijevozu tereta je osoba koja samostalno ili kao član posade obavlja poslove prijevoza tereta u tuzemnom i međunarodnom prijevozu tereta. Obavlja

poslove pripreme vozila za prijevoz, preuzima prijevoznu dokumentaciju i predmet prijevoza; upravlja vozilom tijekom prijevoza; vodi prijevoznu dokumentaciju, otklanja manje kvarove na vozilu, preuzima teret u prijevozu, nadzire utovar i istovar te vodi brigu o njegovoj zaštiti. Tijekom izvršenja prijevoznog procesa odgovoran je za vozilo i teret koji prevozi. Mora biti psihički stabilan i sposoban samostalno donositi odluke u promjenjivim prometnim uvjetima, te rješavati izvanredne situacije. Također obavlja administrativne poslove povezane s prijevozom tereta. Vozač motornog vozila u prijevozu tereta u svojem poslu mora znati uljudno komunicirati na hrvatskom i još jednom stranom jeziku. Poslove najčešće može obavljati u prijevozničkim tvrtkama ili samostalno.

Standard kvalifikacije Vozač motornog vozila

Standard kvalifikacije sadrži ključne ishode učenja za zanimanje Vozač motornog vozila. Standarde kvalifikacije Vozač motornog vozila izrađivala je Škola za cestovni promet izabrana na javnom natječaju kao ustanova koja će izrađivati standard kvalifikacije od Agencije, a oformila je radnu skupinu iz redova nastavnika, sveučilišnih profesora i predstavnika poslodavaca. Prilikom izrade Standarda kvalifikacije Vozač motornog vozila bilo je potrebno navesti opis standarda kvalifikacije, opravdanost uvođenja i ulogu kvalifikacije (potreba tržišta rada i/ili nastavak obrazovanja i/ili druge potrebe pojedinca i društva), prijedlog HKO razine kvalifikacije, popis skupova ishoda učenja iz (postojeći u Registru HKO-a ili novo izrađeni), uvjete za pristupanje stjecanju kvalifikacije.

Osnovi dio standarda kvalifikacije sadrži skupove ishoda učenja sa sljedećim podacima i dijelovima: naziv prijedloga skupa ishoda učenja, razina skupa ishoda učenja prema HKO-u, prijedlog obujma, popis ishoda učenja (u pravilu 3 - 10 ishoda učenja), uvjeti za pristupanje stjecanju skupa ishoda učenja, materijalni i kadrovski uvjeti potrebni za stjecanje/vrednovanje skupa ishoda učenja, postupak i primjer vrednovanja skupa ishoda učenja.

Standard kvalifikacije Vozač motornog vozila uključuje 2 standarda zanimanja i to: vozač motornog vozila u prijevozu tereta i vozač motornog vozila u prijevozu putnika što znači da završetkom navedene kvalifikacije učenik/polaznik stječe oba navedena zanimanja. U standardu kvalifikacije Vozač motornog vozila je navedeno koji su uvjeti za stjecanje kvalifikacije a to su: Stečenih najmanje 180 CSVET bodova (najmanje 120 CSVET bodova na razini 4 ili višoj razini ishoda učenja), od kojih je 141 CSVET bodova iz strukovnog dijela kvalifikacije i 39 boda iz općeg obrazovanja te izrađen i obranjen završni rad. Standard kvalifikacije Vozač motornog vozila se sastoji od 51 skupa ishoda učenja kojima se sječe 15 skupova kompetencija.

1 Strukovni kurikul Vozač motornog vozila

Strukovni kurikul Vozač motornog vozila je dokument je kojim se određuju procesi, načini i uvjeti stjecanja kvalifikacije. Strukovni kurikulum sadržava skupove ishoda učenja, nastavne cjeline za svaki modul, preporuke okruženja za učenje, načine praćenja stjecanja skupova ishoda učenja i načine vrednovanja ishoda učenja. Strukovni kurikulum propisuje stjecanje najmanje 70 % kreditnih bodova obveznih skupova ishoda i do 30 % kreditnih bodova izbornih skupova ishoda učenja od ukupnoga obujma kvalifikacije čime se stvara fleksibilan okvir za kombiniranje skupova ishoda učenja u skladu s potrebama lokalnih zajednica i lokalnog tržišta rada.

Slika 3.: Povezanost kurukulumskih dokumenata – izvor Metodologija izrade sektorskog kurikuluma, strukovnog kurikuluma i kurikuluma ustanove za strukovno obrazovanje – Agencija za strukovno obrazovanje i obrazovanje odraslih



Kurikul Vozač motornog vozila se sastoji od opće obrazovni modula, općeg dijela strukovnog kurikula, obavezni strukovni modula, izborni strukovni modula, razrede modula po godinama obrazovanja i završnog rada. Završni rad provodi se na temelju Zakona o odgoju i obrazovanju u osnovnoj i srednjoj školi, Pravilnika o izradbi i obrani završnoga rada i Nacionalnog kurikuluma za strukovno obrazovanje. Strukovni kurikul kojim se stječe kvalifikacija Vozač motornog vozila završava provjerom strukovnog znanja, vještina te pripadne samostalnosti i odgovornosti. Provjera se provodi izradom i obranom završnoga rada. Za kvalifikaciju razine 4.1 završni rad uključuje praktični rad te provjeru ostaloga strukovnog znanja i vještina predviđenih ishodima učenja kurikula. Završni rad projektni je zadatak u kojemu učenik treba pokazati samostalnost u analizi problema, izradi mogućih rješenja i izvedbi mogućih rješenja, primjenjujući usvojeno znanje i vještine tijekom cjelokupnoga obrazovanja za stjecanje kvalifikacije Vozač motornog vozila.

Općeobrazovni moduli u kurikulu Vozač motornog vozila

U slici ispod su prikazani općeobrazovni predmeti za kvalifikacije na razini 4.1.

Slika 4.: Predmetna struktura kurikula općeobrazovnih predmeta za kvalifikacije na razini 4.1 – izvor: Odluku o donošenju kurikula općeobrazovnih predmeta za srednje strukovne škole na Razinama 4.1. I 4.2., , Narodne novine (službeni list Republike Hrvatske) broj 10 iz 2025. godine.

Naziv nastavnoga predmeta	Razred, sati, bodovi									
	1. razred			2. razred			3. razred			UKUPNO CSVET bodova
	broj sati tjedno	broj sati godišnje	CSVET	broj sati tjedno	broj sati godišnje	CSVET	broj sati tjedno	broj sati godišnje	CSVET	
Hrvatski jezik	3	105	6	3	105	6	3	96	6	18
Strani jezik I	2	70	4	2	70	4	2	64	4	12
Tjelesna i zdravstvena kultura	2	70	2	2	70	2	2	64	2	6
Povijest	2	70	3							3
Vjeronauk/Etika	1	35	1	1	35	1	1	32	1	3
UKUPNO	10	350	16	8	280	13	8	256	13	42

Obavezni strukovni moduli u kurikulu Vozač motornog vozila

Kurikul Vozač motornog vozila ima 20 obaveznih strukovnih modula koji se provode kroz tri godine obrazovanja i koji nose ukupno 118 CSVET bodova.

Tablica 1.: Popis obaveznih strukovnih modula – izvor: Odluka o uvođenju strukovnog kurikula za stjecanje kvalifikacije Vozač motornog vozila / Vozačica motornog vozila (141104) u sektoru Promet i logistika, Narodne novine (službeni list Republike Hrvatske) broj 13 iz 2025. godine.

Popis obaveznih strukovnih modula kurikul Vozač motornog vozila	
Naziv modula	Obujam modula u CSVET bodovima
Cestovna infrastruktura i terminali	13
Vozila u cestovnom prometu	8
Prometna kultura i komunikacija u prometu	8
Prva pomoć i zaštita na radu u prometu i logistici	4
Osnove matematike u struci	4
Informacijsko-komunikacijska tehnologija	4
Pogonska energija i održavanje cestovnih vozila	7
Prometni propisi i sigurnosna pravila u cestovnom prometu	4
Teret kao predmet prijevoza u cestovnom prometu	4
Prekrcajna mehanizacija i rukovanje viličarom	9
Prometni tokovi i mobilnost	8

Pružanje prve pomoći u prometnoj nesreći	4
Jednadžbe i funkcije u struci	3
Tehnologija prijevoza putnika	7
Nadzor i dokumentacija u cestovnom prijevozu	8
Tehnologija prijevoza tereta	9
Sigurnost cestovnog prometa	4
Upravljanje teretnim motornim vozilom	4
Geometrija i financijska pismenost u struci	3
Poslovna komunikacija na stranom jeziku	4

Slika 5.: Primjer opisa modula u kurikulumu – izvor: Odluka o uvođenju strukovnog kurikula za stjecanje kvalifikacije Vozač motornog vozila / Vozačica motornog vozila (141104) u sektoru Promet i logistika, Narodne novine (službeni list Republike Hrvatske) broj 13 iz 2025. godine.

POPIS OBVEZNIH STRUKOVNIH MODULA						
Obujam na razini kvalifikacije iskazan bodovima i u postotcima				118	65,55 %	
ŠIFRA MODULA	NAZIV MODULA	ŠIFRA SKUPA ISHODA UČENJA	NAZIV SKUPA ISHODA UČENJA	OBUJAM MODULA	CIKLUS U KOJEM SE MOŽE POHAĐATI MODUL	NAPOMENE VAŽNE ZA HORIZONTALNU I/ILI VERTIKALNU PROHODNOST
	Cestovna infrastruktura i terminali	https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11696_	Infrastruktura u cestovnom prometu	13	4	Omogućena je prohodnost u drugu kvalifikaciju iste ili niže razine uz polaganje razlikovnih sadržaja specifičnih za pojedinu kvalifikaciju. Nakon stečene kvalifikacije Vozač motornog vozila / vozačica motornog vozila moguć je nastavak školovanja na razini 4.2 HKO-a u području tehničkih znanosti.
		https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11708_	Terminali u cestovnome putničkom prometu			
		https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11709_	Terminali u cestovnome teretnom prometu			
	Vozila u cestovnom prometu	https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11697_	Vozila za prijevoz putnika u cestovnom prometu	8	4	Omogućena je prohodnost u drugu kvalifikaciju iste ili niže razine uz polaganje razlikovnih sadržaja specifičnih za pojedinu kvalifikaciju. Nakon stečene kvalifikacije Vozač motornog vozila / vozačica motornog vozila moguć je nastavak školovanja na razini 4.2 HKO-a u području tehničkih znanosti.
		https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11698_	Vozila za prijevoz tereta u cestovnom prometu			
	Prometna kultura i komunikacija u prometu	https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11721_	Prometna psihologija	8	4	Omogućena je prohodnost u drugu kvalifikaciju iste ili niže razine uz polaganje razlikovnih sadržaja specifičnih za pojedinu kvalifikaciju. Nakon stečene kvalifikacije Vozač motornog vozila / vozačica motornog vozila moguć je nastavak školovanja na razini 4.2 HKO-a u području tehničkih znanosti.
		https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11723_	Komunikacijske vještine			

Izborni strukovni moduli u kurikulu Vozač motornog vozila

Kurikul Vozač motornog vozila ima 9 izbornih strukovnih modula koji se provode kroz tri godine obrazovanja koji nose ukupno 44 CSVET boda. učenici biraju 3 modula i koji nose ukupno 16 CSVET bodova.

Tablica 2.: Popis izbornih strukovnih modula – izvor: Odluka o uvođenju strukovnog kurikula za stjecanje kvalifikacije Vozač motornog vozila / Vozačica motornog vozila (141104) u sektoru Promet i logistika, Narodne novine (službeni list Republike Hrvatske) broj 13 iz 2025. godine.

Popis izbornih strukovnih modula kurikul Vozač motornog vozila	
Naziv modula	Obujam modula u CSVET bodovima
Osnove poduzetništva	4
Ekonomika poslovanja u cestovnom prometu	4
Ergonomija u prometu	4
Organizacija poduzeća u cestovnom prometu	8
Održivost cestovnog prometa	8
Inteligentni transportni sustavi u cestovnom prometu	4
Sustavi integriranog prijevoza putnika	4
Intermodalne tehnologije	4
Upravljanje skupom teretnih vozila	4

U prvom razredu učenici biraju jedan od ponuđena tri modula koji iznosi 4 CSVET boda. U drugom razredu učenici biraju jedan od ponuđena dva modula koji iznosi 8 CSVET bodova. U trećem razredu učenici biraju jedan od ponuđenih četiri modula koji iznosi 4 CSVET boda.

Zaključak

Obzirom na zastarjelost nastavnih planova i programa kao i neujednačenost kurikulumskih dokumenta u sustavu strukovnog obrazovanja i osposobljavanja bilo je nužno započeti sustavnu i opsežnu modernizaciju strukovnog obrazovanja.

Agencija za strukovno obrazovanje i obrazovanje odraslih od 2019. započela je provoditi opsežnu modernizaciju sustava strukovnog obrazovanja i osposobljavanja kroz ESF-ov projekt koji za cilj ima razvoj inovativnih i fleksibilnih sektorskih i strukovnih kurikuluma temeljenih na potrebama tržišta rada uz jačanje kompetencija odgojno-obrazovnih radnika za uvođenje i provedbu kurikuluma. Modernizacija strukovnog obrazovanja usmjerena je na procese učenja koji su snažno povezani s poslovima koje će učenici obavljati stvarnim uvjetima na budućem radnom mjestu, a kako bi se postigli ti učinci nužna je snažna povezanost svih dionika, odnosno učenika, nastavnika u ustanovama za strukovno obrazovanje i/ili u regionalnim centrima kompetentnosti i ustanovama za obrazovanje odraslih, mentora kod poslodavca i drugih.

Za zanimanje vozač motornog vozila su izrađena dva standarda zanimanja Vozač motornog vozila u prijevozu putnika i Vozač motornog vozila u prijevozu tereta, Standard kvalifikacije Vozač motornog vozila koji objedinjuje oba navedena standarda zanimanja i Strukovni kurikul Vozač motornog vozila koji se temelji na ishodima učenja, skupovima ishoda učenja koji se realiziraju kroz module u kurikulu.

Strukovni kurikul se je planirao na temelju kompetencija potrebnih na radnom mjestu dok će se proces učenja i poučavanja realizirati u realnim ili simuliranim situacijama radnih aktivnosti. Ovakvim pristupom strukovno obrazovanje i osposobljavanje u Republici Hrvatskoj općenito a i samo zanimanje Vozač motornog vozila ima mogućnost postati privlačno, inovativno, relevantno, inkluzivno i povezivo s tržištem rada što bi budućim učenicima omogućilo stjecanje dostatnih kompetencija za osobni i profesionalni razvoj kao i nastavak obrazovanja i cjeloživotno učenje, a gospodarstvu nužno potreban kvalitetan i stručan kadar.

Literatura i izvori podataka

Agencija za strukovno obrazovanje i obrazovanje odraslih: Metodologija izrade sektorskog kurikuluma, strukovnog kurikuluma i kurikuluma ustanove za strukovno obrazovanje

Zakon o Hrvatskom kvalifikacijskom okviru - NN 22/13, 41/16, 64/18, 47/20, 20/21

Web stranica ASOO https://www.asoo.hr/projekti-i-suradnja/esf-projekti/modernizacija-sustava-strukovnog-obrazovanja-i-osposobljavanja/

Nacionalni kurikulum za strukovno obrazovanje

https://mzo.gov.hr/UserDocsImages/dokumenti/Obrazovanje/StrukovnoObrazovanje/Nacionalni%20kurikulum%20za%20strukovno%20obrazovanje%20(objavljeno%209.%207.%202018).pdf

Metodologija za izradu standarda zanimanja http://www.kvalifikacije.hr/sites/default/files/documents-publications/2019-06/Metodologija%20za%20izradu%20standarda%20zanimanja.pdf

Narodne novine (službeni list Republike Hrvatske) broj 7, 10. i 13. iz 2025. godine.

ROAD TRAFFIC SCHOOL, ZAGREB

Authors:

Tomislav Kučina, mag.ing.traff.

Tomislav Ćurković, mag.ing.traff.



MODERNIZATION OF THE MOTOR VEHICLE DRIVER CURRICULUM AND ITS INTRODUCTION INTO THE EDUCATIONAL SYSTEM OF THE REPUBLIC OF CROATIA THROUGH MODULAR TEACHING

Summary

The Agency for Vocational Education and Adult Education is the project leader for the project "Modernization of the Vocational Education and Training System". The purpose of the project is to develop vocational education that is attractive, innovative and linked to the labor market, and to strengthen the competences of educational staff for the introduction and implementation of the curriculum.

Modular teaching is also being introduced through the new curricula. The module connects forms of work-based learning, classroom and extracurricular learning and teaching into a meaningful, interconnected and rounded whole, increasing the efficiency of work organization and more meaningful learning. This approach enables student-centered planning and organization of teaching, the application of teaching methods and strategies that encourage independent, responsible and active learning, connecting the needs of the world of work with learning outcomes, problem-based, project-based and research-based learning. During the development of the new curricula, the focus was placed on work-based learning.

For the profession of motor vehicle driver, the creation of occupational standards Motor vehicle driver in passenger transportation and Motor vehicle driver in cargo transportation, the qualification standard Motor vehicle driver that covers both occupational standards, and the creation of the Vocational curriculum Motor vehicle driver based on sets of learning outcomes that are realized through modules in the curriculum have been started.

Keywords: Occupational standard, Qualification standard, Vocational curriculum, Motor vehicle driver

MODERNIZATION OF THE MOTOR VEHICLE DRIVER CURRICULUM AND ITS INTRODUCTION INTO THE EDUCATIONAL SYSTEM OF THE REPUBLIC OF CROATIA THROUGH MODULAR TEACHING

Modernization of vocational education in the Republic of Croatia

The Agency for Vocational Education and Adult Education is the project leader for the "Modernization of the Vocational Education and Training System", which was implemented from 2017 to 2024. The aim of the project is to modernize the offer of vocational education and raise its quality in order to increase student employment and opportunities for further education.

The purpose of the project is to develop vocational education and training that is attractive, innovative, relevant, linked to the labor market and that will enable students to acquire competences for personal and professional development and continued education and lifelong learning, and is achieved through the development of innovative and flexible sectoral and vocational curricula based on labor market needs and strengthening the competencies of educational staff for the introduction and implementation of curricula. 120 new curricula for vocational schools have been developed and work is underway to introduce modular teaching. The module connects forms of work-based learning, classroom and non-classroom learning and teaching into a meaningful, interconnected and rounded whole, increasing the efficiency of work organization (educational process) and more meaningful learning. This approach will enable student-centered planning and organization of classes, applying teaching methods and strategies that encourage independent, responsible and active learning, connecting the needs of the world of work with learning outcomes, connecting informal learning and non-formal education with formal education, problem-based, project-based and research-based learning.

The emphasis is on vertical and horizontal mobility through vocational education and through educational cycles. Educational cycles are educational development periods of students that form a single whole. They cover one or more years of education, and are determined according to common educational goals and learning outcomes that the student needs to achieve. In vocational education, educational cycles differ depending on the level of qualification.

Qualifications in vocational education according to the Croatian Qualifications Framework (CRO):

- Level 3 qualification – qualifications obtained after completing secondary education of less than three years. The total workload for obtaining the qualification is a minimum of 60 CSVET points at level 3 or a higher level of learning outcomes.
- Level 4.1 qualification – qualifications obtained after completing secondary education of three years or more and less than four years. The total workload for obtaining the qualification is a minimum of 180 CSVET points, of which at least 120 CSVET points are at level 4 or a higher level of learning outcomes.
- Level 4.2 qualification – qualifications obtained after completing secondary education of four years or more. The total workload for the qualification is a

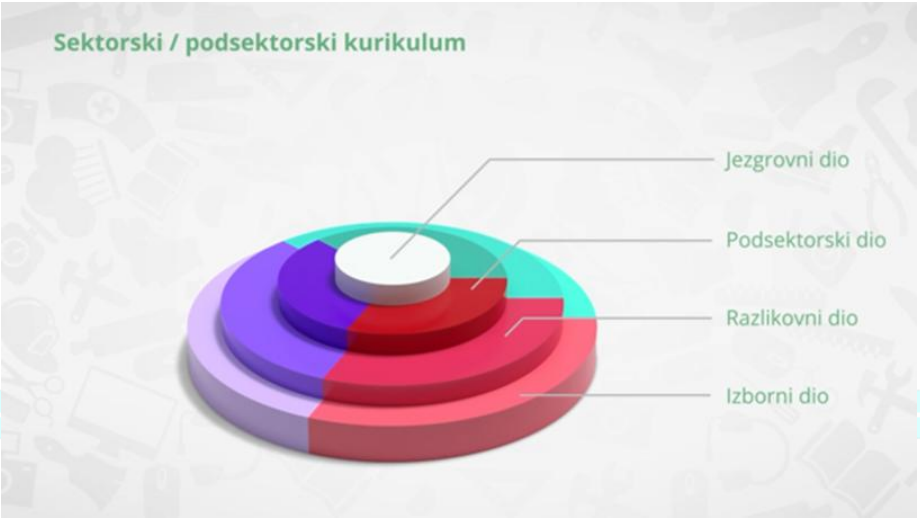
minimum of 240 CSVET points, of which at least 150 CSVET points are at level 4 or higher learning outcomes

- Level 5 qualification – qualifications acquired through completion of professional studies leading to less than 180 ECTS or CSVET points; vocational specialist training; master craftsman programmes with at least two years of assessed work experience. The total workload for the qualification is a minimum of 60 CSVET or 120 ECTS points, of which at least 30 CSVET or 60 ECTS points are at level 6 or higher learning outcomes. The condition for admission is possession of a previous qualification at level 4.1 or higher.

The modernization of the vocational education and training system was approached through several steps, in which working groups formed by the Agencies for Vocational Education and Adult Education drafted the following documents:

- Occupational Standard – which is developed in cooperation with employers and contains a list of key jobs in the workplace and the associated competencies required to work in one or more jobs.
- Qualification Standard – developed on the basis of the Occupational Standard in accordance with the Croatian Classification Framework and which is based on a curricular approach and learning outcomes.
- Sectoral and vocational curriculum – developed on the basis of the Qualification Standard, and leads to a rationalization of the number of curricula, which enables students to more easily enter the labor market, better horizontal mobility, professional development, but also continued education with an emphasis on work-based learning.

Figure 1: Structure of the Sectoral Curriculum *– source: Agency for Vocational Education and Adult Education - https://www.asoo.hr/projekti-i-suradnja/esf-projekti/modernizacija-sustava-strukovnog-obrazovanja-i-osposobljavanja/*

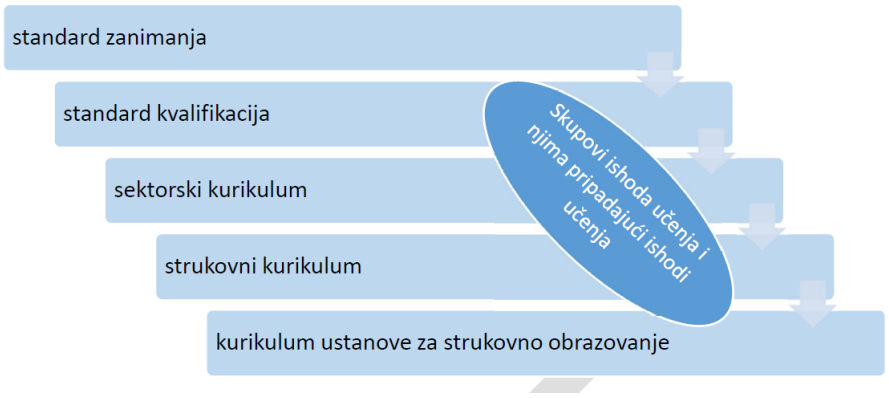


In the Transport and Logistics sector, the vocational part of the curriculum, which constitutes the core part, is carried out during the first semester and is the same for all occupations in the Transport and Logistics sector. The sub-sectoral part is divided into road transport, rail transport, air transport, water transport and logistics, which means that the Transport and Logistics sector has 5 sub-sectors.

Occupational standard Motor vehicle driver

An occupational standard is a description of the work performed by an individual in a particular occupation and contains a list of key tasks and competencies, necessary knowledge and skills, and the level of independence and responsibility that a student should have in order to be able to work in the specified occupation. A working group was established to develop occupational standards, consisting of teachers, employees and employer representatives, and workers in the occupation. Two occupational standards were developed: Driver of a motor vehicle in the transport of goods and Driver of a motor vehicle in the transport of passengers. Employer surveys were conducted on the occupational standard according to the new methodology for developing occupational standards. When developing the Occupational Standard, it was necessary to provide evidence of the validity of the proposed occupational standard and describe the strategic, sectoral, and analytical validity of the occupational standard based on selected labor market indicators.

Figure 2: Relationship between occupational standards, qualification standards and curricula in vocational education –source Methodology for developing sectoral curricula, vocational curricula and curricula of vocational education institutions – Agency for Vocational Education and Adult Education



The occupational standard contains a description of the occupation or set of competencies, a list of key tasks in the workplace and the corresponding individual competencies required for the job.

A driver of a motor vehicle in passenger transport is a person who, independently or as a member of a crew, performs passenger transport tasks on domestic and international passenger transport. During the transport process, he is responsible for the safety of passengers and their luggage, paying special attention to children, the elderly and disabled people. He must be mentally stable and able to make decisions independently in changing traffic conditions and resolve emergency situations. He performs administrative tasks

related to transport (selling tickets and processing other documentation in accordance with the type of transport). A driver of a motor vehicle in passenger transport must undergo continuous professional training in order to acquire new knowledge and skills necessary for performing his job in the workplace and must be able to communicate politely in Croatian and a foreign language. He can perform his jobs in transport companies, tourist companies or independently.

A driver of a motor vehicle in the transport of goods is a person who, independently or as a member of a crew, performs the tasks of transporting goods in domestic and international transport of goods. He/she performs the tasks of preparing the vehicle for transport, takes over the transport documentation and the object of transport; drives the vehicle during transport; keeps transport documentation, eliminates minor vehicle defects, takes over the load in transport, supervises loading and unloading and takes care of its protection. During the transport process, he/she is responsible for the vehicle and the load it is transporting. He/she must be mentally stable and able to make decisions independently in changing traffic conditions and resolve emergency situations. He/she also performs administrative tasks related to the transport of goods. A driver of a motor vehicle in the transport of goods must be able to communicate politely in Croatian and one other foreign language in his/her job. He/she can most often perform the tasks in transport companies or independently.

Qualification standard Motor vehicle driver

The qualification standard contains key learning outcomes for the occupation of Motor Vehicle Driver. The qualification standards for Motor Vehicle Driver were developed by the Road Traffic School, which was selected in a public tender as the institution that will develop the qualification standard by the Agency, and which formed a working group consisting of teachers, university professors and employer representatives. When developing the Qualification Standard for Motor Vehicle Driver, it was necessary to provide a description of the qualification standard, the justification for its introduction and the role of the qualification (labor market needs and/or continued education and/or other needs of the individual and society), a proposal for the CROQF qualification level, a list of sets of learning outcomes from (existing in the CROQF Register or newly developed), and the conditions for accessing the qualification.

The basic part of the qualification standard contains sets of learning outcomes with the following data and parts: name of the proposed set of learning outcomes, level of the set of learning outcomes according to the CROQF, proposed scope, list of learning outcomes (usually 3 - 10 learning outcomes), conditions for accessing the acquisition of the set of learning outcomes, material and personnel conditions required for the acquisition/evaluation of the set of learning outcomes, procedure and example of the evaluation of the set of learning outcomes.

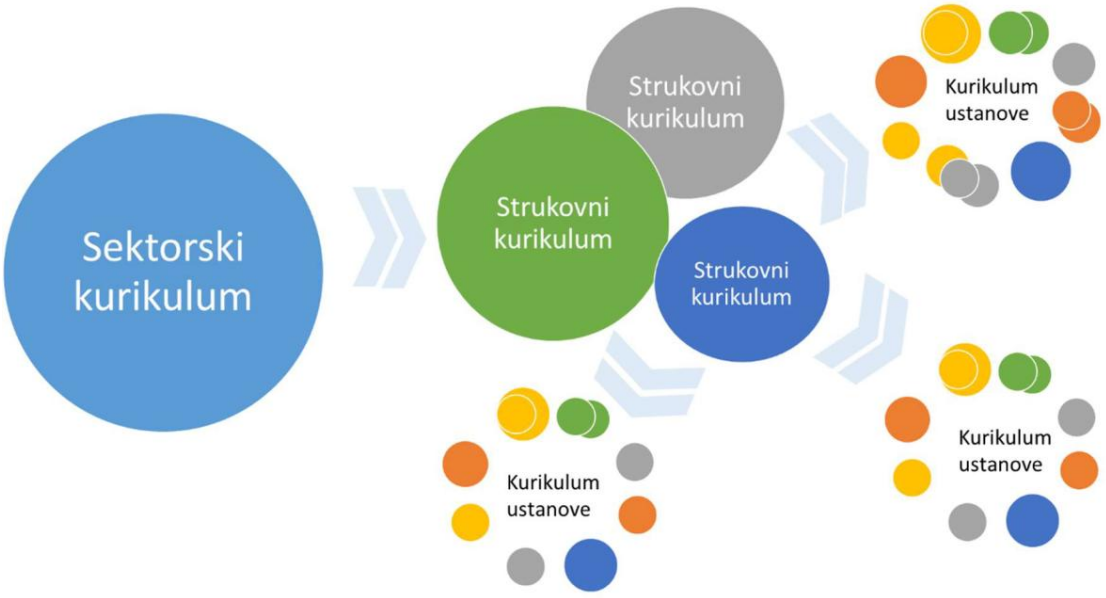
The qualification standard Motor Vehicle Driver includes 2 occupational standards, namely: driver of a motor vehicle in the transport of goods and driver of a motor vehicle in the transport of passengers, which means that upon completion of the specified qualification, the student/attendee acquires both of the specified occupations. The qualification standard for Motor Vehicle Driver states the conditions for obtaining the qualification, which are: At least 180 CSVET points acquired (at least 120 CSVET points at level 4 or higher learning outcome level), of which 141 CSVET points are from the vocational part of the qualification

and 39 points from general education, and a final thesis has been written and defended. The qualification standard for Motor Vehicle Driver consists of 51 sets of learning outcomes that include 15 sets of competences.

Vocational curriculum Motor vehicle driver

The Vocational Curriculum for Motor Vehicle Driver is a document that determines the processes, methods and conditions for acquiring a qualification. The vocational curriculum includes sets of learning outcomes, teaching units for each module, recommendations for the learning environment, methods of monitoring the acquisition of sets of learning outcomes and methods of evaluating learning outcomes. The vocational curriculum prescribes the acquisition of at least 70% of the credit points of the mandatory sets of outcomes and up to 30% of the credit points of the optional sets of learning outcomes from the total volume of the qualification, thus creating a flexible framework for combining sets of learning outcomes in accordance with the needs of local communities and the local labor market.

Figure 3: Relationship between curriculum documents – source Methodology for developing sectoral curriculum, vocational curriculum and curriculum of vocational education institution – Agency for Vocational Education and Adult Education



The Motor Vehicle Driver curriculum consists of a general education module, a general part of the vocational curriculum, mandatory vocational modules, optional vocational modules, module classes by years of education and a final thesis. The final thesis is carried out on the basis of the Primary and Secondary Education Act, the Regulations on the Preparation and Defense of the Final Thesis and the National Curriculum for Vocational Education. The vocational curriculum for acquiring the Motor Vehicle Driver qualification ends with a test of vocational knowledge, skills and related independence and responsibility. The test is

carried out by preparing and defending the final thesis. For the level 4.1 qualification, the final thesis includes practical work and testing of other vocational knowledge and skills provided for by the curriculum learning outcomes. The final thesis is a project task in which the student needs to demonstrate independence in analysing problems, developing possible solutions and implementing possible solutions, applying the knowledge and skills acquired during the entire education for acquiring the Motor Vehicle Driver qualification.

General education modules in the Motor Vehicle Driver curriculum

The figure below shows general education subjects for qualifications at level 4.1.

SFigure 4: Subject structure of the curricula of general education subjects for qualifications at level 4.1 – source: Decision on the adoption of curricula of general education subjects for secondary vocational schools at Levels 4.1 and 4.2, Official Gazette (Official Gazette of the Republic of Croatia) No. 10 of 2025.

Naziv nastavnoga predmeta	Razred, sati, bodovi									
	1. razred			2. razred			3. razred			UKUPNO CSVET bodova
	broj sati tjedno	broj sati godišnje	CSVET	broj sati tjedno	broj sati godišnje	CSVET	broj sati tjedno	broj sati godišnje	CSVET	
Hrvatski jezik	3	105	6	3	105	6	3	96	6	18
Strani jezik I	2	70	4	2	70	4	2	64	4	12
Tjelesna i zdravstvena kultura	2	70	2	2	70	2	2	64	2	6
Povijest	2	70	3							3
Vjeronauk/Etika	1	35	1	1	35	1	1	32	1	3
UKUPNO	10	350	16	8	280	13	8	256	13	42

Mandatory vocational modules in the Motor Vehicle Driver curriculum

The Motor Vehicle Driver curriculum has 20 compulsory vocational modules that are carried out over three years of education and carry a total of 118 CSVET points.

Table 1: List of mandatory vocational modules- source: Decision on the introduction of a vocational curriculum for acquiring the qualification of Motor Vehicle Driver (141104) in the Transport and Logistics sector, Narodne novine (Official Gazette of the Republic of Croatia) No. 13 of 2025.

List of mandatory vocational modules curriculum Motor Vehicle Driver	
Module name	Module volume in CSVET points
Road infrastructure and terminals	13
Vehicles in road traffic	8
Traffic culture and communication in traffic	8
First aid and occupational safety in traffic and logistics	4
Basics of mathematics in the profession	4
Information and communication technology	4
Propulsion energy and maintenance of road vehicles	7
Traffic regulations and safety rules in road traffic	4
Cargo as an object of transport in road traffic	4
Loading machinery and forklift operation	9
Traffic flows and mobility	8
Providing first aid in a traffic accident	4
Equations and functions in the profession	3
Passenger transport technology	7
Supervision and documentation in road transport	8
Cargo transport technology	9
Road traffic safety	4
Drive a freight motor vehicle	4
Geometry and financial literacy in the profession	3
Business communication in a foreign language	4

Figure 5: Example of a module description in the curriculum – source: Decision on the introduction of a vocational curriculum for acquiring the qualification of Motor Vehicle Driver (141104) in the Transport and Logistics sector, Official Gazette (Official Gazette of the Republic of Croatia) No. 13 of 2025.

POPIS OBVEZNIH STRUKOVNIH MODULA						
Obujam na razini kvalifikacije iskazan bodovima i u postotcima				118	65,55 %	
ŠIFRA MODULA	NAZIV MODULA	ŠIFRA SKUPA ISHODA UČENJA	NAZIV SKUPA ISHODA UČENJA	OBUJAM MODULA	CIKLUS U KOJEM SE MOŽE POHAĐATI MODUL	NAPOMENE VAŽNE ZA HORIZONTALNU I/ILI VERTIKALNU PROHODNOST
	Cestovna infrastruktura i terminali	https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11696_	Infrastruktura u cestovnom prometu	13	4	Omogućena je prohodnost u drugu kvalifikaciju iste ili niže razine uz polaganje razlikovnih sadržaja specifičnih za pojedinu kvalifikaciju. Nakon stečene kvalifikacije Vozač motornog vozila / vozačica motornog vozila moguć je nastavak školovanja na razini 4.2 HKO-a u području tehničkih znanosti.
		https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11708_	Terminali u cestovnome putničkom prometu			
		https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11709_	Terminali u cestovnome teretnom prometu			
	Vozila u cestovnom prometu	https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11697_	Vozila za prijevoz putnika u cestovnom prometu	8	4	Omogućena je prohodnost u drugu kvalifikaciju iste ili niže razine uz polaganje razlikovnih sadržaja specifičnih za pojedinu kvalifikaciju. Nakon stečene kvalifikacije Vozač motornog vozila / vozačica motornog vozila moguć je nastavak školovanja na razini 4.2 HKO-a u području tehničkih znanosti.
		https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11698_	Vozila za prijevoz tereta u cestovnom prometu			
	Prometna kultura i komunikacija u prometu	https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11721_	Prometna psihologija	8	4	Omogućena je prohodnost u drugu kvalifikaciju iste ili niže razine uz polaganje razlikovnih sadržaja specifičnih za pojedinu kvalifikaciju. Nakon stečene kvalifikacije Vozač motornog vozila / vozačica motornog vozila moguć je nastavak školovanja na razini 4.2 HKO-a u području tehničkih znanosti.
		https://hko.srce.hr/registar/skup-ishoda-ucenja/detalji/11723_	Komunikacijske vještine			

Elective vocational modules in the Motor Vehicle Driver curriculum

The motor vehicle driver curriculum has 9 optional professional modules that are carried out over three years of education and carry a total of 44 CSVET points. students choose 3 modules that carry a total of 16 CSVET points.

Table 2: List of elective vocational modules – source: Decision on the introduction of a vocational curriculum for acquiring the qualification of Motor Vehicle Driver (141104) in the Transport and Logistics sector, Narodne novine (Official Gazette of the Republic of Croatia) No. 13 of 2025.

List of elective vocational modules curriculum Motor Vehicle Driver	
Module name	Module volume in CSVET points
Fundamentals of Entrepreneurship	4
Business Economics in Road Transport	4
Ergonomics in Transport	4
Organization of Companies in Road Transport	8
Sustainability of Road Transport	8
Intelligent Transport Systems in Road Transport	4
Integrated Passenger Transport Systems	4
Intermodal Technologies	4
Fleet Management of Freight Vehicles	4

In the first grade, students choose one of the three modules offered, which is worth 4 CSVET points. In the second grade, students choose one of the two modules offered, which is worth 8 CSVET points. In the third grade, students choose one of the four modules offered, which is worth 4 CSVET points.

Conclusion

Given the obsolescence of curricula and programs as well as the lack of uniformity of curriculum documents in the vocational education and training system, it was necessary to begin a systematic and comprehensive modernization of vocational education.

Since 2019, the Agency for Vocational Education and Adult Education has begun implementing a comprehensive modernization of the vocational education and training system through an ESF project aimed at developing innovative and flexible sectoral and vocational curricula based on labor market needs, while strengthening the competencies of educators for the introduction and implementation of curricula. The modernization of vocational education is focused on learning processes that are strongly linked to the jobs that students will perform in real conditions in their future workplace, and in order to achieve these effects, a strong connection between all stakeholders is necessary, namely students, teachers in vocational education institutions and/or in regional competence centers and adult education institutions, mentors at employers and others.

For the occupation of motor vehicle driver, two occupational standards have been developed: Driver of a motor vehicle in passenger transport and Driver of a motor vehicle in freight transport, the Qualification Standard of a Motor Vehicle Driver which combines both of the aforementioned occupational standards and the Vocational Curriculum of a Motor Vehicle Driver which is based on learning outcomes, sets of learning outcomes that are realized through modules in the curriculum.

The vocational curriculum was planned based on the competencies required in the workplace, while the learning and teaching process will be realized in real or simulated work activity situations. With this approach, vocational education and training in the Republic of Croatia in general and the occupation of a Motor Vehicle Driver itself has the potential to become attractive, innovative, relevant, inclusive and connected to the labor market, which would enable future students to acquire sufficient competencies for personal and professional development as well as continued education and lifelong learning, and the economy urgently needs quality and professional staff.

Literature and data sources

Agency for Vocational Education and Adult Education: Methodology for the development of sectoral curricula, vocational curricula and curricula of vocational education institutions

Act on the Croatian Qualifications Framework - NN 22/13, 41/16, 64/18, 47/20, 20/21

ASOO website https://www.asoo.hr/projekti-i-suradnja/esf-projekti/modernizacija-sustava-strukovnog-obrazovanja-i-osposobljavanja/

National Curriculum for Vocational Education

https://mzo.gov.hr/UserDocsImages/dokumenti/Obrazovanje/StrukovnoObrazovanje/Nacionalni%20kurikulum%20za%20strukovno%20obrazovanja%20(objavljeno%209.%207.%202018).pdf

Methodology for the development of occupational standards http://www.kvalifikacije.hr/sites/default/files/documents-publications/2019-06/Metodologija%20za%20izradu%20standarda%20zanimanja.pdf

Official Gazette of the Republic of Croatia, No. 7, 10 and 13 of 2025.

МОГУЋНОСТИ УНАПРЕЂЕЊА НАСТАВНО-ОБРАЗОВНОГ ПРОЦЕСА У ВОЈНОМ ВИСОКОШКОЛСКОМ ОБРАЗОВАЊУ

др Момчило Ђорђевић, дипл.инж.[1]

др Срђан Љубојевић, дипл.инж.[1]

др Сретен Перић, дипл.инж.[1]

мр Милан Буквић, дипл.инж.[2]

др Саша Милојевић, дипл.инж.[3]

[1] Универзитет одбране у Београду, Војна академија

[2] Војска Србије

[3] Универзитет у Крагујевцу, Факултет инжењерских наука

Abstract

V prispevku so predstavljene novosti v novoakreditiranih študijskih programih Vojaške akademije Univerze za obrambo v Beogradu, ki med drugim izobražuje bodoče inženirje – logistiki za potrebe enot srbske vojske. Analiza, opravljena v preteklem obdobju, je pokazala, da je treba v prihodnjem obdobju še več pozornosti nameniti študiju sodobnih sistemov vozil, to je njihovemu vzdrževanju, z vse večjim uvajanjem praktičnih dejavnosti, ki bi jih študentje izvajali sami na vajah. Tako bi novi častniki po zaključku študija svoje znanje odnesli s seboj v svoje enote, imeli pa bi tudi dobro izhodišče za delo s sodobnimi in sofisticiranimi sistemi, ki jih je vse več v vozilih. Strokovna usposobljenost, moralna in telesna pripravljenost so nujni za uspešno izvajanje nalog in oblikovanje enot v miru in vojni ter nenehen razvoj in usposabljanje častnikov. Članek opisuje dva predmeta, ki se izvajata v dveh različnih akreditiranih študijskih programih.

1 Увод

На основним академским студијама Војне академије, на студијским програмима Војномашинско инжењерство и Логистика одбране изводе се стручни предмети - курсеви под називима Мехатронички системи возила и Техничка дијагностика. Курсеви су једносеместрални, а сама концепција оба предмета је заснована на 45 часова предавања и 30 часова вежби.

У претходном периоду, након проведених више анализа реализације студијских програма, а посебно приликом акредитације нових студијских програма, утврђена је потреба осавремењавања наставе на основним академским студијама, посебно из нових, савремених области као што су мехатроника односно техничка дијагностика. Поред наведеног, примећен је и недостатак реализације практичних активности од

стране самих студената, што је био јасан сигнал за измену студијских програма, односно унапређење студијских програма у завршним годинама основних академских студија кроз измене и допуне реализације наставног плана и програма.

2 Нови предмети - курсеви

Као што је речено, на студијским програмима Војномашинско инжењерство и Логистика одбране, у завршним годинама на основним академским студијама, изводе се стручни предмети - курсеви под називима Мехатронички системи возила и Техничка дијагностика.

Оба предмета су конципирана на сличан начин.

Циљ курса Мехатронички системи возила, у склопу студијског програма Војномашинско инжењерство, је да студенти развију неопходне вештине и усвоје основна сазнања о мехатроничким системима моторних возила, односно да развију способности у области истраживања, пројектовања, развоја и испитивања мехатроничких система моторних возила. Даље, студенти би требало да буду оспособљени да: објасне појам мехатронике и мехатроничких система, са акцентом на возила; укратко опишу функцију свих компоненти мехатроничких система на возилу; анализирају и објасне специфичности мехатроничких система на возилу, и то системи за ослањање, системи за кочење, системи за пренос снаге, системи за управљање, интегрисани системи на возилима и др.; анализирају конкретне проблеме приликом пројектовања мехатроничких система на возилу; да дефинишу процес пројектовања мехатроничких система на возилу (укључујући одређивање функције циља будућег система, као и развој функционалне шеме мехатроничког система); да симулирају рад пројектованог мехатроничког система, као и да дефинишу начин испитивања предметног система. Последње наведено је постављено за исход предмета.

Са друге стране, за циљ предмета Техничка дијагностика, у склопу студијског програма Логистика одбране, постављен је да се усвоје основна сазнања о техничкој дијагностици, односно да се студенти упознају са теоријом, методама и средствима за одређивање стања техничких система у условима ограничених информација, а све полазећи од основног циља техничке дијагностике, да се открије и спречи потенцијални отказ техничких система без непотребног расчлањивања елемената система, изградњом уређаја, блокова, модула, склопова и делова, а што се постиже мерењем карактеристичних, односно дијагностичких параметара и на основу одређених критеријума донесе закључак о томе да ли се они налазе у дозвољеним границама или не. Даље, студентима је, са похађањем овог курса, кроз савремене поступке, практичне примере и резултате, омогућено да схвате и сами примене сложене методе и технике техничке дијагностике за примену у пракси и у другим областима привреде.

Наведене предмете - курсеве у овом тренутку изводе два наставника која реализују симултано предавања и вежбе. Карактеристично је да слушалачки аудиторијум за оба предмета чине обично мање групе, највише до 15 студената.

За спровођење практичних активности, наставници и студенти користе више опремљених кабинета, са разноврсним мерним средствима и опремом, почев од класичних (нпр. метри, кључаста мерила, мерни листићи, компаратери, тестери и

испитивачи напона, универзални мултиметри – унимери и дигимери, детектори кратких спојева и прекида у електроинсталацији возила, манометри, компресиометри...), преко акустичних којима се детектују појачани тонови или шумови (стетоскопи, електронски мерачи звука, фонометри...), разне камере са могућношћу трајног записа фотографија и филмова (од стандардних до термалних), комплети за мерење пропустљивости и детектори за откривање трагова цурења флуида (било течности, било гаса), електронски анализатори (мерачи) издувних гасова, опациметар за мерење концентрације чађи у издувним гасовима возила са дизел мотором, испитна станица за проверу рада клима уређаја на возилима (за више врста гаса R12, R134a) са потребном опремом, испитни сто за чишћење и испитивање рада бризгаљки Ото и Дизел мотора и др.

Оно што је највише утицало на усавршавање наставног плана и програма, али и набавку опреме јесте свест о све бржем развоју и импуту електронике у возила, али и проблеми који настају у току експлоатације. Исти се постављају као посебан изазов пред лица која одржавају та возила. Непобитно је закључено да и свршени инжењери, прецизније будући технолози у сервисима, за које војска и школује кадар, морају бити оспособљени да раде са савременом опремом и дијагностификују рад појединачних система на возилу односно возила као система у целости. Управо инжењери морају бити ти који ће да предводе у логичком закључивању зашто се предузимају одређене радње са расположивом опремом и ти који ће да дају валидне и рационалне одговоре на предвиђене или непредвиђене, а настале проблеме.

3 Нови комуникациони интерфејс и тестер

У Војној академији се у наставне сврхе, приликом извођења наставе, користи посебно набављени уређај за дијагностику возила и то лиценцирани комуникациони интерфејс (Vehicle Communication Interface - VCI), са разним прикључцима за више типова возила. Комуникациони интерфејс је са осцилоскопом и са мотортестером произвођача ACTIA ATAL и користи програм MULTI-DIAG ACCESS.

Дијагностички интерфејс је базиран на PC рачунару односно преносном уређају - тестеру тзв. MULTI-DIAG Handy, намењен за дијагностику возила која имају конекторе OBD-II (On-Board Diagnostic - OBD). Такође, може да буде прикључен на PC рачунар односно лаптоп и користи могућности истог. Иначе, уређај има могућност дијагностике и старијих возила за која се користе различити прикључци - адаптери (пре усвајања ОБД стандарда).

Multi-Diag Handy (сл. 1) је компактан тестер за детаљну дијагностику електронских система и обухвата дијагностику старијих возила, као и возила по EOBD стандарду и усклађен је са „Pass-Thru“ стандардом (иначе, следећи корак у глобализацији дијагностике). Multi-Diag Handy је срце модуларног система који се може проширити модулом за електрична мерења (Multi-Diag Handy Plus).

Слика 1: *Дијагностички комуникациони интерфејс ACTIA ATAL са MULTIDIAG ACCESS Handy и компонентама за везу са PC рачунаром*





Екран је осетљив на додир (touch screen) и преузима функције миша односно тастатуре. Multi-Diag програм служи за повезивање техничке документације (која укључује експлоатационе податке односно податке за оправку возила) и дијагностичког тестера. Од могућих програма за техничку документацију који се користе су Autodata и Workshop Data VIVID.

Преко OBD-II омогућава се комплетна контрола мотора, праћење каросерије (шасије) аутомобила односно додатних уређаја у аутомобилу. Такође, омогућава дијагностичку контролу свих система који су спојени на мрежу унутар аутомобила (ABS, SRS, ESP, TRC, ACC, аларм, подизачи стакала, светла...).

Прецизније, омогућавају се три врсте мониторинга различитих параметара у аутомобилу:

- дијагностицирање кодова грешака (Diagnostic Trouble Code - DTC);
- анализа података у стварном времену (real-time data);
- анализа података off-line (freeze frame data).

Могућност дијагностификовања система је могуће извршити на око 50 брендова, и на велики број типова возила унутар сваког бренда (сл. 2).

Слика 2: *Почетни мени Multi-Diag програма*



4 Нова методологија оспособљавања студената

Настава се изводи у модерно опремљеним кабинетима на Катедри мотора и возила коришћењем PC рачунара и пројектора односно паметних табли. Све просторије су опремљене пресецима склопова и агрегата или приказима комплетних система које се могу наћи у савременој аутоиндустрији. Иначе, радни модели и експонати су груписани сходно врстама возила: точкаши, гусеничари, борбена и неборбена возила и грађевинске машине.

Технологија реализације наставе оба предмета - курса је класична: најпре се проводе предавања, која обавезно прате вежбе. И предавања и вежбе изводе професори акредитовани као носиоци реализација напред наведених предмета - курсева.

Група студената се најпре теоретски припреми, прво описујући уређај и прикључне делове, затим теоретски опише прикључење комуникационог интерфејса са практичним приказом и на крају се студенти упуте у саму технологију приступа главној електронској управљачкој јединици возила (Engine Control Unit - ECU или Engine Control Module - ECM) у складу са могућностима комуникационог интерфејса (сл. 3).

Слика 3: *Повезивање VCI преко OBD кабла на возило BMW*



Позитивно је то што су за наставу, као што је већ речено, опредељене мање групе студената, те уважавајући планирани фонд часова, сваки студент има могућност непосредног рада на дијагностиковању система возила.

Оно што је посебно вредно је то што студенти бивају задовољни управо када самостално предузимају практичне радње, усредсређени су на исте, а пажња им временом не опада. Шта више, студенти бивају фокусирани на провођење практичних активности које уређај и системи на возилу омогућавају, деле размишљања међу собом, дају критички осврт на предузете радње било индивидуално, било групно и сл.

Послеподневни рад је организован кроз самостални рад студената. Карактеристично је да су сви кабинети доступни за напред наведени вид оспособљавања, а за сложеније видове обезбеђује се и присуство предметних наставника и стручних инструктора.

Провера знања се састоји од колоквијума, практичног полагања испита и усменог испита. Кроз практично полагање испита, студент се наводи да сам дијагностификује отказ дела, склопа, модула, аграгата и система. Квалитет закључивања и брзина реаговања дају сумарну оцену савладаности практичног дела испита.

5 Закључак

У овом раду се, на примеру два предмета – курса, приказују новине уведене на основним академским студијама Војне академије Универзитета одбране у Београду, на акредитованим студијским програмима Војномашинско инжењерство и Логистика одбране.

Прилагођавајући се страховито брзом коришћењу електронике у возилима, која ће у будућности засигурно бити предвођена и вештачком интелигенцијом, постављају се нове препреке пред кориснике тих возила, које треба савладати. Те препреке се постављају још више и пре испред лица која одржавају та возила, те се морају на време оспособити, како би се иста могла на прави начин и правовремено суочити са нарастајућим захтевима у одржавању возила.

У Војној академији се школују будући инжењери – официри логистике. Школују се за потребе јединица Војске Србије и управо они ће се хватати у коштац са наведеним

проблемима софистицираних возила. У том смислу је Војна академија благовремено и предузела одређене кораке на оспособљавању својих кадрова, како би се на време припремили и спремно дочекале напредне технологије и њихово учешће у возилима.

Као што је већ речено, анализа која је спроведена у претходном периоду показала је да у наредном периоду још више треба посветити пажњу на изучавању савремених система у возилима, односно њиховом одржавању, уз све веће увођење практичних активности које реализују сами студенти на вежбама. Са новоуведеним уређајима у наставу на студијским програмима сматрамо да ће будући инжењери –технолози лакше моћи да се упусте у решавање проблема приликом одржавања возила. Академија као установа обезбеђује базична сазнања у новим областима, која могу да се надограде како самостално, тако и системски кроз континуирано развијање и усавршавање официра у јединицама војске.

6 Литература

- Bonnick A.W.M., Automotive Computer Controlled Systems (Diagnostic tools and techniques), Butterworth-Heinemann, 2000, ISBN-13: 978-0-7506-5089-2
- Bosch R. GmbH, Automotive Electrics: Systems and Components: Networking, Hybrid Drive (Automotive Electronics Series), 5th Edition, 2007, ISBN-13: 978-0-8376-1541-7
- Bosch R. GmbH, Bosch Automotive Electrics and Automotive Electronics (Systems and Components, Networking and Hybrid Drive), Springer Vieweg, 5th Edition, 2014, ISBN-13: 978-3-658-01783-5
- Reif K., Automotive Mechatronics (Automotive Networking, Driving Stability Systems, Electronics), Springer Vieweg, 2015, ISBN-13: 978-3-658-03974-5
- Томић М., Опрема мотора, Машински факултет Универзитета у Београду, 2005. ISBN-13: 978-86-7083-769-0
- User manuel Actia Atal (Vehicle Electronics & Diagnostics) - Multi Diag

POSSIBILITIES OF IMPROVING THE TEACHING AND EDUCATIONAL PROCESS IN MILITARY HIGHER EDUCATION

Momčilo Đorđević, PhD, BSc [1]

Srđan Ljubojević, PhD, B.Sc. [1]

Sreten Perić, PhD, B.Sc.[1]

Milan Bukvić, MSc, B.Sc.[2]

Saša Milojević, PhD, BSc [3]

[1] **University of Defence in Belgrade, Military Academy**

[2] **Serbian Armed Forces**

[3] **University of Kragujevac, Faculty of Engineering**

Abstract

The paper presents innovations in the newly accredited study programs of the Military Academy of the University of Defence, Belgrade, which, among other things, educates future engineers – logisticians for the needs of Serbian Army units. The analysis carried out in the past period showed that in the coming period, even more attention should be paid to the study of modern vehicle systems, that is, their maintenance, with the increasing introduction of practical activities that students would carry out on their own during exercises. In this way, after completing their studies, new officers would take their knowledge with them to their units, and they would also have a good starting point for working with modern and sophisticated systems, which are increasingly common in vehicles. Professional competence, moral and physical fitness are necessary for the successful performance of tasks and the formation of units in peace and war, as well as the continuous development and training of officers. The article describes two courses that are taught in two different accredited study programs.

1 Introduction

At the undergraduate academic studies of the Military Academy, in the study programs Military Mechanical Engineering and Defense Logistics, professional subjects are taught - courses called Mechatronic Vehicle Systems and Technical Diagnostics. The courses are one-semester, and the concept of both courses is based on 45 hours of lectures and 30 hours of exercises.

In the previous period, after several analyses of the implementation of study programs, and especially during the accreditation of new study programs, the need for modernization of teaching at basic academic studies was determined, especially in new, modern areas such as

mechatronics and technical diagnostics. In addition to the above, the lack of implementation of practical activities by the students themselves was also noticed, which was a clear signal for the change of study programs, i.e. the improvement of study programs in the final years of basic academic studies through amendments to the implementation of the curriculum.

2 New subjects - courses

As mentioned, in the study programs Military Mechanical Engineering and Defense Logistics, in the final years of the basic academic studies, professional subjects are carried out - courses called Mechatronic Systems of Vehicles and Technical Diagnostics.

Both subjects are conceived in a similar way.

The aim of the course Mechatronic Systems of Vehicles, as part of the study program Military Mechanical Engineering, is for students to develop the necessary skills and acquire basic knowledge about mechatronic systems of motor vehicles, i.e. to develop abilities in the field of research, design, development and testing of mechatronic systems of motor vehicles. Furthermore, students should be able to: explain the concept of mechatronics and mechatronic systems, with an emphasis on vehicles; briefly describe the function of all components of mechatronic systems on the vehicle; analyze and explain the specifics of mechatronic systems on the vehicle, namely suspension systems, braking systems, power transmission systems, steering systems, integrated systems on vehicles, etc.; analyze specific problems in the design of mechatronic systems on the vehicle; define the process of designing on-board mechatronic systems (including determining the target function of the future system, as well as the development of a functional scheme of the mechatronic system); to simulate the operation of the designed mechatronic system, as well as to define the method of testing the system in question . The latter is set for the outcome of the course.

On the other hand, the goal of the course Technical Diagnostics, as part of the study program Logistics of Defense, is to acquire basic knowledge about technical diagnostics, i.e. to familiarize students with the theory, methods and means for determining the state of technical systems in conditions of limited information, all starting from the basic goal of technical diagnostics, to detect and prevent potential failure of technical systems without unnecessary Analysis of system elements, construction of devices, blocks, modules, assemblies and parts, which is achieved by measuring characteristic, i.e. diagnostic parameters and based on certain criteria to make a conclusion about whether they are within the permissible limits or not. Furthermore, by attending this course, through modern procedures, practical examples and results, students are enabled to understand and apply complex methods and techniques of technical diagnostics for application in practice and in other areas of the economy.

At the moment, these courses are conducted by two teachers who carry out simultaneous lectures and exercises. Characteristically, the listening audience for both subjects usually consists of smaller groups, up to a maximum of 15 students.

For the implementation of practical activities, teachers and students use several equipped cabinets, with a variety of measuring means and equipment, starting from classic ones (e.g. meters, beak gauges, measuring sheets, comparators, testers and voltage testers, universal multimeters – unimers and digimers, detectors of short circuits and interruptions in the electrical installation of vehicles, pressure gauges, compressiometers...), through acoustic

ones that detect amplified tones or noises (stethoscopes, electronic sound meters, phonometers...), various cameras with the possibility of permanent recording of photographs and films (from standard to thermal), permeability measurement kits and detectors for detecting traces of fluid leakage (either liquid or gas), electronic analyzers (meters) of exhaust gases, an opacimeter for measuring the concentration of soot in the exhaust gases of vehicles with a diesel engine, a test station for checking the operation of air conditioning on vehicles (for several types of gas R12, R134a) with the necessary equipment, a test bench for cleaning and testing the operation of injectors of Oto and Diesel engines, etc.

What has had the greatest impact on the improvement of the curriculum, as well as the procurement of equipment, is the awareness of the increasingly rapid development and imposition of electronics in vehicles, but also the problems that arise during exploitation. They are posed as a special challenge to the persons who maintain these vehicles. It was irrefutably concluded that graduate engineers, more precisely future technologists in services, for whom the army also trains personnel, must be able to work with modern equipment and diagnose the operation of individual systems on the vehicle, i.e. the vehicle as a whole. Engineers must be the ones who will lead the logical conclusion of why certain actions are taken with the available equipment and the ones who will give valid and rational answers to anticipated or unforeseen problems.

3 New communication interface and tester

At the Military Academy, for teaching purposes, a specially procured device for vehicle diagnostics is used, namely the licensed Vehicle Communication Interface (VCI), with various connectors for several types of vehicles. The communication interface is with the oscilloscope and with the motortester manufactured by ACTIA ATAL and uses the MULTI-DIAG ACCESS program.

The diagnostic interface is based on a PC, i.e. a portable device - a tester of the so-called MULTI-DIAG Handy, designed for diagnostics of vehicles that have OBD-II (On-Board Diagnostic - OBD) connectors. It can also be connected to a PC or laptop and use the capabilities of the same. By the way, the device has the ability to diagnose older vehicles for which different connectors - adapters are used (before the adoption of the OBD standard).

The Multi-Diag Handy (Fig. 1) is a compact tester for detailed diagnostics of electronic systems and includes diagnostics of older vehicles as well as vehicles according to the EOBD standard and is compliant with the "Pass-Thru" standard (the next step in the globalization of diagnostics). The Multi-Diag Handy is the heart of a modular system that can be expanded with an electrical measurement module (Multi-Diag Handy Plus).

Figure 1: *ACTIA ATAL diagnostic communication interface with MULTIDIAG ACCESS Handy and components for connection to the RS computer*





The screen is touch screen and takes over the functions of a mouse or keyboard. The Multi-Diag program is used to connect the technical documentation (which includes exploitation data, i.e. data for vehicle repair) and the diagnostic tester. Of the possible programs for technical documentation that are used, are Autodata and Workshop Data VIVID.

OBD-II enables complete engine control, monitoring of the car body (chassis) or additional devices in the car. It also enables diagnostic control of all systems connected to the network inside the car (ABS, SRS, ESP, TRC, ACC, alarm, windows, lights...).

More precisely, there are three types of monitoring of different parameters in the car:

- Diagnosing Trouble Codes (DTCs);
- real-time data analysis;
- freeze frame data.

The ability to diagnose the system can be carried out on about 50 brands, and on a large number of types of vehicles within each brand (Fig. 2).

Figure 2: *Multi-Diag Program Home Menu*



4 New methodology of training students

Teaching is carried out in modernly equipped cabinets at the Department of Engines and Vehicles using RS computers and projectors, i.e. smart boards. All rooms are equipped with cross-sections of assemblies and aggregates or displays of complete systems that can be found in the modern automotive industry. By the way, working models and exhibits are grouped according to the types of vehicles: wheels, tracked vehicles, combat and non-combat vehicles and construction machinery.

The technology of teaching both subjects - courses is classic: first, lectures are conducted, which must be followed by exercises. Both lectures and exercises are carried out by professors accredited as holders of the implementation of the above-mentioned courses - courses.

A group of students first prepare theoretically, first describing the device and connecting parts, then theoretically describe the connection of the communication interface with a practical display, and finally the students are instructed in the technology of access to the main electronic control unit of the vehicle (Engine Control Unit (ECU or Engine Control Module - ECM) in accordance with the capabilities of the communication interface (Fig. 3).

Figure 3: *Connecting VCI via OBD cable to the BMW vehicle*



It is positive that, as already mentioned, smaller groups of students are assigned to the classes, and taking into account the planned fund of classes, each student has the opportunity to directly work on diagnosing the vehicle system.

What is especially valuable is that students are satisfied when they independently undertake practical actions, are focused on them, and their attention does not decrease over time. What's more, students are focused on carrying out practical activities that the device and systems on the vehicle enable, share thoughts with each other, give a critical review of the actions taken, either individually or in groups, etc.

The afternoon work is organized through the independent work of the students. It is characteristic that all cabinets are available for the above-mentioned type of training, and for more complex types the presence of subject teachers and professional instructors is

provided.

The examination consists of a colloquium, a practical exam and an oral exam. Through practical passing of the exam, the student is stated to diagnose the failure of a part, assembly, module, aggragate and system. The quality of reasoning and the speed of response give a summary assessment of the mastery of the practical part of the exam.

5 Conclusion

This paper presents, on the example of two subjects – courses, the innovations introduced at the basic academic studies of the Military Academy of the University of Defence in Belgrade , at the accredited study programs Military Mechanical Engineering and Defence Logistics.

Adapting to the tremendously rapid use of electronics in vehicles, which in the future will certainly be led by artificial intelligence, new obstacles are being placed in front of users of these vehicles, which need to be overcome. These obstacles are placed even more in front of the persons who maintain these vehicles, and they must be trained in time, so that they can face the growing demands in vehicle maintenance in the right way and in a timely manner.

The Military Academy educates future engineers - logistics officers. They are educated for the needs of the units of the Serbian Armed Forces and it is they who will deal with the aforementioned problems of sophisticated vehicles. In this sense, the Military Academy has taken certain steps to train its personnel in a timely manner, in order to prepare in time and be ready to welcome advanced technologies and their participation in vehicles.

As already mentioned, the analysis that was conducted in the previous period showed that in the coming period even more attention should be paid to the study of modern systems in vehicles, i.e. their maintenance, with the increasing introduction of practical activities that are realized by the students themselves during exercises. With the newly introduced devices in the teaching of study programs, we believe that future engineers - technologists will be able to solve problems during vehicle maintenance more easily. It provides basic knowledge in new areas, which can be upgraded both independently and systematically through the continuous development and training of officers in army units.

6 References

Bonnick A.W.M., Automotive Computer Controlled Systems (Diagnostic tools and techniques), Butterworth-Heinemann, 2000, ISBN-13: 978-0-7506-5089-2

Bosch R. GmbH, Automotive Electrics: Systems and Components: Networking, Hybrid Drive (Automotive Electronics Series), 5th Edition, 2007, ISBN-13: 978-0-8376-1541-7

Bosch R. GmbH, Bosch Automotive Electrics and Automotive Electronics (Systems and Components, Networking and Hybrid Drive), Springer Vieweg, 5th Edition, 2014, ISBN-13: 978-3-658-01783-5

Reif K., Automotive Mechatronics (Automotive Networking, Driving Stability Systems, Electronics), Springer Vieweg, 2015, ISBN-13: 978-3-658-03974-5

Tomić M., Engine Equipment, Faculty of Mechanical Engineering, University of Belgrade, 2005. ISBN -13 : 978-86-7083-769-0

User manuel Actia Atal (Vehicle Electronics & Diagnostics) - Multi Diag

PRIKAZ STUDIJE SLUČAJA PROJEKTNOG PRISTUPA VISOKOŠKOLSKOJ NASTAVI U OBLASTI SAOBRAĆAJA I TRANSPORTA

dr Srđan Ljubojević, dipl. inž.[1]

dr Momčilo Đorđević, dipl. inž.[1]

dr Srđan Dimić, dipl. inž.[1]

[1] Univerzitet odbrane u Beogradu, Vojna akademija

Abstract

U ovom radu predstavljena je studija slučaja primene projektnog pristupa nastavi, koja je realizovana u toku 2023. godine u Vojnoj akademiji Univerziteta odbrane u Beogradu, na studijskom program Vojnosaobraćajno inženjerstvo, kao alternative klasičnim modelima nastave. Istaknuti su pozitivni aspekti takvog pristupa i benefiti za studente, sa naglaskom na publikovanim rezultatima (9 radova na naučnom simpozijumu), na vremenu koje su student proveli na istraživanju tema i u radu po ovom modelu, na njihovoj intenzivnijoj interakciji sa profesorima, na širem izučavanju i korišćenju naučnih i stručnih izvora saznanja, na većem broju samostalno iniciranih aktivnosti, većoj motivisanosti i većem nivou zadovoljstva studenata.

1 Uvod

Savremeno čovekovo okruženje je promenljivo, zahtevi su dinamični, izazovi često nepredvidivi, a zahtevano znanje sve kompleksnije. Ta kompleksnost najpre se projektuje kroz potrebu za fleksibilnim, adaptivnim i interdisciplinarnim pristupom rešavanju problema. Od današnjih učenika i studenata očekuje se da budu digitalno pismeni, što podrazumeva da znaju da koriste, kombinuju i prate razvoj i dostignuća informacionih tehnologija, da poznaju i poštuju principe digitalne etike i da su sposobni da rešavaju probleme u digitalnom svetu (od toga da razumeju algoritme, da znaju da selektuju relevantne podatke i da ih analiziraju, do toga da poznaju principe rada veštačke inteligencije). Pored digitalne pismenosti, od njih se traži i kritičko razmišljanje, inovativno rešavanje problema, povezivanje činjenica iz različitih domena, izvrsne komunikacione veštine, rad u timovima, prilagodljivost multikulturalnim izazovima i kontinuirano, celoživotno učenje, uz stalno usavršavanje itd.

Već vekovima znanje se ne meri samo količinom informacija koje neko poseduje, već sposobnošću njegove primene i prilagođavanja zahtevima, a danas je ta potreba izražena više nego ikada ranije. Adaptivnost znanja podrazumeva brz protok informacija (podstiče se efikasnost, ali istovremeno se zahteva kritičko razmišljanje pri odabiru relevantnih i pouzdanih izvora), interdisciplinarnost (nužna je integracija znanja iz različitih disciplina), inovativne metode učenja (upotrebu interaktivnih modela učenja i prilagođenih edukativnih algoritama) i personalizaciju učenja (prilagođavanje procesa individualnim potrebama

učenika/studenta). Moderna nastava menja paradigmu i učenja i podučavanja, udaljavajući se od tradicionalnih metoda učenja i stavljajući fokus na mnogo interaktivnije i efektivnije tehnike podučavanja.

2 Tradicionalne naspram modernih metoda nastave

Rezultati mnogih analiza i istraživanja ukazuju na pad kvaliteta obrazovanja širom sveta, kako u državama u kojima je niži standard života, slabija industrijska razvijenost i niži bruto nacionalni proizvod po glavi stanovnika u poređenju sa razvijenim državama, tzv. državama u razvoju [1], tako i na području Evrope [2] i tzv. zapadnog Balkana [3]. Posebno su interesantni izveštaji UNICEF [3, 4], u kojima se prikazuju zaključci analiza obrazovnih sistema u Crnoj Gori, Hrvatskoj, Severnoj Makedoniji, Srbiji, Albaniji i na Kosovu[1], na osnovu rezultata PISA (Programme for International Student Assessment) testiranja iz 2018. i 2022. godine. U njima se među suštinskim problemima obrazovnih sistema na zapadnom Balkanu ističu problemi nedostatka nastavnih resursa, neophodnosti reforme nastavnih planova, poboljšanja obuke nastavnika, nedostatka inovacija u obrazovnim metodama i slabog razvoja kritičkog razmišljanja. I u drugim studijama koje se bave obrazovnim sistemom u regionu zapadnog Balkana [5], uključujući i Austriju [6], među ključnim područjima unapređenja kvaliteta obrazovanja navode se nastavne metode i obuka nastavnika. Prema navedenim izvorima ([3, 4, 5]), u školama (osnovnim i srednjim) kao i na univerzitetima na području zapadnog Balkana dominantan je tzv. tradicionalni ili klasični pristup nastavi. Ovaj pristup zasniva se na metodama podučavanja u kojima nastavnik/profesor ima centralnu ulogu u prenošenju znanja učenicima/studentima. Nastava je najčešće organizovana u vidu predavanja, gde nastavnik izlaže gradivo, a učenici ili studenti pasivno slušaju i beleže informacije. Proces komunikacije u ovom obliku nastave pretežno i izraženo je jednosmeran – od nastavnika ka učeniku/studentu. Može se reći da se znanje prenosi direktnim instrukcijama. Na ovaj način nastavnik kontroliše tok učenja, dok se od učenika/studenata očekuje da prate instrukcije i usvajaju „servirane" sadržaje.

Klasične nastavne metode najviše se primenjuju u formi frontalne nastave, gde nastavnik predaje celom razredu ili grupi studenata, uz nizak nivo dvosmerne interakcije sa njima i interakcije unutar grupe/razreda. Često se u ovoj nastavi koristi i metoda demonstracije, gde nastavnik pokazuje određene postupke ili sprovodi određene vežbe, eksperimente i sl., dok učenici/studenti najčešće pasivno posmatraju. U ovakvom modelu nastave, diskusija može biti i jeste prisutna, ali u ograničenoj meri, jer se učenici i studenti uglavnom oslanjaju na nastavnikove instrukcije i materijale. Memorisanje i reprodukcija informacija su ključni elementi ovog pristupa, pri čemu se evaluacija znanja najčešće vrši putem pisanih testova ili pismenih i usmenih provera i ispita. Ovaj pristup nastavi je često kritikovan zbog nedostatka interaktivnosti i podsticanja kritičkog razmišljanja. Uprkos tome, i dalje je u mnogim obrazovnim institucijama dominantan način podučavanja.

Kako je sve očiglednije da ovakve nastavne metode ne odgovaraju ni trenutnim, a ni budućim zahtevima, promene u obrazovanju dešavaju se uporedo i u domenu fizionomije prostora (klasične učionice i predavaonice transformišu se u mnogo inspirativnije prostore,

[1] Sve reference u vezi sa Kosovom u ovom radu, i inače, trebaju i moraju biti shvaćene u kontekstu Rezolucije 1244 Saveta bezbednosti Organizacije Ujedinjenih Nacija, donete 1999. godine (https://digitallibrary.un.org/record/274488?v=pdf).

koji podstiču saradnju, timski i istraživački rad učenika/studenata) i u domenu procesa podučavanja (pomera se focus i interesovanje se sa „prenošenja znanja" prebacuje na „otkrivanje znanja", gde su učenik/student i njegovo aktivno učešće u srži procesa, i gde se ističe proaktivna uloga učenika/studenta, u kojoj on/ona više nije objekat podučavanja, već stvarni subjekat u nastavnom procesu).

U izmenjenoj edukacionoj paradigmi, brojni su modeli učenja. Prema mišljenju autora ovog rada, ti modeli mogu se svesti (klasifikovati) na:

1. Kooperativno učenje (cooperative learning) – Osnovna karakteristika ovog obrazovnog pristupa je rad u malim grupama. Ovakvom organizacijom nastave omogućava se učenicima/studentima da uče na način koji im najviše odgovara, shodno sopstvenim preferencijama i sklonostima, kao i da uče brzinom koja njima odgovara, oslanjajući se pri tome, kako na sopstvene, tako i na snage i veštine svojih kolega. Kroz razmenu ideja sa kolegama učenici/studenti zajednički rešavaju zadatke i postižu akademske ciljeve.

Ovaj metod zasniva se na nekoliko ključnih elemenata [7]: pozitivnoj međuzavisnosti (osećaj odgovornosti za sopstveni, kao i za zajednički uspeh), neposrednoj interakciji (interakcijom „oči u oči" podstiče se diskusija, razmena mišljenja i „zdravo" suparništvo), individualnoj i kolektivnoj odgovornosti (svaki pojedinac ima odgovornost za uspeh grupe, shodno svojoj ulozi u grupi, ali i cela grupa je odgovorna za krajnji rezultat), razvoju socijalnih veština (pospešivanje saradnje, komunikacionih veština i veština prevazilaženja konflikta, odnosno iznalaženja kompromisa), grupnoj refleksiji (auto-analizi i preispitivanju svog rada i doprinosa zajedničkim ciljevima), itd.

Kooperativno učenje, kao model nastave, već se koristi širom sveta i pokazalo se kao efikasan način za poboljšanje akademskih rezultata, socijalnih veština i motivacije učenika/studenata. Istovremeno, ovaj model nosi i određene izazove, a takođe ima i određene nedostatke. Među izazovima za uspešnu implementaciju ovog modela, najčešće se ističu neophodnost da nastavnik dobro poznaje tehnike i metode koje omogućavaju primenu ovog modela, problem evaluacije rada učenika/studenata, potrebno iskustvo nastavnika u upravljanju vremenom i ostalim resursima tokom nastave.

2. Učenje kroz radionice (workshop learning) – Ovaj obrazovni pristup zasniva se na interaktivnim i praktičnim sesijama, gde učenici/studenti aktivno učestvuju u procesu učenja kroz diskusije, različite grupne aktivnosti i rešavanje problema, najčešće po principu studija slučaja. Workshop učenje omogućava dublje razumevanje problema koji se obrađuju, omogućava razvoj individualnih potencijala kroz rad u timovima, kao i razvoj praktičnih veština rešavanja problema.

Ključne karakteristike workshop učenja uključuju: praktičan pristup – umesto pasivnog slušanja predavanja, učesnici aktivno učestvuju u zadacima i vežbama, saradnja – rad u grupama podstiče razmenu ideja i zajedničko rešavanje problema, fokus na primeni znanja – učesnici odmah primenjuju naučeno kroz simulacije, studije slučaja ili kreativne projekte, interaktivnost – nastavnici/facilitatori koriste različite metode, poput brainstorming-a, diskusija i praktičnih demonstracija, kako bi podstakli angažovanje i aktivno učešće učenika/studenata.

3. Učenje zasnovano na istraživanju (inquiry-based learning) - Ovo je pristup učenju koji naglašava istraživanje i rešavanje problema, umesto pasivnog memorisanja činjenica. Umesto da samo primaju informacije, učenici/studenti o ovom modelu učenja istražuju realna pitanja, scenarije i problem, kako bi razvili dublje razumevanje i kritičko razmišljanje. Ovaj model podstiče učenike/studente da postavljaju pitanja i istražuju teme koje ih zanimaju, sprovode istraživanja i analiziraju informacije, razmenjuju zaključke kroz diskusiju ili pisanje i razmišljaju o sopstvenom procesu učenja. Postoje različiti oblici istraživačkog učenja, uključujući strukturirano istraživanje, gde učenici/studenti prate vođeni proces, i otvoreno istraživanje, gde slobodno istražuju teme.

Ovakvim pristupom se podstiče radoznalost, kreativnost i samostalno razmišljanje. Učenicima/studentima se omogućava da postavljaju pitanja, istražuju, diskutuju, da se osećaju slobodno i, posle nekog vremena, oni spontano počnu da reflektuju naučeno. Model je izuzetno pogodan za naprednije učenike ili za više nivoe školovanja (akademske studije).

4. Projektno učenje (project-based learning) – Osnovna karakteristika učenja na ovaj način je da se znanje i veštine stiču radom na realnim, dugoročnim projektima (dugoročnim u odnosu na trajanje časa ili vremena obrade jedne teme u programu predmeta, na primer). Ovakvim pristupom se učenici/studenti podstiču da istražuju kompleksne probleme, da sarađuju i kritički razmišljaju tražeći rešenja problema. Projekat treba biti dizajniran tako da predstavlja dovoljan i razuman izazov za učenike/studente, da je dovoljno intrigantan i obuhvatan.

Od problema istraživanja, kao i od interesovanja i rada učenika/studenata, zavisi koliko dugo će se na određenom projektu raditi (nedelju dana ili možda celo polugodište/semestar, pa i duže) i koliko će se oblast istraživanja širiti. Po tome se projekat, primarno i u ovom kontekstu, razlikuje od drugih školskih aktivnosti. Važno je uočiti da ovaj model učenja nije klasični školski projekat, tj. nije dodatak nastavi, već primarni način učenja.

Naravno, da bi se uspešno primenio ovaj model, neophodno je veliko iskustvo nastavnika/profesora, koji treba da bude vodič, savetnik, facilitator u brojnim sitacijama, koji podstiče i održava interakciju među učenicima/studentima i usmerava ceo proces, ali na način da proces pripada učenicima/studentima, a ne nastavniku/profesoru. U procesu učenja učenici/studenti stiču jedinstveno iskustvo. Učenici ne samo da istražuju određeni problem/temu, već i kreiraju konkretna rešenja ili proizvode, koji imaju primenu u realnom sistemu, u praksi. Jedna od ključnih, izuzetno važnih, karakteristika ovakvog pristupa je da se rezultati rada/istraživanja moraju javno publikovati, odnosno predstaviti javnosti, van učionice.

5. Učenje zasnovano na izazovima (challenge-based learning) – Ovaj model učenja zasniva se na rešavanju stvarnih problema kroz aktivno istraživanje i praktičnu primenu znanja. U ovom pristupu učenju učenici/studenti rade na izazovima koji su relevantni za njihovu grupu/razred/populaciju i kroz proces istraživanja, eksperimentisanja i saradnje dolaze do inovativnih rešenja.

Dakle, potreban je određeni scenario, na samom početku, za čije rešavanje će učenicima/studentima biti „dodeljene" uloge (mogu ih i sami „prisvojiti"). Nakon toga se process prepušta učenicima/studentima. Učenje zasnovano na izazovima sastoji se iz tri ključne faze: Angažovanje – kada učenici/student identifikuju ideje i pitanja povezana sa

postavljenim izazovom; Istraživanje – kada se kroz prikupljanje i analizu podataka, kao i konsultacije - međusobne i sa ekspertima, stiču saznanja i produbljuje razumevanje problema i Akcija – faza u kojoj se kreiraju konkretna rešenja i kada se testiraju/primenjuju u realnom sistemu. Ovaj model učenja je prividno veoma sličan projektnom učenju. Ipak, iako su ovo srodni pristupi učenju, prisutne su značajne razlike, po strukturi procesa i po fokusu.

Učenje zasnovano na rizicima je proces suočavanja učenika/studenata sa stvarnim izazovima iz okruženja, gde se od njih zahteva da kreiraju praktično rešenje, dok je projektno učenje sticanje saznanja i dubljeg razumevanja istraživačkog problema, koje se stiče kroz rad na dugoročnim, pažljivo osmišljenim projektima. Prvi model je fokusiran na stvaranje promene u praksi, a drugi na stvaranje konkretnog rešenja/proizvoda, kao što je i uloga nastavnika/profesora u projektnom modelu izraženija (on vodi process, ali učenici imaju slobodu u donošenju odluka i rešavanju problema). Kod projektnog učenja je naglasak na procesu učenja kroz istraživanje i kreiranju konkretnog proizvoda, koga treba predstaviti javnosti, a kod učenja zasnovanog na izazovu je naglasak na praktičnoj promeni tj. direktnom uticaju na problem sadržan u izazovu. Ako se posmatra iz organizacionog aspekta i aspekta primene u praksi, kao i u drugim bliskim modelima učenja, i ovde je jedan od ključnih problema problem evaluacije rada učenika/studenata.

Iako su poslednji navedeni modeli učenja efektniji, oni su i zahtevniji, kako za nastavnika/profesora, tako i za učenika/studenta. Za njihovu uspešnu primenu neophodno je iskustvo nastavnika/profesora, dobro upravljanje vremenom, potpuno i voljno, motivisano angažovanje učenika/studenata, jasno definisan sistem evaluacije rada i dr.

3 Primer primene projektnog modela učenja u visokoškolskoj nastavi

U cilju stalnog unapređenja postignuća učenika/studenata u procesu učenja, nužno je praksu prilagođavati savremenim trendovima i naučnim dostignućima na polju didaktike i metodike nastave. Na Univerzitetu odbrane u Beogradu (UO)[2] sprovode se brojni akreditovani i neakreditovani programi školovanja i usavršavanja. S obzirom na raznovrsnost programa i naučnih oblasti kojima oni pripadaju, kao i na specifične potrebe sistema odbrane Republike Srbije, u praksi se primenjuju brojni modeli učenja i različite nastavne metode i tehnike. Istovremeno, velika pažnja poklanja se usavršavanju i obuci nastavnog kadra u razumevanju i primeni istih.

Poslednjih godina, na UO, je prisutna težnja da se nastavni process i proces učenja većinski preobrate od klasičnih, autoritativnih, predavačko-ispitivačkih modela ka participativnijim i modernijim modelima, koji su intelektualno i stvaralački produktivniji i u kojima je praktično angažovanje učenika/studenata (kadeta) u vaspitno-obrazovnom radu mnogo aktivnije. U cilju ilustracije tih napora, u ovom radu je prikazan primer projektnog pristupa nastavi na studijskom programu Vojnosaobraćajno inženjerstvo (VSI).

Naime, pomenuti studijski program je program osnovnih akademskih studija, akreditovan u Vojnoj akademiji 2021. godine. S obzirom na strukturu predmeta i sadržaja koji se nude

[2] Univerzitet odbrane u Beogradu u svom sastavu, pored ostalih organizacionih celina, ima i dve visokoškolske ustanove u kojima se realizuju akademske studije I, II i III stepena (Vojna akademija i Medicinski fakultet Vojno-medicinske akademije), kao i dve srednje škole (Vojna gimnazija i Srednja stručna vojna škola „1300 kaplara").

studentima u ovom programu, može se reći da se program sastoji iz četiri grupe predmeta: grupe opštih predmeta (u koju spadaju predmeti kao što su matematika, fizika, engleski jezik, vojno fizičko vaspitanje, sociologija…), zatim grupe opštih vojnih predmeta (kao što su taktika, vojna istorija, vojna geografija i topografija, komandovanje, moral vojske, vojna psihologija…), grupe predmeta iz naučnih oblasti koje su u bliskoj vezi sa saobraćajem i transportom (tehnička mehanika, konstruktivna geometrija, mašinski elementi, informacione tehnologije, programiranje, materijalno-finansijsko poslovanje, motori i motorna vozila, teorija kretanja motornih vozila, teorija održavanja motornih vozila, logistika i geografski informacioni sistemi…) i grupu stručno-specijalističkih predmeta (saobraćajni sistem, robni terminali i robno-transportni centri, tereti u transportu, železnički, vodni i vazdušni saobraćaj, saobraćajni tokovi, međunarodni transport i špedicija, autoparkovi, organizacija putnog transporta, organizacija putnog saobraćaja, ekonomika saobraćaja, mehanizacija pretovara, regulisanje i kontrola saobraćaja i saobraćajna podrška). Stručno-specijalistički predmeti, osim što nude sadržaje koji se odnose na oblast saobraćaja i transporta, sadrže i aplikativni deo koji se odnosi na primenu postulata i principa iz tog domena u specifične vojne svrhe.

S obzirom da su UO i Vojna akademija ustanove u kojima se odvija i značajna naučno-istraživačka delatnost, najveći deo nastavnog osoblja koje učestvuje u realizaciji nastave na studijskom program VSI, učestvuje i u naučno-istraživačkom radu. U tom smislu, u periodu od 2020. do 2025. godine, pored drugih, aktivan je i naučno-istraživački projekat Model vozača u transportnim jedinicama Vojske Srbije. Ključni ciljevi ovog projekta su matematički model vozača u transportnim jedinicama Vojske Srbije (s obzirom da su potrebne psihološke karakteristike, sklonosti, stavovi i sposobnosti vozača u transportnim jedinicama vojske u određenoj meri drugačiji od onih zahtevanih od vozača u društvu) i novi kursevi obuke različitih kategorija vojnih vozača.

Ovaj projekat je bio i okosnica, odnosno jezgro, oko koga je uspostavljen projektni model učenja sa generacijom studenata koja je školovanje počela 2020. godine. Konkretno, grupa od 10 studenata uključena je u istraživanja u okviru projekta[3]. Važno je napomenuti da su svi studenti dobrovoljno prihvatili učešće u projektu.

Na samom početku treće godine školovanja studenti su upoznati sa idejom projekta i sa do tada postignutim rezultatima, predstavljeni su im naredni ciljevi, po fazama izrade projekta, sa rokovima dostizanja ciljeva, i dodeljene su im uloge i istraživački zadaci.

Što se tiče publikovanja rezultata istraživanja, postavljen je dvolinijski vremenski horizont – sa prvim objavljivanjem rezultata istraživanja nakon godinu dana rada (na međunarodnom naučnom simpozijumu), odnosno konačnim objavljivanjem rezultata nakon dve godine rada (prilikom publikovanja završnih radova studenata, na kraju četvorogodišnjeg školovanja).

Shodno ličnim interesovanjima i preferencijama studenata, student su dobili konkretne zadatke u vezi sa parcijalnim projektnim ciljevima. Umrežavanje i formiranje manjih timova (po 2-3 studenta u timu) bilo je neformalnog karaktera – prepušteno je samoorganizovanju studenata. Rad studenata su monitorisala i mentorski vodila tri nastavnika (dva profesora iz oblasti saobraćaja i transporta i jedna profesorica iz oblasti psihologije). Njihova uloga je

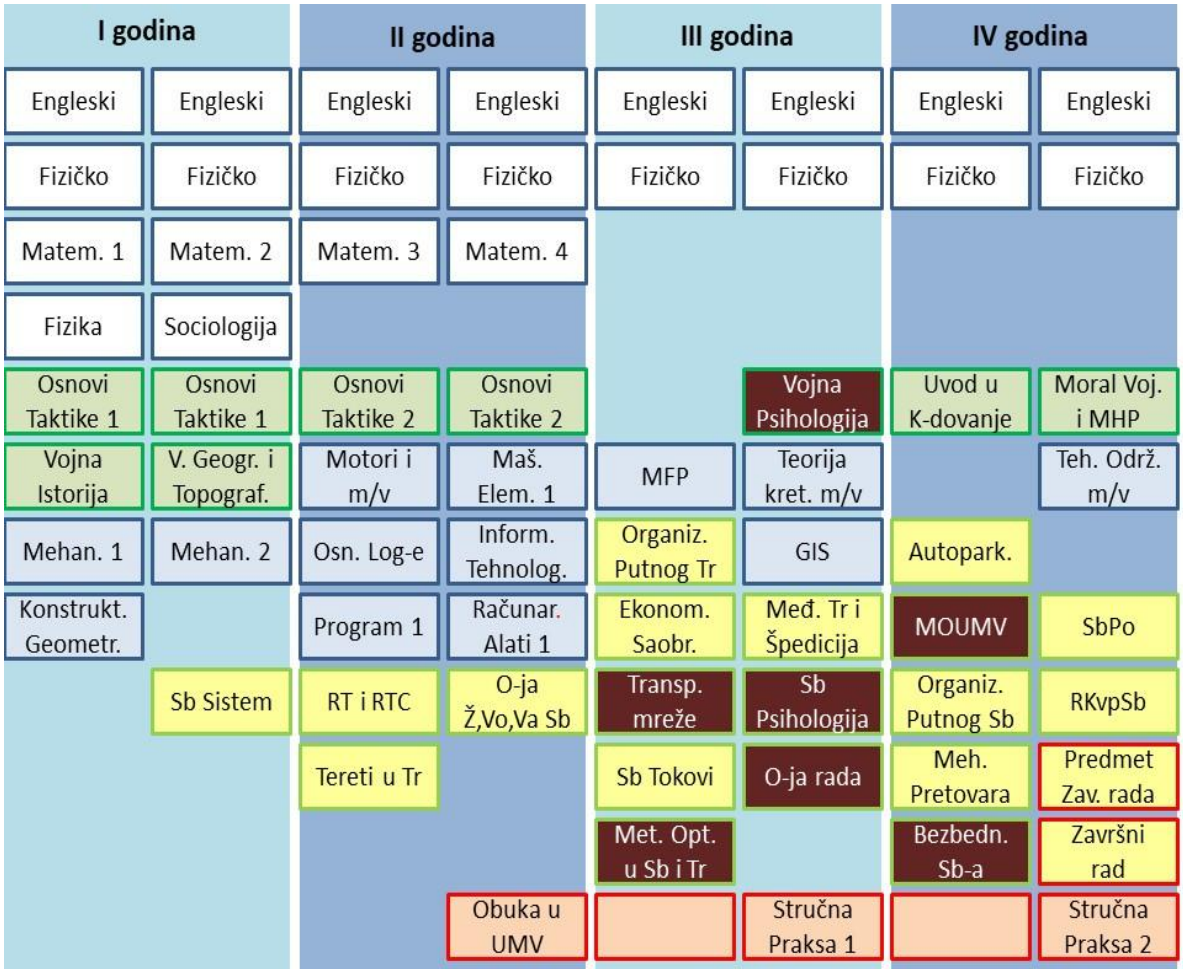
[3] Na kraju je u celokupnom periodu rada, u potpunosti učestvovalo 9 studenata, jer je jedan student, usled oporavka od povreda zadobijenih u saobraćajnoj nezgodi, bio odsutan duži vremenski period.

bila savetodavna i u najvećem delu facilitatorska – brinuli su o stvaranju organizacionih uslova i materijalne podrške za neometan i produktivan rad studenata.

Tokom dvogodišnjeg rada na projektu studenti su na ovaj način savladavali sadržaje iz više predmeta iz kurikuluma studijskog programa i to iz: 1. Bezbednost saobraćaja, 2. Saobraćajna psihologija, 3. Vojna psihologija, 4. Organizacija rada u saobraćaju i transportu, 5. Transportne mreže, 6. Metode optimizacije u saobraćaju i transportu i 7. Metodika obuke u upravljanju motornim vozilima, slika 1.

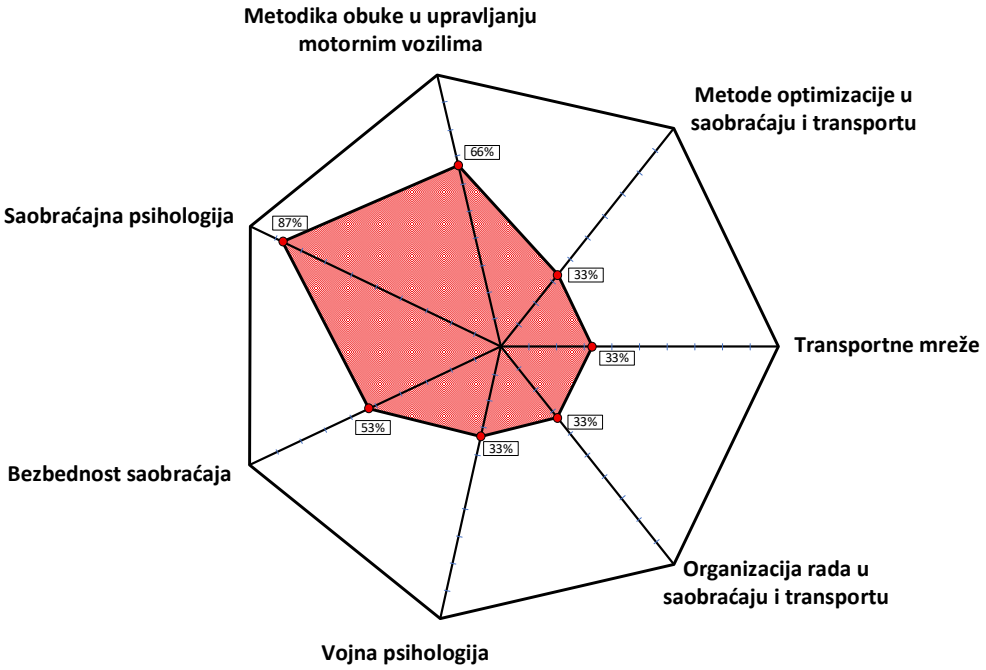
Naravno da sadržaji navedenih predmeta nisu u potpunosti mogli biti pokriveni radom na projektu, pa je nastava za preostali deo sadržaja realizovana na drugi način.

Slika 1: *Predmeti u kurikulumu studijskog programa (obeleženi su tamno-crvenom bojom) čiji su sadržaji obuhvaćeni projektnim pristupom nastavi*



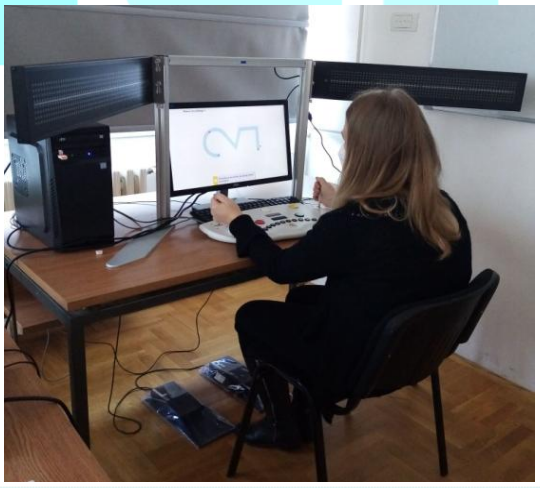
Sadržaji predmeta koji su obuhvaćeni projektnim modelom nastave su (u procentualnom odnosu) prikazani na slici 2.

Slika 2. *Teme (sadržaji) iz različitih predmeta obuhvaćene projektnim modelom nastave*



Najveći deo istraživačkog rada studenata realizovan je kroz testiranje vozača baterijama psihološko-fizičkih testova na Vienna Test System-u (DRIVEPLS i SAROAD baterije testova mogu se videti u [8]), slika 3, i analizu dobijenih rezultata. Drugi deo istraživanja, u skladu sa parcijalnim ciljevima projekta, bio je orijentisan na prikupljanje podataka, po određenim specifičnim pitanjima, iz realnog sistema tj. iz vojne organizacije i njihovu analizu i interpretaciju. Obuhvaćeni period istraživanja odnosio se kako na trenutno - aktuelno stanje, tako i na utvrđivanje trendova razvoja pojava i predviđanje budućeg stanja.

Slika 3: *Testiranje vozača na Vienna Test Systemu*



Na kraju prvog dela istraživačkog perioda, dobijeni rezultati publikovani su u devet radova, u vidu saopštenja štampanog u celini, na nacionalnom naučnom simpozijumu sa međunarodnim učešćem, i sa višegodišnjom tradicijom (2023. godine je bio 50. jubilarni simpozijum). Svaki student bio je nosilac (prvi autor) po jednog rada i učestvovao u izradi (koautor) još jednog rada, a jedan student je bio autor jednog i koautor dva rada. Svi radovi mogu se videti u zborniku radova SYM-OP-IS 2023:

6. Zlatanović, A., Tomić, S., Vićentijević, M.: Rangiranje instruktora u obuci vozača, 50. Simpozijum o operacionim istraživanjima SYM-OP-IS 2023, Zbornik radova, Tara, 2023.
7. Nikolić, I., Rajčić, J.: Sposobnost brze i pravilne percepcije saobraćajne situacije učenika Srednje vojne škole, 50. Simpozijum o operacionim istraživanjima SYM-OP-IS 2023, Zbornik radova, Tara, 2023.
8. Rajčić, J., Nikolić, I.: Određivanje relativne težine klasa i vrsta vozila za izbor najbezbednijeg vozača u Ministarstvu odbrane i Vojsci Srbije, 50. Simpozijum o operacionim istraživanjima SYM-OP-IS 2023, Zbornik radova, Tara, 2023.
9. Mijatović, J., Matejić, N.: Prognoziranje uvođenja vozila na hibridni i električni pogon u Vojsku Srbije, 50. Simpozijum o operacionim istraživanjima SYM-OP-IS 2023, Zbornik radova, Tara, 2023.
10. Tot, L., Jovanović, T.: Tolerancija na stres i crte ličnosti vozača početnika, 50. Simpozijum o operacionim istraživanjima SYM-OP-IS 2023, Zbornik radova, Tara, 2023.
11. Vićentijević, M., Zlatanović, A.: Kreiranje ruta za praktičnu obuku vozača u Vojsci Srbije primenom metoda transportnih mreža, 50. Simpozijum o operacionim istraživanjima SYM-OP-IS 2023, Zbornik radova, Tara, 2023.
12. Matejić, N., Mijatović, J.: Izbor vozača za realizaciju zadataka u vojsci primenom COCOSO metode, 50. Simpozijum o operacionim istraživanjima SYM-OP-IS 2023, Zbornik radova, Tara, 2023.
13. Tomić, S., Zlatanović, A.: Relativna važnost kriterijuma pri evaluaciji sposobnosti vojnih vozača za bezbednu vožnju, 50. Simpozijum o operacionim istraživanjima SYM-OP-IS 2023, Zbornik radova, Tara, 2023.
14. Jovanović, T., Tot, L.: Samopouzdanje i kvalitet perceptivne procene vozača početnika, 50. Simpozijum o operacionim istraživanjima SYM-OP-IS 2023, Zbornik radova, Tara, 2023.

Pored publikovanih rezultata rada, ostvareni su i drugi benefiti:

- Student su u istraživačkom radu na temama iz projekta proveli, prema sopstvenoj gruboj proceni, od 50 do 70% više vremena nego što bi to bilo u regularnoj nastavi. Prema prihvaćenim standardima u Bolonjskom procesu, gde jedan ECTS bod (ECTS - European Credit Transfer System) iznosi 25 do 30 sati rada, za obrađene sadržaje bi u regularnoj nastavi i učenju trebalo da provedu od 47,5 do 57,2 radna sata, a student su proveli u proseku po 80 do 90 radnih sati. Ovaj rezultat čak prevazilazi podatke objavljene u [9], prema kojima je angažovanje studenta veće za 30 do 50%.
- Student su tokom rada na projektu imali značajno više interakcija sa profesorima i kolegama, nego inače. U ovoj konstataciji s se složili i student i profesori.
- Koristili su, prema njihovim rečima, neuporedivo više literature (izvora informacija) nego u redovnoj nastavi, čak i do 7-8 puta više,
- Broj samostalno iniciranih aktivnosti se višestruko uvećao. Treba imati u vidu da se u regularnoj nastavi neretko dešava da u semestru studenti samostalno ne iniciraju niti jednu aktivnost.

- Subjektivno zapažanje studenata je da su bili značajno više motivisani i zadovoljni radom nego u klasičnom modelu nastave.
- Studenti su „nesvesno" naučili i usvojili ispravnu metodologiju naučno-istraživačkog rada.

5 Zaključak

Polazeći od činjenice da se u aktuelnoj epohi svedoči krizi u obrazovanju, te da je većina edukativnih ustanova (škola i fakulteta) autoritativnog karaktera i da se u njima učenik/student još uvek ne oseća kao punopravni subject u procesu obrazovanja, u ovom radu se promovišu alternativni model ii pristupi nastavnom procesu. Na primeru projektne nastave u jednoj visokoškolskoj ustanovi ukazano je na ostvarene benefite i rezultate. Uprkos činjenici da ovakav pristup ima i svoje oponente.

Naučno – tehnološka revolucija omogućava da se nastavni proces racionalizuje i učini efektnijim, u kontekstu bržeg i trajnijeg usvajanja znanja i veština. Isti pristup podučavanja prema svim učenicima/studentima već pripada prošlosti. Reformama obrazovnog sistema treba u učionice i amfiteatre uvesti nove tehnologije, aktivnu i naprednu obrazovnu filozofiju i nastavnike i profesore spremne da razvijaju radoznale, proaktivne, samostalno-učeće mlade ljude, koji nisu ekstrinzično motivisani, već naprotiv, koji motivisani iz lične radoznalosti i unutrašnjeg zadovoljstva zbog stečenih novih znanja.

6 Literatura

[1] Le Nestour, A, Moscoviz, L, Sandefur, J. (2021). The long-term decline of school quality in the developing world, Consultation draft, dostupno na https://www.cgdev.org/sites/default/files/consultation-draft-le-nestour-et-al-school-quality-decline.pdf (preuzeto 25.5.2025. godine)

[2] Stumbriene, D., Camanho, A.S., Jakaitiene, A. (2020). The performance of education systems in the light of Europe 2020 strategy. Annals of Operations Research, Vol. 288, pg. 577–608 (https://doi.org/10.1007/s10479-019-03329-5)

[3] UNICEF ECARO/OECD (2024) Education in the Western Balkans: Findings from PISA 2022. Dostupno na: https://www.unicef.org/eca/media/38941/file/Transforming%20education%20in%20the%20Western%20Balkans.pdf (Preuzeto 25.5.2025. godine).

[4] UNICEF /OECD (2022) Education in the Western Balcans, Eastern Europe and Central Asia: Findings From PISA 2018. Dostupno na: https://www.unicef.org/eca/media/22081/file/PISA%20Highlights_final.pdf%20.pdf (Preuzeto 25.5.2025. godine).

[5] Shmis, T., Cahu, P., Brajkovic, L., Gresham, J. (2025). Unlocking Potential: Enhancing Education Quality in the Western Balkans based on Insights from the PIRLS 2021 and PISA 2022 studies. International Bank for Reconstruction and Development / The World Bank. Dostupno na: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099011025181081356/p5005791deb7fa0ae1be131bcb195f4a666 (Preuzeto 25.5.2025. godine).

[6] https://eurydice.eacea.ec.europa.eu/eurypedia/austria/quality-assurance (Preuzeto 25.5.2025. godine).

[7] https://www.thoughtco.com/what-is-cooperative-learning-2081641 (Preuzeto 27.5.2025. godine)

[8] Vienna Test System – Priručnik za korišćenje, 2013, Schuhfried GmbH, Mödling, Austria.

[9] Ćirić, M. (2022). Angažovanje studenata u visokoškolskim ustanovama – pregled istraživanja. Godišnjak za pedagogiju, VII/2, pg. 25-35 (https://doi.org/10.46630/gped.2.2022.2

Zahvalnost

Ovaj rad je, pored ostalog, proistekao iz rada na naučno-istraživačkom projektu VA-TT/2/20-25 finansiranom od strane Ministarstva odbrane Republike Srbije.

REVIEW OF THE CASE STUDY OF THE PROJECT APPROACH TO HIGHER EDUCATION TEACHING IN THE FIELD OF TRANSPORT AND TRANSPORT

Dr. Srđan Ljubojević, B.Sc. Eng.[1]

Momčilo Đorđević, PhD, B.Sc.[1]

Dr. Srđan Dimić, B.Sc. Eng.[1]

[1] **University of Defence in Belgrade, Military Academy**

Abstract

This paper presents a case study of the application of the project-based approach to teaching, which was implemented during 2023 at the Military Academy of the University of Defense in Belgrade, in the study program Military Traffic Engineering, as an alternative to classical teaching models. The positive aspects of such an approach and the benefits for students are emphasized, with an emphasis on the published results (9 papers at the scientific symposium), on the time that students spent researching topics and working according to this model, on their more intensive interaction with professors, on the wider study and use of scientific and professional sources of knowledge, on a greater number of independently initiated activities, Higher motivation and student satisfaction.

1 Introduction

The modern human environment is changeable, the demands are dynamic, the challenges are often unpredictable, and the required knowledge is increasingly complex. This complexity is first projected through the need for a flexible, adaptive and interdisciplinary approach to problem solving. Today's pupils and students are expected to be digitally literate, which means that they know how to use, combine and follow the development and achievements of information technologies, that they know and respect the principles of digital ethics and that they are able to solve problems in the digital world (from understanding algorithms, knowing how to select relevant data and analyzing them, to know the principles of artificial intelligence. In addition to digital literacy, they are also required to think critically, solve problems innovatively, connect facts from different domains, excellent communication skills, work in teams, adaptability to multicultural challenges and continuous, lifelong learning, with continuous improvement, etc.

For centuries, knowledge has been measured not only by the amount of information one possesses, but by the ability to apply it and adapt it to requirements, and today this need is more pronounced than ever before. Adaptability of knowledge implies a rapid flow of information (efficiency is encouraged, but at the same time critical thinking is required when choosing relevant and reliable sources), interdisciplinarity (integration of knowledge from different disciplines is necessary), innovative learning methods (use of interactive learning models and adapted educational algorithms) and personalization of learning (adaptation of

processes to the individual needs of the student). Modern teaching is changing the paradigm of both learning and teaching, moving away from traditional learning methods and focusing on much more interactive and effective teaching techniques.

2 Traditional vs. Modern Teaching Methods

The results of many analyses and research indicate a decline in the quality of education around the world, both in countries with a lower standard of living, weaker industrial development and lower gross national product per capita compared to developed countries, the so-called developing countries [1], as well as in Europe [2] and the so-called Western Balkans [3]. Of particular interest are UNICEF reports [3, 4], which present the conclusions of analyses of education systems in Montenegro, Croatia, North Macedonia, Serbia, Albania and Kosovo[4], based on the results of PISA (Programme for International Student Assessment) testing from 2018 and 2022. Among the core problems of education systems in the Western Balkans, the lack of teaching resources, the need for curricula reform, the improvement of teacher training, the lack of innovation in educational methods and the poor development of critical thinking are among the core problems of education systems in the Western Balkans. Other studies dealing with the education system in the Western Balkans region [5], including Austria [6], also mention teaching methods and teacher training among the key areas for improving the quality of education. According to the above sources ([3, 4, 5]), the so-called traditional or classical approach to teaching is dominant in schools (primary and secondary) as well as universities in the Western Balkans. This approach is based on teaching methods in which the teacher/professor plays a central role in imparting knowledge to students. Classes are most often organized in the form of lectures, where the teacher presents the material, and students passively listen and record information. The process of communication in this form of teaching is predominantly one-way – from the teacher to the student. It can be said that knowledge is transmitted through direct instructions. In this way, the teacher controls the flow of learning, while the pupils/students are expected to follow the instructions and adopt the "served" content.

Classical teaching methods are mostly applied in the form of frontal teaching, where the teacher teaches to the whole class or a group of students, with a low level of two-way interaction with them and interaction within the group/class. Often, the demonstration method is used in this teaching, where the teacher shows certain actions or conducts certain exercises, experiments, etc., while the pupils/students most often passively observe. In this model of teaching, discussion can and is present, but to a limited extent, because pupils and students mainly rely on the teacher's instructions and materials. Memorizing and reproducing information are key elements of this approach, with knowledge evaluation most often done through written tests or written and oral checks and exams. This approach to teaching is often criticized for its lack of interactivity and encourages critical thinking. Despite this, it is still the dominant mode of teaching in many educational institutions.

As it is increasingly obvious that such teaching methods do not correspond to either current or future demands, changes in education are happening simultaneously in the domain of the

[4] All references to Kosovo in this paper, and otherwise, should and must be understood in the context of United Nations Security Council Resolution 1244, adopted in 1999

(https://digitallibrary.un.org/record/274488?v=pdf).

physiognomy of space (classic classrooms and lecture halls are transformed into much more inspiring spaces, which encourage cooperation, teamwork and research work of pupils/students) and in the domain of the teaching process (the focus is shifting and the interest is shifting from "knowledge transfer" to "knowledge discovery", where the student and his/her active participation are at the core of the process, and where the proactive role of the student is emphasized, in which he/she is no longer the object of teaching, but the actual subject in the teaching process).

In the changing educational paradigm, there are many models of learning. According to the author of this paper, these models can be reduced (classified) to:

1. Cooperative learning – The main characteristic of this educational approach is working in small groups. This organization of teaching enables pupils/students to learn in the way that suits them best, according to their own preferences and preferences, as well as to learn at a speed that suits them, relying on their own strengths and skills of their colleagues. Through the exchange of ideas with colleagues, students jointly solve tasks and achieve academic goals.

This method is based on several key elements [7]: positive interdependence (a sense of responsibility for one's own as well as for the common success), direct interaction (face-to-face interaction encourages discussion, exchange of opinions and "healthy" rivalry), individual and collective responsibility (each individual has responsibility for the success of the group, according to his role in the group, but the whole group is also responsible for the end result), development of social skills (fostering cooperation, communication skills and skills of overcoming conflicts, i.e. finding compromises), group reflection (self-analysis and review of one's work and contribution to common goals), etc.

Cooperative learning, as a teaching model, is already used worldwide and has proven to be an effective way to improve academic performance, social skills, and student motivation. At the same time, this model has some challenges, but it also has some drawbacks. Among the challenges for the successful implementation of this model, the most common are the need for the teacher to have a good knowledge of the techniques and methods that enable the application of this model, the problem of evaluating the work of students, the necessary experience of the teacher in time management and other resources during the lesson.

2. Workshop learning – This educational approach is based on interactive and hands-on sessions, where students actively participate in the learning process through discussions, various group activities and problem solving, most often based on the principle of case studies. Workshop learning enables a deeper understanding of the problems being addressed, enables the development of individual potentials through teamwork, as well as the development of practical problem-solving skills.

Key features of workshop learning include: hands-on approach – instead of passively listening to lectures, participants actively participate in tasks and exercises, collaboration – working in groups encourages the exchange of ideas and joint problem solving, focus on the application of knowledge – participants immediately apply what they have learned through simulations, case studies or creative projects, interactivity – teachers/facilitators use various methods, such as brainstorming, discussions and practical demonstrations, To encourage the engagement and active participation of students.

3. Inquiry-based learning - This is an approach to learning that emphasizes research and problem-solving, rather than passively memorizing facts. Instead of just receiving information, students explore real-world questions, scenarios, and problems about this learning model in order to develop deeper understanding and critical thinking. This model encourages students to ask questions and explore topics that interest them, conduct research and analyze information, share conclusions through discussion or writing, and reflect on their own learning process. There are various forms of exploratory learning, including structured research, where students follow a guided process, and open research, where they explore topics freely.

This approach encourages curiosity, creativity and independent thinking. Students are allowed to ask questions, explore, discuss, feel free and, after a while, spontaneously begin to reflect on what they have learned. The model is extremely suitable for more advanced students or for higher levels of schooling (academic studies).

4. Project-based learning – The main characteristic of learning in this way is that knowledge and skills are acquired by working on realistic, long-term projects (long-term in relation to the duration of the lesson or the time of processing one topic in the course program, for example). With this approach, students are encouraged to explore complex problems, collaborate and think critically in search of solutions to problems. The project should be designed in such a way that it presents a sufficient and reasonable challenge for pupils/students, that it is sufficiently intriguing and comprehensive.

It depends on the problems of the research, as well as on the interest and work of pupils/students, how long a project will be worked on (a week or maybe a whole semester, or even longer) and how much the field of research will expand. In this context, the project, primarily and in this context, differs from other school activities. It is important to note that this model of learning is not a classic school project, i.e. It's not an adjunct to teaching, but a primary way of learning.

Of course, in order to successfully apply this model, it is necessary to have a great experience of the teacher, who should be a guide, advisor, facilitator in numerous situations, who encourages and maintains interaction between students and directs the entire process, but in such a way that the process belongs to the students, not to the teacher. In the learning process, students gain a unique experience. Students not only research a specific problem/topic, but also create concrete solutions or products, which are applied in a real system, in practice. One of the key, extremely important, characteristics of this approach is that the results of work/research must be publicly published, i.e. presented to the public, outside the classroom.

5. Challenge-based learning – This model of learning is based on solving real problems through active research and practical application of knowledge. In this approach to learning, students work on challenges that are relevant to their group/class/population and through a process of research, experimentation and collaboration come up with innovative solutions.

Therefore, a certain scenario is needed, at the very beginning, for which pupils/students will be "assigned" roles (they can also "appropriate" them themselves). After that, the process is left to the pupils/students. Challenge-based learning consists of three key phases:

Engagement – when students identify ideas and questions related to the challenge; Research – when through the collection and analysis of data, as well as consultations - mutual and with experts, knowledge is gained and the understanding of the problem deepens, and Action - the phase in which concrete solutions are created and when they are tested/applied in a real system. This model of learning is very similar to project-based learning. However, although these are related approaches to learning, there are significant differences, both in process structure and focus.

Risk-based learning is the process of confronting students with real-world challenges from the environment, where they are required to create a practical solution, while project-based learning is the acquisition of knowledge and a deeper understanding of a research problem, which is acquired through working on long-term, carefully designed projects. The first model is focused on creating change in practice, and the second on creating a concrete solution/product, just as the role of the teacher/professor in the project model is more pronounced (he leads the process, but the students have the freedom to make decisions and solve problems). In project-based learning, the emphasis is on the process of learning through research and the creation of a specific product, which needs to be presented to the public, and in challenge-based learning, the emphasis is on practical change, i.e. direct impact on the problem in the challenge. If we look at it from the organizational aspect and the aspect of application in practice, as well as in other close learning models, one of the key problems here is the problem of evaluating the work of pupils/students.

Although the latter models of learning are more effective, they are also more demanding, both for the teacher/professor and for the student/student. For their successful implementation, it is necessary to have the experience of the teacher/professor, good time management, complete and voluntary, motivated engagement of pupils/students, a clearly defined system of work evaluation, etc.

3 An example of the application of the project-based learning model in higher education

In order to constantly improve the achievements of pupils / students in the learning process, it is necessary to adapt the practice to modern trends and scientific achievements in the field of didactics and teaching methodology. Numerous[5] accredited and non-accredited education and training programs are implemented at the University of Defense in Belgrade (UO). Given the diversity of programs and scientific fields to which they belong, as well as the specific needs of the defense system of the Republic of Serbia, numerous learning models and different teaching methods and techniques are applied in practice. At the same time, great attention is paid to the training and training of teaching staff in understanding and applying them.

In recent years, there has been a tendency to transform the teaching process and the learning process from classical, authoritative, lecture-inquiry models to more participatory and modern models, which are intellectually and creatively more productive and in which the

[5] The University of Defence in Belgrade, in addition to other organizational units, has two higher education institutions in which academic studies of I, II and III degree are implemented (Military Academy and Faculty of Medicine of the Military Medical Academy), as well as two secondary schools (Military Gymnasium and Secondary Vocational Military School "1300 Corporals").

practical engagement of pupils/students (cadets) in educational work is much more active. In order to illustrate these efforts, this paper presents an example of a project-based approach to teaching in the study program Military Traffic Engineering (VSI).

Namely, the mentioned study program is a bachelor's academic study program, accredited by the Military Academy in 2021. Given the structure of the subjects and the content offered to students in this program, it can be said that the program consists of four groups of subjects: a group of general subjects (which include subjects such as mathematics, physics, English, military physical education, sociology...), then a group of general military subjects (such as tactics, military history, military geography and topography, command, army morale, military psychology...), a group of subjects from scientific fields that are closely related to traffic and transport (technical mechanics, constructive geometry, machine elements, information technology, programming, material and financial operations, engines and motor vehicles, theory of motor vehicle movement, theory of motor vehicle maintenance, logistics and geographic information systems...) and a group of professional-specialist subjects (transport system, cargo terminals and goods transport centers, freight in transport, railway, water and air transport, traffic flows, international transport and forwarding, car parks, organization of road transport, organization of road traffic, traffic economics, transshipment mechanization, traffic regulation and control and traffic support). Professional-specialist courses, in addition to offering content related to the field of transport and transport, also contain an application part related to the application of postulates and principles from this domain for specific military purposes.

Given that the Board of Directors and the Military Academy are institutions in which significant scientific research activities take place, most of the teaching staff who participate in the implementation of teaching at the VSI study program also participate in scientific research. In this regard, in the period from 2020 to 2025, among others, the scientific research project Model of Drivers in Transport Units of the Serbian Armed Forces is active. The key objectives of this project are a mathematical model of drivers in the transport units of the Serbian Armed Forces (given that the necessary psychological characteristics, inclinations, attitudes and abilities of drivers in the transport units of the Army are to a certain extent different from those required of drivers in society) and new training courses for different categories of military drivers.

This project was also the backbone, i.e. the core, around which a project model of learning was established with the generation of students who started their education in 2020. Specifically, a group of 10 students were involved in research within the project[6]. It is important to note that all students voluntarily accepted to participate in the project.

At the very beginning of the third year of education, students are introduced to the idea of the project and the results achieved so far, they are presented with the next goals, according to the phases of project development, with deadlines for achieving goals, and they are assigned roles and research tasks.

As far as the publication of research results is concerned, a two-line time horizon has been set – with the first publication of research results after a year of work (at an international

[6] In the end, in the entire period of work, 9 students fully participated, because one student, due to recovery from injuries sustained in a traffic accident, was absent for a long period of time.

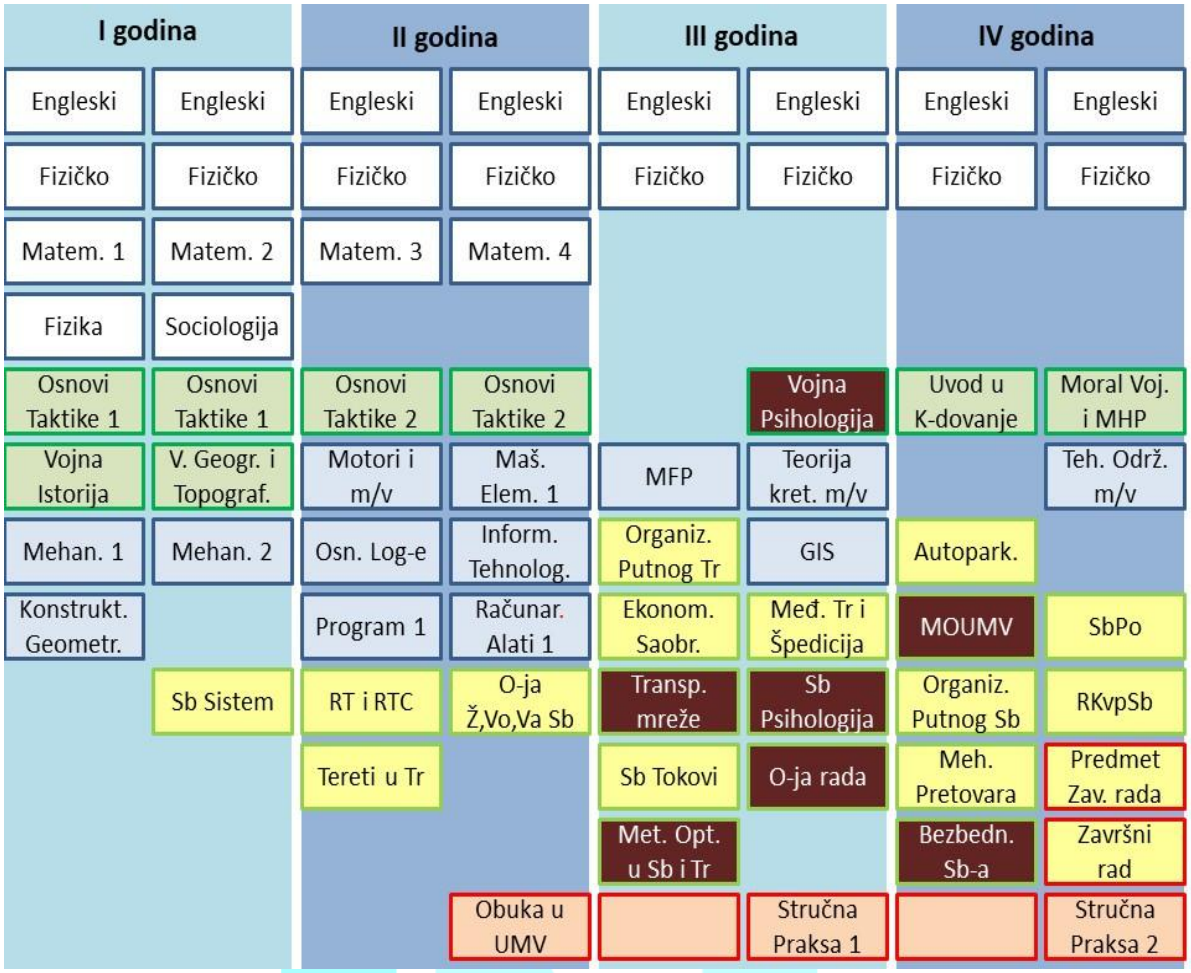
scientific symposium), and the final publication of the results after two years of work (when publishing students' final papers, at the end of four-year education).

According to the personal interests and preferences of the students, the students were given specific tasks related to partial project goals. Networking and the formation of smaller teams (2-3 students per team) was informal in nature – it was left to the students' self-organization. The students' work was monitored and mentored by three teachers (two professors in the field of traffic and transport and one professor in the field of psychology). Their role was advisory and mostly facilitative – they took care of creating organizational conditions and material support for the smooth and productive work of students.

During the two-year work on the project, students mastered the contents of several subjects from the curriculum of the study program, namely: 1. Traffic safety, 2. Traffic psychology, 3. Military psychology, 4. Organization of work in traffic and transport, 5. Transport networks, 6. Optimization methods in traffic and transport and 7. Methodology of Training in Motor Vehicle Driving, Figure 1.

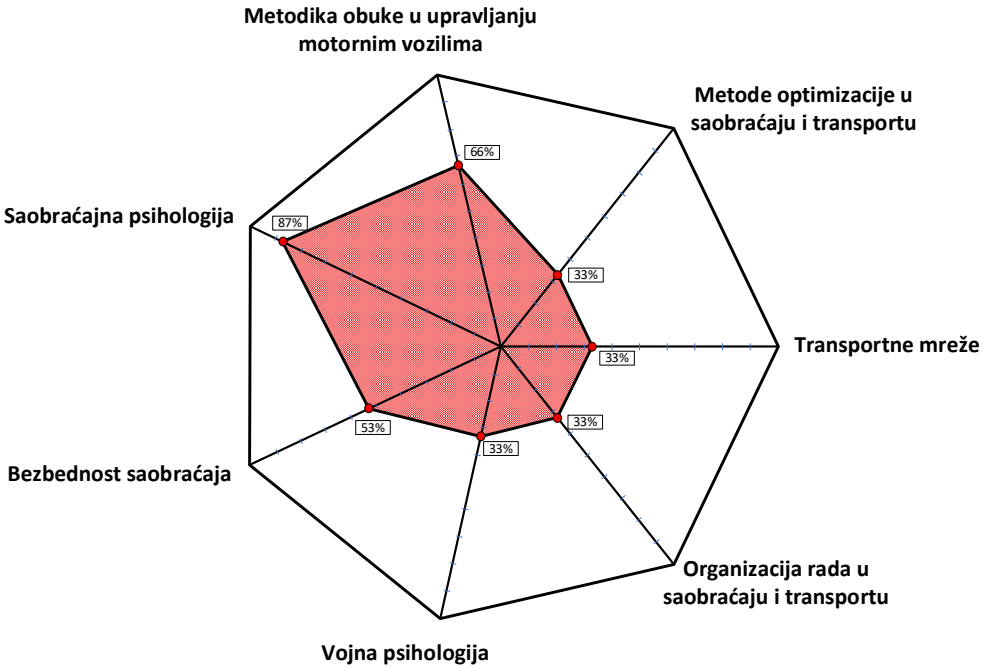
Of course, the contents of these subjects could not be fully covered by the work on the project, so the teaching for the rest of the content was carried out in a different way.

Figure 1: *Subjects in the curriculum of the study program (marked in dark red) whose contents are included in the project-based approach to teaching*



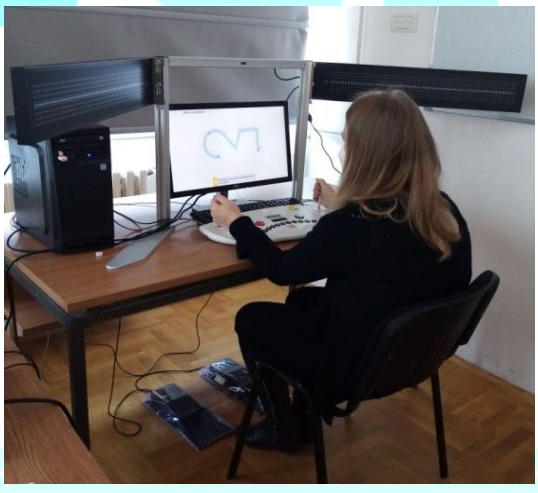
The contents of the subjects included in the project model of teaching are shown (in percentage) in Figure 2.

Figure 2. *Topics (contents) from different subjects covered by the project model of teaching*



Most of the research work of the students was realized through testing of drivers with batteries of psychological-physical tests on the Vienna Test System (DRIVEPLS and SAROAD battery tests can be seen in [8]), Figure 3, and the analysis of the results obtained. The second part of the research, in accordance with the partial objectives of the project, was oriented to the collection of data, on certain specific issues, from the real system, i.e. of the military organization and their analysis and interpretation. The covered period of research was related to the current situation, as well as to the determination of trends in the development of phenomena and prediction of the future state.

Figure 3: *Testing drivers on the Vienna Test System*



At the end of the first part of the research period, the obtained results were published in nine papers, in the form of a press release printed in its entirety, at a national scientific symposium with international participation, and with a long-standing tradition (2023 was the 50th jubilee symposium). Each student was the holder (first author) of one paper and participated in the creation (co-author) of another paper, and one student was the author of one and co-

author of two papers. All papers can be seen in the proceedings SYM-OP-IS 2023:

6. Zlatanović, A., Tomić, S., Vićentijević, M.: Ranking of instructors in driver training, 50. Symposium on Operations Research SYM-OP-IS 2023, Proceedings, Tara, 2023.
7. Nikolić, I., Rajčić, J.: The ability to quickly and correctly perceive the traffic situation of students of the Military Secondary School, 50. Symposium on Operations Research SYM-OP-IS 2023, Proceedings, Tara, 2023.
8. Rajcic, J., Nikolić, I.: Determination of Relative Weight of Vehicle Classes and Types for the Selection of the Safest Driver in the Ministry of Defense and the Serbian Armed Forces, 50. Symposium on Operations Research SYM-OP-IS 2023, Proceedings, Tara, 2023.
9. Mijatović, J., Matejić, N.: Forecasting the introduction of hybrid and electric vehicles in the Serbian Armed Forces, 50. Symposium on Operations Research SYM-OP-IS 2023, Proceedings, Tara, 2023.
10. Tot, L., Jovanović, T.: Stress tolerance and personality traits of novice drivers, 50. Symposium on Operations Research SYM-OP-IS 2023, Proceedings, Tara, 2023.
11. Vićentijević, M., Zlatanović, A.: Creating routes for practical training of drivers in the Serbian Armed Forces using the methods of transport networks, 50. Symposium on Operations Research SYM-OP-IS 2023, Proceedings, Tara, 2023.
12. Matejić, N., Mijatović, J.: Selection of drivers for the realization of tasks in the army using the COCOSO method, 50. Symposium on Operations Research SYM-OP-IS 2023, Proceedings, Tara, 2023.
13. Tomić, S., Zlatanović, A.: The relative importance of criteria in the evaluation of the ability of military drivers to drive safely, 50. Symposium on Operations Research SYM-OP-IS 2023, Proceedings, Tara, 2023.
14. Jovanović, T., Tot, L.: Self-confidence and quality of perceptual assessment of novice drivers, 50. Symposium on Operations Research SYM-OP-IS 2023, Proceedings, Tara, 2023.

In addition to the published results, other benefits have been achieved:

- According to their own rough estimate, the students spent 50 to 70% more time on research work on the topics from the project than they would have in regular classes. According to the accepted standards in the Bologna Process, where one ECTS credit (ECTS - European Credit Transfer System) is 25 to 30 hours of work, for the processed contents they should spend from 47.5 to 57.2 working hours in regular teaching and learning, and students spent an average of 80 to 90 working hours. This result even exceeds the data published in [9], according to which student engagement is higher by 30 to 50%.
- During the course of the project, students had significantly more interactions with professors and colleagues than usual. Both students and professors agreed with this statement.
- According to them, they used incomparably more literature (sources of information) than in regular classes, even up to 7-8 times more.

- The number of self-initiated activities has increased many times over. It should be borne in mind that in regular classes it often happens that students do not initiate any activity on their own during the semester.
- The subjective observation of the students is that they were significantly more motivated and satisfied with their work than in the classic model of teaching.
- The students "unconsciously" learned and adopted the correct methodology of scientific research.

5 Conclusion

Starting from the fact that in the current epoch we are witnessing a crisis in education, and that most educational institutions (schools and faculties) are authoritative and that the student still does not feel like a full-fledged subject in the process of education, this paper promotes an alternative model and approaches to the teaching process. On the example of project teaching in a higher education institution, the benefits and results achieved were pointed out. This approach also has its opponents.

The scientific and technological revolution enables the teaching process to be rationalized and made more effective, in the context of faster and more permanent acquisition of knowledge and skills. The same teaching approach to all students is already a thing of the past. Reforms of the education system should introduce new technologies, active and advanced educational philosophy and teachers and professors ready to develop curious, proactive, self-learning young people, who are not extrinsically motivated, but on the contrary, who are motivated by personal curiosity and inner satisfaction with the acquired new knowledge.

6 Literature

[1] Le Nestour, A, Moscoviz, L, Sandefur, J. (2021). The long-term decline of school quality in the developing world, Consultation draft, dostupno na https://www.cgdev.org/sites/default/files/consultation-draft-le-nestour-et-al-school-quality-decline.pdf (preuzeto 25.5.2025. godine)

[2] Stumbriene, D., Camanho, A.S., Jakaitiene, A. (2020). The performance of education systems in the light of Europe 2020 strategy. Annals of Operations Research, Vol. 288, pg. 577–608 (https://doi.org/10.1007/s10479-019-03329-5)

[3] UNICEF ECARO/OECD (2024) Education in the Western Balkans: Findings from PISA 2022. Dostupno na: https://www.unicef.org/eca/media/38941/file/Transforming%20education%20in%20the%20Western%20Balkans.pdf (Preuzeto 25.5.2025. godine).

[4] UNICEF /OECD (2022) Education in the Western Balcans, Eastern Europe and Central Asia: Findings From PISA 2018. Dostupno na: https://www.unicef.org/eca/media/22081/file/PISA%20Highlights_final.pdf%20.pdf (Preuzeto 25.5.2025. godine).

[5] Shmis, T., Cahu, P., Brajkovic, L., Gresham, J. (2025). Unlocking Potential: Enhancing Education Quality in the Western Balkans based on Insights from the PIRLS 2021 and PISA 2022 studies. International Bank for Reconstruction and Development / The World Bank. Dostupno na: https://documents.worldbank.org/en/publication/documents-

reports/documentdetail/090011025181081356/p5005791deb7fa0ae1be131bcb195f4a666 (Preuzeto 25.5.2025. godine).

[6] https://eurydice.eacea.ec.europa.eu/eurypedia/austria/quality-assurance (Preuzeto 25.5.2025. godine).

[7] https://www.thoughtco.com/what-is-cooperative-learning-2081641 (Preuzeto 27.5.2025. godine)

[8] Vienna Test System – User's Manual, 2013, Schuhfried GmbH, Mödling, Austria.

[9] Ćirić, M. (2022). Student Engagement in Higher Education Institutions – Research Review. Yearbook of Pedagogy, VII/2, pg. 25-35 (https://doi.org/10.46630/gped.2.2022.2

Gratitude

This work stemmed, among other things, from the work on the scientific research project VA-TT/2/20-25 funded by the Ministry of Defense of the Republic of Serbia.

PERCEPCIJA UČENIKA SREDNJE STRUČNE VOJNE ŠKOLE O VIENNA TEST SYSTEM-U KAO DELU PROCESA SELEKCIJE

Jelena Trifunović,

dipl. psih.[1]

Maja Đorđević, dipl.

psih.[2]

[1] Srednja stručna vojna škola „1300 kaplara“, Beograd

[2] Vojna gimnazija, Beograd

Apstrakt

Psihološka selekcija u vojnoobrazovnim institucijama Republike Srbije ima kontinuiranu i obuhvatnu funkciju, koja nadilazi tradicionalno shvatanje selekcije kao isključivo eliminacionog procesa. Ovaj rad prikazuje praktičnu primenu Vienna Test System-a (VTS), savremenog digitalnog alata za psihološko testiranje, u cilju procene psihofizičke spremnosti učenika četvrtog razreda Srednje stručne vojne škole „1300 kaplara“ za izvođenje obuke u upravljanju motornim vozilima. Testiranje je realizovano individualno, uz korišćenje DRIVEPLS baterije testova VTS-a koja obuhvata procenu pažnje, reakcije, otpornosti na stres i perceptivnih sposobnosti. Poseban akcenat stavljen je na kvalitativne uvide dobijene kroz neformalne razgovore sa učenicima, koji osvetljavaju njihovu subjektivnu percepciju testiranja, doživljaj sopstvenih sposobnosti i značaj psihološke procene koja je viđena kao podrška, a ne samo kao procena.

Ključne reči: *psihološka selekcija, vojno obrazovanje, Vienna Test System.*

Uvod - Značaj kontinuirane psihološke selekcije učenika u vojnoobrazovnim institucijama Republike Srbije

Psihološka selekcija zauzima ključnu i neprekidnu ulogu tokom školovanja u vojnoobrazovanim institucijama Republike Srbije, kao što su Srednja stručna vojna škola „1300 kaplara” i Vojna gimnazija. Ovaj važan proces nije ograničen samo na psihološku procenu koju kandidati realizuju prilikom upisa na školovanje, već se isti neprestano odvija u svakom koraku obrazovanja, često ispod površine, nevidljiv za druge. Kroz pažljivo praćenje, podršku i procenu, psihološkim usmeravanjem i diskretnom evaluacijom oblikuje se ličnost i mentalna spremnost učenika, sa ciljem da svaki učenik razvija značajne osobine za uspešan vojni poziv. Na taj način, psihologija odnosno psihološka selekcija u vojnoobrazovnom sistemu Republike Srbije ne služi samo kao filter, već kao kontinuirana

podrška u pravcu formiranja ličnosti spremne za izazove koje vojni poziv zahteva i podrazumeva. Takođe, psihološka selekcija u tom kontekstu ne mora uvek biti strogo eliminaciona, već često ima razvojni i edukativni karakter. Vojska je kroz istoriju predstavljala jedno od najvažnijih i podsticajnih okruženja za razvoj psihološke selekcije, jer je omogućila primenu testova u kontrolisanim, ali realnim uslovima [3].

Vienna Test System (VTS) predstavlja kompjuterski sistem za psihološko testiranje koji je razvio **Schuhfried GmbH** iz Austrije. Koristi se za preciznu dijagnostiku u psihologiji, naročito u oblasti saobraćaja, ispitujući kognitivne sposobnosti, ličnost i psihomotoriku kod ispitanika. Lak je za korišćenje i ne zahteva prethodno računarsko znanje [8].

Cilj rada je da predstavi praktičnu primenu Vienna Test System-a u testiranju učenika četvrtog razreda Srednje stručne vojne škole „1300 kaplara", pred odlazak na obuku u vožnji. Fokus je na prikazu testova koji su korišćeni, prenosa rezultata instruktorima vožnje, kao i na uvidima stečenim kroz neformalne razgovore sa učenicima, a u vezi sa njihovim doživljajem testiranja i razumevanjem njegove svrhe.

Psihološki kontekst učenika u vojnoobrazovnom sistemu Republike Srbije

Učenici Srednje stručne vojne škole „1300 kaplara" i Vojne gimnazije, od najranijih srednjoškolskih dana oblikuju svoje identitete unutar okruženja koje se značajno razlikuje od tipičnog obrazovnog sistema. Osim što se od njih očekuje određena akademska uspešnost, oni su ujedno izloženi zahtevima koji nalažu fizičku spremnost, disciplinu, poštovanje dnevne rutine, hijerarhiju i kolektivni duh. U takvom sistemu odrastanja, razvija se specifičan psihološki profil u kome su samopouzdanje, emocionalna kontrola i motivacija povezani sa osećajem odgovornosti prema grupi, zadatku i autoritetu [4].

Psihološki posmatrano, oni se nalaze u dvostrukoj razvojnoj tranziciji. Adolescenti su, sa svim izazovima koje to podrazumeva, ali su istovremeno i kandidati za vojni poziv koji traži zrelost, kontrolu i visok prag tolerancije na stres.

Upravo zbog toga, kada se učenicima predstavi nova forma procene (poput psihološkog testiranja u okviru priprema za obuku u vožnji) njihova reakcija ne zavisi samo od sadržaja testa, već i od lične percepcije svrhe i moguće posledice te procene. U vojnom kontekstu, gde su sve obuke (posebno praktične) neraskidivo povezane sa preciznošću, procedurom i kolektivnom bezbednošću, prepoznavanje ličnih granica i poštovanje uputstava su neophodni uslovi za uspeh [4].

Uzimajući u obzir kompleksnost psihološkog razvoja učenika u vojnoobrazovnom kontekstu, korisno je da psihološka procena ne bude samo alat za izdvajanje „spremnih" od „nespremnih". Psihološka procena bi trebalo biti, prema iskustvima iz prakse, i sredstvo koje pruža samorazumevanje, usmeravajući učenike ka zrelijem, odgovornijem ponašanju.

Okvir i tok primene psiholoških testova iz Vienna Test System-a

Budući da su učenici u kategoriji mladih vozača, bilo je od značaja proceniti njihove sposobnosti pre izvođenja praktične obuke u vožnji. Mladi vozači imaju dva do tri puta veći rizik od saobraćajnih nezgoda u poređenju sa starijima, a u Evropi se čak petina smrtnih slučajeva, u populaciji od 14 do 24 godine, vezuje za saobraćajne nesreće [7]. Ovi podaci ukazuju na važnost rane selekcije i ciljanog pristupa obuci.

Ovaj rad predstavlja prikaz sprovođenja psihološke procene kod učenika četvrtog razreda Srednje stručne vojne škole „1300 kaplara", u cilju procene psihofizičke spremnosti za

obuku u upravljanju motornim vozilima. Testiranje je deo redovne aktivnosti psihologa i nije sprovedeno kao sistematsko naučno istraživanje Kvantitativni rezultati dobijeni testiranjem korišćeni su kao osnova za izradu izveštaja koji su prosleđeni instruktorima vožnje (koji izvode obuku sa učenicima), dok je fokus ovog rada na kvalitativnim uvidima dobijenim kroz neformalne razgovore sa učenicima, u cilju dubljeg razumevanja njihovog doživljaja testiranja.

U testiranju je učestvovalo ukupno 57 učenika (39 muškaraca i 18 žena, uzrasta 18 i 19 godina), koji su se pripremali za početak praktične obuke u vožnji. Testiranje svakog učenika ponaosob trajalo je približno 55 minuta. Psihološka procena realizovana je neposredno pre početka obuke, kako bi se dobio uvid u psihomotorne i kognitivne sposobnosti učenika. Isto je bilo od naročitog značaja i kako bi se instruktorima vožnje putem izveštaja pružili relevantni podaci o sposobnostima svakog učenika, čime bi se pre svega omogućilo prilagođavanje pristupa individualnim potrebama i unapredilo planiranje obuke.

Za testiranje je korišćena **DRIVEPLS baterija testova** iz Vienna Test System-a koja obuhvata sledeće testove [8]:

1. **Reaction Test (RT):** meri brzinu i preciznost jednostavne i složene reakcije na vizuelne i auditivne podražaje.
2. **Determination Test (DT):** meri otpornost na stres odnosno sposobnost reagovanja u uslovima senzornog stresa.
3. **Adaptive Tachistoscopic Traffic Perception Test (ATAVT):** meri sposobnost brzog prepoznavanja saobraćajnih situacija, kao indikator vozačke pažnje, veštine sagledavanja situacije i perceptivne efikasnosti.
4. Peripheral Perception (PP-R): meri sposobnost perifernog opažanja uz istovremeni zadatak praćenja. Može se tumačiti kao mera podeljene pažnje.
5. Cognitrone (COG): meri selektivnu pažnju i sposobnost razlikovanja bitnih od nebitnih informacija.
6. Adaptive Matrices Test (AMT): ispituje sposobnost apstraktnog rezonovanja i rešavanja problema kao indikator opšte inteligencije.

Testiranje je sprovedeno u individualnim terminima, u tehnički opremljenoj prostoriji za psihološku dijagnostiku. Nakon testiranja, učenici su pojedinačno imali neformalan razgovor sa psihologom, a instruktorima vožnje dostavljeni su pisani izveštaji sa analizom rezultata i stručnim preporukama za izvođenje obuke sa pojedincima. Komentari i reakcije učenika tokom i nakon testiranja nisu sistematski analizirani, ali su sačuvani u vidu kvalitativnih uvida koji mogu doprineti boljem razumevanju njihove percepcije ove psihološke procene.

Percepcija učenika (kvalitativna opažanja)

Iako nije sprovedeno formalno istraživanje stavova učenika, tokom i nakon sprovedenog testiranja evidentirani su brojni spontani komentari i reakcije, koji osvetljavaju način na koji

učenici percipiraju psihološko testiranje, kao i sopstvene sposobnosti u kontekstu predstojeće obuke za vožnju.

Tokom neformalnih razgovora, mnogi učenici su podelili svoja opažanja o samom izgledu i strukturi testiranja. **Prvi kontakt sa Vienna Test System-om bilo je za većinu učenika novo i u izvesnoj meri zbunjujuće iskustvo.** Neki su istakli da ih je posebno iznenadilo to što se testovi ne rade na papiru ili "običnom" računaru, već uključuju specifičnu opremu kao što su **papučice za noge, svetlosni i zvučni signali, periferni panel za proveru vidnog polja.** Takođe, komentarisali su i prisustvo preciznih zadaka koji zahtevaju stalnu pažnju i brzo donošenje odluka. U početku **zbunjeni, ali primetno radoznali,** učenici su se brzo prilagođavali zadacima, a većina je naglašavala da im je bilo „neobično", „drugačije", „zanimljivo" jer "liči na igricu". Neki su čak izrazili zadovoljstvo činjenicom da se ovakva tehnologija koristi u školi, ističući da im se testiranje činilo „ozbiljnije" i „važnije" upravo zbog toga. Za mnoge učenike susret sa Vienna Test System-om bio je prvi kontakt sa naprednim, digitalizovanim načinom psihološke procene. Slične reakcije zabeležili su Burtaverde i Mihaila [2] koji su istraživali iskustva studenata prve godine psihologije i utvrdili da su studenti na početku imali teškoće u korišćenju kompjuterizovanih testova VTS-a, ali su kroz praksu i uz podršku supervizora značajno poboljšali svoje rezultate i percipirali testove kao korisne i zanimljive.

Učenici koji su tokom školovanja pokazivali niži nivo samopouzdanja i izraženiju potrebu za potvrdom svojih sposobnosti testiranje su doživeli sa izvesnom dozom treme. Kod njih se tokom razgovora, u toku i nakon testa, pokazalo da im je značilo pružanje objašnjenja o svrsi testiranja, kao i da ono nije eliminacionog karaktera, već da ima za cilj prepoznavanje snaga, ali i oblasti koje treba dodatno razvijati. U tim individualnim razgovorima, ovi učenici su često spontano otvarali teme vezane za sopstvene nesigurnosti, izražavali zabrinutost ili govorili o konkretnim strahovima (npr. da neće moći da reaguju dovoljno brzo, da će ih trema blokirati i sl.). *„Ja se stvarno uplašim kad pomislim da ću sesti za volan, mislim da će svi drugi to bolje raditi od mene."*, izjavio je jedan od učenika.

S druge strane, kod učenika sa izraženim samopouzdanjem i naglašenim osećajem kompetentnosti, razgovori nakon testiranja su korišćeni kao prilika da se usmeri pažnja na važnost saradnje sa instruktorima i poštovanja instrukcija koje će dobijati. Rezultati sa testova su u tim slučajevima poslužili kao osnova za razvoj realističnije slike o sopstvenim sposobnostima i upozorenje na mogući rizik prilikom izražavanja preterane samouverenosti koja ih često odlikuje. *„Ja ću to odmah savladati, meni ovo ne treba."*, izjavio je učenik koji je pokazivao ležeran stav prema uputstvima tokom testiranja i koji je, u više navrata, skretao pažnju na spoljašnje draži (proveravajući telefon i pokazujući smanjenu usmerenost na zadatak). Nakon razgovora i sagledavanja rezultata, učenik je prepoznao da mu je pažnja oscilirala pri dužem kognitivnom naporu, što može biti relevantno za bezbednost u vožnji. Oscilacije u pažnji predstavljaju značajan rizik u saobraćaju, jer privremeno preusmeravanje fokusa sa vožnje na druge misli, aktivnosti ili objekte smanjuje svest i performanse, ometa odlučivanje i povećava verovatnoću saoobraćajne nezgode [5].

Ovi uvidi pokazuju da psihološka procena ne samo da je pružila objektivne informacije o psihofizičkim sposobnostima učenika, već je imala i edukativnu, razvojnu ulogu. Omogućujući učenicima uvid u sopstvene rezultate pružili smo im priliku da bolje razumeju sebe, da uoče sopstvene reakcije u stresnim situacijama i da kroz razgovor sa psihologom formulišu realističniji stav prema sopstvenim sposobnostima, ali i zahtevima koje će obuka u vožnji pred njih postaviti. Kada se testiranje nije doživelo kao ispitivanje koje ih „kategorizuje", već kao **prilika za samorazumevanje i lični razvoj**, primećeno je i da je njihova motivacija, kao i uvid u značaj buduće saradnje sa instruktorima vožnje značajno

povećana.

Diskusija

Brojna istraživanja potvrđuju da je Vienna Test System validan i pouzdan alat za objektivnu procenu psihofizičkih sposobnosti u različitim kontekstima koji zahtevaju visoke performanse, uključujući i sportsku psihologiju [6]. Ovakvi nalazi pružaju osnovu da se njegova primena razmatra i u psihološkoj proceni učenika vojne škole pred početak obuke u upravljanju motornim vozilima, kao efikasan način za sagledavanje ključnih kognitivnih i motoričkih kapaciteta učenika. Dobijeni podaci pretočeni u psihološki izveštaj omogućili su instruktorima vožnje dodatni uvid u karakteristike učenika, naročito onih kod kojih će znaci neuroticizma biti uočljivi. Ove informacije doprinele su boljem planiranju i prilagođavanju metoda praktične obuke. Imajući u vidu da je neuroticizam povezan sa povećanom emocionalnom reaktivnošću i nižom tolerancijom na stres njegovo prisustvo kod kandidata može predstavljati faktor rizika u saobraćajnom kontekstu [1].

Jedna od ključnih prednosti Vienna Test System-a, konkretno DRIVEPLS baterije, jeste njegova sposobnost da pruži **višedimenzionalan uvid u sposobnosti testiranih kandidata.** Osim što meri pojedinačne funkcije kao što su pažnja, brzina reagovanja, periferno opažanje i otpornost na stres, sistem koristi **veštačku neuronsku mrežu** kako bi rezultate interpretirao na integrisan način. Ova inteligentna obrada rezultata omogućava da se identifikuju **ne samo deficiti, već i potencijal za njihovu kompenzaciju** kroz druge očuvane funkcije [8]. Kao primer, učenikov prikaz rezultata može proizvesti zaključak da on poseduje **dovoljno sposobnosti za upravljanje vozilom B kategorije**, ali da u kontekstu kategorije profesionalnih vozača ispoljava određena **ograničenja** koja, iako prisutna, pokazuju **dovoljno indikacija da bi mogla biti kompenzovana** drugim funkcionalnim kapacitetima. Takva analiza omogućava preciznije i pravednije donošenje odluka prema pojedincu, zasnovanih ne samo na sirovim rezultatima već i na **sveobuhvatnoj proceni ukupnih performansi učenika odnosno ispitanika.**

U tom smislu, značaj VTS se ogleda ne samo u detekciji postojećih poteškoća u smislu ispitanikovih kapaciteta, već i u prepoznavanju **realnih mogućnosti za prilagođavanje i dalji razvoj**, što je posebno važno u radu sa mladima.

Međutim, aspekt subjektivnog doživljaja testiranja od strane učenika ne sme biti zanemaren. Ako im nisu jasno saopšteni ciljevi testiranja, postoji rizik da čitav proces dožive kao oblik ocenjivanja ili nepoverenja prema njima. Pojedini učenici su izražavali osećaj nesigurnosti, straha od neuspeha ili brigu zbog prenosa rezultata instruktorima vožnje. U tom smislu, uloga psihologa mora biti i podržavajuća, kroz objašnjavanje svrhe testiranja, pružanja povratnih informacija i razgovora koji normalizuje testiranje kao sastavni deo buduće obuke, a ne predstavlja „pretnju".

Ograničenja ovog rada proizilaze iz činjenice da se u trenutku pisanja rada proces praktične obuke još uvek odvijao. Stoga, **analiza povezanosti između rezultata psihološkog testiranja i uspešnosti učenika tokom izvođenja vožnje planira se kao naredna faza evaluacije,** što bi moglo doprineti boljem razumevanju prediktivne vrednosti korišćenih testova i dodatno unaprediti selekcione i edukativne postupke u okviru vojne obuke.

Zaključak i preporuke

U obrazovanju, a posebno u vojnim školama, gde se formiraju ne samo budući profesionalci već i ličnosti sa jasno definisanim vrednostima, psihološka procena ne sme biti shvaćena

kao tehnička formalnost. Naprotiv ona je tihi saveznik starešina, nastavnika/instruktora i samih učenika, odnosno oslonac koji omogućava da se individualne razlike prepoznaju, razumeju i usmere u pravcu ličnog i profesionalnog razvoja.

Primena Vienna Test System-a u ovom kontekstu ne donosi samo brojke i grafikone, već i priliku za dijalog sa učenikom koji u fokus stavlja razgovor o njegovim snagama i potencijalima, ali i slabostima i nesigurnostima. Ona otvara prostor za refleksiju i za izgradnju poverenja u sopstvene kapacitete, uz podršku, a ne pod pritiskom.

Učenici nisu samo nosioci rezultata, već i mladi ljudi na raskršću očekivanja i izazova. Zato je svaki oblik psihološke evaluacije ujedno i poziv da ih čujemo. U vojnom kontekstu u kojem se zahteva brzina, preciznost i poslušnost, ne smemo zaboraviti važnost unutrašnje pripreme, a upravo je psihološki uvid ono što tu pripremu čini celovitom.

Ovakav pristup je dragocen jer prepoznaje čoveka iza kandidata. Potvrđuje da i u najstrožim sistemima postoji prostor za razumevanje, prilagođavanje i brigu. Te vrednosti u svakoj formaciji, bilo u vojsci, školi ili životu uopšte, predstavljaju temelje prave discipline i odgovornosti.

Literatura

[1] Alavi, S. S., Mohammadi, M. R., Souri, H., Mohammadi Kalhori, S., Jannatifiard, F., & Sepahbodi, G. (2017). Personality, driving behavior and mental disorders factors as predictors of road traffic accidents based on logistic regression. *Iranian Journal of Medical Sciences*, *42*(1), 24–31.4

[2] Burtaverde, V., & Mihaila, T. (2011). Difficulties experienced by students in the use of Vienna Test Systems computerized psychological tests. *Romanian Journal of Experimental Applied Psychology, 2*(2). Retrieved from https://www.proquest.com/openview/514a5571b92cea1360a630e1cdda58cf

[3] Driskell, J. E., & Olmstead, B. (1989). Psychology and the military: Research applications and trends. *American Psychologist, 44*(1), 43–54.

[4] Jovićević, M. (1987). *Mentalna higijena u oružanim snagama*. Beograd: Vojnoizdavački i novinski centar.

[5] Marinković, T. (2022). Kognitivno ometanje kao jedan od osnovnih faktora rizičnog ponašanja kod vozača. *Zbornik radova sa Naučno-stručnog skupa „Dobra praksa u drumskom saobraćaju“*, Beograd, 11–12. maj 2022, str. 248–254.

[6] Ong, N. C. H. (2015). The use of the Vienna Test System in sport psychology research: A review. *International Review of Sport and Exercise Psychology, 8*(1), 204–223. https://doi.org/10.1080/1750984X.2015.1061581

[7] Peer, S., Muermann, A., & Sallinger, K. (2020). App-based feedback on safety to novice drivers: Learning and monetary incentives. *Transportation Research Part F: Traffic Psychology and Behaviour, 71*, 198–219.

[8] Schuhfried, G. (2007/2008). *Vienna Test System: Manual and interpretation guide*. Mödling, Austria: SCHUHFRIED GmbH.

STUDENTS' PERCEPTION OF THE VIENNA TEST SYSTEM AS PART OF THE SELECTION PROCESS

Jelena Trifunović,

B.Sc. in Psychology[1]

Maja Đorđević, BSc

in Psychology[2]

[1] Military Secondary Vocational School "1300 Corporals", Belgrade

[2] Vojna gimnazija, Beograd

Abstract

Psychological selection within military educational institutions in the Republic of Serbia plays a continuous and comprehensive role, going beyond the traditional understanding of selection as a purely eliminatory process. This paper presents the practical application of the Vienna Test System (VTS), a modern digital tool for psychological assessment, aimed at evaluating the psychophysical readiness of fourth-year students at the Secondary Military Vocational School "1300 Corporals" for driver training. The assessment was conducted individually, using the DRIVEPLS battery of VTS tests, which includes evaluation of attention, reaction speed, stress tolerance, and perceptual abilities. Special emphasis was placed on qualitative insights gathered through informal conversations with the students, shedding light on their subjective perception of the testing process, their view of their own capabilities, and the significance of psychological assessment seen more as a form of support than mere evaluation.

Keywords: *psychological selection, military education, Vienna Test System.*

Introduction - The Importance of Continuous Psychological Selection of Students in Military Education Institutions of the Republic of Serbia

Psychological selection plays a key and continuous role during education in military institutions of the Republic of Serbia, such as the Secondary Vocational Military School "1300 Corporals" and the Military Gymnasium. This important process is not limited to the psychological assessment that candidates realize when enrolling in education, but it is constantly taking place at every step of education, often beneath the surface, invisible to others. Through careful monitoring, support and assessment, psychological guidance and discreet evaluation, the personality and mental readiness of students are formed, with the aim that each student develops significant qualities for a successful military calling. In this

way, psychology, i.e. psychological selection in the military education system of the Republic of Serbia, does not serve only as a filter, but as a continuous support in the direction of forming a personality ready for the challenges that the military profession requires and implies. Also, psychological selection in this context does not always have to be strictly eliminatory, but often has a developmental and educational character. Historically, the military has been one of the most important and stimulating environments for the development of psychological selection, as it has enabled the application of tests in controlled but realistic conditions.

The Vienna Test System (VTS) is a computerized psychological testing system developed by **Schühfried GmbH** in Austria. It is used for accurate diagnostics in psychology, especially in the field of traffic, examining cognitive abilities, personality and psychomotor skills in subjects. It is easy to use and does not require prior computer knowledge [8].

The aim of this paper is to present the practical application of the Vienna Test System in testing students of the fourth grade of the Secondary Vocational Military School "1300 Corporals", before going to driving training. The focus is on the presentation of the tests used, the transmission of results to driving instructors, as well as the insights gained through informal conversations with students, regarding their experience of testing and understanding of its purpose.

Psychological Context of Students in the Military Education System of the Republic of Serbia

From the earliest days of high school, students of the Military Secondary School "1300 Corporals" and the Military Gymnasium shape their identities within an environment that is significantly different from the typical education system. In addition to being expected to perform academically, they are also subject to demands on physical fitness, discipline, adherence to daily routines, hierarchy, and collective spirit. In such a system of growing up, a specific psychological profile develops in which self-confidence, emotional control and motivation are associated with a sense of responsibility towards the group, task and authority [4].

Psychologically, they are in a dual developmental transition. They are adolescents, with all the challenges that this entails, but at the same time they are candidates for a military profession that requires maturity, control and a high threshold of tolerance to stress.

That is why, when students are presented with a new form of assessment (such as psychological testing in preparation for driving training), their reaction depends not only on the content of the test, but also on their personal perception of the purpose and possible consequences of that assessment. In a military context, where all training (especially practical training) is inextricably linked to precision, procedure, and collective security, recognizing personal boundaries and following instructions are necessary conditions for success .

Taking into account the complexity of the psychological development of students in the military-educational context, it is useful that the psychological assessment is not only a tool for distinguishing the "ready" from the "unprepared". Psychological assessment should also be, according to practical experience, a tool that provides self-understanding, directing students towards more mature, responsible behavior.

Framework and course of application of psychological tests from the Vienna Test System

Since the students are in the category of young drivers, it was important to assess their abilities before conducting practical driving training. Young drivers have a two to three times higher risk of accidents compared to older drivers, and in Europe, as many as a fifth of deaths in the population aged 14 to 24 are related to road accidents [7]. These data indicate the importance of early selection and a targeted approach to training.

This paper presents an overview of the implementation of psychological assessment among students of the fourth grade of the Secondary Vocational Military School "1300 Corporals", in order to assess psychophysical readiness for training in driving motor vehicles. Testing is part of the regular activity of psychologists and has not been conducted as a systematic scientific research. The quantitative results obtained from testing were used as the basis for the preparation of reports that were forwarded to driving instructors (who conduct training with students), while the focus of this work is on qualitative insights obtained through informal conversations with students, in order to gain a deeper understanding of their experience of testing.

A total of 57 students (39 men and 18 women, aged 18 and 19) took part in the test, preparing for the start of practical driving training. The testing of each individual student lasted approximately 55 minutes. A psychological assessment was carried out immediately before the start of the training, in order to gain insight into the psychomotor and cognitive abilities of the students. It was also particularly important to provide driving instructors with relevant data on each student's abilities through reports, which would primarily enable the adaptation of the approach to individual needs and improve training planning.

The DRIVEPLS battery of tests **from the Vienna Test System** was used for testing, which includes the following tests [8]:

1. **Reaction Test (RT) measures** the speed and accuracy of simple and complex responses to visual and auditory stimuli.
2. **Determination Test (DT):** Measures the ability to react to sensory stress.
3. **Adaptive Tachistoscopic Traffic Perception Test (ATAVT)** measures the ability to quickly recognize traffic situations, as an indicator of driver's attention, situational awareness and perceptual efficiency.
4. Peripheral Perception (PP-R): Measures the ability to perceive peripherally with a simultaneous monitoring task. It can be interpreted as a measure of divided attention.
5. Cognitrone (COG) is a measure of selective attention and the ability to distinguish between important and irrelevant information.
6. The Adaptive Matrices Test (AMT) examines the ability to abstract reason and solve problems as an indicator of general intelligence.

Testing was carried out in individual terms, in a technically equipped room for psychological diagnostics. After testing, the students individually had an informal conversation with a psychologist, and written reports were delivered to the driving instructors with an analysis of the results and expert recommendations for conducting training with individuals.

Students' comments and reactions during and after testing were not systematically analyzed, but they were preserved in the form of qualitative insights that can contribute to a better understanding of their perception of this psychological assessment.

Student perception (qualitative observations)

Although no formal survey of students' attitudes was conducted, during and after the testing was conducted, numerous spontaneous comments and reactions were recorded, which shed light on the way students perceive psychological testing, as well as their own abilities in the context of the upcoming driving training.

During informal conversations, many students shared their observations about the appearance and structure of the test. **The first contact with the Vienna Test System was a new and somewhat confusing experience for most students.** Some pointed out that they were particularly surprised that the tests are not done on paper or an "ordinary" computer, but include specific equipment such as **foot pedals, light and sound signals, and a peripheral panel to check the field of view.** They also commented on the presence of precise tasks that require constant attention and quick decision-making. Initially **confused, but noticeably curious,** the students quickly adapted to the tasks, and most emphasized that they found it "unusual", "different", "interesting" because "it looks like a game". Some even expressed satisfaction with the fact that this technology is used in school, pointing out that testing seemed "more serious" and "important" to them precisely because of this. For many students, the encounter with the Vienna Test System was their first contact with an advanced, digitized way of psychological assessment. Similar reactions were recorded by Burtaverde and Mihaila [2], who investigated the experiences of first-year psychology students and found that the students initially had difficulties in using the computerized VTS tests, but through practice and with the support of supervisors, they significantly improved their results and perceived the tests as useful and interesting.

Students who showed a lower level of self-confidence and a more pronounced need to confirm their abilities during schooling experienced the test with a certain amount of trepidation. During the interview, during and after the test, it was shown that it meant to them to provide an explanation about the purpose of testing, and that it is not of an eliminatory nature, but that it aims to identify strengths, but also areas that need to be further developed. In these individual conversations, these students often spontaneously raised topics related to their own insecurities, expressed concerns, or spoke about specific fears (e.g., that they would not be able to react quickly enough, that stage fright would block them, etc.). *"I get really scared when I think I'm going to get behind the wheel, I think everyone else is going to do it better than me."*, said one of the students.

On the other hand, for students with a strong sense of self-confidence and a strong sense of competence, post-test interviews were used as an opportunity to focus attention on the importance of cooperating with instructors and following the instructions they will receive. In these cases, the results from the tests served as the basis for developing a more realistic picture of one's own abilities and warning of the possible risks when expressing the overconfidence that often characterizes them. *"I'm going to do it right now, I don't need it."*, said a student who showed a casual attitude towards instructions during the test and who, on several occasions, drew attention to external attractions (checking the phone and showing reduced focus on the task). After talking and looking at the results, the student recognized that his attention fluctuated with prolonged cognitive effort, which can be relevant for driving safety. Attention fluctuations pose a significant risk in traffic, as the temporary shift

of focus from driving to other thoughts, activities, or objects reduces awareness and performance, interferes with decision-making, and increases the likelihood of a traffic accident.

These insights show that psychological assessment not only provided objective information about the student's psychophysical abilities, but also played an educational, developmental role. By enabling students to see their own results, we gave them the opportunity to better understand themselves, to notice their own reactions in stressful situations and to formulate a more realistic attitude to their own abilities, but also to the requirements that the driving training will set for them through a conversation with a psychologist. When the testing was not seen as a test that "categorized" them, but as an **opportunity for self-understanding and personal development**, it was also noticed that their motivation, as well as insight into the importance of future cooperation with driving instructors, was significantly increased.

Discussion

Numerous studies confirm that the Vienna Test System is a valid and reliable tool for objective assessment of psychophysical abilities in various contexts that require high performance, including sports psychology [6]. Such findings provide a basis for its application to be considered in the psychological assessment of military school students before the start of motor vehicle driving training, as an effective way to look at the key cognitive and motor capacities of students. The obtained data, translated into a psychological report, allowed driving instructors additional insight into the characteristics of students, especially those in whom signs of neuroticism will be noticeable. This information has contributed to better planning and adaptation of practical training methods. Given that neuroticism is associated with increased emotional reactivity and lower tolerance to stress, its presence in candidates may be a risk factor in the traffic context [1].

One of the key advantages of the Vienna Test System, specifically the DRIVEPLS battery, is its ability to provide **a multidimensional insight into the capabilities of the test candidates.** In addition to measuring individual functions such as attention, reaction speed, peripheral perception, and stress resistance, the system uses **an artificial neural network** to interpret the results in an integrated way. This intelligent processing of the results makes it possible to identify **not only deficits, but also the potential for their compensation** through other conserved functions [8]. As an example, the student's presentation of the results may lead to the conclusion that he has **sufficient ability to drive a category B vehicle**, but that, in the context of the category of professional drivers, he exhibits certain **limitations** which, although present, show **sufficient indications to be compensated** forother functional capabilities. Such analysis allows for more accurate and equitable decision-making for the individual, based not only on raw results but also on **a comprehensive assessment of the overall performance of students or respondents.**

In this sense, the importance of VTS is reflected not only in the detection of existing difficulties in terms of the respondent's capacities, but also in the recognition **of real opportunities for adaptation and further development**, which is especially important in working with young people.

However, the subjective aspect of the test by the student should not be neglected. If they are not clearly communicated with the objectives of the test, there is a risk that the whole process will be perceived as a form of evaluation or distrust towards them. Some students expressed

feelings of insecurity, fear of failure or worry about the transmission of results to driving instructors. In this sense, the role of the psychologist must also be supportive, through explaining the purpose of testing, providing feedback and a conversation that normalizes testing as an integral part of future training and does not pose a "threat".

The limitations of this paper arise from the fact that at the time of writing the paper, the process of practical training was still taking place. Therefore, **the analysis of the correlation between the results of psychological testing and the performance of students during driving is planned as the next stage of evaluation,** which could contribute to a better understanding of the predictive value of the tests used and further improve selection and educational procedures within military training.

Conclusion and recommendations

In education, and especially in military schools, where not only future professionals but also personalities with clearly defined values are formed, psychological assessment should not be understood as a technical formality. On the contrary, it is a silent ally of elders, teachers/instructors and the students themselves, that is, a support that allows individual differences to be recognized, understood and directed in the direction of personal and professional development.

The application of the Vienna Test System in this context brings not only numbers and graphs, but also an opportunity for a dialogue with the student that focuses on the conversation about his strengths and potentials, but also weaknesses and insecurities. It opens up space for reflection and for building confidence in one's own capacities, with support, not under pressure.

Students are not only the bearers of results, but also young people at the crossroads of expectations and challenges. That is why every form of psychological evaluation is also an invitation to hear them. In a military context where speed, precision and obedience are required, we must not forget the importance of internal preparation, and it is precisely psychological insight that makes this preparation complete.

This approach is valuable because it recognizes the man behind the candidate. It confirms that even in the strictest systems, there is room for understanding, adaptation and care. These values in every formation, whether in the army, school, or life in general, are the foundations of true discipline and responsibility.

Literature

[1] Alavi, S. S., Mohammadi, M. R., Souri, H., Mohammadi Kalhori, S., Jannatifiard, F., & Sepahbodi, G. (2017). Personality, driving behavior and mental disorders factors as predictors of road traffic accidents based on logistic regression. *Iranian Journal of Medical Sciences*, *42*(1), 24–31.4

[2] Burtaverde, V., & Mihaila, T. (2011). Difficulties experienced by students in the use of Vienna Test Systems computerized psychological tests. *Romanian Journal of Experimental Applied Psychology, 2*(2). Retrieved from https://www.proquest.com/openview/514a5571b92cea1360a630e1cdda58cf

[3] Driskell, J. E., & Olmstead, B. (1989). Psychology and the military: Research applications and trends. *American Psychologist, 44*(1), 43–54.

[4] Jovićević, M. (1987). *Mental Hygiene in the Armed Forces*. Belgrade: Military Publishing and Newspaper Centre.

[5] Marinković, T. (2022). Cognitive impairment is one of the main factors of risk behaviour in drivers. *Proceedings of the Scientific and Professional Conference "Good Practice in Road Traffic"*, Belgrade, 11–12 May 2022, pp. 248–254.

[6] Ong, N. C. H. (2015). The use of the Vienna Test System in sport psychology research: A review. *International Review of Sport and Exercise Psychology, 8*(1), 204–223. https://doi.org/10.1080/1750984X.2015.1061581

[7] Peer, S., Muermann, A., & Sallinger, K. (2020). App-based feedback on safety to novice drivers: Learning and monetary incentives. *Transportation Research Part F: Traffic Psychology and Behaviour, 71*, 198–219.

[8] Schuhfried, G. (2007/2008). *Vienna Test System: Manual and interpretation guide*. Mödling, Austria: SCHUHFRIED GmbH.

ZNAČAJ PSIHIČKE PRIPREME UČENIKA ZA UPIS NA FAKULTET

Maja Đorđević, dipl. psih.[1]

Jelena Trifunović, dipl. psih.[2]

[1] **Vojna gimnazija, Beograd**

[2] **Srednja stručna vojna škola "1300 kaplara", Beograd**

Apstrakt

Prelazak iz srednjoškolskog u visokoškolsko obrazovanje predstavlja značajnu tranziciju ispunjenu akademskim, socijalnim i emocionalnim izazovima. Iako učenici iz internatskih škola, poput Vojne gimnazije i Srednje stručne vojne škole u Republici Srbiji, poseduju prednost u razvijenoj samostalnosti i adaptabilnosti, suočavaju se sa jedinstvenim pritiscima i dilemama pred upis na fakultet. Ovaj rad prezentuje značaj psihičke pripreme u prevazilaženju ovih izazova, naglašavajući da akademska spremnost sama po sebi nije dovoljna.

Analizira se specifičan obrazovni model vojnih škola, koji integriše opšteobrazovne i opštevojne sadržaje sa posebnim oblicima nastave i vannastavnim aktivnostima, sistematično razvijajući disciplinu, karakter i psihičku otpornost. Rad ističe ulogu kontinuiranog psihološkog praćenja i selekcije, uključujući primenu standardizovanih baterija testova u okviru Vienna Test System (VTS), koji procenjuje kognitivne sposobnosti (npr. vreme reakcije, pažnju, pamćenje) i osobine ličnosti (npr. toleranciju na stres, frustracionu toleranciju) relevantne za zahtevne vojne i civilne profesije. Rezultati primene VTS-a doprinose detaljnom uvidu u veštine i sposobnosti učenika, omogućavajući prilagođavanje obuke individualnim potrebama.

Zaključuje se da sistemski, holistički i kontinuirani pristup psihičkoj pripremi, kakav primenjuju Vojna gimnazija, Srednja stručna vojna škola i Vojna akademija, osigurava formiranje mentalno otpornih, samouverenih i prilagodljivih mladih ljudi. Visoka stopa upisa na Vojnu akademiju i pozitivna iskustva učenika potvrđuju uspešnost ovog modela u pripremi budućih studenata za izazove visokoškolskog obrazovanja i profesionalnog života.

Ključne reči: *psihička priprema, tranzicija, visokoškolsko obrazovanje.*

1. Uvod

Obrazovni sistemi širom sveta, uprkos svojim inherentnim specifičnostima i razlikama u kurikulumu, organizaciji i pedagoškim metodama, konvergiraju u jednoj ključnoj tački: prelazak iz srednjoškolskog u visokoškolsko obrazovanje. Ovaj tranzicioni period predstavlja fundamentalni segment u akademskom i profesionalnom razvoju mladih pojedinaca, obično se dešavajući u sličnom uzrastu, oko punoletstva, kada se pojedinci suočavaju sa formativnim odlukama koje će direktno oblikovati njihovu budućnost. U tom kontekstu, Republika Srbija se ne razlikuje značajno, gde se po završetku srednje škole

učenici opredeljuju za nastavak obrazovanja na nekoj od visokoškolskih institucija.

Među raznolikim srednjoškolskim institucijama u Republici Srbiji, Vojna gimnazija i Srednja stručna vojna škola zauzimaju posebno mesto. Njihov značaj prevazilazi uobičajene okvire opšteg i stručnog obrazovanja. Specifičnost njihovog nastavnog procesa leži u sistematičnom razvoju discipline, karaktera i, što je najvažnije, psihičke otpornosti, elemenata koji su od krucijalnog značaja za dalje akademske i profesionalne izazove, nezavisno od toga da li se opredeljuju za vojne ili civilne studije.

Nastavni plan i program Vojne gimnazije obuhvata sveobuhvatnu strukturu koja integriše redovnu nastavu po programu gimnazija opšteg smera u Republici Srbiji sa dodatkom specifičnih opštevojnih predmeta. Pored toga, kako u Vojnoj gimnaziji, tako i u Srednjoj stručnoj vojnoj školi primenjuju se i posebni oblici nastave, obogaćeni fakultativnom nastavom i raznovrsnim vannastavnim aktivnostima. Ova sinergija akademskog i specifičnog vojnog obrazovanja stvara jedinstveno okruženje za razvoj ličnosti. Primera radi, bmašinskih materijala, mehanike i osnova vazduhoplovne navigacije. Njihova priprema je dalje unapređena praktičnom obukom, uključujući padobransku obuku, obuku u preživljavanju sa specifičnom ishranom u prirodi, motivaciono letenje na jedrilicama i selektivnu letačku obuku.

Upravo ove karakteristike – opštevojni predmeti, posebni oblici nastave i bogati vannastavni sadržaji – čine nastavni plan i program Vojne gimnazije i Srednje stručne vojne škole jedinstvenim i opravdavaju njihov naziv. Oni ne samo da pružaju izvanrednu akademsku osnovu, već i sistematski izgrađuju mentalnu snagu, sposobnost adaptacije i proaktivno rešavanje problema. Stoga, iako se Vojna gimnazija primarno fokusira na pripremu kadeta za vojne studije, njena specifična pedagoška praksa i rezultati koje postiže pružaju dragocen uvid u to koliko integralna, a posebno psihička, priprema može biti ključna za uspešan upis i adaptaciju na zahtevno visokoškolsko okruženje.

Školovanje u Srednjoj stručnoj vojnoj školi, s druge strane, traje četiri godine i određeno je planom i programom različitih vojnostručnih smerova. Opšteobrazovni, opštevojni i vojnostručni sadržaji izučavaju se u prve tri godine školovanja, a realizuju se u sedištu škole. Stručno-specijalistički deo i nastavak opštevojnog dela nastavlja se u centrima za obuku Vojske Srbije, gde se učenicima škole omogućava, pored teorijskog dela, i praktičan rad na odgovarajućim sredstvima i opremi koja se nalazi na upotrebi u Vojsci Srbije. U nastavnim planovima i programima ugrađeni su posebni oblici nastave i fakultativni predmeti i sadržaji, kao i različiti vannastavni sadržaji.

Cilj ovog rada je da prezentuje i naglasi značaj psihičke pripreme učenika za upis na fakultet, analizirajući izazove tranzicije, ulogu različitih aspekata psihičke spremnosti i potencijalne doprinose specifičnih obrazovnih modela, poput onog u Vojnoj gimnaziji, u formiranju akademski i lično uspešnih studenata. Kroz ovu analizu, pruža se dublji uvid u multidisciplinarni pristup koji je neophodan za optimalnu pripremu budućih studenata.

2. Izazovi tranzicije iz srednje škole na fakultet i uloga psihičke pripreme

Prelazak iz srednjoškolskog u visokoškolsko okruženje predstavlja jednu od najznačajnijih prekretnica u obrazovnom i ličnom razvoju svakog pojedinca. Ova tranzicija donosi sa sobom niz akademskih, socijalnih i emocionalnih izazova, čiji se intenzitet i manifestacija razlikuju u zavisnosti od prethodnog obrazovnog konteksta i individualnih karakteristika. Dok većina učenika tokom srednje škole uživa u relativno strukturiranom porodičnom

okruženju sa kontinuiranim nadzorom i jasnim smernicama, visokoškolsko obrazovanje inherentno zahteva daleko veći stepen autonomije, proaktivnosti i lične odgovornosti.

Studenti se suočavaju sa značajno obimnijim i kompleksnijim gradivom, drugačijim didaktičkim metodama i sistemom ocenjivanja koji često manje naglašava kontinuirano praćenje, a više se oslanja na periodične, obimne provere znanja. To podrazumeva neophodnost samostalnog planiranja vremena, efikasne organizacije učenja i proaktivnog traženja informacija i dodatnih resursa.

Pored evidentnih akademskih pritisaka, javljaju se i značajni socijalni i emocionalni izazovi. Za prosečnog maturanta, ovo uključuje prilagođavanje na novo socijalno okruženje, stvaranje novih prijateljstava u često impersonalnom univerzitetskom ambijentu, kao i odvajanje od primarne porodice i adaptaciju na život u novoj sredini, često u drugom gradu.

Međutim, važno je naglasiti da su učenici koji su svoje srednjoškolsko obrazovanje pohađali u internatskim uslovima, poput onih u Vojnoj gimnaziji i Srednjoj stručnoj vojnoj školi, već prošli kroz specifičan proces adaptacije koji ih delimično priprema za neke od pomenutih izazova. Iskustvo života u internatu, odvojenost od primarne porodice, samostalno snalaženje u svakodnevnim situacijama i adaptaciju na život u zajednici, predstavljaju dragoceno predznanje. Oni su se već suočili sa potrebom za samodisciplinom, poštovanjem pravila i izgradnjom novih socijalnih veza u specifičnom okruženju.

Ipak, čak i za ovu kategoriju učenika, prelazak na fakultet donosi nove nivoe zahteva. Iako su Vojna gimnazija i Srednja stručna vojna škola, na primer, već obezbedile visoko strukturirano okruženje sa jasnim pravilima i mentorskom podrškom, fakultet podrazumeva daleko veći nivo lične inicijative u učenju i akademskom progresu. To znači da su sposobnosti poput samostalnog rešavanja problema, donošenja odluka pod pritiskom i adaptacije na manje rigidne, a samim tim i manje predvidive, zahteve akademskog okruženja, od presudnog značaja. Ovi pritisci, bez obzira na prethodno iskustvo, mogu dovesti do povećanog stresa, anksioznosti, pa čak i do sindroma izgaranja (burnout). Neki se mogu suočiti sa prokrastinacijom, padom motivacije ili problemima u efikasnom učenju, čak i ako su prethodno bili izuzetno uspešni.

Nezavisno od dotadašnjeg iskustva, period pred upis na fakultet je ispunjen specifičnim potrebama, strahovima i dilemama. Rezultati sprovođenih anketa govore nam da je primarna potreba učenika informisanje i razumevanje budućeg akademskog puta, kako bi se smanjila neizvesnost. Međutim, često se javlja strah od neuspeha na prijemnom ispitu, strah od toga da neće ispuniti očekivanja, ili da će pogrešiti u izboru studijskog programa. Dileme se najčešće odnose na izbor "pravog" fakulteta u civilstvu ili odgovarajućeg studijskog programa na Vojnoj akademiji, što je odluka koja značajno oblikuje buduću profesionalnu karijeru. Iako se u Vojnoj gimnaziji ne sprovode klasični testovi profesionalne orijentacije, većina učenika dolazi sa jasno definisanom motivacijom za vojni poziv. Ova opredeljenost se dodatno učvršćuje tokom školovanja kroz posete jedinicama, sistematičan trening i pripremu, koji im pružaju uvid u budući poziv. Ipak, čak i za opredeljene, postojanje prijemnog ispita ima svoju svrhu – ne samo da proverava znanje, već i sposobnost suočavanja sa pritiskom i pokazivanja znanja u stresnim uslovima. Stoga je potreba za psihološkom podrškom univerzalna, kako za one koji su već čvrsto opredeljeni, tako i za one koji i dalje tragaju za svojim profesionalnim putem.

U kontekstu psiholoških procena koje se sprovode u vojnim obrazovnim institucijama,

primena standardizovanih baterija testova poput Vienna Test System (VTS) kompanije Schuhfried GmbH [4], igra ključnu ulogu u identifikovanju kandidata sa specifičnim psihološkim karakteristikama. VTS je poznat po svojoj sposobnosti da objektivno meri širok spektar kognitivnih sposobnosti i osobina ličnosti relevantnih za kompleksne zadatke i stresne situacije. Vienna Test System se koristi kao priznat sistem za procenu sposobnosti vozača i njegovih karakteristika. Još od 1979. godine ovaj sistem se u Evropi koristi za selekciju vozača procenom njihovih psihomotornih sposobnosti.

Različita istraživanja su potvrdila povezanost određenih psihometrijskih pokazatelja iz VTS-a sa performansama u specifičnim domenima. Tako, subtestovi koji mere brzinu reakcije (Reaction Time Test - RT ili Determination Test - DT) koreliraju sa sposobnošću brzog donošenja odluka i reagovanja u dinamičnom okruženju, što je ključno za vojne aktivnosti/operacije [3, 5, 6, 7, 8]. Druga istraživanja ukazuju da su "smanjena koncentracija i usporene reakcije" direktno povezane sa "degradacijom kognitivnih performansi", što može imati fatalne posledice [1]. Upravo u ovom domenu (kognitivne performanse, pažnja, vreme reakcije) VTS ima ključnu ulogu kroz svoje testove poput Reaction Test i Determination Test.

Takođe, određene komponente VTS-a mogu pružiti uvid u frustracionu toleranciju i sposobnost pojedinca da se nosi sa neuspehom i preprekama. Studije su pokazale da visoka frustraciona tolerancija, često merena kroz ponašanje u situacijama ponovljenog izazova ili neuspeha unutar testova, pozitivno korelira sa emocionalnom regulacijom i manjom podložnošću stresu [2]. Istraživanje ukazuje na korelaciju između tipa ličnosti (Type A, prema Mayer-Brigsovoj klasifikaciji ličnosti) i rizika od saobraćajnih nezgoda [2], ide u prilog povezanosti sposobnosti emocionalne regulacije i frustracione tolerancije i bezbednosti u vožnji.

Kognitivne sposobnosti, procenjene kroz VTS subtestove poput testova logičkog zaključivanja, memorije ili pažnje (Cognitive Flexibility - COG, Working Memory Test - WMM), fundamentalni su prediktori akademskog uspeha i sposobnosti rešavanja problema pod pritiskom.

Sveobuhvatna primena ovakvih psiholoških baterija, u kombinaciji sa drugim metodama procene, omogućava formiranje detaljnog psihološkog profila kandidata, što je esencijalno za predviđanje uspešnosti i adaptacije u zahtevnom vojnom okruženju.

Univerzitet odbrane u Beogradu poslednjih godina sprovodi testiranje učenika i kadeta pomoću baterije testova Vienna Test System (VTS). Ovaj pristup omogućava detaljan uvid i praćenje stanja, veština i sposobnosti svakog učenika i kadeta ponaosob. Zahvaljujući tome, obuka se može prilagoditi individualnim potrebama, posebno kada je reč o rizičnim oblicima nastave, kao što je obuka u upravljanju motornim vozilima.

Kvalitativni podaci dobijeni ovim istraživanjima ukazuju na pozitivan fidbek u vezi sa upotrebom VTS-a i uspešnosti individualizovane obuke u vožnji, zbog čega je u planu dalji istraživački rad na ovu temu.

Još jedna značajna prednost korišćenja psihološke baterije testova VTS-a jeste mogućnost da se učenicima predoče njihove prednosti i individualni kvaliteti, odnosno njihove "snage" u zahtevnim situacijama i situacijama pojačanog stresa. Istovremeno, identifikuju se i aspekti gde ispoljavaju slabije performanse, a koji predstavljaju "mesta razvoja" tokom obuke ili treninga. Na taj način, učenicima se pruža dodatna podrška u odlučivanju prilikom

izbora studijskog programa na Vojnoj akademiji, kao i u pripremi pre odlaska na obuku.

3. Sistemski pristup psihičkoj pripremi u Vojnoj gimnaziji, Srednjoj stručnoj vojnoj školi i Vojnoj akademiji

S obzirom na kompleksnost i intenzitet izazova koji prate prelazak iz srednje škole na fakultet, psihička priprema igra ključnu, često nedovoljno prepoznatu, ulogu u obezbeđivanju uspešne tranzicije. Vojna gimnazija, Srednja stručna vojna škola i Vojna akademija, kao integralni delovi sistema vojnog školstva Republike Srbije, prepoznaju i sistematično primenjuju sveobuhvatan pristup psihičkoj pripremi, čime se osigurava da budući kadeti i oficiri budu ne samo akademski kompetentni, već i mentalno otporni i spremni za sve izazove vojnog poziva i života.

Sistem školstva u vojsci Republike Srbije predstavlja jedinstvenu i koherentnu celinu, gde Vojna gimnazija i Vojna akademija zauzimaju centralno mesto u obrazovanju budućeg oficirskog kadra. Vojna gimnazija je institucija srednjeg stručnog obrazovanja koja pruža opšte znanje po akreditovanom programu gimnazija opšteg smera u Republici Srbiji, obogaćeno specifičnim opštevojnim predmetima i obukama. Ona je filter i priprema za Vojnu akademiju, visokoškolsku instituciju koja sprovodi akreditovane studijske programe, čime se obezbeđuje ne samo visoki profesionalni standard, već i puna društvena relevantnost i prepoznatljivost diploma u civilnom sektoru. Specifičnost školovanja u Vojnoj gimnaziji, kao i Srednjoj stručnoj vojnoj školi, obuhvata i elemente poput obaveznog polaganja vozačkog ispita u određenoj fazi školovanja, što je dodatna vrednost za učenike i njihovu buduću mobilnost. Ove škole su namenjene formiranju lidera, odgovornih pojedinaca i visoko obučenih stručnjaka sposobnih da odgovore na složene bezbednosne izazove.

Ono što zaista izdvaja sistem Vojne gimnazije, Srednje stručne vojne škole i Vojne akademije jeste sveobuhvatan i kontinuiran pristup psihičkoj pripremi i podršci, koji se ne svodi samo na jednokratne procene.

- Rigorozne zdravstvene i psihološke provere pri upisu: Put ka Vojnoj akademiji počinje izuzetno rigoroznim zdravstvenim i psihološkim proverama. Cilj ovih provera nije eliminacija, već selekcija kandidata koji poseduju neophodne fizičke i psihičke kapacitete za zahtevan vojni poziv. Kroz primenu standardizovanih psiholoških instrumenata i baterija testova, uključujući specijalizovane subtestove koji koreliraju sa uspešnošću u vojnom okruženju, emocionalnom regulacijom, kontrolom stresa i kognitivnim sposobnostima (poput delova *Vienna Test System* baterije), identifikuju se pojedinci sa visokim potencijalom za uspešno savladavanje izazova. Važno je naglasiti da je težnja sistema da svi koji prođu ove provere i upišu se, uspešno završe školovanje, što je cilj kojem su posvećeni svi resursi.
- Kontinuirano psihološko praćenje i adaptacija: Nakon upisa, psihička podrška ne prestaje. Psiholog kontinuirano prati adaptaciju, razvoj i motivaciju svakog učenika tokom čitavog školovanja u Vojnoj gimnaziji i kasnije kao kadeta na Vojnoj akademiji, isto kao i u Srednjoj stručnoj vojnoj školi. Ovo uključuje individualne razgovore, grupne aktivnosti i redovne procene psihološkog stanja. Ovakav sistem omogućava pravovremeno prepoznavanje potencijalnih poteškoća (npr. adaptacioni problemi, stres, pad motivacije) i brzu intervenciju.
- Integrisani programi podrške i pripreme: Pripreme za upis na Vojnu akademiju i za dalje usavršavanje nisu sporadične, već se odvijaju kontinuirano tokom celokupnog

srednjoškolskog i akademskog školovanja. One obuhvataju:

- Akademske pripreme: Dodatna nastava iz matematike i fizike, predviđena za polaganje prijemnog ispita i uspešno praćenje nastave na akademiji.
- Pripreme za proveru fizičke spremnosti: Sistematičan trening i praćenje fizičkog razvoja, neophodni za vojne standarde i za uspeh na prijemnom ispitu fizičke spremnosti.
- Psihološke radionice i procene: Tokom školovanja, učenici prolaze kroz dodatne psihološke procene i radionice fokusirane na razvoj veština emocionalne regulacije, otpornosti na stres, rešavanja problema i timskog rada.
- Holistički pristup dobrobiti: Učenicima je na raspolaganju podrška nutricioniste, tematska predavanja o zdravom načinu života, predavanja duhovnika, kao i kontinuirana podrška razrednih starešina i vaspitača.
- Saradnja sa roditeljima: Kroz redovnu komunikaciju i savetovanja, roditelji su uključeni u proces, što dodatno jača podršku učenicima.
- Široka saradnja: Postoji kontinuirana i bliska saradnja između Vojne gimnazije, Srednje stručne vojne škole, Vojne akademije, Vojnomedicinskih centara, Vojnomedicinske akademije i drugih vojno-zdravstvenih ustanova, obezbeđujući sveobuhvatnu brigu o zdravlju i psihičkoj stabilnosti učenika.

- Rezultati i potvrda uspešnosti: Sistematičan rad i kontinuirana podrška ogledaju se u impresivnim rezultatima upisa. Podaci za poslednje tri generacije pokazuju da je preko 90% učenika Vojne gimnazije koji su konkurisali za Vojnu akademiju i uspešno položili prijemne ispite, upisalo željeni studijski program. Naša interna istraživanja i ankete među svršenim učenicima i kadetima kontinuirano pokazuju izuzetno pozitivna iskustva u pogledu psihičke pripreme, pri čemu ističu da im je ona "mnogo značila" u prevazilaženju izazova. Ovo potvrđuje da je pristup Vojne gimnazije, Srednje stručne vojne škole i Vojne akademije ne samo akademski efikasan, već i suštinski važan za formiranje mentalno jakih i spremnih mladih ljudi.

4. Zaključak

Prelazak iz srednje škole na fakultet predstavlja složenu tranziciju koja obuhvata značajne akademske, socijalne i emocionalne izazove. Iako su učenici iz internatskih škola, poput Vojne gimnazije i Srednje stručne vojne škole, u određenoj prednosti zbog ranije razvijene samostalnosti i adaptabilnosti, oni se i dalje suočavaju sa specifičnim pritiscima i dilemama. Ključno je prepoznati da puka akademska priprema nije dovoljna; integralna psihička priprema je od suštinskog značaja za uspešno prevazilaženje ovih izazova i za postizanje opšteg blagostanja studenta.

Sistem vojnog školstva u Republici Srbiji, kroz institucije poput Vojne gimnazije, Srednje stručne vojne škole i Vojne akademije, pruža izuzetan model kontinuirane i sveobuhvatne psihičke pripreme. Kroz rigorozne selekcione procese, integraciju razvoja psihičke otpornosti u nastavni plan i program, te sistematično i kontinuirano psihološko praćenje i podršku, ove institucije osiguravaju da njihovi učenici i kadeti budu ne samo visoko kompetentni u akademskom i profesionalnom smislu, već i mentalno otporni, samouvereni i sposobni da se nose sa stresom i donose odluke pod pritiskom. Izuzetni rezultati upisa na

Vojnu akademiju i pozitivna iskustva učenika o psihičkoj pripremi svedoče o uspešnosti ovog sistemskog pristupa.

Na kraju, ovaj rad ističe da je značaj psihičke pripreme fundamentalan za svakog učenika koji teži visokoškolskom obrazovanju. Iskustvo Vojne gimnazije, Srednje stručne vojne škole i Vojne akademije pokazuje da sistemski, holistički i kontinuirani pristup psihičkoj podršci nije samo preporučljiv, već je neophodan za formiranje uspešnih, prilagodljivih i psihički otpornih mladih ljudi, spremnih da odgovore na izazove budućnosti, kako u vojsci tako i u civilnom životu.

Literatura

[1] Almer, A., Weber, A., Haid, F., Paletta, L., Schneeberger, M., Ladstätter, S., Wallner, D., Glanz, P., Klöckl, P., Eder, D., Bauer, G., & Hölzl, T. (2023). Real-Time Remote Stress Monitoring Based on Specific Stress Modelling Considering Load Characteristics of Different Military Forces. *Cognitive Computing and Internet of Things, 73*, 83–92. https://doi.org/10.54941/ahfe1003977

[2] Magnavita, N., Narda, R., Sani, L., & Carbone, A. (1997). Type A behaviour pattern and traffic accidents. *British Journal of Psychology*, *70*(1), 103-107.

[3] Ong, N. C. H. (2015). The use of the Vienna Test System in sport psychology research: A review. *International Review of Sport and Exercise Psychology*, *8*(1), 204–223. https://doi.org/10.1080/1750984X.2015.1061581

[4] Schuhfried, G. (2007/2008). *Vienna Test System: Manual and interpretation guide*. Mödling, Austria: SCHUHFRIED GmbH.

[5] Thanh, H. P., Manh, P. V., Ben, N. H., & Phuong, N. M. (2023). PSYCHOLOGICAL ASSESSMENT OF 300 MILITARY PILOT STUDENTS, PILOTS AND FLIGHT CREW MEMBERS USING VIENNA TEST SYSTEM. *Journal of MILITARY MEDICINE*, (362), 01-02.

[6] Thomas, R. C., Teachout, M. S., Ree, M. J., et al. (2014). Consistency of the relations of cognitive ability and personality traits to pilot training performance. *The International Journal of Aviation Psychology*, *24*(4), 247-264.

[7] Veliks, V., Porozovs, J., Kļaviņa, A., & Zuša, A. (2023). Adolescents' Cognitive Abilities, Reaction Time, and Working Memory Performance by Vienna Test Systems. *International Journal of Online and Biomedical Engineering (iJOE)*, *19*(05), 37057. https://doi.org/10.3991/ijoe.v19i05.37057

[8] Vit M, Houdek M, Sebera M. Reaction time and stress tolerance of police officers in specific and non-specific tests in professional self-defence training. Physical Activity Review 2019; 7: 193-200. doi: 10.16926/par.2019.07.23

THE IMPORTANCE OF MENTAL PREPARATION OF STUDENTS FOR ENROLLMENT IN COLLEGE

Maja Đorđević, B.Sc. in Psychology.[1]

Jelena Trifunović, B.Sc. in Psychology[2]

[1] **Vojna gimnazija, Beograd**

[2] **Military Secondary Vocational School "1300 Corporals", Belgrade**

Abstract

The transition from secondary to higher education represents a significant shift filled with academic, social, and emotional challenges. Although students from boarding schools, such as the Military Gymnasium and the Secondary Vocational Military School in the Republic of Serbia, have an advantage in terms of developed independence and adaptability, they still face unique pressures and dilemmas when enrolling in university. This paper presents the importance of psychological preparation in overcoming these challenges, emphasizing that academic readiness alone is not sufficient.

It analyzes the specific educational model of military schools, which integrates general education and military training with specialized teaching methods and extracurricular activities, systematically fostering discipline, character, and psychological resilience. The paper highlights the role of continuous psychological monitoring and selection, including the application of standardized test batteries within the Vienna Test System (VTS), which assess cognitive abilities (e.g., reaction time, attention, memory) and personality traits (e.g., stress tolerance, frustration tolerance) relevant for demanding military and civilian professions. The results of the VTS contribute to a detailed understanding of students' skills and abilities, enabling training to be tailored to individual needs.

The paper concludes that a systemic, holistic, and continuous approach to psychological preparation, as implemented by the Military Gymnasium, Secondary Vocational Military School, and Military Academy, ensures the development of mentally resilient, confident, and adaptable young individuals. The high enrollment rate at the Military Academy and positive student experiences confirm the success of this model in preparing future students for the challenges of higher education and professional life.

Keywords: *psychological preparation, transition, higher education.*

1. Introduction

Education systems around the world, despite their inherent specificities and differences in curriculum, organization, and pedagogical methods, are converging on one key point: the transition from secondary to higher education. This transitional period represents a fundamental segment in the academic and professional development of young individuals, usually occurring at a similar age, around adulthood, when individuals are faced with formative decisions that will directly shape their future. In this context, the Republic of

Serbia does not differ significantly, where after graduating from high school, students decide to continue their education at one of the higher education institutions.

Among the diverse secondary education institutions in the Republic of Serbia, the Military Gymnasium and the Military Secondary Vocational School occupy a special place. Their significance goes beyond the usual framework of general and vocational education. The specificity of their teaching process lies in the systematic development of discipline, character and, most importantly, psychological resilience, elements that are crucial for further academic and professional challenges, regardless of whether they opt for military or civilian studies.

The curriculum of the Military Gymnasium includes a comprehensive structure that integrates regular teaching according to the program of general gymnasiums in the Republic of Serbia with the addition of specific general military subjects. In addition, both in the Military Gymnasium and in the Secondary Vocational Military School, special forms of teaching are applied, enriched with optional classes and various extracurricular activities. This synergy of academic and specific military education creates a unique environment for personality development. For example, mechanical materials, mechanics and the basics of air navigation. Their preparation is further enhanced by practical training, including parachute training, survival training with a specific diet in nature, motivational flying on gliders and selective flight training.

It is these characteristics – general military subjects, special forms of teaching and rich extracurricular content – that make the curriculum of the Military Gymnasium and the Military Secondary Vocational School unique and justify their name. They not only provide an outstanding academic foundation, but also systematically build mental strength, adaptability, and proactive problem-solving. Therefore, although the Military Gymnasium primarily focuses on the preparation of cadets for military studies, its specific pedagogical practice and the results it achieves provide valuable insight into how integral, and especially psychological, preparation can be key to successful enrollment and adaptation to a demanding higher education environment.

Education at the Military Vocational High School, on the other hand, lasts four years and is determined by the curriculum of various military professional courses. General educational, general military and military professional contents are studied in the first three years of schooling, and are implemented at the school headquarters. The professional-specialist part and the continuation of the general military part continues in the training centers of the Serbian Armed Forces, where the students of the school are enabled, in addition to the theoretical part, practical work on the appropriate means and equipment used in the Serbian Armed Forces. Special forms of teaching and optional subjects and contents, as well as various extracurricular contents, are incorporated into the curricula.

The aim of this paper is to present and emphasize the importance of psychological preparation of students for enrollment at the university, analyzing the challenges of transition, the role of different aspects of mental readiness and the potential contributions of specific educational models, such as the one in the Military Gymnasium, in the formation of academically and personally successful students. Through this analysis, a deeper insight into the multidisciplinary approach that is necessary for the optimal preparation of future students is provided.

2. Challenges of the transition from high school to college and the role of mental preparation

The transition from high school to higher education is one of the most significant milestones in the educational and personal development of any individual. This transition brings with it a series of academic, social and emotional challenges, the intensity and manifestation of which vary depending on the previous educational context and individual characteristics. While most students enjoy a relatively structured family environment with continuous supervision and clear guidance during high school, higher education inherently requires a far greater degree of autonomy, proactivity, and personal responsibility.

Students are faced with significantly more extensive and complex material, different didactic methods and an assessment system that often emphasizes less continuous monitoring and relies more on periodic, extensive examinations of knowledge. This includes the need for independent time planning, effective organization of learning, and proactive search for information and additional resources.

In addition to the obvious academic pressures, there are also significant social and emotional challenges. For the average high school graduate, this involves adjusting to a new social environment, making new friends in an often impersonal university setting, as well as separating from their primary family and adapting to living in a new environment, often in a different city.

However, it is important to emphasize that students who attended their secondary education in boarding conditions, such as those in the Military Gymnasium and the Military Vocational Secondary School, have already gone through a specific adaptation process that partially prepares them for some of the mentioned challenges. The experience of living in a boarding school, separation from the primary family, independent coping with everyday situations and adaptation to life in the community are valuable foreknowledge. They have already faced the need for self-discipline, respect for rules, and building new social bonds in a specific environment.

However, even for this category of students, the transition to college brings new levels of demand. Although the Military Gymnasium and the Military Vocational Secondary School, for example, have already provided a highly structured environment with clear rules and mentoring support, the faculty implies a far greater level of personal initiative in learning and academic progress. This means that abilities such as self-solving problems, making decisions under pressure, and adapting to the less rigid, and therefore less predictable, demands of the academic environment are crucial. These pressures, regardless of previous experience, can lead to increased stress, anxiety and even burnout. Some may face procrastination, a drop in motivation, or problems learning effectively, even if they have previously been extremely successful.

Regardless of previous experience, the period before enrolling in college is filled with specific needs, fears and dilemmas. The results of the surveys show us that the primary need of students is to be informed and understand their future academic path, in order to reduce uncertainty. However, there is often a fear of failing the entrance exam, fear of not meeting expectations, or making a mistake in the choice of study program. Dilemmas most often relate to the choice of the "right" civilian faculty or the appropriate study program at the Military Academy, which is a decision that significantly shapes the future professional

career. Although the Military Gymnasium does not conduct classic professional orientation tests, most students come with a clearly defined motivation for the military profession. This commitment is further strengthened during schooling through visits to units, systematic training and preparation, which provide them with an insight into their future vocation. However, even for those who are determined, the existence of the entrance exam has its purpose – not only to test knowledge, but also the ability to cope with pressure and demonstrate knowledge in stressful conditions. Therefore, the need for psychological support is universal, both for those who are already firmly committed and for those who are still looking for their professional path.

In the context of psychological assessments carried out in military educational institutions, the use of standardized test batteries such as the Vienna Test System (VTS) from Schühfried GmbH plays a key role in identifying candidates with specific psychological characteristics. VTS is known for its ability to objectively measure a wide range of cognitive abilities and personality traits relevant to complex tasks and stressful situations. The Vienna Test System is used as a recognized system for assessing the driver's abilities and characteristics. Since 1979, this system has been used in Europe to select drivers by assessing their psychomotor abilities.

Various studies have confirmed the association of certain psychometric indicators from VTS with performance in specific domains. Thus, subtests that measure reaction time (RT or Determination Test - DT) correlate with the ability to make decisions and react quickly in a dynamic environment, which is crucial for military activities/operations [3, 5, 6, 7, 8]. Other research indicates that "decreased concentration and slowed reactions" are directly related to "degradation of cognitive performance", which can have fatal consequences [1]. It is in this domain (cognitive performance, attention, reaction time) that VTS plays a key role through its tests such as the Reaction Test and the Determination Test.

Also, certain components of a VTS can provide insight into an individual's frustration tolerance and ability to cope with setbacks and obstacles. Studies have shown that high frustration tolerance, often measured through behavior in situations of repeated challenge or failure within tests, positively correlates with emotional regulation and less susceptibility to stress [2]. The research indicates a correlation between personality type (Type A, according to the Mayer-Briggs personality classification) and the risk of traffic accidents [2], in favor of the correlation between the ability to emotionally regulate and frustration tolerance and driving safety.

Cognitive ability, as assessed through VTS subtests such as the Cognitive Flexibility (COG) Working Memory Test (WMM), are fundamental predictors of academic performance and ability to solve problems under pressure.

The comprehensive application of such psychological batteries, combined with other assessment methods, enables the formation of a detailed psychological profile of the candidate, which is essential for predicting success and adaptation in a demanding military environment.

In recent years, the University of Defence in Belgrade has been conducting testing of students and cadets using a battery of Vienna Test System (VTS) tests. This approach provides a detailed insight and monitoring of the status, skills and abilities of each student and cadet individually. Thanks to this, training can be adapted to individual needs, especially

when it comes to risky forms of teaching, such as training in driving motor vehicles.

Qualitative data obtained from these studies indicate positive feedback regarding the use of VTS and the success of individualized driving training, which is why further research work on this topic is planned.

Another significant advantage of using the psychological battery of VTS tests is the ability to present students with their strengths and individual qualities, i.e. their "strengths" in demanding situations and situations of increased stress. At the same time, aspects where they exhibit lower performance are identified, which are "places of development" during training or training. In this way, students are provided with additional support in decision-making when choosing a study program at the Military Academy, as well as in preparation before going to training.

3. Systemic approach to mental preparation in the Military Gymnasium, Secondary Vocational Military School and Military Academy

Given the complexity and intensity of the challenges that accompany the transition from high school to college, mental preparation plays a crucial, often underrecognized, role in ensuring a successful transition. The Military Gymnasium, the Military Secondary Vocational School and the Military Academy, as integral parts of the military education system of the Republic of Serbia, recognize and systematically apply a comprehensive approach to mental preparation, which ensures that future cadets and officers are not only academically competent, but also mentally resilient and ready for all the challenges of the military profession and life.

The education system in the Army of the Republic of Serbia represents a unique and coherent whole, where the Military Gymnasium and the Military Academy occupy a central place in the education of future officers. The Military Gymnasium is an institution of secondary vocational education that provides general knowledge according to the accredited program of general gymnasiums in the Republic of Serbia, enriched with specific general military subjects and trainings. It is a filter and preparation for the Military Academy, a higher education institution that implements accredited study programs, which ensures not only a high professional standard, but also full social relevance and recognition of diplomas in the civilian sector. The specificity of education in the Military Gymnasium, as well as the Secondary Vocational Military School, includes elements such as the mandatory driving test at a certain stage of education, which is an added value for students and their future mobility. These schools are designed to form leaders, responsible individuals, and highly trained professionals capable of responding to complex security challenges.

What really sets the system of the Military Gymnasium, the Military Secondary Vocational School and the Military Academy apart is a comprehensive and continuous approach to mental preparation and support, which is not reduced to one-time assessments.

- Rigorous Health and Psychological Checks at Enrollment: The path to the Military Academy begins with extremely rigorous medical and psychological checks. The aim of these tests is not the elimination, but the selection of candidates who possess the necessary physical and mental capacities for the demanding military profession. Through the use of standardized psychological instruments and test batteries, including specialized subtests that correlate with success in a military setting, emotional regulation, stress control, and cognitive abilities (such as parts of *the*

Vienna Test System battery), individuals with high potential to successfully overcome challenges are identified. It is important to emphasize that the aspiration of the system is for everyone who passes these checks and enrolls to successfully complete their education, which is the goal to which all resources are dedicated.

- Continuous psychological monitoring and adaptation: After enrollment, psychological support does not stop. A psychologist continuously monitors the adaptation, development and motivation of each student throughout their education at the Military Gymnasium and later as a cadet at the Military Academy, as well as at the Military Secondary Vocational School. This includes one-on-one conversations, group activities, and regular psychological assessments. Such a system enables timely identification of potential difficulties (e.g. adaptation problems, stress, drop in motivation) and rapid intervention.
- Integrated support and preparation programs: Preparations for enrollment in the Military Academy and for further training are not sporadic, but take place continuously throughout secondary and academic education. They include:
    - Academic preparations: Additional classes in mathematics and physics, provided for passing the entrance exam and successfully following classes at the Academy.
    - Preparation for physical fitness: Systematic training and monitoring of physical development, necessary for military standards and for success in the entrance exam of physical fitness.
    - Psychological Workshops and Assessments: During their schooling, students undergo additional psychological assessments and workshops focused on developing emotional regulation, stress resilience, problem-solving, and teamwork skills.
    - Holistic approach to well-being: Students have at their disposal the support of a nutritionist, thematic lectures on a healthy lifestyle, lectures by spiritual leaders, as well as continuous support from class leaders and educators.
    - Cooperation with parents: Through regular communication and counseling, parents are involved in the process, which further strengthens support for students.
    - Broad cooperation: There is continuous and close cooperation between the Military Gymnasium, the Military Vocational School, the Military Academy, the Military Medical Centers, the Military Medical Academy and other military-medical institutions, providing comprehensive care for the health and mental stability of students.
- Results and confirmation of success: Systematic work and continuous support are reflected in impressive enrollment results. Data for the last three generations show that over 90% of students of the Military Gymnasium who applied for the Military Academy and successfully passed the entrance exams, enrolled in the desired study program. Our internal research and surveys among graduate students and cadets continuously show extremely positive experiences in terms of mental preparation, emphasizing that it "meant a lot" to them in overcoming challenges. This confirms

that the approach of the Military Gymnasium, the Military Secondary Vocational School and the Military Academy is not only academically effective, but also essential for the formation of mentally strong and prepared young people.

4. Conclusion

The transition from high school to college is a complex transition that encompasses significant academic, social, and emotional challenges. Although students from boarding schools, such as the Military Gymnasium and the Military Secondary Vocational School, have a certain advantage due to their previously developed independence and adaptability, they still face specific pressures and dilemmas. It is crucial to recognize that mere academic preparation is not enough; Integral mental preparation is essential to successfully overcome these challenges and to achieve the overall well-being of the student.

The military education system in the Republic of Serbia, through institutions such as the Military Gymnasium, the Military Secondary Vocational School and the Military Academy, provides an exceptional model of continuous and comprehensive mental preparation. Through rigorous selection processes, the integration of the development of mental resilience into the curriculum, and systematic and continuous psychological monitoring and support, these institutions ensure that their students and cadets are not only highly competent academically and professionally, but also mentally resilient, confident and able to cope with stress and make decisions under pressure. The exceptional results of enrollment at the Military Academy and the positive experiences of students on mental preparation testify to the success of this systemic approach.

Finally, this paper emphasizes that the importance of mental preparation is fundamental for every student who aspires to higher education. The experience of the Military Gymnasium, the Military Secondary Vocational School and the Military Academy shows that a systemic, holistic and continuous approach to psychological support is not only recommended, but is necessary for the formation of successful, adaptable and mentally resilient young people, ready to respond to the challenges of the future, both in the army and in civilian life.

Literature

[1] Almer, A., Weber, A., Haid, F., Paletta, L., Schneeberger, M., Ladstätter, S., Wallner, D., Glanz, P., Klöckl, P., Eder, D., Bauer, G., & Hölzl, T. (2023). Real-Time Remote Stress Monitoring Based on Specific Stress Modelling Considering Load Characteristics of Different Military Forces. *Cognitive Computing and Internet of Things, 73*, 83–92. https://doi.org/10.54941/ahfe1003977

[2] Magnavita, N., Narda, R., Sani, L., & Carbone, A. (1997). Type A behaviour pattern and traffic accidents. *British Journal of Psychology*, *70*(1), 103-107.

[3] Ong, N. C. H. (2015). The use of the Vienna Test System in sport psychology research: A review. *International Review of Sport and Exercise Psychology*, *8*(1), 204–223. https://doi.org/10.1080/1750984X.2015.1061581

[4] Schuhfried, G. (2007/2008). *Vienna Test System: Manual and interpretation guide*. Mödling, Austria: SCHUHFRIED GmbH.

[5] Thanh, H. P., Manh, P. V., Ben, N. H., & Phuong, N. M. (2023). PSYCHOLOGICAL ASSESSMENT OF 300 MILITARY PILOT STUDENTS, PILOTS AND FLIGHT CREW MEMBERS USING VIENNA TEST SYSTEM. *Journal of MILITARY MEDICINE*, (362), 01-02.

[6] Thomas, R. C., Teachout, M. S., Ree, M. J., et al. (2014). Consistency of the relations of cognitive ability and personality traits to pilot training performance. *The International Journal of Aviation Psychology*, *24*(4), 247-264.

[7] Veliks, V., Porozovs, J., Kļaviņa, A., & Zuša, A. (2023). Adolescents' Cognitive Abilities, Reaction Time, and Working Memory Performance by Vienna Test Systems. *International Journal of Online and Biomedical Engineering (iJOE)*, *19*(05), 37057. https://doi.org/10.3991/ijoe.v19i05.37057

[8] Vit M, Houdek M, Sebera M. Reaction time and stress tolerance of police officers in specific and non-specific tests in professional self-defence training. Physical Activity Review 2019; 7: 193-200. doi: 10.16926/par.2019.07.23

TJAŠA GERIČ, univ. dipl. inž. živ. tehn.
mag. inž. log.

EKONOMSKA ŠOLA MURSKA SOBOTA
Noršinska ulica 13
9000 Murska Sobota

PROJEKT IZGRADNJE VAROVANEGA PARKIRIŠČA V SODELOVANJU S PODJETJEM FRBEJZAR d. o. o.

Povzetek:

Ključne besede: *počivališča, varovano parkirišče, varnost, tovorna vozila*

V prispevku smo predstavili problematiko parkiranja tovornih vozil v Sloveniji in Evropi. Opisali smo težave s katerimi se soočajo vozniki tovornih vozil na parkiriščih. Predstvili smo slovensko zakondajo, glede prepovedi vožnje za tovorna vozila. Predstavili smo ugotovitve ankete, ki smo jo izvedli med vozniki na pomurskih avtocestnih postajališčih in prikazali trende razvoja varovanih parkirišč. Predstavili smo projekt gradnje varovanega parkirišča v obrtnoindustrijski coni ob obvoznici v Murski Soboti, v sodelovanju s podjetjem FRBEJZAR d.o.o. Izvedli smo tudi študijo o gospodarskem učinku izgradnje novega varovanega parkirišča.

Uvod

Nujni sestavni del avtocest so tudi počivališča oziroma avtocestna parkirišča, ki so namenjena avtomobilom, tovornim vozilom in drugim vozilom, ki želijo prekiniti vožnjo po avtocesti zaradi takšnih ali drugačnih razlogov. Počitki so zelo pomembni za voznike tovorih vozil, saj jih k temu zavezuje že zakonodaja. Na počutje voznikov na avtocestnih počivališčih pozitivno vpliva predvsem urejenost in opremljenost počivališč. Ob slovenskih avtocestah poznamo različne vrste počivališč. Najbolj preprosta ponujajo samo prostor za zaustavitev vozila, po možnosti toaletne prostore, pa morda še kakšno mizo in klop. Največja in najbolj urejena počivališča imajo običajno bencinski servis s ponudbo goriva in drugih izdelkov ter storitev, pa tudi restavracijo ter zunanje mize in klopi. V bližini nekaterih počivališč po Sloveniji, se nahajajo tudi moteli, kjer lahko vozniki prespijo. Ti moteli so tudi odlična rešitev za voznike tovornih vozil, ki nimajo vgrajene postelje v vozilu. Zaželeno je, da so taka parkirišča varovana vsaj z osnovno stopnjo varnosti, torej videonadzor. Obstajajo pa tudi primeri, ki so sicer redki, da na takšnih parkiriščih ni nobenega varovanja.

Problematika na postajališčih za tovorna vozila

Na avtocestnih počivališčih se vozniki tovornih vozil srečujejo z različnimi izzivi in

problemi, kot so vročina, mraz, opravljanje potrebe, zadrževanje izpušnih plinov, higiena, preživljanje prostega časa ob vikendih in praznikih, kraje in vlomi.

V poletnih mesecih se vozniki soočajo s težavami zaradi visokih temperatur. Pomanjkanje sence in ustrezne klimatizacije v tovornih vozilih lahko povzroča neudobje in različne težave. Nasprotje tega so zimski meseci, kadar lahko velik izziv povzročajo pomanjkanje ogrevanja, zamrzovanje vozil in različne druge probleme, zaradi nizkih temperatur. Določena avtocestna počivališča so obdana z intenzivnim prometom, kar povzroča poslabšanje kakovosti zraka in s tem izpostavljenost voznikov izpušnim plinom in posledično do zdravstvenih težav.

Velik problem na počivališčih so tudi prostori za osebno higieno. Pomanjkanje dostopnih sanitarnih prostorov na počivališčih lahko povzroča težave pri opravljanju osnovnih potreb, kar negativno vpliva na higieno in zdravje voznikov. Vozniki tovornih vozil, ki preživljajo proste vikende in praznike na počivališčih, se soočajo s samoto in pomanjkanjem možnosti za druženje ter preživljanje prostega časa.

V zadnjih letih vedno bolj prihaja do izraza problematika kriminalnih dejanj, ki se izvajajo predvsem na parkiriščih za tovorna vozila po celi Evropi, ko vozniki morajo opravljati zakonsko določene odmore in počitke. Vozniki se soočajo s tveganjem kraje in vlomov na počivališčih, zlasti ponoči. Kraja dragocenih tovorov, kot so bela tehnika, cigarete, alkohol, čokolada, elektronika in izdelki znanih priznanih blagovnih znamk je vse bolj razširjen problem v transportnem sektorju. Te vrste blaga so posebej privlačne za tatove, zaradi svoje visoke vrednosti in lahke preprodaje na črnem trgu. Pomanjkanje varnostnih ukrepov lahko poveča možnosti za tatvine, kar posledično vpliva na varnost in počutje voznikov in varnost njihovega premoženja. Eden izmed ključnih dejavnikov, ki vplivajo na pogostost kraj, je tudi dejstvo, da vozniki tovornjakov pogosto morajo parkirati na mestih brez zadostne varnostne zaščite, kjer so vozila in tovor lažje dostopna za tatove.

Po statističnih podatkih se s krajo v transportnem sektorju sooča kar 75% voznikov, kar pomeni, da je skoraj vsak voznik že doživel krajo. Problematika je opazna po celi Evropski uniji in seveda tudi v Sloveniji. Še več pa je tega v nekaterih državah zunaj EU, ki veljajo iz tega vidika za "manj varne". Ta problem je posebej izrazit pri voznikih, ki s svojimi tovornimi vozili potujejo po državah zunaj Evropske unije (Turčija, Rusija, Belorusija, Srbija, Bosna, Bolgarija, Romunija, Ukrajina, Makedonija in Črna Gora), kjer je ogromno kraj blaga in tovornih vozil. Vozniki iz tujih držav na svoji poti proti zahodni Evropi pogosto prvič naletijo na Slovenijo kot državo Evropske Unije, ki je iz tega vidika znana kot "bolj varna". Kaže se velik trend pomanjkanja parkirišč za tovorna vozila, zato se vozniki pogosto znajdejo v situaciji, ko ne morejo najti prostega parkirnega prostora, morajo pa opraviti zakonsko določen počitek. V tem primeru parkirajo kar na bližnjih poljih, travnikih oziroma na vseh lokacijah, kjer le morejo.

Zaradi krizne situacije med Rusijo in Ukrajino, imata Rusija in Belorusija trenutno prepoved oziroma omejitev trgovanja, zato je trenutno tovornih vozil iz teh dveh držav manj. A ko bo enkrat konec krizne situacije med Rusijo in Ukrajino, se bo povečal tudi promet iz Rusije in Belorusije, kar bo posledično privedlo do še večjega pomanjkanja prostora za parkiranje in prostega dostopa do parkirišča. Torej problematika se bo z leti samo še stopnjevala.

V mnogih primerih lastniki blaga točno določijo voznikom kje lahko parkirajo zaradi varnosti. Če se voznik kjer drugje ustavi, na lastno odgovornost, je sam kriv, če pride do

škodnega dogodka. To je zdaj tudi velik problem, ker pri nas skorajda ni varovanih parkirišč, kjer bi vozniki lahko varno parkirali in opravili počitek. Letno v Sloveniji ukradejo okoli 500 vozil. Vozila so pogosto ukradena na neobljudenih mestih in mirnih parkiriščih, z manj osvetlitve, brez varovanja ali video nadzora. Kraji, kjer je omejen dostop ali redne patrulje, zmanjšajo tveganje za krajo. Uporaba mehanskih in elektronskih blokad, sledilnih naprav in alarmov sicer zmanjša verjetnost kraje, a problematika vseeno ostaja odprta.

Rešitve za te težave vključujejo izboljšanje infrastrukture na in ob počivališčih, za zagotavljanje osnovnih storitev, kot so sanitarni prostori in tuši, krepitev varnostnih ukrepov ter spodbujanje socialnih in rekreacijskih možnosti za voznike, predvsem med prazniki in med prostimi vikendi. Kaže se torej zelo velika potreba po parkiriščih za tovorna vozila in še celo po varovanih parkiriščih, kjer lahko vozniki varno pustijo vozilo in spijo ali pa pustijo polprikolico, zaradi kombiniranega transporta (da jo pride iskat drugi voznik z vlečnim vozilom). Trenutno je to prepovedano s strani pošiljateljev in prejemnikov tovorov, zaradi varnosti.

Slovenska zakonodaja o prepovedi vožnje tovornih vozil

V Sloveniji velja splošna prepoved vožnje težkih tovornih vozil nad 7,5 t ob nedeljah in praznikih med 8. in 22. uro, ter na Veliki petek med 14. in 22. uro. Na določenih glavnih prometnih poteh so tudi dodatne omejitve, ki se v poletni sezoni še zaostrijo. Na teh cestah velja prepoved vožnje tovornih vozil nad 7,5 t tudi ob sobotah med 6. ali 8. uro do 13. oziroma do 16. ure (odvisno od prometne funkcije ceste) in seveda ob nedeljah in praznikih.

Prepoved o omejitvi vožnje težkih tovornih vozil ob nedeljah in praznikih je bila v Sloveniji formalno uvedena z Odredbo o omejitvi prometa na cestah v Republiki Sloveniji, za kar je odgovorna institucija Ministrstvo za infrastrukturo v sodelovanju s policijo, DARS-om in drugimi prometnimi organi.

Slovenija tako velja tudi kot prva država, ko vozila potujejo v Evropsko unijo, ki ima prepoved vožnje v nedeljo in ob praznikih. Na Hrvaški nimajo nedeljske prepovedi vožnje tovornih vozil, razen v poletni sezoni, in sicer med 15. junijem in 15. septembrom, ko velja prepoved vožnje za tovorna vozila nad 7,5 t ali daljša od 14 m, vsako nedeljo med 12. in 23. uro. Zato se pri nas celoten tranzit ustavi v nedeljo, praznikih in dela prostih dnevih ter v času poletne sezone tudi ob sobotah na turistično obremenjenih cestah. Zaradi pomanjkanja parkirišč, vozniki stojijo vsepovsod, pogosto že na hrvaški strani. Ukrep je bil zasnovan predvsem za izboljšanje prometne varnosti na slovenskih cestah, zmanjšanje prometnih nesreč in povečanje pretočnosti na cestah, zlasti v turistični sezoni.

Smiselno bi bilo razmisliti o dodatnih ukrepih, kot so širitev in izboljšanje parkirne infrastrukture, zlasti z varovanimi parkirišči, ki bi omogočala varno in udobno čakanje voznikov tovornih vozil. Prav tako bi lahko uvedli boljše informacijske sisteme za voznike, ki bi jih pravočasno usmerjali na prosta parkirišča ali jim omogočili načrtovanje poti glede na prepovedi vožnje.

Anketa med vozniki tovornih vozil na slovenskih parkiriščih

V sodelovanju z našimi dijaki programa logistični tehnik na Ekonomski šoli Murska Sobota, smo izvedli anketo med vozniki tovornih vozil na avtocestnih počivališčih za tovorna vozila v Pomurju.

Z anketo smo ugotovili, da največ voznikov izhaja iz Bolgarije, Madžarske, Romunije in

drugih balkanskih držav, ki tukaj opravljajo odmore, dnevne in tudi tedenske počitke. Vozniki so v Sloveniji večinoma v tranzitu in so namenjeni iz jugovzhodne Evrope v zahodno Evropo ali obratno. Mnogo od njih preživijo v tovornem vozilu nekaj dni na teden. Počitke in pavze vozniki najpogosteje delajo na avtocestnih počivališčih, nekateri pa tudi na javnih plačljivih parkiriščih ali varovanih parkiriščih. Razlog za to je večja varnost, čisti toaletni prostori in tuši, boljša prehrana ali ker naročniki tako zahtevajo.

Večina postajališč v Sloveniji ima urejene sanitarije, nima pa urejenih prostorov, kjer bi se vozniki lahko stuširali. Večina voznikov, ko opravljajo dnevne ali tedenske počitke prenočuje v vozilu, fiziološke potrebe in higienska opravila pa nekateri imajo možnost opravljati v toaletah na postajališčih, ponekod pa nimajo te možnosti in to opravijo kar zunaj ali pa se izognejo tuširanju in drugim opravilom v zvezi s higieno. Problem se pojavi tudi pozimi zaradi mraza ali poleti zaradi vročine, ko se nimajo kam zateči. V najboljšem primeru posedajo po lokalih postajališč, da se izognejo mrazu ali vročini, ponekod pa nimajo niti te možnosti in se zadržujejo v vozilu. Anketirani vozniki poudarjajo tudi, da se na postajališčih ne počutijo varno. Najbolj ogroženi se počutijo ponoči in ko so parkirišča nezavarovana in nerazsvetljena. Kar tri četrtine voznikov se je že soočilo s krajo goriva, odtujitvijo tovora iz vozila ali drugim kriminalnim dejanjem (ropi, poškodovanje vozila). Pogosto se pojavi potreba, da bi na parkirišču pustili tovornjak ali polprikolico, a si tega ne upajo. V prevozništvu se v zadnjih letih pojavlja tudi vse več žensk, voznic tovornih vozil, ki so glede vsega tega še bolj ranljive.

Vozniki poudarjajo, da je v Pomurju na splošno premalo parkirišč za tovorna vozila in čutijo potrebo po večjih kapacitetah, predvsem ob cestnih povezavah in v industrijskih conah. Vozniki so tudi izrazili potrebo po varovanih parkiriščih, z možnostjo digitalne rezervacije. Poudarjajo, da je v Sloveniji premalo varovanih parkirišč, še manj je pa možnosti digitalne rezervacije, tako pogosto ostanejo brez parkirnega prostora. Pogosto voznikom naročnik odreja kje točno morajo parkirati.

Vozniki na postajališčih za tovorna vozila najbolj pogrešajo hranljivo in zdravo hrano, prostorne sanitarije in tuširnice, ki so ločene za moške in ženske, varnostnika 24 ur na dan, video nadzor, pralnico za posodo in oblačila, servisno delavnico, piknik prostor z žarom, več košev, prostor za vadbo in družabni prostor. Ker mnogo voznikov vozil na daljše relacije, so ogromno časa ločeni od svoje družine, kar na njih v mnogih primerih vpliva zelo slabo. Mnogi zato pogrešajo tudi dobro wi-fi povezavo ali brezplačen internet na postajališčih, za potrebe komunikacije s svojci. Na dobro opremljeno parkirišče bi se vozniki bili pripravljeni peljati večinoma do 5 kilometrov dlje, nekateri tudi več. Menijo, da bi v ceno parkirnine za varovano parkirišče morala biti vključena uporaba toalet, tuša in hrane.

Glede na zgoraj navedene ugotovitve, bi bilo nujno, da se na postajališčih ob avtocesti izboljša infrastruktura. Bilo bi tudi nujno potrebno, da se izboljša stanje sanitarij na nekaterih počivališčih, ter zagotovi ustrezne možnosti za higieno in udobje. Povečati bi se morala tudi varnost. Zaradi ogroženosti voznikov bi bilo potrebno zaostriti nadzore, okrepiti varnostne ukrepe, izboljšati razsvetljavo in namestiti varnostne kamere. Glede na to, da večina voznikov svoj prosti čas preživlja v vozilih, bi se lahko izboljšale ponudbe za rekreacijo. Lahko bi razmišljali o fitnes centrih, igriščih, sprehajalnih poteh ipd. Razmisliti bi bilo potrebno o dodatnih storitvah ali dejavnostih na počivališčih.

V Sloveniji je nekaj motelov, ki se nahajajo v bližini avtocest, a je njihovo število zelo nizko. Zato vozniki, ki opravljajo svoj postanek v Prekmurju, nimajo na voljo urejenih spalnih

prostorov, ne morejo pa niti skrbeti za svojo higieno. Moramo pa upoštevati tudi novo zakonodajo, ko bo voznikom tovornih vozil prepovedano spati v vozilih, to pa povzroči še večjo potrebo po nekih motelih oz. zgradbah s spalnimi prostori.

Trendi razvoja varovanih parkirišč v Sloveniji in Evropski uniji

Ker je dandanes kriminal še v porastu in se pojavlja vedno več kraj tovora, si dejansko vozniki ne morejo privoščiti, da bi zapustili svoje vozilo za dalj časa. Zato so na nekaterih delih Slovenije že uvedli varovana parkirišča, kjer lahko vozniki brez skrbi pustijo svoja vozila. Varovana parkirišča na avtocestnih počivališčih in obvoznicah na obrobju industrijskih con, so ključni element logistične infrastrukture in ponujajo različne stopnje zaščite. V Sloveniji in EU obstajajo različni nivoji varnosti na parkiriščih, ki so lahko osnovni videonadzor ali pa celo napredni pametni sistemi za obvladovanje parkirnih mest.

Precej razširjen je sistem za prepoznavanje registrskih številk vozil. Ko vozilo vstopi na parkirišče, sistem prepozna registrsko številko in zapiše čas prihoda. Tako se omogoči boljša sledljivost in zaščita pred nezakonitim parkiranjem. Pametni sistemi omogočajo, da se zasedena parkirna mesta sproti posodabljajo, kar voznikom omogoča, da najdejo prosta mesta brez nepotrebnega iskanja. V nekaterih državah EU (predvsem na Nizozemskem, v Nemčiji in na Švedskem) so parkirišča za polnjenje električnih vozil opremljena z naprednimi zaščitami proti zlorabam.

V mnogih evropskih državah se pojavljajo zasebna parkirišča, kjer so uporabniki zaščiteni s sistemi za elektronsko rezervacijo in digitalnim prepoznavanjem vozil. Ta parkirišča omogočajo večjo fleksibilnost in dostopnost, vendar pa se od javno dostopnih parkirišč ločijo predvsem po ceni. Upravljanje in vzdrževanje varnostih sistemov pa običajno predstavlja visok strošek, ki ga morajo pokriti uporabniki.

Portali za rezervacijo parkirišč

V zadnji letih so se v EU in Sloveniji pojavili številne aplikacije za rezervacijo parkirnih mest, ki omogočajo enostavno iskanje, rezerviranje in plačevanje parkirnih mest. Uporabljajo se tako za prosta parkirišča in parkirne hiše v mestih, kakor tudi za avtocestna parkirišča za tovorna vozila. Uporaba takšnih platform se povečuje zaradi vse večjega povpraševanja po parkirnih mestih in seveda želji po optimizaciji časa, ki ga porabimo za iskanje parkirnega prostora.

Čeprav so aplikacije za rezervacijo parkirnih mest izjemno koristne, se vseeno soočajo z različnimi težavami, kot so pomanjkanje podatkov o prostih mestih, težava s točnostjo lokacije oziroma zemljevida, napake pri plačilih, pomanjkanje možnosti za spremembo rezervacije in preobremenjenost parkirnih mest. Če bi želeli rešiti zgoraj navedene težave bi morali kombinirati tehnične izboljšave, izkušnjo uporabnikov in povezave z različnimi drugimi sistemi. Takšna je na primer težava s točnostjo lokacije, ki bi se jo dalo rešiti z uporabo natančnejših zemljevidov kot sta npr. Google Maps in OpenStreetMap. Težava z napakami pri plačilih bi se lahko rešila s pomočjo uporabe večstopenjske avtentifikacije, kjer bi zaščitili plačilni sistem in podatke uporabnika. Lahko pa omogočili plačevanje s pomočjo varnejših platform, kot so npr. Apple Pay, Google Pay in PayPal. Težava glede pomanjkanje podatkov o prostih mestih bi lahko rešili z ažuriranjem podatkov v realnem času. Aplikacije bi povezali z avtomatiziranimi sistemi za zbiranje podatkov, kar bi omogočilo posodabljanje podatkov o prostih mestih v realnem času.

Projekt gradnje varovanega parkirišča

Evropska unija med svojimi prednostnimi nalogami v okviru razvoja celovitega omrežja nemotene varne in trajnostne mobilnosti na prvo mesto postavlja razvoj gostejše mreže varnih in varovanih parkirnih površin za gospodarske uporabnike (gospodarska in tovorna vozila) na vsakih 100 kilometrov.

Podjetje FRBEJZAR d.o.o se je prijavilo na razpis za subvencijo gradnje varovanega parkirišča v obliki nepovratnih sredstev, v okviru evropskega programa Connecting Europe Facility (CEF), katerega cilj je podpirati naložbe v gradnjo nove prometne infrastrukture ter sanacijo ali nadgradnjo obstoječe.

Projekt bi izvedli v sodelovanju s podjetjem FRBERJZAR d. o. o., ki bi priskrbelo prostor za izgradnjo parkirišča, Ministrstvom za infrastrukturo in podjetjem Mercedes-Benz, ki bi na parkirišču namestilo polnilnice za električne tovornjake.

Projekt je skladen s političnimi prioritetami vseevropskega prometnega omrežja (TEN-T), kjer so kot specifični poudarjeni naslednji cilji:

- podpora nemotenemu delovanju notranjega trga in nemotenim prometnim povezavam s sosednjimi državami;
- omogočanje nemotene, varne in trajnostne mobilnosti blaga in ljudi;
- vzpostavljanje medsebojnih povezav med nacionalnimi prometnimi omrežji na trajnosten način;
- prispevanje k nadaljnji gospodarski rasti in konkurenčnosti na svetovni ravni.

Podjetje FRBEJZAR d.o.o

Je slovensko logistično podjetje, s sedežem v Murski Soboti, ki od leta 1990 deluje pod okriljem podjetja Murska transport. Ponujajo prevoze in skladiščenje blaga. V skladu s prednostnimi nalogami Evropske unije in Strategijo razvoja prometa v Republiki Sloveniji do leta 2030 želi investitor, podjetje FRBEJZAR d.o.o., na strateško pomembni lokaciji vzpostaviti nujno potrebno varno in varovano parkirno infrastrukturo za voznike tovornih vozil.

Podjetje FRBEJZAR d.o.o. je predhodno izvedlo analizo varnostnih zahtev parkirne infrastrukture na predmetni lokaciji obrtnoindustrijska cona SOIC v Nemčavcih. Na osnovi analize je podjetje sprejelo odločitev glede implementacije parkirne infrastrukture za tovorna vozila, ki se bo uvrščala v platinasto raven varnosti, ki pomeni v praksi najvišjo možno raven varnosti. Skladno z letnim poročilom Global Peace Index (GPI) je Slovenija edina izmed srednjeevropskih držav, ki se uvršča med 10 najbolj varnih držav glede kriminalitete. Vozniki tovornih vozil, ki potujejo po Baltsko-Jadranskem ali po Mediteranskem jedrnem koridorju TEN-T omrežja, med drugim prečkajo sosednjo državo Madžarsko, kjer je stopnja kriminala višja kot v Sloveniji, zato raje načrtujejo počitek na varnih in varovanih parkiriščih v Sloveniji, saj se tu počutijo varneje.

Opis projekta

Splošni cilj projekta »Izgradnja varnega in varovanega parkirišča za tovorna vozila v Murski Soboti« je voznikom tovornih vozil ponuditi zanesljivo storitev certificiranega varnega in

zaščitenega parkiranja na osrednjih koridorjih vseevropskega prometnega omrežja (TEN-T) med Sredozemskim, Baltskim in Jadranskim morjem. Učinki vzpostavitve nove parkirne infrastrukture se bodo pokazali v:

- varnejšem prevozu blaga in splošni prometni varnosti na mednarodni ravni;
- izboljšanem udobju in dobrem počutju voznikov tovornjakov;
- višji kakovosti življenja prebivalcev Mestne občine Murska Sobota in sosednjih občin;
- višji stopnji digitalizacije prometne infrastrukture v Sloveniji in Evropski uniji;
- izboljšanem logističnem načrtovanju in zmanjšanju nepričakovanih stroškov;
- zmanjšanih vplivih na okolje;
- krepitvi lokalnega gospodarstva in ustvarjanju novih delovnih mest;
- spodbujanju novih naložb domačih in tujih vlagateljev.

Predmet načrtovanega projekta je izgradnja sodobnega digitaliziranega parkirišča v bližini avtoceste A5, ki povezuje avtocesto A1 s sosednjo Madžarsko (Maribor– Pince) in je del evropskih poti z oznako E653. Avtocesta A5 je del Mediteranskega in Baltsko-Jadranskega koridorja, ki predstavljata najpomembnejši evropski cestni in železniški osi v Srednji Evropi. Trasi omenjenih jedrnih koridorjev predstavljata strateško pomembni vozlišči vseevropskega prometnega omrežja (TEN-T), zato je nujna vzpostavitev varne in varovane parkirne infrastrukture na predmetni lokaciji. Projekt se nahaja v severni obrtno-industrijski coni (SOIC) v Nemčavcih, severno od avtocestnih odsekov Vučja vas – Murska Sobota in Murska Sobota – Lipovci.

Samostojno varno in varovano parkirišče za tovornjake bo vključevalo 64 parkirnih mest za tovorna vozila in 3 parkirna mesta za osebna vozila. Od tega so naslednja načrtovana z električnim priključkom oziroma polnilno postajo:

- 10 mest e-polnilnih postaj za vlečna vozila in tovornjake (priprava),
- 10 mest električnih priključkov za hladilnike (hladilnik),
- mesta ADR.

Parkirna mesta za tovornjake so načrtovana v velikosti 8.416 m^2, preostali del parcele pa predstavljajo zelene površine, pohodniške površine in pozidane površine. Skupna velikost vseh funkcionalnih površin je 9.990 m^2. Območje bo ograjeno z 1,8 m visoko panelno ograjo.

Predmetni investicijski projekt predvideva ureditev in izgradnjo naslednje infrastrukture:

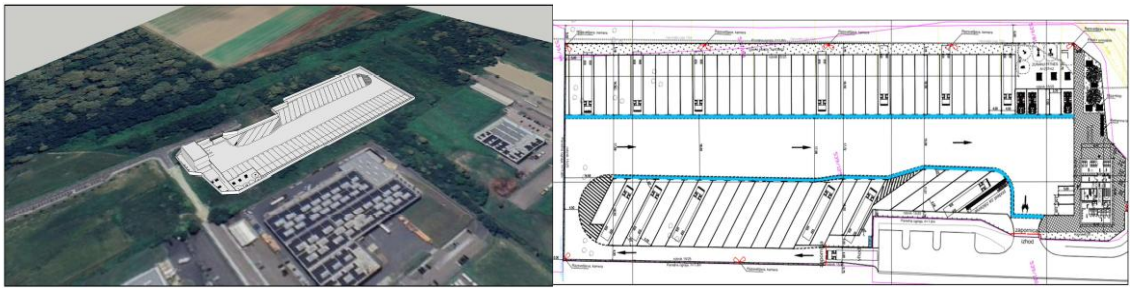
- varno in varovano parkirišče za tovorna vozila z nadzorovanim vhodom in izhodom;
- pomožnimi objekti (WC in tuši ločeni po spolu s kabinami za moške in ženske, skupni prostori z avtomati s prigrizki in pijačo);
- spremljajoči pomožni objekti (kuhinja, pralnica, sušilnica, igralnica, fitnes in jedilnica);

- zelene površine, vključno z urbano opremo (klopi in mize za piknike) in fitnesom na prostem;
- pralnica tovornih vozil;
- klančina za odstranjevanje snega in ledu s tovornin vozil;
- povezave z obstoječo komunalno infrastrukturo (kanalizacija, vodovod, meteorna kanalizacija, nizkonapetostni priključek, plin, telekomunikacije);
- nadzorna soba, ki bo omogočala digitalni nadzor parkirne infrastrukture, snemanje 24 ur na dan in bo omogočala brezplačno neprekinjeno internetno povezavo (Wi-Fi);
- po celotnem obodu varovanega parkirišča bo nameščen sistem CCTV za nadzor parkirišča.

V ponudbo bodo neposredno na lokaciji parkirišča in v njeni bližini (1 – 3 km) vključene dodatne storitve z višjo dodano vrednostjo:

- šport in rekreacija na prostem, vključno s fitnesom na prostem in prostori za piknik;
- druge storitve, vključno s trgovinami z rezervnimi deli in servisnimi delavnicami;
- podporne storitve, vključno s trgovinami, lekarnami in bolnišnicami, bencinskimi črpalkami; bankami in plačilnimi mesti, kemičnimi čistilnicami;
- gostinske storitve, vključno z restavracijami, hoteli, kmečkim turizmom in hitro prehrano.

Slika 9: Tloris varovanega parkirišča (vir: Ferbejzar d.o.o., Call: CEF-T-2024-SAFEMOBGEN-PARKINGS



Študija o gospodarskem učinku izgradnje novega varovanega parkirišča v obrtni coni Murska Sobota

Obstaja velik primanjkljaj certificiranih varnih in varovanih parkirišč ne le na jedrnih koridorjih, temveč na celotnem vseevropskem prometnem omrežju (TEN-T), saj je treba poklicnim voznikom tovornih vozil zagotoviti zakonsko predpisan počitek in oddih.

Projekt izgradnje varovanega parkirišča bo omogočil centralizirano parkiranje tovornih vozil na varovanem območju in posledično preprečil neustrezno parkiranje v naseljih in ob nevarnih cestnih odsekih. Trenutno mnogi vozniki, zlasti tuji vozniki tovornih vozil, parkirajo na nezakonitih območjih kot so npr. njive, ob cesti ali pa sploh ne parkirajo in kršijo predpise o obveznih počitkih. Seveda tako početje velikokrat povzroči nevarne situacije (nesreče). Število kriminalnih deliktov v prometu je v zadnjih letih znova v porastu, zato je pomembno tudi, da je v času počitka samo vozilo parkirano na varnem mestu. Varovano parkirišče bi pripomoglo k zmanjšanju tatvin in poškodb, kar bo vplivalo na izboljšano zaupanje logističnih partnerjev in prevoznikov.

Projekt izgradnje varovanega parkirišča bo spodbujal gospodarski razvoj in omogočal dodatne investicije v Pomurski regiji. Pomurje bi lahko iz teh investicij pridobilo številne koristi. Prispeval bo tudi k povečanju konkurenčnosti logističnega sektorja v Sloveniji v mednarodnem logističnem okolju. Tako bodo lahko tovorna vozila hitreje in bolj organizirano vstopala v logistične centre in tovorne terminale, kar bi skrajšalo čas dostave, povečalo produktivnost in optimiziralo logistične verige. Tako bi bila podjetja bolj konkurenčna na trgu, kar pa bi pripomoglo k rasti gospodarstva, pozitivno pa bi vplivala tudi na lokalno logistično industrijo. Varovano parkirišče, ki bi se gradilo na območju mursko-soboške obrtno-industrijske cone sever, bi imelo v prihodnosti, zaradi gradnje obvoznice, direktno povezavo s pomursko avtocesto A5. To bi tovornim vozilom prihrani veliko časa, kot pa če bi se vozilo skozi celotno mesto da pridejo do avtoceste.

Izgradnja novega varovanega parkirišča bi ustvarila številna nova delovna mesta, tako že pri sami izgradnji parkirišča, kakor tudi kasneje med samim obratovanjem varovanega parkirišča.

Projekt bo podpiral trajnostno mobilnost, kar bo prispevalo k zmanjšanju emisij in boljši izrabi obstoječe prometne infrastrukture. Predvsem Industrijsko ulico v Murski Soboti dnevno prevozi veliko število tovornih vozil, ki povzročajo hrup, onesnažujejo zrak v mestu in povzročijo zastoje v mestu.

Parking Murska Sobota je del globalnega projekta za trajnostni, zeleni in digitalni prehod, ki prinaša napredne rešitve na področju mobilnosti, prometa, gospodarstva in turizma v Pomurski regiji. Skupina FRBEJZAR želi ustvariti »Smart Mobility Hub«, ki bo imel

naslednje daljnosežne učinke:

- nadaljnji razvoj obrtno-poslovne cone (SOIC) v Nemčavcih;
- privabljanje novih domačih in tujih investitorjev;
- razvoj najsodobnejše parkirne infrastrukture za tovorna vozila;
- redukcija ogljičnega odtisa;
- dobro počutje vseh deležnikov logističnih verig;
- digitalizacija in uvedba digitalnih sistemov v vsakdanje poslovanje.

Skupina FRBEJZAR se osredotoča na tri ključne kategorije trajnostnega delovanja, ki hkrati podpirajo zeleni prehod. Te kategorije vključujejo ukrepe za zmanjšanje emisij, izboljšanje energetske učinkovitosti in podporo inovacijam podjetniškega sektorja:

1. Mobilnost z nizkimi emisijami: uporaba umetne inteligence za načrtovanje energetsko učinkovitih transportnih poti, elektrifikacija transporta v smislu gradnje mreže hitrih polnilnih postaj na ključnih prometnih koridorjih, vzpostavljanje intermodalnih terminalov, ki povezujejo cestni, železniški in pomorski transport.

2. Trajnostna in pametna infrastruktura: gradnja energetsko učinkovitih skladišč s sistemi za recikliranje in uporabo obnovljivih virov energije, uvedba naprednih digitalnih sistemov za sledenje tovoru in zmanjšanje administrativnih ovir (e-tovorni listi), razvoj pametnih logističnih sistemov za spremljanje obremenitev vozil in redukcijo voženj z minimalnim tovorom.

3. Novi poslovni modeli: razvoj digitalnih platform, ki povezujejo različne načine prevoza, uvedba »Blockchain« tehnologije, kjer se vsi podatki o premikih blaga pregledno in trajno zapišejo v digitalno verigo blokov, kar pomeni večjo sledljivost, varnost in učinkovitost pri upravljanju oskrbovalnih verig.

Sklep

Mestna občina Murska Sobota in Skupina FRBEJZAR predvidevata, da se bo poslovna cona razmeroma hitro razvila v dinamično poslovno središče in postala pomembna poslovna cona na mednarodni ravni, saj se nahaja v bližini treh držav EU: Avstrije, Madžarske in Hrvaške. Izjemno ugodna geostrateška lega izkazuje potencial za veliko prepoznavnost na mednarodni ravni in predstavlja pomembno prednost za gospodarski razvoj ter povečanje vpliva v globalnem merilu. Hkrati omogoča lažji dostop do ključnih trgov, privablja nove domače in tuje investitorje ter spodbuja razvoj pametne infrastrukture. Z novimi delovnimi mesti, večjo varnostjo za tovor in voznike ter kvalitetnejšimi logističnimi storitvami bi lahko prispevali k boljši prometni infrastrukturi in boljšemu življenjskemu standardu v regiji.

Viri in literatura

Projektna dokumentacija Skupine FRBEJZAR d.o.o., kot prijava na evropski razpis CEF-T-2024-SAFEMOBGEN-PARKINGS-WORKS — Safe and secure parking infrastructure – works.

TJAŠA GERIČ, univ. dipl. inž. živ. tehn.
mag. inž. log.

EKONOMSKA ŠOLA MURSKA SOBOTA
Noršinska ulica 13
9000 Murska Sobota

PROJECT FOR THE CONSTRUCTION OF A SECURED PARKING LOT IN COLLABORATION WITH THE COMPANY FRBEJZAR d. o. o.

Summary:

Keywords: *rest areas, secured parking, safety, trucks*

In the contribution, we presented the issue of parking for freight vehicles in Slovenia and Europe. We described the challenges faced by truck drivers in parking lots. We introduced Slovenian legislation regarding the prohibition of driving for freight vehicles. We presented the findings of a survey we conducted among drivers at rest areas on the Pomurje highways and illustrated the trends in the development of secure parking lots. We introduced the project for the construction of a secure parking lot in the industrial zone along the bypass in Murska Sobota, in cooperation with the company FRBEJZAR d.o.o. We also conducted a study on the economic impact of building a new secure parking lot.

Introduction

An essential part of highways are also rest areas or highway parking lots, which are intended for cars, trucks, and other vehicles that wish to interrupt their journey on the highway for various reasons. Breaks are very important for truck drivers, as required by legislation. The condition and facilities of rest areas positively affect the well-being of drivers. Along Slovenian highways, there are different types of rest areas. The simplest ones offer only space to stop the vehicle, possibly toilet facilities, and perhaps a table and bench. The largest and best-equipped rest areas usually have a gas station with fuel and other product and service offerings, as well as a restaurant and outdoor tables and benches. Near some rest areas in Slovenia, there are also motels where drivers can spend the night. These motels are also an excellent solution for truck drivers who do not have a bed built into their vehicle. It is desirable that such parking lots are secured with at least a basic level of security, namely video surveillance. However, there are also cases, which are rather rare, where there is no security at such parking lots.

Problems at truck parking areas

At highway rest areas, truck drivers face various challenges and problems, such as heat, cold, performing bodily functions, holding back exhaust fumes, hygiene, spending leisure time during weekends and holidays, thefts, and break-ins. In the summer months, drivers encounter issues due to high temperatures. The lack of shade and adequate air conditioning in trucks can cause discomfort and various problems. In contrast, the winter months can pose significant challenges due to the lack of heating, freezing vehicles, and various other issues due to low temperatures. Certain highway rest areas are surrounded by heavy traffic, which leads to deteriorating air quality, exposing drivers to exhaust fumes and consequently resulting in health problems.

A major problem at rest areas is also the facilities for personal hygiene. The lack of accessible sanitary facilities at rest areas can cause issues with meeting basic needs, which negatively impacts the hygiene and health of drivers. Truck drivers, who spend their free weekends and holidays at rest areas, face loneliness and a lack of opportunities for socializing and spending their free time.

In recent years, the issue of criminal acts, particularly those occurring in truck parking lots across Europe when drivers are required to take legally mandated breaks and rest periods, has become increasingly evident. Drivers face the risk of theft and break-ins at rest areas, especially at night. The theft of valuable cargo such as white goods, cigarettes, alcohol, chocolate, electronics, and products from well-known branded companies is becoming a widespread problem in the transport sector. These types of goods are particularly attractive to thieves due to their high value and ease of resale on the black market. A lack of security measures can increase the likelihood of thefts, which in turn affects the safety and well-being of drivers and the security of their property. One of the key factors influencing the frequency of thefts is also the fact that truck drivers often have to park in areas without adequate security protection, where vehicles and cargo are more accessible to thieves.

According to statistics, 75% of drivers in the transport sector face theft, meaning that almost every driver has experienced theft. The issue is noticeable throughout the European Union and of course also in Slovenia. Even more so in some countries outside the EU, which are considered 'less safe' in this regard. This problem is particularly pronounced for drivers who travel with their trucks through countries outside the European Union (Turkey, Russia, Belarus, Serbia, Bosnia, Bulgaria, Romania, Ukraine, North Macedonia, and Montenegro), where there are numerous thefts of goods and trucks. Drivers from foreign countries often encounter Slovenia for the first time on their way to Western Europe as a European Union country that is known to be 'safer' in this regard. There is a significant trend of lack of parking spaces for trucks, which often puts drivers in a situation where they cannot find an available parking space, yet are required to take a legally mandated break. In this case, they park in the nearby fields, meadows, or at any locations where they can.

Due to the crisis situation between Russia and Ukraine, Russia and Belarus currently have a ban or restriction on trade, so there are currently fewer freight vehicles from these two countries. However, once the crisis situation between Russia and Ukraine is over, traffic from Russia and Belarus will also increase, which will consequently lead to an even greater shortage of parking space and free access to parking lots. Therefore, the issue will only escalate over the years.

In many cases, the owners of goods specify exactly where drivers can park for safety reasons. If a driver stops elsewhere at their own risk, they are to blame if an accident occurs. This is now a significant problem, as there are hardly any secure parking lots in our country where drivers can park safely and take a break. About 500 vehicles are stolen annually in Slovenia. Vehicles are often stolen in uninhabited areas and quiet parking lots, with less lighting, without security or video surveillance. Areas with restricted access or regular patrols reduce the risk of theft. The use of mechanical and electronic locks, tracking devices, and alarms does reduce the likelihood of theft, but the issue remains unresolved.

Solutions to these problems include improving infrastructure at and around rest areas to provide basic services such as sanitary facilities and showers, enhancing security measures, and promoting social and recreational opportunities for drivers, especially during holidays and on long weekends. There is thus a very high demand for truck parking areas and even for secured parking where drivers can safely leave their vehicles and sleep or leave their trailers for combined transport (so that another driver can pick it up with a towing vehicle). Currently, this is prohibited by shippers and receivers of cargo due to safety concerns.

Slovenian legislation on the prohibition of driving heavy goods vehicles

In Slovenia, there is a general ban on the driving of heavy goods vehicles over 7.5 tons on Sundays and public holidays between 8 AM and 10 PM, and on Good Friday between 2 PM and 10 PM. There are also additional restrictions on certain main traffic routes, which become stricter during the summer season. On these roads, there is a ban on driving heavy goods vehicles over 7.5 tons on Saturdays from 6 AM or 8 AM until 1 PM or 4 PM (depending on the road's traffic function) and, of course, on Sundays and public holidays.

The ban on restricting the driving of heavy goods vehicles on Sundays and public holidays was formally introduced in Slovenia by the Regulation on Traffic Restrictions on Roads in the Republic of Slovenia, for which the responsible institution is the Ministry of Infrastructure in cooperation with the police, DARS, and other traffic authorities.

Slovenia is also considered the first country where vehicles traveling to the European Union have a driving ban on Sundays and holidays. In Croatia, there is no Sunday driving ban for trucks, except during the summer season, specifically from June 15 to September 15, when there is a driving ban for vehicles over 7.5 tons or longer than 14 meters every Sunday between 12 PM and 11 PM. Therefore, all transit traffic is halted here on Sundays, holidays, and non-working days, and during the summer season, it is also halted on Saturdays on tourist-heavy roads. Due to the lack of parking spaces, drivers park everywhere, often already on the Croatian side. This measure was primarily designed to improve traffic safety on Slovenian roads, reduce traffic accidents, and increase traffic flow, especially during the tourist season. It would make sense to consider additional measures, such as expanding and improving parking infrastructure, especially with secure parking lots that would allow for safe and comfortable waiting for truck drivers. We could also implement better information systems for drivers that would direct them to available parking spaces in a timely manner or allow them to plan their routes based on driving restrictions.

Survey among truck drivers in Slovenian parking lots

In collaboration with our students of the logistics technician program at the Economic School of Murska Sobota, we conducted a survey among truck drivers at truck rest stops in

Pomurje.

The survey revealed that most drivers come from Bulgaria, Hungary, Romania, and other Balkan countries, where they take breaks, daily, and also weekly rests. Drivers are mostly in transit in Slovenia, heading from Southeast Europe to Western Europe or vice versa. Many of them spend a few days a week in the truck. Breaks and pauses are most often taken at highway rest areas, although some also use public paid parking or secure parking lots. The reason for this is greater safety, clean toilet facilities and showers, better nutrition, or because customers require it.

Most of the rest areas in Slovenia have sanitary facilities, but they do not have designated areas where drivers can take a shower. Most drivers, when taking their daily or weekly breaks, spend the night in their vehicles, while some have the option to fulfill their physiological needs and hygiene tasks in the toilets at the rest areas; however, in some places, they do not have this option and have to do so outside or avoid showering and other hygiene-related tasks. The problem also arises in winter due to the cold or in summer due to the heat when they have nowhere to take refuge. In the best case, they sit in the local establishments of the rest areas to avoid the cold or heat, but in some places, they do not even have this option and stay in their vehicles. Surveyed drivers also emphasize that they do not feel safe at the rest areas. They feel most threatened at night and when the parking lots are unprotected and poorly lit. A full three-quarters of drivers have already encountered fuel theft, cargo theft from their vehicles, or other criminal acts (robberies, vehicle damage). There is often a need to leave a truck or a trailer in a parking lot, but drivers are hesitant to do so. In recent years, there have also been more women truck drivers in the transport industry, who are even more vulnerable regarding all of this.

Drivers emphasize that there are generally too few parking spaces for trucks in Pomurje and feel the need for larger capacities, especially along road connections and in industrial zones. Drivers have also expressed the need for secured parking spaces, with the possibility of digital reservations. They stress that there are too few secured parking lots in Slovenia, and even fewer options for digital reservations, so they often find themselves without parking space. Often, the client dictates exactly where drivers must park. Drivers at truck stopping points miss nutritious and healthy food the most, spacious restrooms and shower facilities, which are separated for men and women, a security guard available 24 hours a day, video surveillance, a dish and laundry service, a maintenance workshop, a picnic area with a grill, multiple trash bins, a workout area, and a social space. Since many drivers are on long routes, they spend a lot of time away from their families, which affects them very negatively in many cases. Many also miss a good Wi-Fi connection or free internet at stopping points for communication with their relatives. Drivers would be willing to drive mostly up to 5 kilometers further for a well-equipped parking area, and some even more. They believe that the use of restrooms, showers, and food should be included in the parking fee for a secure parking area.

Given the above findings, it is essential to improve the infrastructure at rest areas along the highway. It is also necessary to improve the condition of sanitary facilities at some rest areas and to ensure adequate hygiene and comfort options. Safety should also be increased. Due to the vulnerability of drivers, it is necessary to tighten controls, strengthen security measures, improve lighting, and install security cameras. Considering that most drivers spend their free time in vehicles, recreational offers could be improved. We could consider

fitness centers, playgrounds, walking paths, etc. Additional services or activities at rest areas should be considered. In Slovenia, there are a few motels located near highways, but their number is very low. Therefore, drivers who make their stop in Prekmurje do not have access to proper sleeping accommodations, nor can they attend to their hygiene. We must also consider the new legislation, which will prohibit truck drivers from sleeping in their vehicles, which will create an even greater need for motels or buildings with sleeping accommodations.

Trends in the development of secured parking lots in Slovenia and the European Union

As crime is currently on the rise and there are more and more cargo thefts, drivers really cannot afford to leave their vehicles unattended for long periods of time. Therefore, in some parts of Slovenia, guarded parking lots have already been introduced, where drivers can leave their vehicles without worry. Guarded parking lots at highway rest areas and on bypasses around industrial zones are a key element of logistics infrastructure and offer various levels of protection. In Slovenia and the EU, there are different levels of security at parking lots, which can range from basic video surveillance to advanced smart systems for managing parking spaces.

The system for recognizing vehicle license plates is quite widespread. When a vehicle enters a parking lot, the system recognizes the license plate and records the arrival time. This enables better traceability and protection against illegal parking. Smart systems allow for the occupancy of parking spaces to be updated in real-time, enabling drivers to find available spots without unnecessary searching. In some EU countries (especially in the Netherlands, Germany, and Sweden), parking lots for electric vehicle charging are equipped with advanced abuse protection. In many European countries, private parking lots are emerging where users are protected by electronic reservation systems and digital vehicle recognition. These parking lots offer greater flexibility and accessibility, but they primarily differ from publicly accessible parking lots in terms of price. The management and maintenance of security systems usually represent a high cost that users have to cover.

Parking reservation portals

In recent years, numerous applications for booking parking spaces have emerged in the EU and Slovenia, allowing for easy searching, reserving, and paying for parking spots. They are used for both free parking lots and parking garages in cities, as well as for highway parking areas for trucks. The use of such platforms is increasing due to the growing demand for parking spaces and, of course, the desire to optimize the time we spend searching for parking. Although parking reservation applications are extremely useful, they still face various issues such as a lack of data on available spaces, difficulties with location or map accuracy, payment errors, a lack of options for changing reservations, and congestion at parking locations. To address the aforementioned issues, a combination of technical improvements, user experience enhancements, and connections to various other systems would be necessary. For example, the issue of location accuracy could be resolved by using more precise maps such as Google Maps and OpenStreetMap. The problem of payment errors could be tackled by implementing multi-factor authentication to protect the payment system and user data. Additionally, enabling payments through more secure platforms such as Apple Pay, Google Pay, and PayPal could help. The issue of insufficient data on available

spaces could be resolved by updating data in real time. The applications would be connected to automated data collection systems, which would allow for real-time updates of vacancy information.

Project for the construction of a secured parking lot

The European Union prioritizes the development of a denser network of safe and secure parking areas for commercial users (commercial and freight vehicles) every 100 kilometers as part of its overarching goal of developing a comprehensive network for uninterrupted safe and sustainable mobility. The company FRBEJZAR d.o.o has applied for a grant for the construction of a secured parking lot in the form of non-repayable funds under the European program Connecting Europe Facility (CEF), which aims to support investments in the construction of new transport infrastructure and the renovation or upgrade of existing ones. The project would be implemented in collaboration with the company FRBERJZAR d.o.o., which would provide space for the construction of the parking lot, the Ministry of Infrastructure, and Mercedes-Benz, which would install charging stations for electric trucks at the parking lot.

The project is in line with the political priorities of the trans-European transport network (TEN-T), where the following specific objectives are highlighted:

- supporting the smooth operation of the internal market and seamless transport connections with neighboring countries;
- enabling smooth, safe, and sustainable mobility of goods and people;
- establishing interconnections between national transport networks in a sustainable manner;
- contributing to further economic growth and global competitiveness.

FRBEJZAR d.o.o. company

It is a Slovenian logistics company based in Murska Sobota, operating under the umbrella of Murska transport since 1990. They offer transportation and warehousing of goods. In line with the priority tasks of the European Union and the Transport Development Strategy in the Republic of Slovenia until 2030, the investor, FRBEJZAR d.o.o., aims to establish urgently needed safe and secured parking infrastructure for truck drivers at a strategically important location. The company FRBEJZAR d.o.o. previously conducted an analysis of the security requirements for the parking infrastructure at the relevant location in the industrial zone SOIC in Nemčavci. Based on the analysis, the company made a decision regarding the implementation of parking infrastructure for heavy vehicles, which will be classified at the platinum security level, representing the highest possible level of safety in practice. According to the annual Global Peace Index (GPI) report, Slovenia is the only Central European country ranked among the 10 safest countries regarding crime rates. Heavy vehicle drivers traveling through the Baltic-Adriatic or Mediterranean core corridor of the TEN-T network cross the neighboring country of Hungary, where the crime rate is higher than in Slovenia, and therefore prefer to plan their rest at safe and secured parking lots in Slovenia, as they feel safer here.

Project description

The main goal of the project 'Construction of a safe and secured parking area for trucks in Murska Sobota' is to offer truck drivers a reliable service of certified safe and secure parking on the central corridors of the trans-European transport network (TEN-T) between the Mediterranean, Baltic, and Adriatic Seas. The effects of establishing new parking infrastructure will be reflected in:

- safer transport of goods and overall traffic safety at the international level; increased comfort and well-being of truck drivers;
- improved quality of life for residents of the City Municipality of Murska Sobota and neighboring municipalities;
- higher degree of digitalization of transport infrastructure in Slovenia and the European Union;
- improved logistics planning and reduced unexpected costs;
- reduced environmental impacts;
- strengthening of the local economy and creation of new jobs;
- encouragement of new investments from both domestic and foreign investors.

The subject of the planned project is the construction of a modern digitized parking lot near the A5 motorway, which connects the A1 highway with neighboring Hungary (Maribor - Pince) and is part of the European routes marked E653. The A5 motorway is part of the Mediterranean and Baltic-Adriatic corridors, which represent the most important European road and rail axes in Central Europe. The routes of these core corridors represent strategically important nodes in the trans-European transport network (TEN-T), therefore the establishment of a safe and secure parking infrastructure at the designated location is essential. The project is located in the northern craft and industrial zone (SOIC) in Nemčavci, north of the motorway sections Vučja vas - Murska Sobota and Murska Sobota - Lipovci.

The independent secure and guarded parking lot for trucks will include 64 parking spaces for heavy vehicles and 3 parking spaces for personal cars. Of these, the following are planned with an electric connection or charging station:

- 10 e-charging station spaces for trailers and trucks (preparation);
- 10 electrical connection spaces for refrigerators (refrigerator);
- ADR spaces.

The parking spaces for trucks are planned to be 8,416 m^2 in size, while the remaining part of the parcel represents green areas, pedestrian areas, and built-up areas. The total size of all functional areas is 9,990 m^2. The area will be enclosed with a 1.8 m high panel fence.

The subject investment project envisages the arrangement and construction of the following infrastructure:

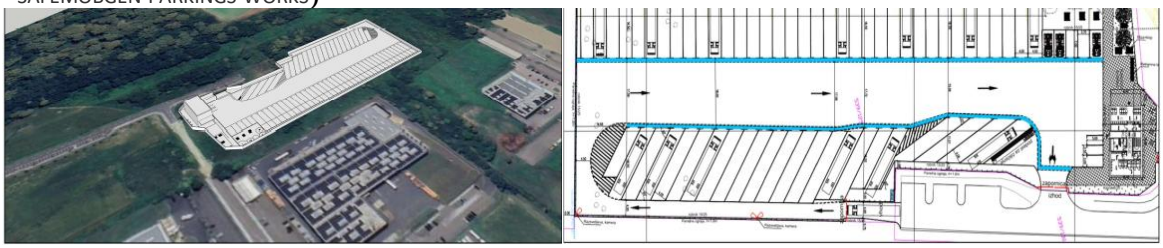
- a safe and secure parking lot for trucks with controlled entry and exit;

- auxiliary facilities (WC and showers separated by gender with cabins for men and women, common areas with vending machines for snacks and drinks);
- accompanying auxiliary facilities (kitchen, laundry, drying room, playroom, gym, and dining room);
- green spaces, including urban furniture (benches and picnic tables) and outdoor fitness;
- a laundry for trucks;
- a ramp for snow and ice removal from trucks;
- connections to existing utility infrastructure (sewerage, water supply, storm drainage, low-voltage connection, gas, telecommunications);
- a control room that will enable digital monitoring of the parking infrastructure, recording 24 hours a day, and will provide free uninterrupted internet access (Wi-Fi);
- a CCTV system will be installed around the entire perimeter of the secured parking lot to monitor the parking area.

The offer will directly include additional services with higher added value at the location of the parking lot and in its vicinity (1 – 3 km):

- sports and outdoor recreation, including outdoor fitness and picnic areas;
- other services, including spare parts stores and service workshops;
- support services, including shops, pharmacies and hospitals, gas stations; banks and payment locations, dry cleaners;
- catering services, including restaurants, hotels, agritourism, and fast food.

Image 1: Floor plan of the secured parking lot (source: Ferbejzar d.o.o., Call: CEF-T-2024-SAFEMOBGEN-PARKINGS-WORKS)



Study on the economic impact of the construction of a new secured parking lot in the industrial zone of Murska Sobota

There is a large shortage of certified safe and secure parking spaces not only on core corridors but throughout the entire trans-European transport network (TEN-T), as professional truck drivers need to be provided with legally mandated rest and relaxation.

The project for the construction of a secured parking area will enable centralized parking for freight vehicles in a protected area, consequently preventing inappropriate parking in residential areas and near hazardous road sections. Currently, many drivers, especially foreign truck drivers, park in illegal areas such as fields, along the road, or do not park at all, violating regulations regarding mandatory rest periods. Of course, such behavior often leads to dangerous situations (accidents). The number of traffic-related criminal offenses has been on the rise again in recent years, so it is also important that during rest periods, the vehicle is parked in a safe place. A secured parking lot would help reduce thefts and damages, which will impact the improved trust of logistics partners and carriers.

The project of building a secured parking lot will promote economic development and enable additional investments in the Pomurje region. Pomurje could gain numerous benefits from these investments. It will also contribute to increasing the competitiveness of the logistics sector in Slovenia in the international logistics environment. This way, freight vehicles will be able to enter logistics centers and cargo terminals more quickly and in a more organized manner, which would shorten delivery times, increase productivity, and optimize logistics chains. Thus, companies would be more competitive in the market, which would help the growth of the economy and positively impact the local logistics industry. The secured parking lot, which would be built in the area of the Murska Sobota industrial zone north, would in the future, due to the construction of a bypass, have a direct connection to the A5 Pomurje motorway. This would save freight vehicles a lot of time compared to driving through the entire city to reach the highway. he construction of a new secure parking lot would create numerous new jobs, both during the construction of the parking lot itself and later during the operation of the secure parking lot.

The project will support sustainable mobility, which will contribute to reducing emissions and better utilization of the existing transport infrastructure. In particular, Industrial Street in Murska Sobota is traversed daily by a large number of trucks that cause noise, pollute the air in the city, and create traffic jams.

Parking in Murska Sobota is part of a global project for sustainable, green, and digital transition, which brings advanced solutions in the fields of mobility, transportation, economy, and tourism to the Pomurje region. The FRBEJZAR group aims to create a "Smart

Mobility Hub" that will have the following far-reaching effects:

- further development of the craft and business zone (SOIC) in Nemčavci;
- attracting new domestic and foreign investors;
- development of state-of-the-art parking infrastructure for freight vehicles;
- reduction of carbon footprint;
- well-being of all stakeholders in logistics chains;
- digitization and implementation of digital systems in everyday business.

The FRBEJZAR group focuses on three key categories of sustainable action that simultaneously support the green transition. These categories include measures to reduce emissions, improve energy efficiency, and support innovation in the business sector:

1. Low-emission mobility: the use of artificial intelligence to plan energy-efficient transport routes, electrification of transport in terms of building a network of fast charging stations on key transport corridors, and establishing intermodal terminals that connect road, rail, and maritime transport.
2. Sustainable and smart infrastructure: construction of energy-efficient warehouses with recycling systems and the use of renewable energy sources, implementation of advanced digital systems for tracking cargo and reducing administrative barriers (e-freight documents), development of smart logistics systems for monitoring vehicle loads and reducing trips with minimal cargo.
3. New business models: development of digital platforms that connect different modes of transport, introduction of 'Blockchain' technology, where all data about the movement of goods is transparently and permanently recorded in a digital block chain, which means greater traceability, security, and efficiency in supply chain management.

Conclusion

The City Municipality of Murska Sobota and the FRBEJZAR Group anticipate that the business zone will relatively quickly develop into a dynamic business center and become an important business area on an international level, as it is located near three EU countries: Austria, Hungary, and Croatia. The extremely favorable geostrategic position demonstrates potential for significant international recognition and represents an important advantage for economic development and increased influence on a global scale. At the same time, it enables easier access to key markets, attracts new domestic and foreign investors, and encourages the development of smart infrastructure. With new jobs, greater security for goods and drivers, and higher quality logistics services, it could contribute to better transport infrastructure and an improved standard of living in the region.

Sources and literature

Project documentation of the FRBEJZAR Group d.o.o., as an application for the European call CEF-T-2024-SAFEMOBGEN-PARKINGS-WORKS — Safe and secure parking infrastructure – works.

ŠKOLA ZA CESTOVNI PROMET, ZAGREB

Autori:

Renata Heljić, dipl. ing. strojarstva

Tomislav Kučina, dipl. ing. prometa

OSIGURANJE KVALITETE U SUSTAVU ODGOJA I OBRAZOVANJA U REPUBLICI HRVATSKOJ

Sažetak:

Osiguranje kvalitete u odgojno-obrazovnom sustavu Republike Hrvatske temelj je sustavnog unaprjeđenja obrazovanja. Sustavi samovrednovanja i vanjskog vrednovanja postaju ključni alati u identificiranju stvarnih potreba, razvoju škola i ustanova te postizanju transparentnosti i odgovornosti. Proces samovrednovanja uključuje unutarnju procjenu kvalitete rada škole kroz odabrana područja kao što su učenje i poučavanje, upravljanje, školska klima i postignuća učenika. Rezultati samovrednovanja služe za izradu plana unaprjeđenja koji se integrira u godišnji plan škole. Osim škola i ustanove za obrazovanje odraslih obvezne su provoditi samovrednovanje, a ono uključuje ocjenu područja poput upravljanja, nastavnog procesa, podrške polaznicima i etike. Vanjsko vrednovanje skupova ishoda učenja provodi se kao postupak neovisne provjere usvojenosti znanja i vještina učenika i polaznika tijekom školovanja ili završnih provjera i obrana završnog rada. Postupak provode povjerenstva koja imenuju nadležne institucije. Rezultati vrednovanja koriste se za unaprjeđenje programa, kao i za očuvanje vjerodostojnosti stečenih kvalifikacija. Kvalitetno obrazovanje zahtijeva sustavno vrednovanje i unaprjeđenje. Hrvatski sustav osiguravanja kvalitete, kroz samovrednovanje i vanjsko vrednovanje, potiče škole i ustanove za obrazovanje odraslih na odgovornost, transparentnost i kontinuirano poboljšanje. Korištenje rezultata vrednovanja kao temelja za strateško planiranje ključ je razvoja obrazovnog sustava u skladu s potrebama društva i tržišta rada.

Ključne riječi:

samovrednovanje škola, vanjsko vrednovanje ustanova, vanjsko vrednovanje skupova ishoda učenja

Uvod

Pojam osiguravanja kvalitete u odgojno-obrazovnom sustavu u Republici Hrvatskoj temeljen je na Strategiji obrazovanja, znanosti i tehnologije koja predviđa ustrojavanje cjelovitog sustava kao jednu od ključnih mjera za unapređivanje i osiguravanja kvalitete odgoja i obrazovanja u Hrvatskoj. Osiguranje kvalitete obuhvaća skup normi, mjera, postupaka i alata koji omogućuju praćenje, vrednovanje i unaprjeđenje kvalitete obrazovnog procesa. Obrazovne sustave potrebno je razvijati na način da su fleksibilne, učinkovite i usmjeren na učenike i polaznike prateći pokazatelje koji govore o tome koliko je obrazovanje svrhovito i je li u skladu s potrebama učenika, odnosno zadovoljava li potrebe tržišta rada. Uspostava sustava osiguravanja kvalitete omogućava transparentnost, odgovornost i stalno planiranje poboljšanja rada škola kao i ustanova za obrazovanje odraslih. Osiguravanje kvalitete obrazovanja uključuje unutarnje osiguravanje kvalitete samih obrazovnih ustanova na temelju samovrednovanja, te vanjsko osiguravanje kvalitete koje, na temelju propisanih objektivnih standarda i kriterija, provode nadležne agencije.

Samovrednovanje u srednjim školama Republike Hrvatske

Temeljna svrha samovrednovanja je kontinuirano unaprjeđivanje kvalitete odgojno-obrazovnoga procesa temeljeno na sveobuhvatnoj unutarnjoj procjeni vlastitog rada škole te je u biti podloga daljnjega strateškoga razvoja škole. Sustavno praćenje, analiziranje i vrjednovanje koje se provodi tijekom procesa samovrednovanja prvenstveno treba biti usmjereno na prepoznavanje snaga i područja za unaprjeđenje. Proces samovrednovanja u srednjim školama provodi se jednom godišnje, a provodi ga tim za samovrednovanje koji organizira i koordinira provedbu u suradnji s Povjerenstvom za kvalitetu. Rezultati samovrednovanja se ugrađuju u godišnji plan i program rada škole.

Slika 1.-Postupci vrednovanja škola i ustanova – izvor: Agencija za strukovno obrazovanje i obrazovanje odraslih)



Temeljno načelo procesa samovrednovanja je stavljanje učenika u središte pa je naglasak na procjeni kvalitete procesa poučavanja i učenja i na učeničkim iskustvima u tom procesu. Važno je da u procesu samovrednovanja sudjeluju svi oni o kojima ovisi kvaliteta obrazovanja u školi (učenici, nastavnici, uprava škole i vanjski dionici) te da dobro razumiju

svoju ulogu u tomu procesu. Proces samovrednovanja provodi se kao analiza prioritetnih područja a ona uključuju: kvalitetu nastave, zadovoljstvo učenika, učenička postignuća, profesionalni razvoj nastavnika, materijalne uvjete, suradnju unutar ustanove kao i suradnju ustanove s ostalim dionicima te školsku klimu. U procesu samovrednovanja, prosudbe o kvaliteti pojedinih područja kvalitete, trebaju biti potkrijepljene relevantnim dokazima I pokazateljima, pa se sukladno tome i planiranje daljnjega razvoja temelji na podatcima i dokazima.

Slika 2.- Metodologija-samovrednovanja-ustanova – izvor: Metodologija-samovrjednovanja-ustanova-za-strukovno-obrazovanje_2020.

<table>
<tr><td></td><td colspan="6">Prioritetna područja</td></tr>
<tr><td></td><td>Planiranje i programiranje rada</td><td>Poučavanje i podrška učenju</td><td>Postignuća učenika i ishodi učenja</td><td>Materijalni uvjeti i ljudski potencijali – profesionalni razvoj radnika ustanove</td><td>Suradnja unutar ustanove za strukovno obrazovanje - suradnja s ostalim dionicima - promicanje ustanove</td><td>Upravljanje (ustanova i kvaliteta)</td></tr>
<tr><td rowspan="10">Područja kvalitete</td><td rowspan="5">Školski kurikulum i godišnji plan i program rada ustanove</td><td>Upisi polaznika</td><td rowspan="2">Unutarnje praćenje i ocjenjivanje odgojno--obrazovnih postignuća polaznika</td><td rowspan="2">Osiguravanje okruženja za učenje</td><td>Školski odbor</td><td rowspan="2">Upravljanje kvalitetom</td></tr>
<tr><td>Planiranje nastave, poučavanja i učenja</td></tr>
<tr><td>Nastavni proces</td><td rowspan="2">Materijalni uvjeti/ upravljanje resursima</td><td rowspan="2">Ravnatelj ustanove</td></tr>
<tr><td>Učenje kroz iskustvo (vježbe i praktična nastava)</td><td rowspan="2">Ispiti (predmetni, popravni, razlikovni, razredni i završni rad)</td><td rowspan="2">Interno praćenje postupaka kvalitete</td></tr>
<tr><td>Vježbenička tvrtka</td><td rowspan="3">Financije</td><td>Poslovna komunikacija</td></tr>
<tr><td>Izvannastavne aktivnosti (izvannastavne i izvanškolske aktivnosti)</td><td rowspan="2">Vanjsko vrjednovanje</td><td>Informacijski sustav</td><td rowspan="2">Proces samovrjednovanja</td></tr>
<tr><td rowspan="4">Izradba i poboljšanja programa obrazovanja odraslih</td><td>Služba za pružanje podrške polaznicima</td><td rowspan="3">Kadrovska politika</td><td>Partnerstva</td></tr>
<tr><td>Polaznici s posebnim odgojno--obrazovnim potrebama</td><td rowspan="3">Natjecanja i smotre radova polaznika</td><td rowspan="3">Promicanje ustanove za strukovno obrazovanje i obrazovnih programa</td><td rowspan="3">Proces unaprjeđenja</td></tr>
<tr><td>Pohađanje nastave</td></tr>
<tr><td>Komunikacija i suradnja</td><td>Trajno stručno usavršavanje radnika</td></tr>
</table>

Proces se odvija kroz nekoliko faza:

1. Priprema i planiranje

- Pri planiranju samovrednovanja vrlo je važno osigurati da svi uključeni u sam proces razumiju koja je svrha provedbe samovrednovanja, kako će pojedine aktivnost pridonijeti poboljšanju kvalitete rada škole te koje će dobrobiti na kraju imati učenici, nastavnici i uprava. Za uspješnu provedbu procesa samovrednovanja potrebno je dobro proučiti područja kvalitete, standarde kvalitete i opisnice standarda. Potrebno je dogovoriti nadležnosti i odgovornosti svih sudionika u procesu samovrednovanja. Ključnu ulogu u tome ima uprava škole koja treba jasno odrediti osobe odgovorne za provedbu pojedinih aktivnosti.

2. Provedba procesa samovrednovanja

- Proces samovrednovanja temelji se na donošenju prosudbi za svako od područja

djelovanja škole kojima se procjenjuje do koje razine su ispunjeni pojedini standardi kvalitete. U procesu ocjenjivanja izvedbe i donošenja prosudbi treba utvrditi provode li se određene aktivnosti ili ne i koliko se one dobro provode, pri čemu se uzimaju u obzir kriteriji kvalitete pojedinoga područja. Prvi korak u tom procesu je prikupljanje podataka i dokaza koji će poslužiti za samoprocjenu ispunjenosti standarda kvalitete utemeljenoj na relevantnim informacijama. Dokazi se prikupljaju iz postojećih izvora, odnosno školske dokumentacije. Neke dokaze će biti potrebno izraditi, to su npr. ankete o zadovoljstvu dionika (učenika, roditelja, nastavnika i sl.). U proces samovrednovanja potrebno je uključiti i vanjske dionike kao što su poslodavci odnosno predstavnici tržišta rada, predstavnici lokalne uprave s kojima škola surađuje, predstavnici dugih obrazovnih ustanova i sl.

3. Sastavljanje izvješća o samovrednovanju i izrada plana unapređenja

- Na temelju rezultata provedenoga procesa samovrjednovanja škola sastavlja izvješće, koje sadrži:
  - cjelokupnu prosudbu - kratko objašnjenje o misiji i viziji škole, i njezinu radu, podatke o planovima i programima, učenicima i nastavnicima, te onome što vidi kao svoje glavne ciljeve i svrhu, sažetak ključnih prednosti i nedostataka u pojedinim područjima rada, uključujući i kvantitativne podatke. Ovdje treba istaknuti unaprjeđenja što ih je škola postigla od zadnjeg ciklusa samovrednovanja, navesti primjere dobre prakse koji pridonose kvaliteti poučavanja i učenja te pružanju podrške učenicima u ostvarivanju rezultata
  - prosudbe po prioritetnim područjima pri čemu svako prioritetno područje treba sadržavati ocjene područja kvalitete i dokaze koji potkrjepljuju donesene ocjene i prosudbe
  - godišnje planove unaprjeđenja kojim se definiraju ciljevi po određenim područjima rada koji se žele postići kako bi se unaprijedilo postojeće stanje i otklonile utvrđene poteškoće. Ciljevi trebaju biti jasni, ostvarivi i mjerljivi, te je uz njih potrebno definirati aktivnosti kojima će se oni postići, tko je odgovoran za provedbu, utvrditi vremenik i definirati resurse koji su potrebni za provedbu planiranih aktivnosti

4. Praćenje realizacije plana

- Tijekom provedbe praćenja realizacije plana i prosudbe u kojoj mjeri su postignuti rezultati za unaprjeđenje treba analizirati:
  - koji su rezultati postignuti i do koje mjere su oni u skladu s postavljenim ciljevima
  - jesu li postignuti neki neplanirani rezultati
  - postoje li dokazi o godišnjem unaprjeđenju
  - razmotriti mogućnosti za razmjenu iskustava i najboljih praksi.

Samovrednovanje i vanjsko vrednovanje ustanova za obrazovanje odraslih

U sustavu obrazovanja odraslih, kvaliteta se osigurava kroz samovrednovanje i vanjsko vrednovanje koje provodi Agencija za strukovno obrazovanje i obrazovanje odraslih (ASOO). Samovrednovanje u ustanovama provodi se najmanje svake četiri godine i

obuhvaća ključna područja: upravljanje, obrazovne programe, poučavanje i učenje, podršku polaznicima, resurse i kulturu kvalitete. Postupak uključuje korištenje različitih alata: analize dokumenata, anketa, SWOT analize i samoprocjenskih obrazaca. Temeljem nalaza izrađuje se plan unaprjeđenja. Vanjsko vrednovanje ustanova provodi ASOO. Obuhvaća analizu samovrednovanja, posjet ustanovi, intervjue s dionicima i ocjenjivanje prema jasno definiranim kriterijima. Kvaliteta rada ustanove se ocjenjuje kao: vrlo visoka, visoka, zadovoljavajuća ili nezadovoljavajuća razina kvalitete. Na temelju zapisnika, Agencija donosi rješenje koje se javno objavljuje.

Samovrednovanje ustanova za obrazovanje odraslih

Ustanove za obrazovanje odraslih igraju ključnu ulogu u osiguravanju kvalitete obrazovnih procesa, a samovrednovanje se pokazuje kao jedan od najučinkovitijih alata za unaprjeđenje kvalitete rada tih ustanova. Riječ je o sustavnom i kontinuiranom procesu u kojem ustanova sama analizira, vrednuje i unapređuje vlastiti rad. U suvremenom obrazovnom okruženju, samovrednovanje nadilazi ulogu administrativne obveze jer ono postaje strateški alat kojim se potiče refleksija, odgovornost, planiranje i razvoj. Samovrednovanje omogućava ustanovama da prepoznaju vlastite snage i slabosti te da kontinuirano odgovaraju na potrebe tržišta rada i društva u cjelini. Samovrednovanje se temelji na konceptu unutarnje evaluacije i kvalitativnog razvoja institucija. Cilj mu je potaknuti zaposlenike i upravu na kritičko promišljanje o vlastitim praksama, ishodima i resursima. Ono pruža ustanovi priliku da iz vlastite perspektive procijeni razinu učinkovitosti i uspješnosti u ispunjavanju svojih obrazovnih ciljeva. Samovrednovanje je alat za postizanje izvrsnosti, povećanje učinkovitosti i jačanje povjerenja javnosti u ustanovu.

U okviru obrazovanja odraslih, svrha samovrednovanja obuhvaća:

- unapređenje kvalitete nastave i učenja
- praćenje uspješnosti i zadovoljstva polaznika
- identifikaciju potreba za stručnim usavršavanjem nastavnika
- poboljšanje organizacijskih procesa i strategija
- jačanje komunikacije unutar ustanove
- osiguravanje transparentnosti prema korisnicima i partnerima

Ustanove su dužne razviti vlastite mehanizme unutarnje kontrole kvalitete, što uključuje prikupljanje i analizu podataka, evaluaciju programa, nastavnika i metoda rada. Agencija za strukovno obrazovanje i obrazovanje odraslih (ASOO) daje smjernice i podršku ustanovama u procesu samovrednovanja. ASOO je razvila Vodič za samovrednovanje ustanova za obrazovanje odraslih, koji detaljno opisuje korake, metode i instrumente koje ustanove mogu koristiti u tom procesu. Ustanove su pozvane da samovrednovanje provode najmanje jednom godišnje i o rezultatima obavijeste nadležne institucije, uključujući i planove za unaprjeđenje.

Proces samovrednovanja obično se provodi u nekoliko ključnih faza:

1. Planiranje - u ovoj fazi definiraju se ciljevi samovrednovanja, određuju područja koja će se analizirati (npr. kvaliteta nastave, zadovoljstvo korisnika, upravljanje

ustanovom), formira se tim za samovrednovanje te se razvija vremenski plan i metodologija.

2. Prikupljanje podataka - ustanove koriste različite metode za prikupljanje informacija, uključujući:

- anketiranje polaznika i nastavnika
- fokus-grupe
- intervjue
- analizu statističkih pokazatelja (npr. broj polaznika, prolaznost, uspjeh)
- analizu dokumentacije i strategija

3. Analiza i interpretacija - prikupljeni podaci se obrađuju i interpretiraju u kontekstu postavljenih ciljeva. Ključno je identificirati što funkcionira dobro, a gdje postoje izazovi i prostori za poboljšanje.

4. Izvještavanje i dijeljenje rezultata - rezultati samovrednovanja trebaju biti dokumentirani u obliku izvještaja koji se dijeli s relevantnim dionicima – zaposlenicima, upravom, a u nekim slučajevima i vanjskim partnerima ili korisnicima.

Izrada plana unaprjeđenja - na temelju rezultata, ustanova izrađuje konkretan akcijski plan koji uključuje aktivnosti za poboljšanje, vremenske rokove, odgovorne osobe i pokazatelje uspjeha.

Ustanove najčešće vrednuju sljedeća područja:

- Kvaliteta nastavnog procesa: uključuje metodički pristup, usklađenost nastavnog plana s ishodima učenja, korištenje suvremenih metoda rada, primjenu digitalnih alata i zadovoljstvo polaznika.
- Stručno usavršavanje nastavnika: evaluira se učestalost i relevantnost edukacija, kao i način primjene novostečenih znanja.
- Zadovoljstvo korisnika: prikupljaju se povratne informacije o organizaciji nastave, sadržaju, pristupu predavača i općem dojmu polaznika.
- Upravljanje i organizacija rada: odnosi se na učinkovitost rukovođenja, komunikaciju unutar ustanove, planiranje i evaluaciju poslovnih procesa.
- Materijalni i prostorni uvjeti: vrednuju se resursi poput opreme, prostora za učenje, pristupačnosti i digitalne infrastrukture.

Provedba samovrednovanja u ustanovi za obrazovanje odraslih važna je jer prije svega potiče jačanje kvalitete i odgovornosti, omogućeno je brzo prepoznavanje i rješavanje problema, potiče se profesionalni razvoj zaposlenika, povećava se zadovoljstvo polaznika, podupire se strateško planiranje i donošenje odluka temeljenih na dokazima. Naravno, samovrednovanje ustanovi za obrazovanje odraslih donosi i određene izazove, a to su prije svega nedostatak vremena i resursa za provedbu temeljitog samovrednovanja, moguća subjektivnost u procjeni, otpor samovrednovanju i promjenama kod dijela zaposlenika, potreba za dodatnom edukacijom u području evaluacije i analize podataka.

Samovrednovanje ustanova za obrazovanje odraslih predstavlja ključni mehanizam za osiguranje i unapređenje kvalitete obrazovnih usluga. U konačnici, riječ je o procesu koji vodi ne samo boljoj kvaliteti obrazovanja, već i većem profesionalnom zadovoljstvu djelatnika te većem povjerenju javnosti u obrazovne institucije.

Vanjsko vrednovanje ustanova za obrazovanje odraslih

Osiguranje kvalitete u sustavu obrazovanja odraslih predstavlja nužan preduvjet za njegovu učinkovitost i relevantnost. Jedan od najvažnijih mehanizama tog sustava je vanjsko vrednovanje ustanova za obrazovanje odraslih, koje se provodi u svrhu provjere usklađenosti rada ustanova s propisanim standardima, unapređenja kvalitete te jačanja povjerenja korisnika i javnosti. Vanjsko vrednovanje je sustavan proces u kojem neovisna tijela ili stručnjaci izvan ustanove provode procjenu rada obrazovne ustanove u odnosu na unaprijed definirane kriterije i standarde. Za razliku od samovrednovanja, koje je unutarnji i introspektivni proces, vanjsko vrednovanje donosi objektivnu, nepristranu sliku stanja i osigurava dodatnu razinu nadzora i kontrole kvalitete.

Vanjsko vrednovanje ujedno djeluje i poticajno jer ustanove koje prolaze vanjsku evaluaciju često su motiviranije za profesionalni razvoj, bolju organizaciju rada i učinkovitije odgovaranje na potrebe polaznika. U Republici Hrvatskoj, vanjsko vrednovanje ustanova za obrazovanje odraslih temelji se na Zakonu o obrazovanju odraslih koji propisuje da se obrazovanje odraslih provodi u skladu s načelima kvalitete, učinkovitosti i transparentnosti te da su ustanove dužne sudjelovati u vanjskom vrednovanju i nadzoru koje provodi Agencija za strukovno obrazovanje i obrazovanje odraslih i Pravilniku o načinu i postupku vanjskog vrednovanja kojim se uređuje metodologija, kriteriji i dinamika vanjskog vrednovanja.

U ustanovi za obrazovanje odraslih vanjsko vrednovanje se provodi kroz pet područja kvalitete i svako područje kvalitete ima svoje standarde kvalitete koji su detaljnije razrađeni u tablici ispod.

Tablica 1.: Područja kvalitete i standardi kvalitete za vrednovanje ustanova za obrazovanje odraslih – izvor: Smjernice za provedbu vanjskog vrednovanja ustanova za obrazovanje odraslih – Agencija za strukovno obrazovanje i obrazovanje odraslih.

PODRUČJA KVALITETE	STANDARDI KVALITETE
I. UPRAVLJANJE USTANOVOM I SUSTAVOM OSIGURAVANJA KVALITETE	1.1. Ustanova za obrazovanje odraslih uspostavila je učinkovit sustav upravljanja ustanovom.
	1.2. Ustanova za obrazovanje odraslih uspostavila je učinkovit unutarnji sustav osiguravanja kvalitete koji je dio strateškog upravljanja.
	1.3. Ustanova za obrazovanje odraslih redovito provodi proces samovrednovanja i temeljem nalaza procesa samovrednovanja kontinuirano unaprjeđuje kvalitetu svih svojih aktivnosti.
	1.4. Ustanova za obrazovanje odraslih redovito prikuplja i analizira podatke o svim svojim aktivnostima te dobivene analize koristi za daljnja unaprjeđenja
	1.5. Ustanova za obrazovanje odraslih vodi i čuva andragošku dokumentaciju i evidencije te izdaje javne isprave u skladu s propisima
II. OBRAZOVNI PROGRAMI, UČENJE I POUČAVANJE	2.1. Program obrazovanja odraslih utemeljen je na konceptu ishoda učenja i usklađen s HKO.
	2.2. Učenje i poučavanje usmjereno je na polaznika i u skladu je s predviđenim ishodima učenja.
	2.3. Ustanova za obrazovanje odraslih omogućava učenje temeljeno na radu i stjecanje praktičnih vještina.
III. POSTIGNUĆA POLAZNIKA I BRIGA O POLAZNICIMA	3.1. Vrednovanje postignuća polaznika je objektivno i dosljedno te osigurava stjecanje predviđenih ishoda učenja.
	3.2. Ustanova za obrazovanje odraslih prati polaznike nakon završetka obrazovanja i u skladu s nalazima unapređuje kvalitetu svoga rada.
	3.3. Ustanova za obrazovanje odraslih osigurava upis polaznika odgovarajućeg predznanja i motivacije, potiče uključivanje polaznika iz ranjivih i podzastupljenih skupina te vodi brigu o napredovanju polaznika.
	3.4. Ustanova za obrazovanje odraslih ima odgovarajući sustav podrške polaznicima koji je prilagođen potrebama raznolike populacije polaznika
IV. LJUDSKI I MATERIJALNI RESURSI	4.1. Nastavnički kapaciteti zadovoljavajući su za kvalitetno izvođenje nastave i osiguravaju postizanje predviđenih ishoda učenja.
	4.2. Prostorni i materijalni uvjeti zadovoljavajući su za izvođenje programa obrazovanja odraslih i osiguravaju postizanje predviđenih ishoda učenja.

	4.3. Ustanova za obrazovanje odraslih upravlja financijama na održiv i razvojno usmjeren način.
V. INFORMIRANJE JAVNOSTI, KOMUNIKACIJA I SURADNJA, INTEGRITET I ETIČNOST	5.1. Ustanova za obrazovanje odraslih objavljuje informacije o svim svojim aktivnostima te aktivno promovira ulogu i važnost obrazovanja odraslih.
	5.2. Ustanova za obrazovanje odraslih aktivno surađuje s drugim ustanovama i organizacijama te potiče mobilnost i internacionalizaciju, prijenos znanja i inovativnost.
	5.3. Ustanova za obrazovanje odraslih je razvila mehanizme za očuvanje integriteta, prevenciju i sankcioniranje svih oblika neetičnog ponašanja.

Agencija za strukovno obrazovanje i obrazovanje odraslih je središnje tijelo nadležno za provedbu vanjskog vrednovanja ustanova za obrazovanje odraslih. Agencija razvija smjernice i instrumente za vrednovanje, organizira i provodi stručne nadzore i evaluacije, izrađuje izvješća i preporuke temeljem vrednovanja i pruža stručnu potporu ustanovama u procesu unaprjeđenja kvalitete.

Vanjsko vrednovanje se provodi kroz nekoliko jasno definiranih faza:

1. Priprema vrednovanja - ustanova koja će biti vrednovana dobiva najavu ili obavijest o predstojećem vrednovanju. Može se zatražiti dostava dodatne dokumentacije te se određuje tim stručnjaka koji će provoditi vrednovanje.

2. Terenski posjet - tijekom posjeta ustanovi, evaluatori razgovaraju s upravom, nastavnicima i polaznicima, analiziraju nastavne aktivnosti, materijale i dokumentaciju, promatraju nastavu i vode zabilješke, provjeravaju ispunjenosti zakonskih i programskih zahtjeva

3. Izrada izvješće o vanjskom vrednovanju ustanove - na temelju prikupljenih podataka izrađuje se izvješće o vanjskom vrednovanju koje uključuje opis stanja u ustanovi, ocjenu razine usklađenosti s propisanim standardima, identifikaciju snaga i slabosti, preporuke za poboljšanje

4. Praćenje provedbe preporuka - ustanove su obvezne izraditi akcijski plan za provedbu preporuka, dok ASOO može provoditi naknadni nadzor radi provjere implementacije mjera.

Vanjsko vrednovanja u obrazovanju odraslih suočava se i s izazovima a to su otpor promjenama jer djelatnici ponekad doživljavaju vrednovanje kao prijetnju umjesto kao priliku, nedovoljna standardizacija u provedbi može dovesti do različitih tumačenja kriterija te je potrebna dodatna edukacija za ustanove i za vrednovatelje u području andragogije i evaluacije. Za prevladavanje ovih izazova važno je ulaganje u kontinuirano usavršavanje kadrova, unaprjeđenje procedura i jačanje suradnje između ustanova i Agencije.

Vanjsko vrednovanje ustanova za obrazovanje odraslih ključno je za osiguranje i unaprjeđenje kvalitete obrazovanja u Hrvatskoj. Ono omogućuje sustavan uvid u rad ustanova, promiče profesionalnost, potiče razvoj i povećava povjerenje javnosti. Uz jasno definirane kriterije, stručne evaluatore i konstruktivnu suradnju, vrednovanje može biti snažan alat za poticanje izvrsnosti u obrazovanju odraslih.

Vanjsko vrednovanje skupova ishoda učenja

Skup ishoda učenja predstavlja najmanji cjelovit skup povezanih ishoda učenja, odnosno konkretan mjerljivi rezultat koji učenik ili polaznik treba usvojiti tijekom obrazovanja na određenoj razini.

Vanjsko vrednovanje ishoda učenja je standardizirano vrednovanje koje se provodi kako bi se osigurala vjerodostojnost kvalifikacija i dosljednost provedbe obrazovnih programa. Može se provoditi na određenoj populaciji učenika, na razini škole ili ustanove za obrazovanje odraslih ili na nacionalnoj razini. Na nacionalnoj razini provode se ispiti državne mature i nacionalni ispiti, pomoću standardiziranih testova i postupaka, a škole su dužne rezultate tih ispita koristiti za analizu i samovrednovanje u svrhu unapređivanja rada i poboljšanja kvalitete škole.

Strategija obrazovanja, znanosti i tehnologije na području vrednovanja ishoda učenja propisuje sljedeće mjere:

- razrada, rasprava i uspostavljanje cjelovitog okvira vanjskog vrednovanja ishoda učenja u različitim vrstama obrazovanja i na različitim obrazovnim razinama;
- definiranje nadležnosti za upravljanje i primjenu okvira vanjskog vrednovanja;
- razrada modela korištenja rezultata periodičnih vanjskih ispita za praćenje ostvarivanja obrazovnih ishoda na nacionalnoj razini;
- rekonceptualizacija modela državne mature u skladu s novim kurikularnim ciljevima;
- uspostavljanje modela vanjskog vrednovanja - certificiranja strukovnih kvalifikacija u sustavu strukovnog obrazovanja.

Prema Protokolu vanjskog vrednovanja skupova ishoda učenja (ASOO, 2023), postupak vrednovanja u ustanovama za obrazovanje odraslih odvija se tijekom završne provjere znanja ili obrane završnog rada na samom kraju obrazovnog ciklusa. Vrednovanje provodi povjerenstvo koje se sastoji od dva vanjska ispitivača imenovana od strane Agencije za strukovno obrazovanje i obrazovanje odraslih te jednog člana povjerenstva ustanove koje provodi završnu provjeru ili obranu završnog rada.

- Odluku o provedbi vanjskog vrednovanja skupova ishoda učenja Agencija može donijeti na temelju:
- stručno-andragoške procjene Agencije
- rezultata vanjskog vrednovanja ustanove
- nalaza nadzora nad stručnim radom i inspekcijskoga nadzora nad radom ustanove
- prijave na rad ustanove.

Ustanova za obrazovanje odraslih podnosi prijavu provedbe završne provjere ili obrane završnog rada Agenciji, najkasnije 15 dana prije održavanja završne provjere ili obrane završnog rada, ili provjere ishoda učenja u sklopu programa vrednovanja. Prijava sadrži popis kandidata, termine i sastav povjerenstva ustanove, te program obrazovanja u skladu s kojim se vrednovanje provodi. Na temelju zaprimljenih prijava, Agencija donosi Odluku o provedbi vanjskog vrednovanja skupova ishoda učenja u sklopu programa obrazovanja /

programa vrednovanja za one ustanove nad kojima će se provesti vanjsko vrednovanje skupova ishoda učenja te obavještava ustanovu te imenuje vanjske ispitivače.

Povjerenstvo imenovano od strane Agencije provodi završnu provjeru ili obranu završnog rada te sastavlja zapisnik. Ako se tijekom provedbe utvrde nepravilnosti, Agencija može naložiti ponavljanje postupka, dodatni nadzor ili zabranu izdavanja javnih isprava. Ovaj postupak pridonosi objektivnosti i nepristranosti u vrednovanju postignuća polaznika, osigurava dosljednost u provedbi programa obrazovanja i ukupno podiže kvalitetu obrazovanja.

Zaključak

Kako bi se osigurala kvaliteta obrazovnog sustava potrebno je imati razvijene mehanizme za praćenje i unaprjeđenje rada školskih ustanova i ustanova za obrazovanje odraslih. Sustav osiguravanja kvalitete u Republici Hrvatskoj kontinuirano se razvija na svim razinama, a temelji se na kombinaciji samovrednovanja i vanjskog vrednovanja, koji zajedno omogućuju školama i ustanovama za obrazovanje odraslih da djeluju strateški, odgovorno i transparentno. Osiguravanje kvalitete podrazumijeva kvalitetnu procjenu i evaluaciju postojećeg stanja kako bi se buduće aktivnosti unapređenja kvalitete temeljile na pouzdanim informacijama o uočenim nedostacima te se na temelju njih planirale aktivnosti potrebne za napredovanje. Vrlo je važno da u tom procesu vrednovanje ne bude formalnost, već kontinuitet kojim su omogućene stvarne promjene. Daljnji razvoj kvalitete i dalje se treba temeljiti na jačanju kapaciteta donositelja odluka, obrazovnih djelatnika te obrazovnih stručnjaka koji rade u javnim institucijama a koji su odgovorni za razvoj i provedbu politike obrazovanja.

Strukturiran i sveobuhvatan sustav osiguravanja kvalitete ojačat će povjerenje u kvalitetu obrazovnih ustanova na svim razinama, potaknuti veću suradnju svih dionika u sustavu te u konačnici povećati kompetencije i zapošljivost radne snage u Hrvatskoj.

Literatura i izvori podataka

- Zakon o odgoju i obrazovanju u osnovnoj i srednjoj školi (Narodne novine, br. 87/08 i dr.)
- Zakon o obrazovanju odraslih (Narodne novine, br. 144/21)
- Pravilnik o načinu vanjskog vrednovanja ustanova za obrazovanje odraslih i skupova ishoda učenja (Narodne novine, br. 19/23)
- Priručnik za unutarnje osiguravanje kvalitete u obrazovanju odraslih, ASOO, 2022.
- Protokol vanjskog vrednovanja skupova ishoda učenja, ASOO, 2023.
- Smjernice AZOO-a i ASOO-a za samovrednovanje u školama i ustanovama
- Metodologija-samovrjednovanja-ustanova-za-strukovno-obrazovanje_2020.

ROAD TRAFFIC SCHOOL, ZAGREB

Authors:

Renata Heljić, mag.ing.mech.

Tomislav Kučina, mag.ing.traff.



QUALITY ASSURANCE OF THE EDUCATION SYSTEM

IN THE REPUBLIC OF CROATIA

Summary:

Quality assurance of the education system of the Republic of Croatia is the basis for the systematic improvement of education. Self-evaluation and external evaluation systems are becoming key tools in identifying real needs, developing schools and institutions, and achieving transparency and accountability. The self-evaluation process includes an internal assessment of the quality of school work through selected areas such as learning and teaching, management, school climate, and student achievement. The results of self-evaluation are used to develop an improvement plan that is integrated into the annual school plan. In addition to schools, adult education institutions are required to conduct self-evaluation, which includes an assessment of areas such as management, teaching process, student support, and ethics. External evaluation of sets of learning outcomes is carried out as a procedure for independent verification of the acquisition of knowledge and skills by students and trainees during schooling or final examinations. The procedure is carried out by committees appointed by competent institutions. The evaluation results are used to improve the program, as well as to preserve the credibility of the acquired qualifications. Quality education requires systematic evaluation and improvement. The Croatian quality assurance system, through self-evaluation and external evaluation, encourages schools and adult education institutions to be accountable, transparent and continuously improve. Using evaluation results as a basis for strategic planning is key to developing the education system in line with the needs of society and the labor market.

Keywords:

- School self-evaluation

- External evaluation of institutions

- External evaluation of learning outcomes

QUALITY ASSURANCE OF THE EDUCATION SYSTEM

IN THE REPUBLIC OF CROATIA

Introduction

The concept of quality assurance in the education system in the Republic of Croatia is based on the Strategy of Education, Science and Technology, which envisages the establishment of a comprehensive system as one of the key measures for improving and ensuring the quality of education in Croatia. Quality assurance encompasses a set of norms, measures, procedures and tools that enable monitoring, evaluating and improving the quality of the educational process. Educational systems need to be developed in a way that is flexible, efficient and focused on students and participants, following indicators that show how purposeful education is and whether it is in line with the needs of students, i.e. whether it meets the needs of the labor market. The establishment of a quality assurance system allows for transparency, accountability and continuous planning for improving the work of schools and adult education institutions. Quality assurance in education includes internal quality assurance of educational institutions ~~themselves~~ based on self-evaluation, and external quality assurance, which is carried out by competent agencies based on prescribed objective standards and criteria.

Self-evaluation in secondary schools in the Republic of Croatia

The fundamental purpose of self-evaluation is to continuously improve the quality of the educational process based on a comprehensive internal assessment of the school's own work and is essentially the basis for the school's further strategic development. Systematic monitoring, analysis and evaluation carried out during the self-evaluation process should primarily be focused on identifying strengths and areas for improvement. The self-evaluation process in secondary schools is carried out once a year, and is carried out by a self-evaluation team that organizes and coordinates the implementation in cooperation with the School Quality Commission. The results of the self-evaluation are incorporated into the school's annual work plan and program.

Figure 1.- Evaluation procedures for schools and institutions – source: Agency for Vocational Education and Adult Education



The fundamental principle of the self-evaluation process is to put students at the centre, so the emphasis is on assessing the quality of the teaching and learning process and on students' experiences in that process. It is important that all those on whom the quality of education in the school depends (students, teachers, school management and external stakeholders) participate in the self-evaluation process and that they clearly understand their role in the process. The self-evaluation process is carried out as an analysis of priority areas, which include: teaching quality, student satisfaction, student achievement, teacher professional development, material conditions, cooperation within the institution as well as cooperation between the institution and other stakeholders, and school climate. In the self-evaluation process, judgments about the quality of individual quality areas should be supported by relevant evidence and indicators, and accordingly, planning for further development is based on data and evidence.

Figure 2.- Methodology-of-self-evaluation-of-institutions – source: Methodology-of-self-evaluation-of-institutions-for-vocational-education_2020.



The process takes place in several stages:

1. Preparation and planning

When planning a self-evaluation, it is very important to ensure that everyone involved in the process understands the purpose of implementing the self-evaluation, how individual activities will contribute to improving the quality of the school's work, and what benefits students, teachers, and administration will ultimately have. For the successful implementation of the self-evaluation process, it is necessary to thoroughly study the quality areas, quality standards, and standard descriptors. It is necessary to agree on the competencies and responsibilities of all participants in the self-evaluation process. The school administration plays a key role in this, as it should clearly identify the persons responsible for implementing individual activities.

2. Implementation of the self-evaluation process

The self-evaluation process is based on making judgments for each of the school's areas of activity, which assess the level to which individual quality standards have been met. In the process of assessing performance and making judgments, it should be determined whether or not certain activities are being implemented and how well they are being implemented, taking into account the quality criteria of each area. The first step in this process is to collect data and evidence that will serve for self-assessment of the fulfilment of quality standards based on relevant information. Evidence is collected from existing sources, i.e. school documentation. Some evidence will need to be produced, such as surveys on stakeholder satisfaction (students, parents, teachers, etc.). External stakeholders such as employers or representatives of the labor market, representatives of local authorities with whom the school cooperates, representatives of other educational institutions, etc. need to be included in the self-evaluation process.

3. Compiling a self-evaluation report and developing an improvement plan based on the results of the self-evaluation process, the school compiles a report, which contains:

- overall assessment - a brief explanation of the school's mission and vision, and its work, information on curricula, students and teachers, and what it sees as its main goals and purpose, a summary of key strengths and weaknesses in individual areas of work, including quantitative data. This should highlight improvements the school has made since the last self-evaluation cycle, and provide examples of good practice that contribute to the quality of teaching and learning and support for students in achieving results
- judgments by priority areas, whereby each priority area should contain assessments of quality areas and evidence supporting the assessments and judgments made
- annual improvement plans, which define the goals for specific areas of work that are to be achieved in order to improve the current situation and eliminate identified difficulties. The goals should be clear, achievable and measurable, and along with them, it is necessary to define the activities that will achieve them, who is responsible for implementation, determine the timetable and define the resources that are needed for the implementation of the planned activities

4. Monitoring the implementation of the plan

During the implementation of the plan and the assessment of the extent to which the results for improvement have been achieved, the following should be analysed:

- what results have been achieved and to what extent they are in line with the set objectives
- whether any unplanned results have been achieved
- whether there is evidence of annual improvement
- consider opportunities for the exchange of experiences and best practices.

Self-evaluation and external evaluation of institutions for adult education

In the adult education system, quality is ensured through self-evaluation and external evaluation carried out by the Agency for Vocational Education and Training (ASOO). Self-evaluation in institutions is carried out at least every four years and covers key areas: management, educational programs, teaching and learning, support for participants, resources and quality culture. The procedure involves the use of various tools: document analysis, surveys, SWOT analysis and self-assessment forms. Based on the findings, an improvement plan has been developed. External evaluation of institutions is carried out by ASOO. It includes a self-evaluation analysis, a visit to the institution, interviews with stakeholders and an assessment according to clearly defined criteria. The quality of the institution's work is assessed as: very high, high, satisfactory or unsatisfactory quality level. Based on the minutes, the Agency issues a decision which is publicly announced.

Self-evaluation of institutions for adult education

Adult education institutions play a key role in ensuring the quality of educational processes, and self-evaluation has proven to be one of the most effective tools for improving the quality of work of these institutions. It is a systematic and continuous process in which the institution itself analyzes, evaluates and improves its own work. In the modern educational environment, self-evaluation goes beyond the role of an administrative obligation because it becomes a strategic tool that encourages reflection, responsibility, planning and development. Self-evaluation allows institutions to recognize their own strengths and weaknesses and to continuously respond to the needs of the labor market and society as a whole. Self-evaluation is based on the concept of internal evaluation and qualitative development of institutions. Its goal is to encourage employees and management to critically reflect on their own practices, outcomes and resources. It provides an institution with the opportunity to assess, from its own perspective, the level of efficiency and success in fulfilling its educational goals. Self-evaluation is a tool for achieving excellence, increasing efficiency and strengthening public trust in the institution.

Within adult education, the purpose of self-evaluation includes:

- improving the quality of teaching and learning
- monitoring the success and satisfaction of students
- identifying the needs for the professional development of teachers
- improving organizational processes and strategies
- strengthening communication within the institution
- ensuring transparency towards users and partners

Institutions are required to develop their own internal quality control mechanisms, which include data collection and analysis, evaluation of programmes, teachers and working methods. The Agency for Vocational Education and Training provides guidance and support to institutions in the self-evaluation process. Agency has developed a Guide for Self-Evaluation of Adult Education Institutions, which describes in detail the steps, methods and instruments that institutions can use in this process. Institutions are invited to conduct self-evaluation at least once a year and to inform the competent institutions about the results,

including plans for improvement.

The self-evaluation process is usually carried out in several key phases:

1. Planning - in this phase, the objectives of the self-evaluation are defined, the areas to be analysed (e.g. teaching quality, user satisfaction, institutional management) are determined, a self-evaluation team is formed, and a timeline and methodology are developed.
2. Data collection - institutions use various methods to collect information, including:

- student and teacher surveys
- focus groups
- interviews
- analysis of statistical indicators (e.g. number of students, pass rate, success)
- analysis of documentation and strategies

3. Analysis and interpretation - the collected data is processed and interpreted in the context of the set objectives. It is crucial to identify what is working well and where there are challenges and room for improvement.
4. Reporting and sharing results - the results of the self-evaluation should be documented in the form of a report that is shared with relevant stakeholders - employees, management, and in some cases, external partners or users.
5. Creation of an improvement plan - based on the results, the institution creates a concrete action plan that includes activities for improvement, timelines, responsible persons and indicators of success.

Institutions most often evaluate the following areas:

- Quality of the teaching process: includes the methodological approach, the alignment of the curriculum with learning outcomes, the use of modern work methods, the application of digital tools and student satisfaction.
- Professional development of teachers: the frequency and relevance of training is evaluated, as well as the way in which newly acquired knowledge is applied.
- User satisfaction: feedback is collected on the organization of classes, content, the approach of the lecturer and the general impression of the students.
- Management and organization of work: refers to the effectiveness of management, communication within the institution, planning and evaluation of business processes.
- Material and spatial conditions: resources such as equipment, learning space, accessibility and digital infrastructure are evaluated.

The implementation of self-evaluation in an adult education institution is important because, above all, it encourages the strengthening of quality and accountability, enables rapid identification and resolution of problems, encourages the professional development of employees, increases student satisfaction, supports strategic planning and evidence-based

decision-making. Of course, self-evaluation in an adult education institution also brings certain challenges, primarily the lack of time and resources to conduct a thorough self-evaluation, possible subjectivity in assessment, resistance to self-evaluation and changes on the part of employees, and the need for additional education in the field of evaluation and data analysis. Self-evaluation of adult education institutions is a key mechanism for ensuring and improving the quality of educational services. Ultimately, it is a process that leads not only to better quality of education, but also to greater professional satisfaction of employees and greater public trust in educational institutions.

External evaluation of adult education institutions

Quality assurance in the adult education system is a necessary prerequisite for its effectiveness and relevance. One of the most important mechanisms of this system is the external evaluation of adult education institutions, which is carried out for the purpose of checking the compliance of the institutions' work with prescribed standards, improving quality and strengthening the trust of users and the public. External evaluation is a systematic process in which independent bodies or experts outside the institution assess the work of an educational institution in relation to predefined criteria and standards. Unlike self-evaluation, which is an internal and introspective process, external evaluation provides an objective, impartial picture of the situation and ensures an additional level of supervision and quality control.

External evaluation also has an encouraging effect, because institutions that undergo external evaluation are often more motivated for professional development, better organization of work and more efficient response to the needs of participants. In the Republic of Croatia, external evaluation of adult education institutions is based on the Adult Education Act, which stipulates that adult education is carried out in accordance with the principles of quality, efficiency and transparency and that institutions are obliged to participate in external evaluation and supervision carried out by the Agency for Vocational Education and Adult Education and the Ordinance on the method and procedure of external evaluation, which regulates the methodology, criteria and dynamics of external evaluation.

In the institution for adult education, external evaluation is carried out through five quality areas and each quality area has its own quality standards, which are detailed in the table below.

Table 1: Quality areas and quality standards for the evaluation of adult education institutions – source: Guidelines for the implementation of external evaluation of adult education institutions – Agency for Vocational Education and Training and Adult Education.

AREAS OF QUALITY	QUALITY STANDARDS
I. INSTITUTION MANAGEMENT AND QUALITY ASSURANCE SYSTEM	1.1. The adult education institution has established an effective system of institutional management.
	1.2. The adult education institution has established an effective internal quality assurance system that is part of strategic management.
	1.3. The adult education institution regularly conducts self-evaluation and continuously improves the quality of all its activities based on the findings.
	1.4. The adult education institution regularly collects and analyses data on all its activities and uses the analyses for further improvements.
	1.5. The adult education institution maintains and stores andragogical documentation and records and issues public documents in accordance with regulations.
II. EDUCATIONAL PROGRAMS, LEARNING AND TEACHING	2.1. The adult education program is based on the concept of learning outcomes and aligned with the Croatian Qualifications Framework (CQF).
	2.2. Learning and teaching are learner-centred and aligned with the intended learning outcomes.
	2.3. The adult education institution enables work-based learning and the acquisition of practical skills.
III. LEARNER ACHIEVEMENTS AND LEARNER SUPPORT	3.1. The assessment of learner achievements is objective and consistent and ensures the acquisition of intended learning outcomes.
	3.2. The adult education institution tracks learners after completion of education and uses findings to improve its quality of work.
	3.3. The adult education institution ensures the enrolment of learners with appropriate prior knowledge and motivation, encourages the inclusion of learners from vulnerable and underrepresented groups, and supports learner progress.
	3.4. The adult education institution has an appropriate support system tailored to the needs of a diverse learner population.
IV. HUMAN AND MATERIAL RESOURCES	4.1. Teaching staff capacities are adequate for high-quality instruction and ensure the achievement of intended learning outcomes.
	4.2. Spatial and material conditions are adequate for delivering adult education programs and ensure the achievement of

	intended learning outcomes.
	4.3. The adult education institution manages finances in a sustainable and development-oriented manner.
V. PUBLIC INFORMATION, COMMUNICATION AND COOPERATION, INTEGRITY AND ETHICS	5.1. The adult education institution publishes information about all its activities and actively promotes the role and importance of adult education.
	5.2. The adult education institution actively cooperates with other institutions and organizations, encourages mobility and internationalization, knowledge transfer, and innovation.
	5.3. The adult education institution has developed mechanisms for preserving integrity and preventing and sanctioning all forms of unethical behaviour.

The Agency for Vocational Education and Adult Education is the central body responsible for implementing external evaluation of adult education institutions. The Agency develops guidelines and instruments for evaluation, organizes and conducts expert supervision and evaluations, prepares reports and recommendations based on evaluations, and provides expert support to institutions in the process of quality improvement.

External evaluation is carried out through several clearly defined phases:

1. Preparation of the evaluation - the institution to be evaluated receives an announcement or notification of the upcoming evaluation. Additional documentation may be requested and a team of experts is appointed to conduct the evaluation.
2. Field visit - during the visit to the institution, evaluators talk to the administration, teachers and students, analyse teaching activities, materials and documentation, observe classes and take notes, check compliance with legal and program requirements
3. Preparation of a report on the external evaluation of the institution - based on the collected data, an external evaluation report is prepared that includes a description of the state of the institution, an assessment of the level of compliance with the prescribed standards, identification of strengths and weaknesses, and recommendations for improvement
4. Monitoring the implementation of recommendations - institutions are required to develop an action plan for the implementation of recommendations, while ASOO may conduct subsequent supervision to verify the implementation of measures.

External evaluation in adult education also faces challenges, such as resistance to change because staff sometimes perceive evaluation as a threat rather than an opportunity, insufficient standardization in implementation can lead to different interpretations of criteria, and additional education is needed for institutions and evaluators in the field of andragogy and evaluation. To overcome these challenges, it is important to invest in continuous training of staff, improve procedures, and strengthen cooperation between institutions and the Agency.

External evaluation of adult education institutions is crucial for ensuring and improving the quality of education in Croatia. It provides a systematic insight into the work of institutions, promotes professionalism, encourages development, and increases public trust. With clearly

defined criteria, expert evaluators, and constructive cooperation, evaluation can be a powerful tool for fostering excellence in adult education.

External evaluation of learning outcome sets

A set of learning outcomes represents the smallest complete set of related learning outcomes, or a specific measurable result that a student or trainee should acquire during education at a certain level.

External evaluation of learning outcomes is a standardized evaluation that is carried out to ensure the credibility of qualifications and the consistency of the implementation of educational programs. It can be carried out on a specific population of students, at the level of a school or adult education institution, or at the national level. At the national level, state matriculation exams and national exams are conducted, using standardized tests and procedures, and schools are obliged to use the results of these exams for analysis and self-evaluation for the purpose of improving the work and quality of the school.

The Strategy for Education, Science, and Technology in the field of evaluation of learning outcomes prescribes the following measures:

- development, discussion, and establishment of a comprehensive framework for external evaluation of learning outcomes in different types of education and at different educational levels;
- definition of responsibilities for the management and application of the external evaluation framework;
- development of a model for using the results of periodic external examinations to monitor the achievement of educational outcomes at the national level;
- reconceptualization of the state matura model in accordance with new curricular goals;
- establishment of a model for external evaluation - certification of vocational qualifications in the vocational education system.

According to the Protocol for the External Evaluation of Learning Outcomes (ASOO, 2023), the evaluation process in adult education institutions takes place during the final knowledge assessment or the defence of the final thesis at the very end of the educational cycle. The evaluation is carried out by a committee consisting of two external examiners appointed by the Agency for Vocational Education and Training and one member of the committee of the institution conducting the final assessment or defence of the final thesis.

The Agency can make a decision on the implementation of external evaluation of sets of learning outcomes on the basis of:

- expert andragogical assessments of the Agency
- the results of the institution's external evaluation
- findings of supervision over professional work and inspection supervision over the work of the institution
- applications for the work of the institution

An adult education institution shall submit an application for the implementation of a final assessment or defence of a final thesis to the Agency, no later than 15 days before the final assessment or defence of a final thesis, or the assessment of learning outcomes as part of an evaluation programme. The application shall contain a list of candidates, the dates and composition of the institution's committee, and the education programme in accordance with which the evaluation is to be carried out. Based on the applications received, the Agency shall adopt a decision on the implementation of an external evaluation of learning outcome sets as part of an education programme/evaluation programme for those institutions on which an external evaluation of learning outcome sets will be carried out, and shall notify the institution and appoint external examiners.

The committee appointed by the Agency shall carry out the final assessment or defence of the final thesis and draw up a report. If irregularities are identified during the implementation, the Agency may order a repetition of the procedure, additional supervision or a ban on the issuance of public documents. This procedure contributes to objectivity and impartiality in the evaluation of student achievements, ensures consistency in the implementation of the education programme and overall raises the quality of education.

Conclusion

To ensure the quality of the education system, it is essential to develop tools for monitoring and enhancing the work of both school institutions and adult education institutions. The quality assurance system in the Republic of Croatia is continuously developing at all levels and is based on a combination of self-evaluation and external evaluation. Together, these approaches enable schools and adult education institutions to act strategically, responsibly, and transparently. Quality assurance involves assessing the current situation so that future quality improvement activities are based on reliable information about the identified shortcomings. Based on this, the necessary activities for progress can be planned. It is crucial that in this process, evaluation is not a formality but a continuity that enables real changes. Further development of quality should focus on strengthening the capacities of decision-makers, educational staff, and educational experts working in public institutions who are responsible for the development and implementation of education policy.

A structured and comprehensive quality assurance system will strengthen trust in the quality of educational institutions at all levels, encourage greater cooperation among all stakeholders in the system, and ultimately increase the competence and employability of the workforce in Croatia.

Literature and data sources

1. Act on Primary and Secondary Education (Official Gazette, No. 87/08 etc.)
2. Act on Adult Education (Official Gazette, No. 144/21)
3. Ordinance on the Method of External Evaluation of Adult Education Institutions and Learning Outcome Sets (Official Gazette, No. 19/23)
4. Manual for Internal Quality Assurance in Adult Education, ASOO, 2022.
5. Protocol for External Evaluation of Learning Outcome Sets, ASOO, 2023.
6. ETTA and ASOO Guidelines for Self-Evaluation in Schools and Institutions

7. Methodology-of-Self-Evaluation-of-Institutions-for-Vocational-Education_2020.

J.U. SREDNJA ŠKOLA ZA SAOBRAĆAJ I KOMUNIKACIJE SARAJEVO

Alija Šoljić, dipl.ing.saob.
MA Arnela Mujić, dipl.ing.saob. i kom.
Dr.sc. Kemal Jaganjac, dipl.ing.saob.

OD INFRASTRUKTURE ZA AUTOMOBILE KA ULICAMA ZA LJUDE

SAŽETAK

U kontekstu savremenih izazova urbanog saobraćaja – porasta motorizacije, zagađenja, saobraćajnih gužvi i smanjenja kvaliteta života u gradovima – sve veći broj evropskih metropola prepoznaje potrebu za redefinisanjem uloga javnog prostora i transformacijom ulica. Ovaj rad analizira pristupe transformacije gradskih ulica na primjerima dobre prakse, gdje su mjere usmjerene ka ograničavanju automobilskog saobraćaja, unapređenju pješačke i biciklističke infrastrukture, te promovisanju javnog prevoza dale mjerljive rezultate u vidu smanjenja emisija štetnih gasova, saobraćajnih nezgoda, te porasta fizičke aktivnosti i socijalne interakcije među građanima. Primjeri ovih gradova pokazuju kako se prostorna preraspodjela može koristiti kao sredstvo za unapređenje javnog zdravlja, ekonomske vitalnosti i ekološke održivosti. Na osnovu ovih iskustava, rad nudi preporuke za grad Sarajevo, usmjerene na integrisano planiranje održive mobilnosti, davanje prioriteta pješačkom i biciklističkom saobraćaju, te postepenu transformaciju ključnih gradskih ulica u prostore orijentisane na čovjeka.

Ključne riječi: ***infrastruktura, urbani saobraćaj, transformacija, pješaci, bicklisti***

UVOD

Brzi rast gradskih područja širom svijeta doveo je do saobraćajnih izazova sa kojima tradicionalni pristupi planiranju i upravljanju saobraćajem više ne mogu uspješno da izađu na kraj. Pretjerana usmjerenost ka korištenju privatnog automobila i razvoj infrastrukture koja primarno podržava ovaj vid transporta rezultovali su nizom prostornih i ekoloških problema. U urbanim sredinama visoke gustine jednostavno nema dovoljno prostora da se izgrade saobraćajnice i obezbijedi parking za sve korisnike privatnog prevoza, a da se istovremeno očuva kvalitet životne sredine i pravedna dostupnost prostora. Očekivanja da svi mogu voziti, parkirati besplatno ili jeftino i istovremeno uživati u zdravom gradskom okruženju pokazala su se kao neodrživa.

Poređenjem podataka iz 2012. i 2024. godine uočava se nastavak trenda rasta broja registrovanih cestovnih motornih vozila u Bosni i Hercegovini. Dok je 2012. zabilježen porast od 6,82% u odnosu na prethodnu godinu, u 2024. godini zabilježeno je povećanje od 4,98% u odnosu na 2023. godinu. Iako je godišnja stopa rasta nešto manja u novijem periodu, ukupan broj vozila je znatno veći, što ukazuje na kontinuirano povećanje stepena motorizacije. U nastavku su prikazane tabele s pregledom ukupnog broja registrovanih vozila u BiH u periodu od 2003. do 2024. godine.

Godina	Broj registrovanih vozila
2003	646.658
2004	695.828
2005	705.827
2006	769.682
2007	778.474
2008	881.389
2009	905.418
2010	954.425
2011	1.026.254
2012	1.096.232

Tabela 10. Broj registrovanih motornih vozila u BiH u periodu 2003. – 2012. godina

	Ukupan broj registrovanih vozila za 2021.	Ukupan broj registrovanih vozila za 2022.	Ukupan broj registrovanih vozila za 2023.	Ukupan broj registrovanih vozila za 2024.	Razlika u broju registrovanih vozila u % (2024. i 2023.)
Federacija BiH	690.600	707.521	740.101	**777.993**	**+ 5,12 %**
Republika Srpska	423.965	438.352	453.719	**476.077**	**+ 4,93 %**
Distrikt Brčko	38.178	38.885	39.963	**41.154**	**+ 2,98 %**
Ukupno u BiH	1.152.743	1.184.758	1.233.783	**1.295.224**	**+ 4,98 %**

Tabela 2. Ukupan broj registrovnih vozila za 2021; 2022; 2023; i 2024. godinu

U eri ubrzanih klimatskih promjena kojima se svi sistemi moraju prilagoditi, prostorna, ekonomska i ekološka ograničenja za dosadašnji način planiranja i regulisanja saobraćaja postaju još očiglednija, a njihove posljedice neizbježne i izražene kroz:

1. Saobraćajne gužve;
2. Duža putovanja;
3. Nedostatak prostora za sve učesnike u saobraćaju;
4. Povećane emisije štetnih gasova;
5. Loš kvalitet vazduha;
6. Zdravstvene probleme (gojaznost, kardiovaskularne probleme, stres);
7. Saobraćajne nezgode.

Saobraćaj zasnovan na svakodnevnoj upotrebi ličnih automobila ostavlja vidljive posljedice na naše gradove i živote. Zagađen zrak, buka i svakodnevne gužve nisu samo tehnički problemi – oni utiču na zdravlje, raspoloženje i osjećaj pripadnosti prostoru u kojem živimo. Osim što trošimo vrijeme u kolonama i traženju parkinga, gradovi gube dragocjen prostor koji bi mogao biti iskorišten za parkove, igrališta, biciklističke staze ili prostore za druženje. Ekonomski teret održavanja takvog sistema je velik, dok istovremeno oni koji nemaju pristup automobilu često ostaju uskraćeni za osnovnu mobilnost, usluge i sadržaje. Na taj

način se produbljuju društvene nejednakosti, a život u gradovima postaje sve stresniji i manje održiv.

Zato sve više gradova širom svijeta mijenja paradigmu – umjesto da se urbanistički planovi podređuju automobilima, fokus se pomjera ka ljudima i kvalitetu života. Preraspodjela prostora u korist pješačenja, biciklizma i javnog prevoza ne znači samo saobraćajnu reformu, već i novu viziju gradova kao mjesta susreta, kretanja i zdravog života. U pitanju nije samo transport, već način na koji koristimo i doživljavamo zajednički prostor.

TRANSFORMACIJA U ULICE ZA LJUDE

Ulice su mnogo više od pukih komunikacionih koridora – one su mjesta susreta, kretanja, svakodnevnog života. Ipak, savremeno urbano planiranje ih je decenijama tretiralo primarno kao infrastrukturu za motorna vozila, zanemarujući njihov društveni, kulturni i ekološki potencijal. Danas sve više gradova prepoznaje potrebu za promjenom tog pristupa i vraćanjem ulica ljudima.

Jedan od ključnih koraka u toj transformaciji jeste davanje prioriteta pješačenju i biciklizmu. Kada se kretanje gradom ne oslanja isključivo na automobil, otvara se mogućnost za zdravije, pristupačnije i inkluzivnije zajednice. Pješačke i biciklističke staze ne zauzimaju mnogo prostora, ali omogućavaju ljudima da se kreću slobodnije, osjećaju sigurnije i više povežu s gradom. Takav pristup ne samo da doprinosi fizičkom zdravlju, već i psihološkom blagostanju – hodanje kroz mirne, zelene i uređene gradske prostore potiče osjećaj pripadnosti i smanjuje stres.

Alternativni vidovi prevoza, poput bicikala, električnih romobila, dijeljenih vozila i javnog prevoza, omogućavaju stanovnicima veću fleksibilnost i slobodu kretanja. Javni prevoz, kao okosnica održive mobilnosti, igra presudnu ulogu u smanjenju broja automobila na ulicama i osiguravanju jednakog pristupa svim građanima – bez obzira na ekonomski status, godine ili fizičke sposobnosti. Dobar javni prevoz znači manje gužvi, kraće vrijeme putovanja i manji pritisak na urbanu infrastrukturu.

Koncept „ulica za ljude“ podrazumijeva preraspodjelu javnog prostora tako da bude u funkciji života, a ne samo saobraćaja. U takvim ulicama prioritet se daje pješacima, biciklistima, djeci, starijima i svima koji žele da koriste grad kao mjesto boravka, a ne samo prolaska. Ulice se oplemenjuju zelenilom, klupama, igralištima, javnom umjetnošću i prostorima za spontane susrete i zajedničke aktivnosti. Time grad postaje živ, ugodan i inkluzivan – prostor koji ne guši, već podstiče zajedništvo.



Slika 1. Transformacija prostora namijenjenog za kretanje motornih vozila u prostor za bicikliste

Humanizacija gradskih ulica nije luksuz već nužnost ako želimo gradove koji njeguju zdravlje, jednakost i kvalitet života. Ona nije isključivo tehničko pitanje saobraćaja, već civilizacijski iskorak – ka gradu koji stavlja čovjeka, a ne automobil, u središte pažnje. Takvi gradovi postaju otporniji, ljepši, bezbjedniji i, najvažnije, dostojniji života za sve njihove stanovnike.

PRIMJERI DOBRE PRAKSE

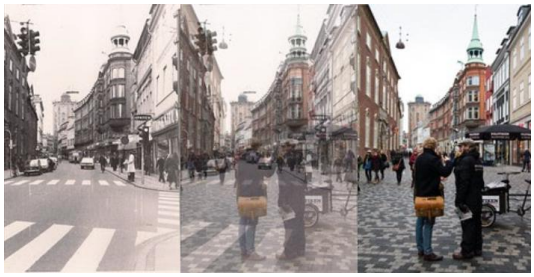
Kopenhagen

Kopenhagen je danas prepoznat kao jedan od vodećih svjetskih gradova po biciklističkoj kulturi i infrastrukturi, gdje gotovo polovica stanovnika svakodnevno koristi bicikl kao glavno sredstvo prevoza. Grad je sistemskli transformisao svoje ulice tako da daju prednost ljudima i biciklima, a ne automobilima, stvarajući urbani prostor prilagođen životu i kretanju stanovnika. S preko 400 kilometara odvojenih i sigurnih biciklističkih staza, te inovativnim rješenjima poput posebnih mostova i "super-cesta" za bicikliste, Kopenhagen osigurava sigurnije i brže kretanje kroz grad, dok istovremeno doprinosi smanjenju zagađenja i poboljšanju kvalitete života svih građana.

U početnim fazama smanjenja upotrebe automobila u urbanim sredinama, mjere poput zatvaranja ulica i smanjenja broja parking mjesta izazvale su skepticizam. Prevladavala je zabrinutost da bi takve intervencije mogle negativno uticati na ekonomsku aktivnost, povećati saobraćajne gužve u okolnim dijelovima grada i usporiti urbani razvoj u poređenju s drugim gradovima koji su favorizirali automobilsku mobilnost.

Međutim, dugoročna posvećenost ovim politikama pokazala je suprotne rezultate. Ekonomski pokazatelji su se poboljšali, a kvaliteta urbanog života znatno je porasla. Empirijske analize u Kopenhagenu i drugim gradovima ukazale su na fenomen indukovane potražnje: povećanje cestovne infrastrukture ne vodi smanjenju gužvi, već generiše dodatni saobraćaj. Nasuprot tome, redukcija automobilskog prostora rezultirala je prilagodbom stanovništva kroz veće korištenje alternativnih vidova mobilnosti, poput pješačenja i vožnje biciklom, bez značajnog pogoršanja ukupne saobraćajne protočnosti.

Kopenhagen je sistematski razvio mrežu pješačkih staza i mostova s ciljem omogućavanja nesmetanog i ugodnog kretanja pješaka, bez suvišnih prepreka ili zaustavljanja. Usporedba troškova izgradnje infrastrukture za pješake i bicikliste s troškovima automobilskih puteva pokazuje značajne prednosti, uključujući pozitivne uticaje na javno zdravlje i smanjenje zdravstvenih troškova. Grad je prepoznao širi društveni značaj aktivne mobilnosti – više ljudi na ulicama znači više socijalnih interakcija, razmjenu ideja i jačanje društvene kohezije. Transformacija ulice Strøget u pješačku zonu 1962. godine bila je prekretnica, nakon koje je do 2005. površina namijenjena pješacima i javnim prostorima povećana sedam puta. Paralelno s pješačkom infrastrukturom razvijena je i visoko efikasna mreža biciklističkih staza – fizički odvojena od pješačkih i automobilskih puteva, s posebnim biciklističkim semaforima i sigurnim prelazima označenim plavim trakama. Zahvaljujući ovim mjerama, bicikl je danas dominantno prevozno sredstvo u Kopenhagenu, jer predstavlja bržu i jeftiniju alternativu ostalim vidovima transporta, istovremeno doprinoseći održivosti i vitalnosti gradskog života.



Slika 2. Transformacija ulice namijenjene za automobile u ulicu namijenjenu za pješake



Slika 3. Transformacija uice Strøget u pješačku zonu 1962.

Oslo

Oslo, nekada kao i većina evropskih prijestolnica isprepleten prometnim ulicama i parkinzima, danas predstavlja izuzetan primjer kako se hrabrim urbanim politikama može vratiti život gradskim prostorima. U protekloj deceniji, norveška prijestolnica je tiho, ali odlučno, sprovela jednu od najradikalnijih transformacija centra grada u Evropi – eliminaciju automobila iz ključnih zona i uspostavljanje urbane svakodnevice koja u središte stavlja čovjeka, a ne vozilo.

Centar Osla je danas prostor u kojem se više čuje smijeh djece nego zvuk sirena. Tamo gdje su nekada bile kolone automobila, danas se nalaze drvoredi, biciklističke staze, umjetničke instalacije i terase kafića. Više od 700 parking mjesta uklonjeno je i zamijenjeno sadržajem koji poziva na zadržavanje – klupe, cvjetne gredice, igrališta, prostori za kulturna dešavanja.

Ove promjene nisu prošle bez otpora. Mnogi su strahovali da će zabrana automobila usporiti grad, ugroziti trgovine i zakomplikovati svakodnevne navike. Realnost je pokazala suprotno. Maloprodaja u centru je ojačala, a broj biciklista i pješaka značajno porastao. Umjesto automobila, građani su se okrenuli javnom prevozu, biciklu i hodanju – uz podršku kvalitetne i efikasne infrastrukture. Oslo je uložio u proširenje tramvajske mreže, izgradnju biciklističkih "autoputeva" i uređenje trotoara koji pozivaju na šetnju čak i u hladnijim mjesecima.

Rezultati su višeslojni:

1. smanjenje zagađenja,
2. veća bezbjednost na ulicama,
3. rast lokalne ekonomije i
4. jačanje socijalne povezanosti.

Više ljudi na ulicama znači više interakcije, više osjećaja pripadnosti i više prostora za spontanost – osobine koje često nestaju u gradovima podređenim automobilima. Norveški model pokazuje da održiva mobilnost nije samo pitanje saobraćaja, već i pitanje zdravlja, pravde i kvaliteta života. Automobili nisu zabranjeni, ali su pažljivo i promišljeno potisnuti tamo gdje ljudska prisutnost ima veću vrijednost.



Slika 4 Prije i poslije poboljšanja pješačke i biciklističke zone na gradskoj obilaznici u Oslu

Na slici 4. prikazana je transformacija gradske obilaznice u Oslu. Nakon pet smrtonosnih nesreća i 13 teških povreda između 2008. i 2017. godine, četiri saobraćajne trake na putu su smanjene na jednu u svakom smjeru, sa podignutom trakom za bicikliste i autobuse odvojenom ivičnjakom. Od obnove puta prijavljena je samo jedna teška povreda.

Uvođenjem niza mjera za smanjenje automobilskog saobraćaja i povećanje bezbjednosti, u Oslu su postignuti značajni i mjerljivi rezultate. Od 2015. godine izgrađeno je 50 kilometara biciklističkih staza, uklonjeno više od 4.250 parking mjesta, instalirano oko 500 ležećih policajaca, spuštena brzina na dvije trećine ulične mreže na 30 km/h, značajno smanjen broj teških i smrtonosnih nesreća, povećan broj pješaka i biciklista, ojačana lokalna maloprodaja i postignut pad ukupnog automobilskog saobraćaja, djelimično zahvaljujući povećanju gradskih putarina.

Ove mjere pokazuju da strateško planiranje saobraćaja usmjereno na ljude, a ne vozila, donosi konkretne koristi za bezbjednost, javno zdravlje, kvalitet života i održivu mobilnost.

Ljubljana

Grad Ljubljana predstavlja jedan od najuspješnijih primjera integracije principa održive urbane mobilnosti u savremeno planiranje i upravljanje gradskim prostorom. Tokom posljednje dvije decenije, slovenačka prijestolnica je sprovela niz sistemskih mjera usmjerenih na smanjenje zavisnosti od individualnog automobilskog saobraćaja i unapređenje uslova za pješake, bicikliste i korisnike javnog prevoza. Ovakav strateški pristup rezultirao je transformacijom urbane strukture i značajnim poboljšanjem kvaliteta života u centralnim gradskim zonama.

Ključna promjena dogodila se 2007. godine zatvaranjem centralnog gradskog jezgra za motorna vozila, čime je pokrenut proces konverzije ulica u pješačke i javne prostore. U periodu nakon implementacije ove mjere, centar grada je preuređen u skladu s principima ljudski orijentisanog urbanizma: uklanjanjem saobraćajnica i parking površina otvoren je prostor za šetališta, biciklističke staze, javni gradski mobilijar, urbanu zelenu infrastrukturu i sadržaje za slobodno vrijeme.

Istovremeno, grad je intenzivno ulagao u unapređenje infrastrukture za alternativne vidove mobilnosti. Uveden je sistem javnih bicikala "Bicikelj", koji se pokazao kao efikasan i široko prihvaćen vid mikromobilnosti. Biciklistička mreža je proširena i fizički odvojena od

automobilskog saobraćaja, čime je unaprijeđena sigurnost i atraktivnost biciklističkog prevoza. Također, javni prevoz je poboljšan uvođenjem ekološki prihvatljivih električnih minibuseva ("Kavalir") koji omogućavaju mobilnost u pješačkim zonama, posebno za starije osobe i osobe sa smanjenom pokretljivošću.

Kvantitativni i kvalitativni pokazatelji ukazuju na brojne pozitivne efekte ovih intervencija. Među najznačajnijima su:

- smanjenje emisije štetnih gasova i poboljšanje kvaliteta vazduha u urbanom jezgru,
- pad broja saobraćajnih nezgoda, posebno onih sa teškim posljedicama za pješake i bicikliste - Prema istraživanju Pirnat i Mlaker (2016), broj saobraćajnih nesreća u općini Ljubljana smanjen je za gotovo 50% u poslednjoj deceniji, a povrede su postale manje ozbiljne nego ranije. Ova poboljšanja rezultat su integrisanih mjera saobraćajne politike, uključujući unapređenje infrastrukture, preventivne aktivnosti i angažman komunalnih redara,
- porast broja korisnika aktivnih vidova prevoza (hodanje, biciklizam),
- jačanje lokalne maloprodaje i ugostiteljstva u centralnim zonama, te
- porast percepcije bezbjednosti i zadovoljstva korisnika urbanog prostora.

Uvođenje mjera za ograničenje automobilskog saobraćaja nije uzrokovalo negativne efekte u pogledu dostupnosti i funkcionalnosti gradskog prostora. Naprotiv, analiza tokova kretanja i ekonomske aktivnosti ukazuje na tzv. fenomen „prilagođene potražnje“, gdje se smanjenjem dostupnosti za automobile povećava korištenje alternativnih vidova mobilnosti bez narušavanja ukupne efikasnosti saobraćajnog sistema.

Transformacija Ljubljane potvrđuje da su prostori oslobođeni od motornih vozila ne samo funkcionalno održivi, već i socijalno i ekološki korisni. Grad je dobio priznanje "Evropska zelena prijestonica" 2016. godine, što dodatno potvrđuje uspješnost sprovedenih politika. Ljubljana danas predstavlja relevantan primjer kako male i srednje evropske prijestonice mogu uspješno implementirati mjere održive mobilnosti uz ostvarenje mjerljivih koristi na više nivoa: saobraćajnom, ekološkom, ekonomskom i društvenom.



Slika 5 Transformacija ulice u Ljubljani Slika 6 Transformacija Tromostovja u centralnom jezgri Ljubljane

ZAKLJUČAK

Analiza slučajeva Kopenhagena, Osla i Ljubljane pokazuje da strateška transformacija urbanih ulica – od prostora dominiranih automobilima ka prostorima prilagođenim ljudima – nije samo poželjna, već i ostvariva praksa sa širokim spektrom koristi. Uspjeh ovih gradova temelji se na dosljednim politikama, infrastrukturnim ulaganjima i snažnoj političkoj volji. Poboljšanja u kvalitetu zraka, saobraćajnoj bezbjednosti, urbanoj ekonomiji i općem zadovoljstvu građana potvrđuju da održiva mobilnost nije ograničena samo na transportne koristi, već ima duboke implikacije na javno zdravlje, društvenu koheziju i kvalitet života.

Za Sarajevo, grad koji se suočava s porastom broja motornih vozila, zagađenjem i nedostatkom prostora za nemotorizovane oblike kretanja, preporučuje se postepeno redefinisanje pristupa saobraćaju kroz:

1. implementaciju Plana odžive urbane mobilnosti (SUMP),
2. povećanje površina za pješačenje i biciklizam,
3. rasterećenje centralnih zona od automobila,
4. poboljšanje dostupnosti i kvaliteta javnog prevoza.

Gradovi koji daju prioritet ljudima, a ne vozilima, postaju ne samo funkcionalniji, već i zdraviji, pravedniji i otporniji na savremene izazove. Sarajevo bi, koristeći iskustva navedenih evropskih primjera, moglo da započne proces urbane transformacije u pravcu održivosti i veće društvene inkluzije.

Kopenhagen, Oslo i Ljubljana dosljedno su postavili pješake i bicikliste u središte svojih saobraćajnih politika. Kopenhagen se ističe razvijenom mrežom od preko 400 km

biciklističkih staza i konceptom „biciklističkih super-cesta“. U Oslu su uvedene fizički odvojene staze i značajno je smanjen broj parking mjesta, dok je u Ljubljani zatvoreno čitavo gradsko jezgro za automobile i razvijen je sistem javnih bicikala „Bicikelj“. U SUMP-u za Sarajevo takođe se prepoznaje važnost aktivne mobilnosti, s planiranim proširenjem biciklističke infrastrukture i uvođenjem pilot zona za dijeljena sredstva prevoza („Mobility Islands“). Međutim, za razliku od evropskih primjera, Sarajevo još uvijek nije implementiralo fizičku zaštitu prostora za pješačenje i biciklizam u širem obimu.

U gradovima poput Osla i Ljubljane dosljedno je ograničavan pristup automobilima u centralnim zonama. U Oslu su do 2019. godine u potpunosti eliminisani automobili iz centra, dok je u Ljubljani uspostavljena pješačka zona od preko 17 hektara. Kopenhagen se već decenijama oslanja na visoke cijene parkinga i ograničeni pristup vozilima. S druge strane, Sarajevo u okviru SUMP-a planira smanjenje broja parking mjesta i uvođenje ograničenja u centralnim dijelovima, ali bez jasne strategije ili rokova za potpunu transformaciju zone visoke frekvencije.

Evropski gradovi posvećeni su integraciji javnog prevoza s biciklističkom i pješačkom infrastrukturom. Oslo i Ljubljana ulažu u električne minibuseve, dok Kopenhagen razvija intermodalna rješenja i omogućava nesmetanu kombinaciju biciklizma i javnog prevoza. U Sarajevu je planirano uvođenje električnih autobusa, unapređenje tarifnog sistema i proširenje pristupa alternativnim vidovima prevoza, ali ti procesi su još u fazi planiranja.

Osim infrastrukturnih mjera, ključno obilježje uspjeha evropskih gradova jeste kontinuirano uključivanje građana, civilnog sektora i stručne javnosti. Participativno planiranje, otvorene rasprave i transparentna evaluacija doprinose dugoročnoj održivosti mjera. U SUMP-u za Sarajevo i Kanton Sarajevo se predviđa uključivanje različitih aktera, ali participacija i institucionalna koordinacija još uvijek nisu u potpunosti operativne i sistemski uvezane.

Uporedna analiza pokazuje da Sarajevo posjeduje strateški okvir koji je u skladu s evropskim standardima održive mobilnosti. Međutim, ključna razlika leži u fazi provedbe – dok su Kopenhagen, Oslo i Ljubljana implementirali fizičke i regulatorne mjere, Sarajevo je još uvijek u ranoj fazi transformacije. Neophodno je ubrzati implementaciju postojećih ciljeva iz SUMP-a, uz poseban fokus na fizičku zaštitu prostora za nemotorizovani saobraćaj, pilot zone bez automobila, integraciju javnog i mikromobilnog prevoza, te uključivanje građana u odlučivanje i praćenje realizacije mjera.

Primjeri evropskih gradova pokazuju da urbanističke i saobraćajne promjene ne samo da su izvodive, već i poželjne, te da mogu donijeti mjerljive koristi za zdravlje, sigurnost, ekonomsku aktivnost i ukupni kvalitet urbanog života.

LITERATURA

[1] Bihamk, 2013, Informacija o ukupnom broju registrovanih i prodatih novih motornih vozila u BiH u periodu Januar – Decembar 2012, [datum pristupanja: 9.6.2025.], https://bihamk.ba/assets/files/YYFaLSg2Gs-registrovana-vozila-u-2012godinipdf.pdf

[2] Bihamk, 2025, Informacija o registrovanim/registriranim cestovnim motornim vozilima u Bosni i Hercegovini u periodu januar/siječanj – decembar/prosinac 2024., [datum pristupanja: 9.6.2025.], https://bihamk.ba/assets/files/1739351705-2024-godina.pdf

[3] GIZ – ORF EE, 2020, Održiva urbana mobilnost: Kratak vodič za poslanike (Crna Gora)

[1] Izvor: Bauhaus, 2023, Cities Alive: stories of a future city, [datum pristupanja: 10.6.2025.], https://www.bauhaus.nrw/sites/default/files/2023-03/Prima.Klima%20Auftaktveranstaltung%20Vortrag%20Scheuermann.pdf

[4] Copenhagenize, 2014, Bycicle Culture by Design: transforming Copenhagen – Købmagergade in 1973 & 2014, [datum pristupanja: 10.6.2025.], https://copenhagenize.com/2014/02/transforming-copenhagen-kbmagergade-in.html?utm

[5] ArchitectureQuote, 2019, 40 Before and After Examples of Urban Architecture Transformations, [datum pristupanja: 10.6.2025.], https://architecturequote.com/before-and-after-urban-architecture/

[6] TheCityFix, 2020, How Oslo Achieved Zero Pedestrian and Bicycle Fatalities, and How Others Can Apply What Worked, [datum pristupanja: 11.6.2025.], https://thecityfix.com/blog/how-oslo-achieved-zero-pedestrian-and-bicycle-fatalities-and-how-others-can-apply-what-worked/

[7] City of Ljubljana, 2011, Slovenia reducing co², [datum pristupanja: 12.6.2025.], https://www.ljubljana.si/en/news/slovenia-reducing-co/?utm

[8] Pirnat, U., & Mlaker, M., 2016., Ensuring Local Safety – Traffic Safety in the Municipality of Ljubljana. CJS Book of Abstracts 2016., [datum pristupanja: 12.6.2025.], https://www.scribd.com/document/391404540/CJS-Book-of-abstracts-2016-pdf?utm

[9] EBRD Green Cities, Pedestrianisation and car-free zones: Ljubljana, Slovenia, [datum pristupanja: 12.6.2025.], https://www.ebrdgreencities.com/policy-tool/pedestrianisation-and-car-free-zones-ljubljana-slovenia-2/?utm

[10] Qucit, 2022, Priority for bikes and pedestrians in the city center: When the city goes green. The case of Ljubljana, [datum pristupanja: 12.6.2025.], https://qucit.com/en/news/ljubljana-city-center-pedestrianization?utm

[11] Polis, 2024, Member in the Spotlight: Ljubljana, [datum pristupanja: 12.6.2025.], <https://www.polisnetwork.eu/news/member-in-the-spotlight-ljubljana/>

P.I. HIGH SCHOOL FOR TRAFFIC AND COMMUNICATIONS

SARAJEVO

Alija Šoljić, traffic engineer

MA Arnela Mujić, traffic engineer and communcations

PhD Kemal Jaganjac, traffic engineer

FROM INFRASTRUCTURE FOR CARS TO STREETS FOR PEOPLE

ABSTRACT

In the context of the contemporary challenges of urban traffic - the increase in motorization, pollution, traffic jams and the reduction of the quality of life in cities - an increasing number of European metropolises recognize the need to redefine the roles of public space and transform the streets. This paper analyzes approaches to the transformation of city streets using examples of good practice, where measures aimed at limiting car traffic, improving pedestrian and bicycle infrastructure, and promoting public transport have produced measurable results in the form of a reduction in harmful gas emissions, traffic accidents, and an increase in physical activity and social interaction among citizens. The examples of these cities show how spatial redistribution can be used as a way to improve public health, economic vitality and environmental sustainability. Based on these experiences, the paper offers recommendations for the city of Sarajevo, aimed at integrated planning of sustainable mobility, giving priority to pedestrian and bicycle traffic, and the gradual transformation of key city streets into human-oriented spaces.

Key words: ***infrastructure, urban traffic, transformation, pedestrians, cyclists***

INTRODUCTION

The rapid growth of urban areas worldwide has led to transport challenges that traditional approaches to planning and traffic management can no longer successfully address. An excessive reliance on private car use and the development of infrastructure primarily supporting this mode of transport have resulted in a range of spatial and environmental problems. In high-density urban environments, there is simply not enough space to build roads and provide parking for all private vehicle users while preserving environmental quality and equitable access to space. Expectations that everyone can drive, park for free or at a low cost, and still enjoy a healthy urban environment have proven unsustainable.

A comparison of data from 2012 and 2024 shows a continued trend in the growth of registered road motor vehicles in Bosnia and Herzegovina. While 2012 recorded an increase of 6.82% compared to the previous year, in 2024 the increase was 4.98% compared to 2023. Although the annual growth rate is somewhat lower in the recent period, the overall number of vehicles is significantly higher, indicating a constant rise in motorization levels. The following tables present an overview of the total number of registered vehicles for the period 2003–2024.

Godina	Broj registrovanih vozila
2003	646.658
2004	695.828
2005	705.827
2006	769.682
2007	778.474
2008	881.389
2009	905.418
2010	954.425
2011	1.026.254
2012	1.096.232

Table 1 Number of registered motor vehicles in BiH in the period 2003 - 2012

	Ukupan broj registrovanih vozila za 2021.	Ukupan broj registrovanih vozila za 2022.	Ukupan broj registrovanih vozila za 2023.	Ukupan broj registrovanih vozila za 2024.	Razlika u broju registrovanih vozila u % (2024. i 2023.)
Federacija BiH	690.600	707.521	740.101	**777.993**	**+ 5,12 %**
Republika Srpska	423.965	438.352	453.719	**476.077**	**+ 4,93 %**
Distrikt Brčko	38.178	38.885	39.963	**41.154**	**+ 2,98 %**
Ukupno u BiH	1.152.743	1.184.758	1.233.783	**1.295.224**	**+ 4,98 %**

Table 2 Total number of registered vehicles in BiH for 2021; 2022; 2023; and 2024

In the era of accelerating climate change to which all systems must adapt, spatial, economic, and environmental constraints to the existing approach to traffic planning and regulation are becoming increasingly evident, with their consequences inevitable and reflected in:

1. Traffic congestion
2. Longer travel times
3. Lack of space for all road users
4. Increased emissions of harmful gases
5. Poor air quality
6. Health problems (obesity, cardiovascular diseases, stress)
7. Traffic accidents.

Car-based transport systems, dependent on daily private car use, leave visible impacts on our cities and lives. Polluted air, noise, and daily congestion are not merely technical issues – they affect health, mood, and the sense of belonging to the space we live in. Beyond the time lost in traffic and searching for parking, cities lose valuable space that could be used for parks, playgrounds, cycling paths, or social spaces. The economic burden of maintaining such a system is high, while those without access to a car are often deprived of basic mobility, services, and amenities. This deepens social inequalities and makes urban life

increasingly stressful and less sustainable.

Therefore, more and more cities worldwide are changing the paradigm – instead of tailoring urban plans to cars, the focus is shifting towards people and quality of life. The redistribution of space in favor of walking, cycling, and public transport is not merely a transport reform but a new vision of cities as places of encounter, movement, and healthy living. This is not just about transport, but about how we use and experience our shared space.

TRANSFORMING THE STREETS FOR PEOPLE

Streets are much more than just communication corridors – they are places of meeting, movement, and everyday life. Yet, for decades, modern urban planning has treated them primarily as infrastructure for motor vehicles, neglecting their social, cultural, and ecological potential. Today, more and more cities recognize the need to change that approach and return the streets to people.

One of the key steps in this transformation is prioritizing walking and cycling. When city mobility is not solely reliant on cars, the opportunity opens up for healthier, more accessible, and more inclusive communities. Pedestrian and bike paths don't take up much space, but they allow people to move more freely, feel safer, and feel more connected to the city. Such an approach not only contributes to physical health, but also to psychological well-being – walking through peaceful, green, and well-maintained urban spaces fosters a sense of belonging and reduces stress.

Alternative modes of transport, such as bicycles, electric scooters, shared vehicles and public transport, allow residents greater flexibility and freedom of movement. Public transport, as the backbone of sustainable mobility, plays a crucial role in reducing the number of cars on the streets and ensuring equal access for all citizens – regardless of economic status, age or physical ability. Good public transport means less congestion, shorter travel times and less pressure on urban infrastructure.

The concept of "streets for people" involves the redistribution of public space so that it is a function of life, not just traffic. In such streets, priority is given to pedestrians, cyclists, children, the elderly and everyone who wants to use the city as a place to live, not just to pass through. Streets are enriched with greenery, benches, playgrounds, public art and spaces for spontaneous meetings and joint activities. This makes the city lively, pleasant and inclusive – a space that does not suffocate, but encourages togetherness.



Figure 1 Transformation of the space intended for the movement of motor vehicles into a space for cyclists

Humanizing city streets is not a luxury but a necessity if we want cities that nurture health, equality and quality of life. It is not exclusively a technical issue of traffic, but a civilizational step forward - towards a city that puts a person, not a car, in the center of attention. Such cities become more resilient, more beautiful, safer and, most importantly, more livable for all their inhabitants.

EXAMPLES OF GOOD PRACTICE

Kopenhagen

Copenhagen is today recognized as one of the world's leading cities in terms of cycling culture and infrastructure, where nearly half of the population uses a bicycle as their primary mode of transportation on a daily basis. The city has systematically transformed its streets to prioritize people and bicycles over cars, creating an urban environment designed for the everyday life and movement of its residents. With over 400 kilometers of separated and safe cycling lanes, as well as innovative solutions such as dedicated bridges and "superhighways" for cyclists, Copenhagen ensures safer and faster movement throughout the city, while at the same time contributing to the reduction of pollution and the improvement of quality of life for all citizens.

In the initial stages of reducing car use in urban areas, measures such as closing streets and reducing the number of parking spaces were met with skepticism. Concerns prevailed that such interventions might negatively affect economic activity, increase traffic congestion in surrounding areas, and slow down urban development compared to other cities that favored automobile mobility.

However, long-term commitment to these policies has shown the opposite results. Economic indicators have improved, and the quality of urban life has risen significantly. Empirical analyses in Copenhagen and other cities have highlighted the phenomenon of induced demand: increasing road infrastructure does not lead to reduced congestion but instead generates additional traffic. Conversely, reducing space for cars has resulted in population adaptation through greater use of alternative modes of mobility, such as walking and cycling, without significantly worsening overall traffic flow.

Copenhagen has systematically developed a network of pedestrian paths and bridges to enable smooth and pleasant walking, free from unnecessary obstacles or interruptions. A comparison of the construction costs for pedestrian and cycling infrastructure with those for car roads reveals significant advantages, including positive impacts on public health and reductions in healthcare costs. The city has recognized the broader social significance of active mobility – more people on the streets means more social interaction, exchange of ideas, and stronger social cohesion. The transformation of Strøget Street into a pedestrian zone in 1962 was a turning point, after which the area dedicated to pedestrians and public spaces increased sevenfold by 2005. Alongside pedestrian infrastructure, a highly efficient network of cycling lanes was developed – physically separated from both pedestrian and car lanes, with dedicated bicycle traffic lights and safe crossings marked with blue lanes. Thanks to these measures, the bicycle is today the dominant mode of transport in Copenhagen, as it represents a faster and cheaper alternative to other forms of transport, while at the same time contributing to the sustainability and vitality of urban life.

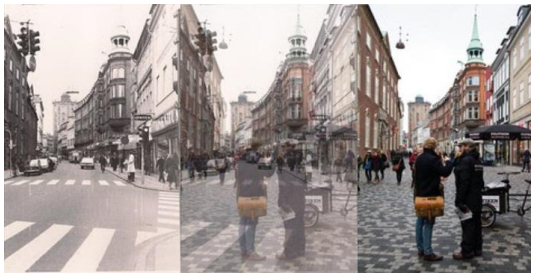


Figure 2 Transformation of a street intended for cars into a street intended for pedestrians



Figure 3 Transformation of Strøget into a pedestrian zone

Oslo

Oslo, once like most European capitals interwoven with busy streets and parking lots, today stands as an outstanding example of how bold urban policies can restore life to city spaces. Over the past decade, the Norwegian capital has quietly but decisively carried out one of the most radical transformations of a city center in Europe – eliminating cars from key zones and establishing an urban everyday life that places people, rather than vehicles, at its core.

The center of Oslo is now a space where the laughter of children is heard more often than the sound of sirens. Where lines of cars once stood, there are now tree-lined avenues, cycling lanes, art installations, and café terraces. More than 700 parking spaces have been removed and replaced with amenities that invite people to linger – benches, flower beds, playgrounds, and spaces for cultural events.

These changes were not without resistance. Many feared that banning cars would slow the city down, harm retail businesses, and complicate daily routines. Reality proved the opposite. Retail in the city center has strengthened, and the number of cyclists and pedestrians has grown significantly. Instead of cars, citizens turned to public transport, cycling, and walking – supported by high-quality and efficient infrastructure. Oslo invested in expanding its tram network, building “cycling highways,” and designing sidewalks that invite walking even in the colder months.

The results are multifaceted:

1. Reduced pollution,
2. Greater street safety,
3. Growth of the local economy, and
4. Strengthened social connectivity.

More people on the streets means more interaction, a stronger sense of belonging, and more room for spontaneity – qualities that often disappear in cities dominated by cars. The Norwegian model shows that sustainable mobility is not merely a question of transport, but also a question of health, justice, and quality of life. Cars are not banned outright, but are carefully and deliberately pushed aside where human presence holds greater value.



Figure 4 Before and after the improvement of the pedestrian and bicycle zone on the city ring road in Oslo

In Figure 4, the transformation of an urban bypass in Oslo is presented. Following five fatal accidents and 13 serious injuries between 2008 and 2017, the four traffic lanes on the road were reduced to one in each direction, with an elevated lane for cyclists and buses separated by a curb. Since the road's reconstruction, only one serious injury has been reported.

By introducing a series of measures to reduce car traffic and increase safety, Oslo has achieved significant and measurable results. Since 2015, the city has built 50 kilometers of cycling lanes, removed more than 4,250 parking spaces, installed around 500 speed bumps, reduced the speed limit to 30 km/h on two-thirds of the street network, significantly decreased the number of serious and fatal accidents, increased the number of pedestrians and cyclists, strengthened local retail, and achieved an overall decline in car traffic, partly due to increased urban tolls.

These measures demonstrate that traffic planning strategies focused on people rather than vehicles bring tangible benefits for safety, public health, quality of life, and sustainable mobility.

Ljubljana

The city of Ljubljana stands as one of the most successful examples of integrating the principles of sustainable urban mobility into contemporary urban planning and management. Over the past two decades, the Slovenian capital has implemented a series of systemic measures aimed at reducing dependence on individual motor vehicle traffic and improving conditions for pedestrians, cyclists, and public transport users. This strategic approach has resulted in a transformation of the urban structure and significant improvements in the quality of life within the city's central zones.

A key change occurred in 2007, when the central city core was closed to motor vehicles, initiating the conversion of streets into pedestrian and public spaces. Following the implementation of this measure, the city center was redesigned in line with the principles of human-oriented urbanism: by removing traffic lanes and parking areas, space was opened

up for promenades, cycling lanes, public urban furniture, green infrastructure, and leisure facilities.

At the same time, the city invested heavily in improving infrastructure for alternative modes of mobility. The public bike-sharing system "Bicikelj" was introduced, proving to be an efficient and widely accepted form of micromobility. The cycling network was expanded and physically separated from motor vehicle traffic, improving the safety and attractiveness of cycling as a transport mode. Public transport was also enhanced by introducing environmentally friendly electric minibuses ("Kavalir"), which facilitate mobility within pedestrian zones, particularly for older individuals and people with reduced mobility.

Among the most significant are:

- reduction of harmful gas emissions and improvement of air quality in the urban core,
- decrease in traffic accidents, especially those with severe consequences for pedestrians and cyclists – According to research by Pirnat and Mlaker (2016), the number of traffic accidents in the Municipality of Ljubljana decreased by almost 50% in the past decade, and injuries have become less severe than before. These improvements are the result of integrated traffic policy measures, including infrastructure upgrades, preventive activities, and the involvement of municipal wardens,
- increase in the number of users of active transport modes (walking, cycling),
- strengthening of local retail and hospitality sectors in central zones, and
- increased perception of safety and user satisfaction with urban space.

The introduction of measures to restrict car traffic did not cause negative effects in terms of accessibility and functionality of the urban space. On the contrary, analysis of movement flows and economic activity points to the so-called phenomenon of "adjusted demand," where reduced car accessibility leads to increased use of alternative mobility modes without impairing the overall efficiency of the transport system.

Ljubljana's transformation confirms that spaces freed from motor vehicles are not only functionally sustainable, but also socially and environmentally beneficial. The city received the title of "European Green Capital" in 2016, further confirming the success of its implemented policies. Today, Ljubljana serves as a relevant example of how small and medium-sized European capitals can successfully implement sustainable mobility measures while achieving measurable benefits on multiple levels – transport, environmental, economic, and social.



Figure 5 Transformation of a street in Ljubljana

Figure 6 The transformation of Tromostovje in the central core of Ljubljana

CONCLUSION

The analysis of the cases of Copenhagen, Oslo, and Ljubljana shows that the strategic transformation of urban streets—from spaces dominated by cars to spaces designed for people—is not only desirable but also an achievable practice with a wide range of benefits. The success of these cities is based on consistent policies, infrastructural investments, and strong political will. Improvements in air quality, traffic safety, urban economy, and overall citizen satisfaction confirm that sustainable mobility is not limited to transport-related benefits, but has profound implications for public health, social cohesion, and quality of life.

For Sarajevo, a city facing an increase in the number of motor vehicles, pollution, and a lack of space for non-motorized modes of movement, it is recommended to gradually redefine its approach to transport through:

1. Implementation of the Sustainable Urban Mobility Plan (SUMP),
2. Increasing the areas dedicated to walking and cycling,
3. Reducing car traffic in central zones, and
4. Improving the accessibility and quality of public transport.

Cities that prioritize people over vehicles become not only more functional, but also healthier, fairer, and more resilient to contemporary challenges. By drawing on the experiences of the aforementioned European examples, Sarajevo could begin the process of urban transformation towards sustainability and greater social inclusion.

Copenhagen, Oslo, and Ljubljana have consistently placed pedestrians and cyclists at the center of their transport policies. Copenhagen stands out with its developed network of over 400 km of cycling lanes and the concept of “cycling superhighways.” In Oslo, physically

separated lanes have been introduced and the number of parking spaces has been significantly reduced, while in Ljubljana the entire city center has been closed to cars and a public bicycle system ("Bicikelj") has been developed. Sarajevo's SUMP also recognizes the importance of active mobility, with plans to expand cycling infrastructure and introduce pilot zones for shared mobility solutions ("Mobility Islands"). However, unlike the European examples, Sarajevo has not yet implemented physical protection of spaces for walking and cycling on a larger scale.

In cities such as Oslo and Ljubljana, car access to central zones has been consistently restricted. By 2019, Oslo had completely eliminated cars from the city center, while Ljubljana established a pedestrian zone covering more than 17 hectares. Copenhagen has relied for decades on high parking fees and restricted vehicle access. On the other hand, Sarajevo plans to reduce the number of parking spaces and introduce restrictions in central areas within its SUMP, but without a clear strategy or deadlines for the complete transformation of high-traffic zones.

European cities are committed to integrating public transport with cycling and pedestrian infrastructure. Oslo and Ljubljana invest in electric minibuses, while Copenhagen develops intermodal solutions that allow seamless combinations of cycling and public transport. In Sarajevo, the introduction of electric buses, improvement of the fare system, and expansion of access to alternative modes of transport are planned, but these processes are still in the planning phase.

Beyond infrastructural measures, a key characteristic of the success of European cities is the continuous involvement of citizens, the civil sector, and the professional public. Participatory planning, open debates, and transparent evaluation contribute to the long-term sustainability of measures. The SUMP for Sarajevo and the Sarajevo Canton foresees the involvement of various stakeholders, but participation and institutional coordination are not yet fully operational or systematically integrated.

A comparative analysis shows that Sarajevo has a strategic framework in line with European sustainable mobility standards. However, the key difference lies in the implementation stage—while Copenhagen, Oslo, and Ljubljana have implemented physical and regulatory measures, Sarajevo is still in the early phase of transformation. It is necessary to accelerate the implementation of existing SUMP objectives, with a special focus on the physical protection of spaces for non-motorized transport, pilot car-free zones, integration of public and micromobility transport, and the inclusion of citizens in decision-making and monitoring of measure implementation.

The examples of European cities show that urban and transport changes are not only feasible but also desirable, and can deliver measurable benefits for health, safety, economic activity, and the overall quality of urban life.

LITERATURA

[1] Bihamk, 2013, Informacija o ukupnom broju registrovanih i prodatih novih motornih vozila u BiH u periodu Januar – Decembar 2012, [datum pristupanja: 9.6.2025.], https://bihamk.ba/assets/files/YYFaLSg2Gs-registrovana-vozila-u-2012godinipdf.pdf

[2] Bihamk, 2025, Informacija o registrovanim/registriranim cestovnim motornim vozilima u Bosni i Hercegovini u periodu januar/siječanj – decembar/prosinac 2024., [datum pristupanja: 9.6.2025.], https://bihamk.ba/assets/files/1739351705-2024-godina.pdf

[3] GIZ – ORF EE, 2020, Održiva urbana mobilnost: Kratak vodič za poslanike (Crna Gora)

[1] Izvor: Bauhaus, 2023, Cities Alive: stories of a future city, [datum pristupanja: 10.6.2025.], https://www.bauhaus.nrw/sites/default/files/2023-03/Prima.Klima%20Auftaktveranstaltung%20Vortrag%20Scheuermann.pdf

[4] Copenhagenize, 2014, Bycicle Culture by Design: transforming Copenhagen – Købmagergade in 1973 & 2014, [datum pristupanja: 10.6.2025.], https://copenhagenize.com/2014/02/transforming-copenhagen-kbmagergade-in.html?utm

[5] ArchitectureQuote, 2019, 40 Before and After Examples of Urban Architecture Transformations, [datum pristupanja: 10.6.2025.], https://architecturequote.com/before-and-after-urban-architecture/

[6] TheCityFix, 2020, How Oslo Achieved Zero Pedestrian and Bicycle Fatalities, and How Others Can Apply What Worked, [datum pristupanja: 11.6.2025.], https://thecityfix.com/blog/how-oslo-achieved-zero-pedestrian-and-bicycle-fatalities-and-how-others-can-apply-what-worked/

[7] City of Ljubljana, 2011, Slovenia reducing co², [datum pristupanja: 12.6.2025.], https://www.ljubljana.si/en/news/slovenia-reducing-co/?utm

[8] Pirnat, U., & Mlaker, M., 2016., Ensuring Local Safety – Traffic Safety in the Municipality of Ljubljana. CJS Book of Abstracts 2016., [datum pristupanja: 12.6.2025.], https://www.scribd.com/document/391404540/CJS-Book-of-abstracts-2016-pdf?utm

[9] EBRD Green Cities, Pedestrianisation and car-free zones: Ljubljana, Slovenia, [datum pristupanja: 12.6.2025.], https://www.ebrdgreencities.com/policy-tool/pedestrianisation-and-car-free-zones-ljubljana-slovenia-2/?utm

[10] Qucit, 2022, Priority for bikes and pedestrians in the city center: When the city goes green. The case of Ljubljana, [datum pristupanja: 12.6.2025.], https://qucit.com/en/news/ljubljana-city-center-pedestrianization?utm

[11] Polis, 2024, Member in the Spotlight: Ljubljana, [datum pristupanja: 12.6.2025.], <https://www.polisnetwork.eu/news/member-in-the-spotlight-ljubljana/>

Obnova in predelava pitbike motocikla

Avtor: Zoran Jazbinšek, dipl. inž. str. (VS), Šolski center Celje

Povzetek

Pri praktičnem pouku programa Avtoserviser smo se odločili izvesti projekt, ki bo zanimiv za dijake, finančno relativno nezahteven, obenem pa bo imel praktično vrednost tudi po tem, ko bo cilj projekta dosežen. Po nekaj zanimivih projektih, kot so izdelava robotske kosilnice, predelava mini motocikla v električno gnano vozilo ipd., smo se svoje izkušnje z električnim pogonom odločili prenesti na večje vozilo. Pokazala se je možnost za nizko ceno kupiti dotrajan pitbike motocikel, ki je bil sicer v dokaj slabem stanju, a mu ni manjkala nobena komponenta. To so lastnosti, ki so idealne za projekt obnove ali predelave.

Motocikel smo kupili in izdelali načrt za predelavo v električno vozilo. Ker je ta tip motocikla precej pogost pojav, so tudi rezervni deli lahko dosegljivi. Kupili smo motor, regulator motorja in baterijske celice, iz katerih smo sestavili baterijo kapacitete 1 kWh. Hkrati smo zaradi dotrajanosti zamenjali ležaje, zavore, zadnji amortizer, ter ga olepšali z novim sedežem, plastikami in z nekaj drugimi komponentami. Razen po prednjih vilic in platišč so vse komponente v novi barvi, kar mu da svež videz.

Izkazal se je s presenetljivo zmogljivo vožnjo, trdoživostjo v grobi uporabi, uporabno avtonomijo, hkrati pa nudi ogromno veselja lastnici, ki ga v prostem času s pridom uporablja.

Uvod

Cilj projekta je bil ustvariti motocikel, ki bo s pomočjo vožnje služilo razvoju otrokove koordinacije, refleksov in predvidevanja. Različne raziskave sicer kažejo različne rezultate glede varnosti motoristov in nemotoristov, večina pa se jih strinja, da vožnja motorja pripomore k boljšim vozniškim sposobnostim v avtomobilu, saj vožnja motocikla zahteva izjemno visoko raven situacijske ozaveščenosti in predvidevanja. Pridobljene veščine glede opazovanja okolice in predvidevanja se prenesejo tudi v vožnjo avtomobila, kar pripomore k večji varnosti in boljšemu obvladovanju situacije v prometu.

Vozilo mora biti primerne velikosti za 10- do 14-letnega otroka, primerno nizke mase, nezahteven za vzdrževanje, mora imeti kar se da nizke delovne stroške, hkrati pa mora biti nemoteč v naravi. Idealna izbira bi bil moped, vendar se ne sklada z vsemi točkami (hrup, delovni stroški, ipd), zato sem se odločil za nakup pitbike motocikla in predelavo pogona na elektriko.

Razstavljanje

Sam motocikel je bil ob nakupu v precej slabem stanju, a manjkala ni nobena komponenta. Agregat je bil tako rekoč uničen, zato je bil motocikel idealen kandidat za predelavo. Ob razstavljanju smo ugotovili še precej slabo stanje vseh ležajev, zavor, barve na okvirju, dekorativnih plastik, verige ipd.



Slika 11: osnova za predelavo ob nakupu

Motocikel smo razstavili do zadnjega vijaka, in razvrstili dele na uporabne, pogojno uporabne in neuporabne.

Motor smo shranili za kasnejše proučevanje pri praktičnem pouku.

Vsi plastični deli so bili na takšen ali drugačen način poškodovani, zato smo vse razen rezervoarja za gorivo ekološko odstranili.

Krmilo je bilo zvito, zato smo ga zavrgli. Naročili smo novega.

Zadnji amortizer z vzmetjo je bil uničen, zato smo ga zavrgli. Naročili smo pnevmatski nastavljivi amortizer za gorsko kolo Rock Shox, ki ima nastavljivo pnevmatsko vzmet in nastavljivo moč blaženja.

Obe zavorni čeljusti sta imeli korodirana bata, zato sta bili neuporabni. Naročili smo nove. Hkrati smo naročili tudi nova glavna zavorna valja in nove zavorne cevi. Naročilo smo seveda dopolnili s posodico zavorne tekočine in dvema kompletoma zavornih oblog. Zavorna koluta sta bila v dobrem stanju, zato smo se odločili za ponovno uporabo.

Prednja teleskopska vilica je izgledala v dokaj spodobnem stanju, zato smo opravili servis, in jo s tem pripravili na ponovno uporabo. Zamenjali smo olje in preverili tesnila.

V platiščih smo zamenjali vse štiri kolesne ležaje in tesnila, ob tem smo zamenjali tudi zadnjo pnevmatiko in zračnico, saj je bila obstoječa popolnoma iztrošena.

Zamenjali smo tudi krmilni ležaj, saj je glede na stanje obstoječemu že dlje časa manjkalo maziva.

Odstranili smo tudi stvari, ki se neposredno tičejo pogona z bencinskim agregatom: zračni in gorivni filter, uplinjač, izpuh, ročico za sklopko, stikalo za izklop ipd. Vse to ob električnemu pogonu nima več funkcije.

Predelava

Z odstranitvijo agregata se je v okvirju naredilo precej prostora, kar nam je omogočilo veliko svobode pri namestitvi elektromotorja. Na voljo smo imeli tri praktično izvedljive namestitve:

- namestitev v samo platišče (t.i. Hub motor),
- Namestitev na zadnjo nihajko pred zadnje kolo,

- Centralna namestitev, kjer je bil nameščen originalni bencinski agregat.

Vsaka izbira namestitve elektromotorja s seboj prinese določene lastnosti, ki lahko pozitivno ali negativno vplivajo na vožnjo, lahkotnost izvedbe, ceno, maso, ipd.

Glede enostavnosti predelave je najboljša izbira t.i. Hub motor. Ta izbira zahteva ojačitev zadnje nihajke (t.i. »torque arm«), ne zahteva pa sekundarnega prenosa v obliki verige ali jermena, vendar pa s seboj prinese zamenjavo zadnjega platišča ali predelavo le tega (zamenjavo peste). Ker je montaža novega pesta na platišču z naperami umetnost, ki je ne obvlada vsak, bi ta postopek zahteval outsourcing in s tem zahtevane zamude in stroške. Hub motor skupaj s platiščem je sicer dobavljiv, vendar gre v tej dimenziji praviloma za kolo v obliki aluminijastega litega platišča, kar je za uporabo motocikla po brezpotjih manj primerno. Hub motor bi s seboj prinesel tudi veliko nevzmetenih in vrtečih se mas, kar negativno vpliva na kvaliteto in lahkotnost vožnje.

Namestitev na zadnjo nihajko je precej popularna izbira pri določenih motociklih (npr. model Razer), in je nekakšen miks med lastnostmi centralne namestitve in namestitve v kolesu. Sicer gre za nevzmeteno maso, a je le ta blizu vpetja nihajke, sam motor se pa ne vrti, zato so vplivi teh mas na vožnjo močno zmanjšani v primerjavi z namestitvijo v kolo. Za svoje delovanje potrebuje sekundarni prenos v obliki jermena ali verige, vendar je težav z verigo načeloma precej manj kot pri centralni namestitvi, saj se razdalja med osema zobnikov ne spreminja, zato je veriga lahko napreta na precej nižjo zračnost. Žal pa tudi ta namestitev ni idealna, saj potrebuje pred prednjim kolesom kar nekaj prostora. Tega pa na našem motociklu ni na voljo.

Centralna namestitev prinaša najnižje nevzmetene mase, žal pa tudi najdaljšo verigom katere pot in napetost morata upoštevati ne le premike osi zadnjega zobnika, pač pa tudi obliko in pozicijo vpetja nihajke v okvir, saj le to pride znotraj verižnega prenosa. Ker smo za pogon izbrali precej visoko vrteč se motor (Vevor 3kW inrunner komplet), je sekundarni prenos moral zagotoviti precejšnjo redukcijo vrtilne frekvence. V praksi to pomeni, da je prednji zobnik zelo majhen (8 zob), nihajka pa ima precej robustno izdelano vpetje. Zaradi teh dveh lastnosti smo morali pogonski motor pomakniti precej daleč naprej. To je za seboj potegnilo dve novi težavi: izjemno dolga veriga lahko proizvede neprijetne nihljaje, in pa vodenje verige in njen nased na zobnik postane manj zanesljiv. Ti dve težavi se lahko omilita z dodatnim napenjanjem verige, kar pa s seboj prinese visoke mehanske obremenitve za verigo in ležaje. Da bi zagotovili zanesljiv nased verige na zobnika, smo izdelali dve vodili. Na tak način smo lahko zagotovili dovolj zračnosti verigi da mehanski deli niso preobremenjeni, sam nased verige pa je vseeno zanesljiv. Ker vodili skrajšata odprti razdalji poti verige, je tudi nihanje le te v obvladljivih merah.



Slika 12: šasija motocikla z izdelanim nosilcem za centralno namestitev elektromotorja

Za verižni set smo izbrali zobnika in verigo standarda 25H, ki nudi dovolj vzdržljivosti za 3 kW motor, hkrati pa s svojimi majhnimi sestavnimi deli ni preveč robustna za tako omejeno zalogo moči. Verižnika sta v razmerju 8/64, kar po izračunih pri nazivni vrtilni frekvenci motorja 5250 rpm pomeni hitrost vozila 71 km/h.



Slika 13: predelava sekundarnega prenosa (povečevanje sredinske vrtine ter izdelava novih izvrtin za vijake)

Sestavljanje

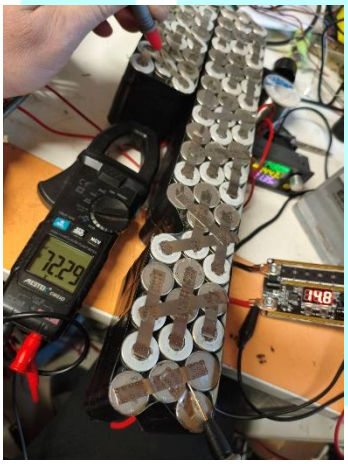
Najzahtevnejši del sestavljanja vozila je bila namestitev motorja in prenosa. Za motor smo izdelali poseben jekleni adapter, ki zagotavlja dovolj togo namestitev za predvidene obremenitve. S to nalogo pod streho, je vse ostalo bila rutina vsake obnove: motocikel smo razstavili do zadnjega vijaka. Okvir, nihajko, križe vilic in vse nosilce smo po potrebi povarili, na novo pobarvali v črno barvo, zamenjali vse ležaje, in kupili vse sestavne dele, katere smo imeli namen zamenjati z novimi.

Začeli smo s sestavo okvirja, nihajke, prednjih teleskopov, platišč (zadnjemu smo poprej namestili novo pnevmatiko in zračnico) in stranskega stojala. Namestili smo tudi krmilo, in tako smo imeli t.i. »rolling chassis«. Na tak način smo lahko motocikel na lahek način selili iz delavnice v delavnico. Nadaljevali smo z bistvom – s pogonskim sklopom: namestili smo motor, sekundarni prenos, na prej dovarjene nosilce smo privijačili tudi regulator motorja.



Slika 14: šasija z nameščenim motorjem, novim sekundarnim prenosom in krmilnikom motorja

Sledila je izdelava baterije, le to smo sestavili iz 80 celic tipa 21700, katere smo vezali v 20S4P konfiguracijo. Tako smo dobili 72 V paket s kapaciteto 12 Ah. Baterijo smo sestavljali s točkovnim varjenjem, uporabili smo 20S 45A BMS, kupili pa smo tudi polnilnik za 72V litijeve baterije. Baterijski paket tehta 7 kg, namestili smo ga na prej izdelane nosilce na okvirju, in tako je z izjemo periferije pogonski del sestavljen.



Slika 15: pravkar sestavljena baterija; na sliki še manjka BMS

Sledila je predelava rezervoarja za gorivo, ki sedaj služi kot mesto za namestitev kabelske instalacije in kot nosilec za nadzorni zaslonček. Na bok smo namestili tudi polnilni priključek. Hkrati rezervoar služi tudi kot mesto za pritrditev okrasnih oz. zaščitnih plastik, katere smo kupili nove – z njimi je motor dobil podobo novega oz. zares dobro ohranjenega motocikla. Namestili smo tudi nov sedež, potem smo se lotili še zavor.

Zavore niso bile v dobrem stanju, in po nekajkratnih poskusih obnove starih komponent, smo se odločili kompleten sistem zamenjati. Spredaj smo namestili drugo rabljeno zavorno čeljust, na katero smo privijačili novo cev in nov glavni zavorni valj z nastavljivo ročico. Zadnja zavorna čeljust je bila tako rekoč uničena, zato sem naročil novo, ki je glede na slike izgledala identično, bila pa je malenkost večja, in ni pasala na stari nosilec čeljusti. Na CNC laser sem dal izdelati nov nosilec čeljusti (zahvala za izris in izdelavo gre podjetju Hekos d.o.o. in g. Petru Šolinc), po namestitvi smo nanjo privijačili novo zavorno cev in nov glavni zavorni valj. Zavorni koluti so bili v dobrem stanju, zato smo jih obdržali.



Slika 16: v podjetju Hekos d.o.o. izdelan novi nosilec zadnje zavorne čeljusti; desno: nameščen nov nosilec, zavorna čeljust ter zavorna cev

Prednje vilice smo že ob razdiranju poservisirali (notranje čiščenje in zamenjava olja), zadnji blažilec pa ni več zaslužil svojega imena – funkcije blaženja že dolgo ni opravljal, vzmet pa je imela zračnost. Za zamenjavo smo izbrali MTB zračni blažilec znamke Rock Shox, ki nam s tlakom zraka in zasukom nastavitvenega vijaka omogoča moč vzmetenja in blaženja. Za uporabo le tega smo morali spremeniti zgornje vpetje v okvir. Z njegovo uporabo se je motocikel povsem prerodil.



Slika 17: nova nastavljiva RockShox pnevmatska vzmet z integriranim nastavljivim blažilnikom

Namestili smo še krmilne komponente – na mesto pokrovčka rezervoarja smo privijačili krmilni zaslon, na staro mesto kontaktne ključavnice smo namestili novo, delujočo kontaktno ključavnico, ki služi vklopu in izklopu krmilnika, na krmilo pa smo namestili ročico za prednjo zavoro, ročico za plin (e-gas) ter nove »gripe«.

S tem je bil motocikel v grobem sestavljen. Med testiranji se je izkazalo, da ni potreboval nobene dodelave ali predelave, kar je glede na dosedanje izkušnje presenetljiv podatek.

Rezultat

Nastal je motocikel, ki tehta 51 kilogramov, maso pa ima razporejeno 50% na prednji in 50% na zadnji osi. Masa je nižja od izvorne mase motocikla v originalnem stanju (z bencinskim motorjem), je pa nižja tudi njegova moč. Testiranja so pokazala predvidljive

zmogljivosti: najvišja hitrost z odraslim človekom je okrog 50 km/h, otrok s 40 kilogrami ga prižene krepko čez 60 km/h. Najvišja zabeležena hitrost do sedaj je bila 75 km/h, vendar je šlo za spust.



Slika 18: sestavljen motocikel se polni in čaka na prvi preizkus v praksi

Motocikel ima presenetljivo dober pospešek do 35 km/h, kar je ravno območje, kjer preživi največ časa. Nudi odlične zmogljivosti za vzpenjanje po brezpotjih, avtonomija baterije je preko 20 km. Trenutno ima prevoženih 90 km, od tega bore malo asfalta.

Največja razlika v primerjavi z bencinsko izvedbo je lahkotnost uporabe ter relativna tišina ob delovanju. Hkrati na motociklu ni vročih delov, ki bi lahko povzročili opekline ob dotiku, prav tako ni vonja in dela z vnetljivim in strupenim gorivom. Motocikel razen polnjenja ne potrebuje priprave in vzdrževanja, kar pomeni, da ga lahko 11-letna deklica sama spravi v pogon – obrne ključ in obrne ročico za plin. Brez natakanja goriva, brez skakanja po ročici za zagon, brez nastavljanja uplinjača ipd. Polnjenje pogonske baterije se izvrši s priklopom zunanjega polnilnika na polnilni priključek, traja pa manj kot 4 ure. Cilj projekta je bil dosežen – sestaviti motocikel, ki bo zahteval malo in nudil veliko.



Slika 19: motocikel v uporabi

Kaj smo se ob tem naučili?

Z zgledom avtoindustrije, ki vse bolj poudarja gradnjo in pomen električnih in ostalih vozil z alternativnimi pogoni, smo zgradili vozilo, ki je za svoj namen uporabno, saj nudi dovolj avtonomije, dovolj zmogljivosti in hkrati nudi izredno lahkotnost uporabe. Združili smo

sodobne tehnologije, ki so finančno dosegljive, obenem pa nudijo precej fleksibilnosti. Poglobili smo se v drobovje krmilne logike akumulatorske baterije, ter izbrali komponente, ki so zmogljivostno sklade, tako da nobeden izmed sestavnih delov za svoj namen uporabe ni poddimenzioniran, hkrati pa svojo predimenzioniranost ne kaznuje s previsoko nakupno ceno. Za izvedbo projekta smo porabili okroglih 1000 eur finančnega vložka za nakup komponent, kar je glede na rezultat projekta sprejemljivo. Če bi projekt ponovili, bi se vložen čas skrajšal za najmanj polovico, saj bi uporabili ob izvedbi projekta pridobljene izkušnje, ki jih do sedaj nismo imeli.

Zaključek

Naš izdelek nudi skoraj vse funkcije, ki jih nudi sodoben električni motocikel v tem rangu: uporabno vrednost, lahkotnost uporabe, precejšnjo avtonomijo teh precejšnjo hitrost polnjenja. Z nastavljivim vzmetenjem in za svoj namen dobro usklajeno geometrijo podvozja je lepo vozen, okreten, in ima dovolj zmogljive zavore, katere nudijo dovolj povratne informacije da niso zahtevne za modulacijo zavorne moči. Primerjava stroškov s stroškom nakupa primerljivega motocikla je pokazala, da bi nakup že narejenega izdelka stal polovico več, vendar bi s tem prihranili precej dela v delavnici, hkrati pa ne bi pridobili izkušenj pri predelavi motociklov oz. izdelavi različnih sestavnih delov. Pridobili smo tudi ogromno izkušenj pri vezavi na trgu dobavljivih krmilnikov BLDC motorjev, ki se uporabljajo pri manjših električnih vozilih (motociklih, kolesih in skirojih), kar nam bo v prihodnje z vedno večjo razširjenostjo tovrstnih vozil najverjetneje precej koristilo.

Pri praktičnem pouku programa Avtoserviser smo uporabili in poglobili znanja predmetov Električni sistemi vozil, Zavorni sistemi vozil, Podvozja motornih vozil in Osnov motornih vozil, kar je velika dodana vrednost. Uporabili smo izkušnje, pridobljene pri izdelavi manjšega mini motocikla (350 W minimoto z 8-palčnimi platišči), nove izkušnje pa bomo lahko uporabili pri izdelavi njegovega naslednika, ki bo za osnovo imel večje (full size) motorno kolo. S tovrstnim pristopom (od manjšega proti večjem) se namreč močno zmanjša cena napak pri izboru komponent.

Restoration and Modification of a Pitbike Motorcycle

Author: Zoran Jazbinšek, B.Sc. Mechanical Engineering (VS)

Abstract

For the practical lessons of the Car Mechanic program, we decided to carry out a project that would be interesting for the students, relatively inexpensive, and at the same time have practical value even after the project's goal was achieved. After several interesting projects, such as building a robotic lawnmower, converting a mini-motorcycle into an electric vehicle, etc., we decided to transfer our experience with electric propulsion to a larger vehicle. An opportunity arose to buy a dilapidated pitbike motorcycle for a low price, which was in a rather poor condition, but was not missing any component. These are ideal characteristics for a restoration or modification project.

We bought the motorcycle and developed a plan for converting it into an electric vehicle. Since this type of motorcycle is quite common, spare parts are also easily accessible. We purchased a motor, a motor controller, and battery cells, from which we assembled a 1 kWh capacity battery. At the same time, due to wear and tear, we replaced the bearings, brakes, rear shock absorber, and enhanced its appearance with a new seat, plastics, and a few other components. Apart from the front forks and rims, all components are in a new colour, giving it a fresh look. It proved itself with surprisingly powerful ride, toughness in rough use, useful autonomy, and at the same time provides immense joy to the owner, who uses it diligently in their free time.

Introduction

The goal of the project was to create a motorcycle that, through riding, would aid in the development of a child's coordination, reflexes, and anticipation. Various studies show different results regarding the safety of motorcyclists and non-motorcyclists, but most agree that riding a motorcycle contributes to better driving skills in a car, as riding a motorcycle requires an extremely high level of situational awareness and anticipation. The acquired skills regarding observing the surroundings and anticipation are also transferred to car driving, which contributes to greater safety and better handling of situations in traffic.

The vehicle had to be suitably sized for a 10- to 14-year-old child, lightweight, undemanding to maintain, have the lowest possible operating costs, and at the same time be unobtrusive in nature. An ideal choice would have been a moped, but it does not align with all points (noise, operating costs, etc.), so I decided to purchase a pitbike motorcycle and convert the drivetrain to electric.

Dismantling

The motorcycle itself was in quite poor condition upon purchase, but no component was missing. The engine was virtually destroyed, making the motorcycle an ideal candidate for conversion. Upon dismantling, we also found a rather poor condition of all bearings, brakes, paint on the frame, decorative plastics, chain, etc.



Figure 1: The basis for conversion upon purchase

We disassembled the motorcycle down to the last screw and sorted the parts into usable, conditionally usable, and unusable.

We stored the engine for later study during practical lessons.

All plastic parts were damaged in one way or another, so we ecologically disposed of everything except the fuel tank.

The handlebar was bent, so we discarded it. We ordered a new one.

The rear shock absorber with the spring was destroyed, so we discarded it. We ordered a Rock Shox pneumatic adjustable shock absorber for a mountain bike, which has an adjustable pneumatic spring and adjustable damping power.

Both brake calipers had corroded pistons, making them unusable. We ordered new ones. At the same time, we also ordered new master brake cylinders and new brake lines. Naturally, we supplemented the order with a container of brake fluid and two sets of brake pads. The brake discs were in good condition, so we decided to reuse them.

The front telescopic fork looked to be in decent condition, so we performed a service to prepare it for reuse. We changed the oil and checked the seals.

In the rims, we replaced all four wheel bearings and seals, and at the same time, we also replaced the rear tyre and inner tube, as the existing one was completely worn out.

We also replaced the steering bearing, as, judging by the condition, it had been lacking lubricant for a long time.

We also removed items that directly concern the petrol-powered drivetrain: air and fuel filters, carburettor, exhaust, clutch lever, kill switch, etc. All of these no longer have a function with electric propulsion.

Conversion

Removing the engine created a lot of space in the frame, which gave us a lot of freedom in positioning the electric motor. We had three practically feasible mounting options:

- Installation in the wheel itself (the so-called Hub motor),
- Installation on the rear swingarm in front of the rear wheel,
- Central installation, where the original petrol engine was mounted.

Each choice of electric motor placement brings with it certain characteristics that can positively or negatively affect riding, ease of execution, price, mass, etc.

In terms of ease of conversion, the best choice is the so-called Hub motor. This choice requires reinforcing the rear swingarm (the so-called "torque arm"), but it does not require a secondary transmission in the form of a chain or belt. However, it requires replacing the rear rim or modifying it (replacing the hub). Since mounting a new hub on a spoked rim is an art that not everyone masters, this process would require outsourcing, leading to delays and costs. A Hub motor with a rim is available, but in this dimension, it is usually a cast aluminium wheel, which is less suitable for off-road motorcycle use. A Hub motor would also bring a lot of unsprung and rotating mass, which negatively affects the quality and ease of riding.

Installation on the rear swingarm is quite a popular choice for certain motorcycles (e.g., the Razer model), and it is a mix between the characteristics of central mounting and in-wheel mounting. Although it's unsprung mass, it is close to the swingarm pivot point, and the motor itself does not rotate, so the effects of this mass on riding are greatly reduced compared to in-wheel mounting. It requires a secondary transmission in the form of a belt or chain for its operation, but chain problems are generally much smaller than with central mounting, as the distance between the sprockets does not change, so the chain can be tensioned with a much lower slack. Unfortunately, this placement is also not ideal, as it requires quite a bit of space in front of the rear wheel. This space is not available on our motorcycle.

Central mounting brings the lowest unsprung mass, but unfortunately also the longest chain, whose path and tension must be considered not only with the movements of the rear sprocket axis but also the shape and position of the swingarm pivot in the frame, as this comes within the chain transmission. Since we chose a very high-revving motor for the drivetrain (Vevor 3kW inrunner kit), the secondary transmission had to provide a considerable reduction in rotational speed. In practice, this means that the front sprocket is very small (8 teeth), and the swingarm has a quite robustly made pivot. Due to these two characteristics, we had to move the drive motor quite far forward. This brought two new problems: an extremely long chain can produce unpleasant oscillations, and chain guidance and its engagement with the sprocket become less reliable. These two problems can be mitigated by additional chain tensioning, which, however, brings high mechanical loads to the chain and bearings. To ensure reliable engagement of the chain with the sprockets, we manufactured two guides. In this way, we could ensure enough chain slack so that the mechanical parts are not overloaded, but the chain engagement is still reliable. Since the guides shorten the open path lengths of the chain, its oscillation is also within manageable limits.



Figure 2: Motorcycle rolling chassis with manufactured mount for central electric motor installation

For the chain set, we chose sprockets and a chain of the 25H standard, which offers enough durability for a 3 kW motor, but at the same time, with its small components, is not too robust for such a limited power reserve. The sprockets are in an 8/64 ratio, which, according to calculations at the nominal motor speed of 5250 rpm, means a vehicle speed of 71 km/h.



Figure 3: Modification of the secondary transmission (increasing the centre bore and manufacturing new screw holes)

Assembly

The most demanding part of assembling the vehicle was the installation of the motor and transmission. We manufactured a special steel adapter for the motor, which ensures sufficiently rigid mounting for the anticipated loads. With this task completed, everything else was routine for any restoration: we disassembled the motorcycle down to the last screw. We welded, repainted the frame, swingarm, fork crowns, and all mounts black as needed, replaced all bearings, and bought all the components we intended to replace with new ones.

We started by assembling the frame, swingarm, front telescopes, rims (we had previously installed a new tyre and inner tube on the rear one), and kickstand. We also installed the handlebars, giving us a so-called "rolling chassis." This way, we could easily move the motorcycle from workshop to workshop. We continued with the essence—the drivetrain: we installed the motor, the secondary transmission, and screwed the motor controller onto the previously welded brackets.



Figure 4: Rolling chassis with installed motor, new secondary transmission, and motor controller

Next was the manufacture of the battery; we assembled it from 80 cells of type 21700, which we wired in a 20S4P configuration. This gave us a 72 V pack with a capacity of 12 Ah. We assembled the battery using spot welding, used a 20S 45A BMS, and also purchased a charger for 72 V lithium batteries. The battery pack weighs 7 kg and was installed on the previously manufactured brackets on the frame, completing the drivetrain part except for the periphery.

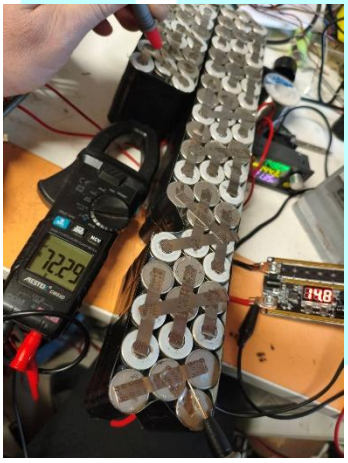


Figure 5: Newly assembled battery; the BMS is still missing in the picture

This was followed by the modification of the fuel tank, which now serves as a place for the cable installation and as a holder for the control display. We also mounted the charging connector on the side. At the same time, the tank also serves as a mounting point for the decorative or protective plastics, which we bought new—with them, the motorcycle gained the appearance of a new or truly well-preserved motorcycle. We also installed a new seat, and then we tackled the brakes.

The brakes were not in good condition, and after several attempts to restore the old components, we decided to replace the complete system. At the front, we installed another used brake caliper, to which we screwed a new hose and a new master brake cylinder with an adjustable lever. The rear brake caliper was virtually destroyed, so I ordered a new one, which looked identical based on the pictures, but was slightly larger and did not fit the old caliper bracket. I had a new caliper bracket manufactured on a CNC laser (thanks for the

design and manufacturing to the company Hekos d.o.o. and Mr. Peter Šolinc). After installation, we screwed a new brake hose and a new master brake cylinder onto it. The brake discs were in good condition, so we kept them.



Figure 6: New rear brake caliper bracket manufactured at Hekos d.o.o.; right: new bracket, brake caliper, and brake hose installed

We had already serviced the front forks during disassembly (internal cleaning and oil change), but the rear shock absorber no longer deserved its name—it had not performed the damping function for a long time, and the spring had slack. For replacement, we chose an MTB air shock absorber from the Rock Shox brand, which allows us to adjust the suspension and damping power with air pressure and the turn of an adjustment screw. To use it, we had to change the upper mounting in the frame. With its use, the motorcycle was completely reborn.



Figure 7: New adjustable RockShox pneumatic spring with integrated adjustable damper

We also installed the control components—we screwed the control display onto the fuel tank cap, installed a new, working ignition switch in the old place of the ignition lock, which serves to turn the controller on and off, and mounted the front brake lever, the throttle grip (e-gas), and new "grips" on the handlebars.

The motorcycle was roughly assembled by this point. During testing, it turned out that it did not require any modification, which is a surprising fact considering our previous experience.

Result

The result is a motorcycle that weighs 51 kilograms, with the mass distributed 50% on the front and 50% on the rear axle. The mass is lower than the original mass of the motorcycle in its original state (with the petrol engine), but so is the power. Testing showed predictable performance: the top speed with an adult is around 50km/h, and a child weighing 40 kilograms can drive it with speeds well over 60km/h. The highest speed recorded so far was 75 km/h, but this was downhill.



Figure 8: The assembled motorcycle is charging and waiting for its first practical test

The motorcycle has surprisingly good acceleration up to 35 km/h, which is exactly the range where it spends most of its time. It offers excellent capabilities for climbing off-road, and the battery autonomy is over 20km It currently has 90km driven, very little of which is on asphalt.

The biggest difference compared to the petrol version is the ease of use and the relative quietness during operation. At the same time, there are no hot parts on the motorcycle that could cause burns upon contact, nor is there any smell or work with flammable and toxic fuel. The motorcycle, apart from charging, requires no preparation or maintenance, which means that an 11-year-old girl can operate it herself—she turns the key and turns the throttle. No pouring fuel, no jumping on the kick-start lever, no carburettor adjustment, etc. Charging the drive battery is done by connecting an external charger to the charging port and takes less than 4 hours. The goal of the project was achieved—to assemble a motorcycle that would demand little and offer much.



Figure 9: The motorcycle in use

What did we learn from this project?

Following the example of the auto industry, which increasingly emphasizes the construction and importance of electric and other vehicles with alternative drivetrains, we built a vehicle that is useful for its purpose, as it offers enough autonomy, enough performance, and at the same time offers extreme ease of use. We combined modern technologies that are financially accessible, while also offering considerable flexibility. We delved into the intricacies of the control logic of the rechargeable battery and selected components that are compatible in terms of performance, so that none of the components are undersized for their intended use, and at the same time, their oversizing does not penalize with too high a purchase price. For the implementation of the project, we spent approximately 1000 EUR in financial investment for the purchase of components, which is acceptable considering the result of the project. If the project were repeated, the time invested would be reduced by at least half, as we would use the experience gained during the project, which we did not have until then.

Conclusion

Our product offers almost all the features offered by a modern electric motorcycle in this range: usability, ease of use, considerable autonomy, and fairly fast charging speed. With adjustable suspension and chassis geometry well-coordinated for its purpose, it is pleasant to ride, manoeuvrable, and has sufficiently powerful brakes that offer enough feedback not to be demanding for brake power modulation. A comparison of costs with the cost of purchasing a comparable motorcycle showed that buying an already made product would cost half as much, but this would save a lot of work in the workshop, and at the same time, we would not gain experience in modifying motorcycles or manufacturing various components. We also gained a lot of experience in wiring commercially available BLDC motor controllers used in smaller electric vehicles (motorcycles, bicycles, and scooters), which will likely be very useful in the future with the increasing spread of such vehicles.

In the practical lessons of the Car Mechanic program, we used and deepened the knowledge from the subjects Vehicle Electrical Systems, Vehicle Braking Systems, Motor Vehicle Chassis, and Motor Vehicle Basics, which is a great added value. We used the experience gained in manufacturing a smaller mini-motorcycle 350W minimoto with 8-inch rims), and the new experience can be used in manufacturing its successor, which will be based on a larger (full size) motorcycle. This kind of approach (from smaller to larger) significantly

reduces the cost of errors in component selection.

Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko

Rosana Jordan, prof.

AVTOSERVISNA STROKA NA POKLICNI MATURI IZ ANGLEŠČINE

(3. PREDMET)

Povzetek

Prispevek predstavi poklicno maturo kot državni zaključni izpit v programu avtoservisni tehnik. Natančneje seznanja z izvedbo izpita iz angleščine (tretji in izbirni predmet) in z deležem avtoservisne stroke v ustnem delu izpita. Vključuje tudi razmišljanja in zadovoljstvo dijakov z obsegom strokovnih vsebin iz področja avtoservisne stroke pri pouku angleščine in na poklicni maturi iz angleščine.

Ključne besede: avtoservisni tehnik, poklicna matura, jezik stroke, avtoservisna stroka, angleščina

Uvod

Danes si sodobnega poslovnega sveta, še posebej pa področja avtoservisne stroke, ne moremo predstavljati brez znanja angleškega jezika. Angleščina je prisotna v tehnični dokumentaciji, servisnih priročnikih, programih za diagnostiko vozil, navodilih za uporabo in komunikaciji s tujimi proizvajalci ter strankami. Znanje angleščine pomembno prispeva k uspešnemu nadaljevanju izobraževanja, izboljšuje zaposlitvene možnosti ter povečuje možnosti napredovanja v tehničnih in inženirskih poklicih. Pri tem je ključno obvladovanje tako splošne kot tudi strokovne angleščine. Jezik tehnične stroke je natančen, specifičen in pogosto zelo zahteven. Učitelji imamo odgovorno nalogo, da dijake pripravimo na učinkovito sporazumevanje v strokovnem okolju, bodisi med študijem bodisi na delovnem mestu.

Cilj tega prispevka je prikazati, kako poklicna matura iz angleščine usmerja učitelje in spodbuja dijake k pridobivanju znanja, ki jim omogoča uspešno opravljanje nalog v angleščini znotraj avto stroke, ter v kolikšni meri in na kakšen način je strokovna angleščina vključena v ta zaključni izpit.

Poklicna matura

Zaključni izpit na koncu štiriletnega šolanja je za vse strokovne programe poklicna matura.

Če jo dijaki uspešno opravijo, pridobijo srednjo strokovno izobrazbo in s tem dokaz, da so dosegli standarde znanj, ki so določeni s cilji izobraževalnega programa, ter da so usposobljeni za visokošolski študij.

https://www.ric.si/poklicna-matura/splosne-informacije/

Sestavljena je iz štirih predmetov. Dva sta splošnoizobraževalna, to sta prvi predmet, ki je skupni oziroma enotni, in tretji predmet, ki je izbirni. Drugi in četrti predmet temeljita na strokovnem znanju.

Za dijake, ki na naši šoli zaključujejo program avtoservisni tehnik, je sestavljena iz naslednjih štirih predmetov:

1. PREDMET: slovenščina

2. PREDMET: avtomehatronika

3. PREDMET: angleščina ali matematika

4. PREDMET: izdelek oziroma storitev in zagovor

https://www.ric.si/mma/MIK_PM_2024__popravljen_2023.pdf/2023071012292391/?m=1688984963

Tretji predmet je izbirni. Izberejo lahko angleščino ali matematiko. To šolsko leto smo v 2. letniku PTI programa avtoservisni tehnik imeli 28 dijakov. 15 izmed njih je za tretji predmet izbralo angleščino, kar je 53%.

Tretji predmet - angleščina

Izpit iz angleščine je sestavljen iz pisnega in ustnega dela.

Pisni del

Enoten je za vse programe. Traja 120 minut in obsega tri pole, ki jih pripravi državna predmetna komisija za poklicno maturo za angleščino. Izpitna pola 1 preverja bralno razumevanje, izpitna pola 2 slušno razumevanje (kar je novost letošnjega šolskega leta), izpitna pola 3 pa zmožnosti pisnega sporočanja, saj morajo dijaki napisati dva sestavka, krajšega in daljšega. Na pisnem izpitu je možno zbrati 70 točk.

Ustni del

Opravlja se pred šolsko izpitno komisijo, ki ga tudi točkuje na predlog izpraševalca. Ta je praviloma učitelj, ki je poučeval kandidata v zaključnem letniku. Za ustni izpit so pripravljeni listki z vprašanji. Kandidat ima pravico do 15-minutne priprave na odgovore. Ustni izpit traja največ 20 minut. Možno je zbrati 30 točk.

https://www.ric.si/mma/MIK_PM_2024__popravljen_2023.pdf/2023071012292391/?m=1688984963

Naloge za ustni izpit pripravimo učitelji angleščine oziroma aktiv učiteljev angleščine na šoli, na kateri kandidat opravlja izpit. Ta mora biti zastavljen tako, da preverja govorno in slušno zmožnost pri sporazumevanju v vsakdanjem življenju, pa tudi zmožnost sporazumevanja v jeziku stroke oziroma v poklicnem življenju. **Dve nalogi od treh pri ustnem izpitu morata preverjati zmožnost govornega sporazumevanja in sporočanja s kandidatovega strokovnega področja**. Vrstni red nalog ni predpisan.

https://www.ric.si/poklicna-matura/predmeti/tretji-predmet/anglescina/

Na izpitnih lističih so torej tri naloge različnih tipov, ki vključujejo eno splošno in dve strokovni temi. S tema preverjamo znanje jezika stroke, in sicer strokovno besedišče, razumevanje strokovnih besedil in zmožnost sporazumevanja na poklicnem področju. Na izbiro so teme, ki smo jih obravnavali pri pouku, in splošne strokovne teme, ki so navedene v katalogu.

Izpitni lističi vsebujejo tri izmed nalog, kot so igra vlog, pogovor na podlagi besedilne iztočnice (npr. kratka besedila do 100 besed, reklamni oglasi, izhodiščna vprašanja) ali vizualne/grafične iztočnice (npr. slike, preglednice, grafi), interpretacija avtentičnega strokovnega (npr. opis naprave, postopka, navodila) ali splošnega besedila (npr. pregovori, naslovi, izreki, šale) do 100 besed, napisanega v angleščini ali slovenščini, in razgovor o njem.

Kandidati se s temami in tipi nalog seznanijo med poukom angleščine oziroma med pripravami na izpit. Ker je število šolskih ur omejeno, se priporoča, da tudi zunaj šolskega pouka berejo in poslušajo različne vrste besedil v angleščini, Pomagajo si lahko s časopisi, revijami in zvočnimi zapisi ter s strokovno periodiko, tiskanim gradivom in drugimi besedili, ki se nanašajo na njihovo strokovno področje. Pri kandidatih razvijamo zanimanje za: spremljanje radijskih in televizijskih programov v angleškem jeziku, branje, poslušanje in gledanje vsebin na spletu o aktualnih, splošnih in strokovnih temah, dopisovanje in pogovori z znanci iz tujine, ki jih srečajo na šolskih izmenjavah v tujino, iskanje podatkov v različnih virih s splošnega in strokovnega področja ...

Pri poteku pogovora mora biti dijak sposoben ustrezno uporabiti naslednje komunikacijske funkcije: začetek, ohranitev, prekinitev pogovora, vključitev v pogovor in zaključek pogovora.

Pri pridobivanju in prenašanju informacij mora med drugim znati: poizvedovati, se identificirati in poimenovati ter opisovati osebe, predmete, okoliščine, kraje, stroje, orodja in druga delovna sredstva iz posamezne stroke, delovno mesto, opravila v zvezi s poklicnim delom, poročati o dogodkih v zvezi s posamezno stroko (poslovna srečanja in sestanki, obiski razstav in sejmov, obiski partnerskih podjetij in tovarn), o prebranem (splošna in strokovna besedila) in mnenjih/stališčih koga drugega …

Naloge morajo biti avtentične (podobne tistim iz resničnih življenjskih okoliščin, tudi poklicnih), smiselne (izvirnost, problemskost, celovitost, različne perspektive) in komunikacijsko zastavljene. Poklicna/strokovna tematska področja obsegajo osnovno strokovno izrazoslovje na posameznem strokovnem področju (materiali, naprave, orodje, oprema, pripomočki in navodila) in opis poklicnih dejavnosti in delovnih postopkov, osnovno znanje iz poslovne komunikacije, informacijsko in komunikacijsko tehnologijo (oprema, naprave, odgovorna raba medmrežja), varovanje okolja, varnost na delovnem mestu (zaščitna sredstva, nevarne snovi, prva pomoč, varstvo pri delu), razvoj znanosti in tehnologije na posameznih strokovnih področjih (znane osebnosti, tehnološki dosežki, izumi).

Govorne dejavnosti so izbrane tako, da omogočajo prikaz kandidatovega funkcionalnega jezikovnega znanja in zmožnosti: predstavitvene/opisovalne zmožnosti, opis dejstev, predstavitev, primerjanje, izražanje navodil, povzemanje; zmožnosti vrednotenja (izražanje in utemeljevanje mnenja, predlaganje, izražanje želja, poizvedovanje, povpraševanje po mnenju, strinjanje, nestrinjanje, pojasnjevanje); interakcijske zmožnosti (sodelovanje v

razgovoru, obvladovanje dialoga, obvladovanje poteka pogovora: znati začeti in končati pogovor, prepustiti besedo, prevzeti besedo); zmožnosti prilagajanja (preverjanje/ugotavljanje pravilnosti razumevanja, prilagajanje, pogajanje, usklajevanje s sogovornikom). Med govornim sporazumevanjem kandidati pokažejo tudi obvladovanje in širino besedišča ter raven in širino jezikovnega znanja nasploh, tekočnost govora in ustrezne komunikacijske strategije.

https://www.ric.si/mma/PIK_ANG_2024-novi.pdf/202111709281391/?m=1668673693

Avtoservisna stroka v nalogah izpitnih lističev ustnega dela izpita

V naloge vključimo strokovne teme, ki smo jih obravnavali pri pouku. Dijaki so z njimi seznanjeni.

V izpitnih lističih naše šole so tako vključene naslednje teme:

- Avtoservisna stroka (definicija, primeri)
- Delovna mesta v avtoservisni stroki
- Načini potovanja in prevozna sredstva
- Javni potniški prevoz
- Cestno prometni predpisi
- Prometne nesreče (vzroki, posledice, zakonodaja)
- Varnost pri delu (zaščitna oblačila in oprema, predpisi)
- Storitve (redni pregledi, servisiranje, predelava, popravilo, menjava pnevematik, …)
- Varovanje okolja (trajnost, električna vozila, hibridi, onesnaževanje, …)

Pri sestavljanju izpitnih lističev upoštevamo osnovne smernice. To so:

- Oblikovanje takšnih nalog za preverjanje sporazumevalnih zmožnosti, s katerimi bomo dobili kar se da veljaven in zanesljiv vzorec kandidatovih jezikovnih zmožnosti.
- Pestrost – vsaka naloga je zastavljena drugače in temelji na drugačni izhodiščni temi.
- Zaporedje nalog je poljubno.

POKLICNA MATURA – ustni del

1.1 Oglejte si sliko in razmislite o kratkem opisu ali komentarju. Slika je tudi osnova za razgovor.



http://financialtribune.com/archive/2015/10/18/articles/economy-auto/27648/intl-auto-confab-focus-environment

1.2 Preberite besedilo in razmislite o kratkem povzetku. Besedilo je zgolj pobuda za razgovor, ki se bo odvijal med vami in izpraševalcem.

According to a study, more elite child football players had a sports injury over the 10-year period compared with the other sports. Elite child swimmers suffered very few sport-related injuries.

http://www.greencarreports.com/news/1104425_how-to-turn-long-haul-trucking-all-electric-tractor-swapping

1.3 Igra vlog

Si lastnik avtoservisne delavnice. Sprejmi stranko (izpraševalec), ki potrebuje redni servis vozila. Pozdravi stranko, vprašaj kako ji lahko pomagaš, dogovori se za termin in pojasni kako bo redni pregled vozila izgledal.

Izpraševalci si pred izpitom pripravimo okvirna vprašanja, ki dijakom pomagajo razumeti naloge in spodbudijo smiselno izražanje. Pri prvi nalogi na primer kandidata spodbudimo, da najprej na kratko opiše podano sliko, nato razloži pojem »trajnost« in varovanje okolja oziroma pojasni, kako sta ti dve prisotni v avtoservisni stroki – na primer v avto industriji, uredbah, navadah ljudi, ipd. V nadaljevanju dijak predstavi vrste vozil in goriv, njihove prednosti in slabosti.

Pri tretji nalogi dijak nastopi v vlogi v simulirani situaciji, denimo avtoservisni delavnici, kjer se pogovarja s stranko. Postaviti mora ustrezna vprašanja, odgovarjati na zastavljena vprašanja in na primer opisati okvaro vozila, potek pregleda ali predlagane rešitve – tako izkaže sposobnost sodelovanja v vsakdanjem strokovnem pogovoru v angleškem jeziku.

Izpitni listič vključuje slikovno in besedilno iztočnico (2. naloga) ter igro vlog, kar omogoča raznoliko preverjanje komunikacijskih zmožnosti in strokovnega besedišča.

Še nekaj drugih primerov strokovnih iztočnic s področja avtoservisne stroke

- Slikovne iztočnice:

A)



http://www.clipartkid.com/car-repair-free-cliparts/

Pri tej slikovni iztočnici kandidat predvidoma opiše delo avtoservisnega tehnika, njegovo opremo in orodje. V nadaljevanju lahko navede različna prevozna sredstva, opiše delovne pogoje, varnost na delovnem mestu, delo s strankami,… Pogovor se lahko usmeri v izkušnjo z vožnjo avtomobila, znamkah, prednostih in slabostih posedovanja avtomobila, vzdrževanju, izbiri pogona (bencinski/električni …) in njihovih prednostih in slabostih …

B)



https://www.google.si/search?q=traffic+accidents&espv=2&biw=1366&bih=643&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiPoNnk86LNAhWHSBQKHa6vCSwQ_AUIBigB#imgrc=MawqnUAATSAXEM%3A

Kandidat bi v tem primeru opisal, kaj prikazuje slika. Vprašali bi ga, ali je že sam bil kdaj udeležen v kakšni nesreči kot sopotnik ali voznik, kakšne vrste nesreč se lahko zgodijo in kaj so najpogostejši vzroki. Vprašali bi še, kako ukrepati ob prometni nesreči in kako bi lahko izboljšali prometno varnost oziroma zmanjšali število in posledice prometnih nesreč.

C)



http://www.ebay.com/gds/How-to-Change-a-Tyre-on-Your-Mazda-/10000000177591931/g.html

Pri tej iztočnici bi kandidat sklepal kaj se je zgodilo in kako bi ukrepal v takšnem primeru. Navedel bi potrebno orodje in postopek menjave kolesa. Pogovor bi lahko stekel tudi v smeri zakaj je pomembno, da voznik zna sam zamenjati kolo in kdaj je potrebno poklicati na pomoč. Dijak lahko tudi deli svoje lastne izkušnje in kako preventivno ukrepati ter vzdrževati vozilo nasploh. Takšna naloga omogoča, da kandidat izrazi tehnično znanje, osebne izkušnje in zmožnost logične, povezane komunikacije v angleškem jeziku.

Besedilne iztočnice:

A)

Rules of the road are the general practices and procedures that road users follow, especially motorists and cyclists. They govern interactions with other vehicles and pedestrians ... As a general rule, a driver is expected to avoid hitting other vehicles, pedestrians, etc. regardless of whether or not the applicable rules of the road allow them to be where they happen to be.

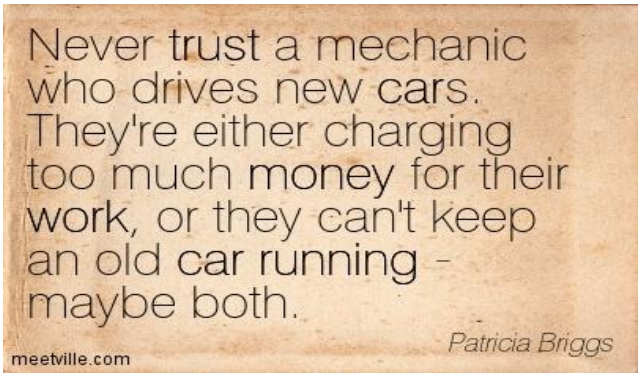
Pri tej besedilni iztočnici imamo izpraševalci pripravljena naslednja vprašanja: o čem govori besedilo, katere cestno prometne predpise pozna, zakaj jih je nujno upoštevati, zakaj jih nekateri kršijo in kakšne so posledice neupoštevanja predpisov. Kandidata bi spodbudili k razmišljanju o lastnem odnosu do vožnje in upoštevanja predpisov.

B)

When bringing your vehicle in for a specific problem it is very beneficial to have a detailed and accurate description of how and when the problem occurs. Describing car problems descriptively and accurately can be very helpful. A good description of the problem can point us in the right direction and potentially reduce diagnostic time.

To besedilo bi bilo osnova za pogovor o popravilih vozil, pomembnosti komunikacije s stranko, potekom ugotavljanja napak in okvar, potrebna oprema in orodja za popravilo, ipd. V nadaljevanju bi dijak lahko naštel najpogostejše okvare vozil in postopek popravil ter pomembnost rednega vzdrževanja in servisiranja vozila.

C)



http://www.thequotepedia.com/quotes/car/page/4/

Besedilna iztočnica zgoraj je podlaga dijaku za pogovor o dobrih lastnostih vsakega avtoservisnega tehnika, zakaj je pomembno zaupanje med stranko in avtoserviserjem, kakšni so tipični stereotipi o le-teh in zakaj ta pomembna doslednost, profesionalnost in zanesljivost v avto stroki.

- Igre vlog:

Pri igrah vlog udeleženci igrajo vlogo po določenem scenariju in skladno z danimi opisi v nalogi. Predstavljati si morajo glavne značilnosti okolja, v katerem poteka pogovor in si izmisliti ključna dejstva. Delno si med 15-minutno pripravo na pogovor zamislijo ustrezni govor, delno pa med dialogom improvizirajo.

A. Si avtomehanik v delavnici. Stranka (izpraševalec) ti pripelje avto na popravilo. Pozdraviš jo in vprašaš, kaj je narobe. Stranki poveš, da danes nimaš časa in boš avto popravil šele jutri. Stranko prosiš naj se vrne naslednji dan.

B. Pelješ se v avtu in ob cesti zagledaš stoječe vozilo s predrto pnevmatiko. Ustaviš se in priskočiš na pomoč. Ob menjavi pnevmatike lastniku vozila (izpraševalcu) pojasniš postopek menjave.

C. Si prodajalec avtomobila. Stranki (izpraševalcu) opiši vse lastnosti avtomobila in navedi ceno. Stranki ponudi popust in jo skušaj prepričati v nakup vozila.

Mnenje dijakov programa avtoservisni tehnik

Dijake zaključnih letnikov v šolskem letu 2024/2025 sem vprašala po mnenju o obsegu jezika stroke s področja avtoservisne stroke na poklicni maturi iz angleščine in pri pouku angleščine, pri katerem se na poklicno maturo pripravljamo. Za pridobitev mnenja sem uporabila spletno orodje *Mentimeter*. 25 dijakov je odgovorilo na naslednja vprašanja:

1. Ali je bilo po tvojem mnenju pri pouku angleščine dovolj poudarka na jeziku stroke?
2. Če bi želel več, katere strokovne teme bi vključil?
3. Ali bi v ustni del poklicne mature iz angleščine vključil več strokovnih vsebin (npr.

da bi se namesto dveh vse tri iztočnice navezovale na stroko)?

4. Ali bi v pisni del poklicne mature iz angleščine vključil stroko: DA/NE?

Na prvo vprašanje je večina dijakov (86%) odgovorila pritrdilno. Bili so mnenja, da je bilo pri pouku angleščine dovolj poudarka na jeziku stroke, in da so bile pri pouku in pri ocenjevanju zelo pogosto prisotne strokovne vsebine.

V odgovorih na drugo vprašanje so predlagali naslednje vsebine, ki bi jih vključili v pouk oziroma bi jih obravnavali podrobneje: orodje in oprema, deli motorja in vozila, delovanje motorja, komunikacija s strankami, naročanje delov in opreme, zavarovanje in cenitve, delo z dokumentacijo (naročila, dnevniki za prakso, servisna knjiga, navodila za uporabo, …).

Pri tretjem vprašanju, ki se je navezovalo na obseg avtoservisne stroke na poklicni maturi iz angleščine, je velika večina dijakov izrazila mnenje, da je strokovnih tem dovolj. V ustni del tako kar 88% dijakov ne bi vključilo več stroke in ne bi želelo, da se vse tri iztočnice (namesto dveh) navezujejo na stroko. Nekateri so odgovor utemeljili z dejstvom, da se nekaj dijakov po končani srednji šoli preusmeri in nadaljuje izobraževanje v drugih strokah.

Zanimivo je bilo četrto vprašanje kjer je 70% dijakov mnenja, da bi tudi v pisni del poklicne mature vključili stroko. To gre pripisovati dejstvu, da so zelo povezani s svojim poklicem in se počutijo dovolj suverene in podkovane na svojem področju, zato bi jim bilo lažje izkazovati znanje angleščine, četudi bi vse tri teme vsebovale stroko.

Zaključek

Na poklicni maturi iz angleščine je tuji strokovni jezik s področja avtoservisne stroke zastopan v približno 20 % celotne vrednosti izpita. Kljub temu pa ostaja dejstvo, da sta splošna in strokovna angleščina tesno prepleteni. Trdno znanje splošne angleščine je temelj na katerem gradimo strokovno jezikovno znanje. Obvladovanje obeh ravni jezika dijakom in odraslim kandidatom omogoča uspešnejše nadaljevanje izobraževanja, spodbuja vseživljenjsko učenje ter prispeva k samozavesti pri študiju, delu v avtomehaničnih delavnicah, servisih, tehničnih pregledih ali v stiku s tujimi strankami.

Angleščina danes velja za evropski in svetovni „lingua franca“ – jezik znanosti, tehnologije, avtomobilske industrije, mednarodne komunikacije in poslovanja. V praksi se uporablja kot vsakodnevni delovni jezik, kar pomeni, da je tudi na področju avtoservisne stroke obvladovanje strokovne angleščine ključnega pomena. Poznavanje tehnične terminologije in sposobnost razumevanja navodil, shem, diagnostike ali komunikacije z mednarodnimi partnerji močno prispevata k večji učinkovitosti, varnosti in kakovosti opravljenih storitev.

Uspešno opravljena poklicna matura iz angleščine tako predstavlja pomembno potrditev jezikovnega znanja, ki dijakom odpira vrata v nadaljnje šolanje in poklicno udejstvovanje, bodisi doma ali v tujini.

Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko

Rosana Jordan, prof.

AUTOMOTIVE PROFESSION AT THE VOCATIONAL MATURA IN ENGLISH (3RD SUBJECT)

Summary

The paper presents the vocational matura examination as the state final exam in the automotive technician program. It provides more detailed information about the implementation of the English exam (the third and optional subject) and the part of the auto service profession in the oral part of the exam. It also includes students' thoughts and satisfaction with the scope of professional content from the field of auto service profession in English classes and at the vocational matura examination in English.

Keywords: auto service technician, vocational matura, language of the profession, auto service profession, English

Introduction

Today, the modern business, and especially the field of auto service profession, the car industry, cannot be imagined without knowledge of the English language. English is present in technical documentation, service manuals, vehicle diagnostic programs, user manuals, and communication with foreign manufacturers and customers. Knowledge of English significantly contributes to the successful continuation of education, improves employment opportunities and increases the chances of advancement in technical and engineering professions. Mastering both general and professional English is key. The language of the technical profession is precise, specific and often very demanding. As teachers, we have a responsible task to prepare students for effective communication in a professional environment, whether during studies or at work.

The aim of this paper is to show how the vocational matura in English guides teachers and encourages students to acquire knowledge that enables them to successfully perform tasks in English within the automotive profession, and to what extent and in what way professional English is included in this final exam.

Vocational Matura

The final exam at the end of four or five years of education is the vocational matura exam for all professional programs. If students successfully pass it, they obtain secondary

vocational education and thus proof that they have achieved the knowledge standards set by the goals of the educational program and that they are qualified for higher education studies. https://www.ric.si/poklicna-matura/splosne-informacije/

It consists of four subjects. Two are considered to test general knowledge: the first subject, which is common or uniform – exam of mother tongue language, Slovene language, and the third subject, which is optional, either mathematics or a foreign language (English, German, Italian, Hungarian, etc.). The second and fourth subjects are based on professional knowledge.

For students completing the automotive vehicle technician program at our school, it consists of the following four subjects:

1. SUBJECT: Slovenian

2. SUBJECT: Automotive mechatronics

3. SUBJECT: English or mathematics

4. SUBJECT: Product or service and defense

https://www.ric.si/mma/MIK_PM_2024__popravlen_2023.pdf/2023071012292391/?m=1688984963

The third subject is optional. They can choose English or mathematics. This school year, we had 28 students in the 2nd year of the automotive service technician PTI program. 15 of them chose English as their third subject, which is 53%.

Third subject – English

The English exam consists of a written and oral part.

Written part

It is uniform for all programs. It lasts 120 minutes and consists of three parts, prepared by the state subject committee for the vocational matura in English. Exam part 1 tests reading comprehension, exam part 2 tests listening comprehension (which is new this school year), and exam part 3 tests written communication skills, as students must write two essays, a shorter one and a longer one. The written exam can be scored up to 70 points.

Oral part

It is taken before the school exam committee, which also scores it on the proposal of the examiner. This is usually the teacher who taught the candidate in the final year. Question papers are prepared for the oral exam. The candidate has the right to 15 minutes to prepare answers. The oral exam lasts a maximum of 20 minutes. It is possible to score 30 points. https://www.ric.si/mma/MIK_PM_2024__popravlen_2023.pdf/2023071012292391/?m=1688984963

The tasks for the oral exam are prepared by English teachers or active English teachers at the school where the candidate is taking the exam. The test must be designed to test speaking and listening skills in everyday life, as well as the ability to communicate in the language of the profession or in professional life. Two of the three tasks in the oral exam must test the ability to communicate and communicate in the candidate's field of expertise. The order of the tasks is not prescribed. https://www.ric.si/poklicna-matura/predmeti/tretji-predmet/anglescina/

There are therefore three tasks of different types on the exam papers, which include one general and two specialist topics. This topic tests knowledge of the language of the profession, namely professional vocabulary, understanding of professional texts and the ability to communicate in a professional field. The topics covered in class and general professional topics listed in the catalogue can be chosen.

The exam papers contain three tasks, such as role-playing, conversation based on a textual cue (e.g. short texts up to 100 words, advertisements, starting questions) or visual/graphic cues (e.g. pictures, tables, graphs), interpretation of an authentic professional (e.g. description of a device, procedure, instructions) or general text (e.g. proverbs, titles, sayings, jokes) up to 100 words, written in English or Slovenian, and a conversation about it.

Candidates become familiar with the topics and types of tasks during English classes or during preparation for the exam. Since the number of school hours is limited, it is recommended that they also read and listen to various types of texts in English outside of school hours. They can use newspapers, magazines and audio recordings as well as professional periodicals, printed materials and other texts related to their professional field. We develop in candidates an interest in: following radio and television programs in English, reading, listening and watching content on the Internet on current, general and professional topics, corresponding and talking with acquaintances from abroad whom they meet on school exchanges abroad, searching for information in various sources from general and professional fields ...

During the course of a conversation, the student must be able to appropriately use the following communication functions: starting, maintaining, interrupting a conversation, joining in a conversation and ending a conversation.

When acquiring and transmitting information, they must be able to, among other things, inquire, identify themselves and name and describe people, objects, circumstances, places, machines, tools and other work equipment from a particular profession, workplace, tasks related to professional work, report on events related to a particular profession (business meetings and conferences, visits to exhibitions and fairs, visits to partner companies and factories), on what they have read (general and professional texts) and the opinions/viewpoints of someone else...

Tasks must be authentic (similar to those from real life situations, including professional ones), meaningful (originality, problem-solving, integrity, different perspectives) and communicatively oriented. Professional/professional thematic areas include basic professional terminology in a particular professional field (materials, devices, tools, equipment, aids and instructions) and description of professional activities and work procedures, basic knowledge of business communication, information and communication technology (equipment, devices, responsible use of the Internet), environmental protection, safety at work (protective equipment, hazardous substances, first aid, occupational safety), development of science and technology in particular professional fields (famous figures, technological achievements, inventions).

Speaking activities are selected in such a way that they enable the demonstration of the candidate's functional language knowledge and abilities: presentation/descriptive abilities, description of facts, presentation, comparison, expression of instructions, summarization; evaluation skills (expressing and justifying opinions, proposing, expressing wishes,

inquiring, asking for opinions, agreeing, disagreeing, explaining); interaction skills (participating in a conversation, managing dialogue, managing the flow of a conversation: knowing how to start and end a conversation, letting others speak, taking the floor); adaptation skills (checking/determining correct understanding, adapting, negotiating, coordinating with the interlocutor). During oral communication, candidates also demonstrate their mastery and breadth of vocabulary, as well as the level and breadth of language knowledge in general, fluency of speech and appropriate communication strategies.

https://www.ric.si/mma/PIK_ANG_2024-novi.pdf/202111709281391/?m=1668673693

Car service profession in the tasks of the oral exam papers

The tasks include professional topics that we have discussed in class. Students are familiar with them.

The following topics are included in the exam papers of our school:

- Car service profession (definition, examples)
- Jobs in the car service profession
- Travel methods and means of transport
- Public passenger transport
- Road traffic regulations
- Traffic accidents (causes, consequences, legislation)
- Safety at work (protective clothing and equipment, regulations)
- Services (regular inspections, servicing, conversion, repair, tire change, ...)
- Environmental protection (sustainability, electric vehicles, hybrids, pollution, ...)

When compiling exam papers, we follow the basic guidelines. These are:

1. Designing such tasks for testing communication skills that will provide the most valid and reliable sample of the candidate's language skills.
2. Variety – each task is set differently and is based on a different starting topic.
3. The sequence of tasks is arbitrary.

POKLICNA MATURA – ustni del

1.4 Oglejte si sliko in razmislite o kratkem opisu ali komentarju. Slika je tudi osnova za razgovor.



http://financialtribune.com/archive/2015/10/18/articles/economy-auto/27648/intl-auto-confab-focus-environment

1.5 Preberite besedilo in razmislite o kratkem povzetku. Besedilo je zgolj pobuda za razgovor, ki se bo odvijal med vami in izpraševalcem.

According to a study, more elite child football players had a sports injury over the 10-year period compared with the other sports. Elite child swimmers suffered very few sport-related injuries.

http://www.greencarreports.com/news/1104425_how-to-turn-long-haul-trucking-all-electric-tractor-swapping

1.6 Igra vlog

Si lastnik avtoservisne delavnice. Sprejmi stranko (izpraševalec), ki potrebuje redni servis vozila. Pozdravi stranko, vprašaj kako ji lahko pomagaš, dogovori se za termin in pojasni kako bo redni pregled vozila izgledal.

Before the exam, examiners prepare framework questions that help students understand the tasks and encourage meaningful expression. For example, in the first task, the candidate is encouraged to first briefly describe the given picture, then explain the concept of "sustainability" and environmental protection, or explain how these two are present in the car service profession - for example, in the car industry, regulations, people's habits, etc. Next, the student presents the types of vehicles and fuels, their advantages and disadvantages.

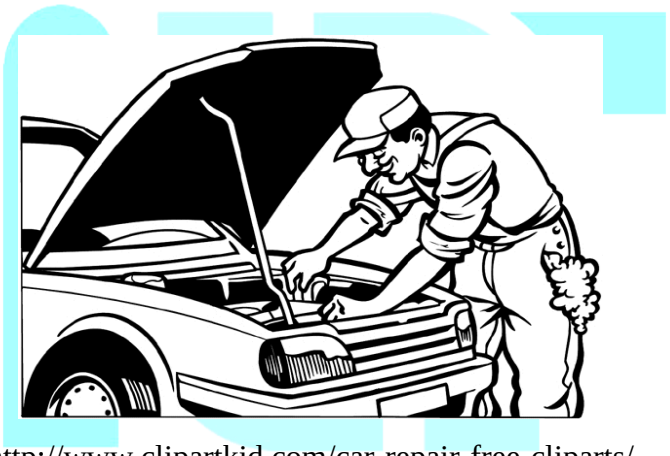
In the third task, the student takes on a role in a simulated situation, such as a car repair shop, where he/she is talking to a customer. He/she must ask appropriate questions, answer the questions asked and, for example, describe the vehicle malfunction, the course of the inspection or the proposed solutions – thus demonstrating the ability to participate in everyday professional conversation in English.

The exam paper includes a picture and text cue (task 2) and a role play, which allows for a varied assessment of communication skills and professional vocabulary.

A few other examples of professional cues from the automotive repair profession

Image cues:

A)



http://www.clipartkid.com/car-repair-free-cliparts/

In this visual cue, the candidate is expected to describe the work of a car service technician, his equipment and tools. He can then list different means of transport, describe working conditions, safety at the workplace, working with customers, etc. The conversation can focus on the experience of driving a car, brands, advantages and disadvantages of owning a car, maintenance, choice of drive (petrol/electric...) and their advantages and disadvantages...

B)



https://www.google.si/search?q=traffic+accidents&espv=2&biw=1366&bih=643&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiPoNnk86LNAhWHSBQKHa6vCSwQ_AUIBigB#imgrc=MawqnUAATSAXEM%3A

In this case, the candidate would describe what the picture shows. They would be asked whether they have ever been involved in an accident as a passenger or driver, what types of accidents can occur and what the most common causes are. They would also be asked what to do in the event of a traffic accident and how traffic safety could be improved or the number and consequences of traffic accidents could be reduced.

C)



http://www.ebay.com/gds/How-to-Change-a-Tyre-on-Your-Mazda-/10000000177591931/g.html

With this cue, the candidate would infer what happened and how he would act in such a case. He would list the necessary tools and the procedure for changing a wheel. The conversation could also move towards why it is important for a driver to know how to change a wheel himself and when it is necessary to call for help. The student can also share his own experiences and how to take preventive measures and maintain the vehicle in general. Such a task allows the candidate to express technical knowledge, personal experience and the ability to communicate logically, coherently in English.

- Text cues:

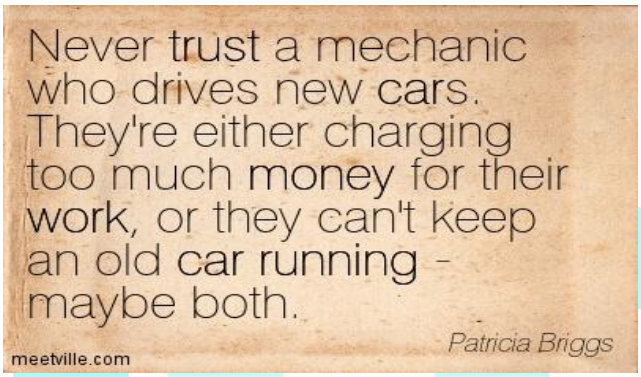
A) Rules of the road are the general practices and procedures that road users follow, especially motorists and cyclists. They govern interactions with other vehicles and pedestrians ... As a general rule, a driver is expected to avoid hitting other vehicles, pedestrians, etc. regardless of whether or not the applicable rules of the road allow them to be where they happen to be.

For this textual cue, the examiners have prepared the following questions: what the text is about, which road traffic regulations the candidate knows, why it is important to follow them, why some people break them, and what are the consequences of not following the regulations. The candidate would be encouraged to think about their own attitude towards driving and following the regulations.

B) When bringing your vehicle in for a specific problem it is very beneficial to have a detailed and accurate description of how and when the problem occurs. Describing car problems descriptively and accurately can be very helpful. A good description of the problem can point us in the right direction and potentially reduce diagnostic time.

This text would be the basis for a conversation about vehicle repairs, the importance of communication with the customer, the process of identifying errors and defects, the necessary equipment and tools for repair, etc. The student could then list the most common vehicle defects and the repair procedure, as well as the importance of regular vehicle maintenance and servicing.

C)



http://www.thequotepedia.com/quotes/car/page/4/

The text cue above is the basis for students to discuss the good qualities of every auto repair technician, why trust between the customer and the auto repair technician is important, what are the typical stereotypes about them, and why consistency, professionalism, and reliability are important in the automotive profession.

Roleplay:

In role-playing, participants play a role according to a specific scenario and according to the descriptions given in the task. They have to imagine the main features of the environment in which the conversation takes place and invent key facts. They partly imagine the appropriate speech during the 15-minute preparation for the conversation, and partly improvise during the dialogue.

A. Si avtomehanik v delavnici. Stranka (izpraševalec) ti pripelje avto na popravilo. Pozdraviš jo in vprašaš, kaj je narobe. Stranki poveš, da danes nimaš časa in boš avto popravil šele jutri. Stranko prosiš naj se vrne naslednji dan.

B. Pelješ se v avtu in ob cesti zagledaš stoječe vozilo s predrto pnevmatiko. Ustaviš se in priskočiš na pomoč. Ob menjavi pnevmatike lastniku vozila (izpraševalcu)

pojasniš postopek menjave.

C. Si prodajalec avtomobila. Stranki (izpraševalcu) opiši vse lastnosti avtomobila in navedi ceno. Stranki ponudi popust in jo skušaj prepričati v nakup vozila.

Opinion of students of the automotive technician program

I asked students in their final year, in the 2024/2025 school year, about the scope of the language of the profession in the automotive service profession in the vocational matura in English and in the English class in which we prepare for the vocational matura. I used the online tool Mentimeter to obtain their opinion. 25 students answered the following questions:

1. In your opinion, was there enough emphasis on the language of the profession in the English class?

2. If I wanted more, which professional topics would I include?

3. Would you include more professional content in the oral part of the vocational matura in English (e.g. so that all three cues instead of two would be related to the profession)?

4. Would you include the profession in the written part of the vocational matura in English: YES/NO?

The majority of students (86%) answered the first question in the affirmative. They believed that there was enough emphasis on the language of the profession in English lessons, and that professional content was very often present in lessons and assessments.

In the answers to the second question, they suggested the following topics to be included in the lessons or to be discussed in more detail: tools and equipment, engine and vehicle parts, engine operation, communication with customers, ordering parts and equipment, insurance and valuations, working with documentation (orders, practice logs, service book, user manuals, etc.).

In the third question, which was related to the scope of the car service profession in the vocational matura in English, the vast majority of students expressed the opinion that there were enough professional topics. As many as 88% of students would no longer include the profession in the oral part and would not want all three cues (instead of two) to be related to the profession. Some justified their answer by the fact that some students switch careers after finishing high school and continue their education in other professions.

The fourth question was interesting, where 70% of students were of the opinion that the profession would also be included in the written part of the vocational matura. This can be attributed to the fact that they are very connected to their profession and feel sufficiently confident and knowledgeable in their field, so it would be easier for them to demonstrate their knowledge of English, even if all three topics contained a profession.

Conclusion

In the vocational matura in English, a foreign professional language from the field of automotive repair is represented in approximately 20% of the total value of the exam.

Nevertheless, the fact remains that general and professional English are closely intertwined. A solid knowledge of general English is the foundation on which we build professional language knowledge. Mastering both levels of the language enables students and adult candidates to continue their education more successfully, promotes lifelong learning and contributes to self-confidence in studying, working in car repair shops, service stations, technical inspections or in contact with foreign customers.

Today, English is considered the European and global "lingua franca" - the language of science, technology, the automotive industry, international communication and business. In practice, it is used as an everyday working language, which means that mastering professional English is also of key importance in the field of automotive repair. Knowledge of technical terminology and the ability to understand instructions, diagrams, diagnostics or communication with international partners greatly contribute to greater efficiency, safety and quality of services provided.

Successfully completing the vocational matura in English thus represents an important confirmation of language knowledge, which opens the door for students to further education and professional activities, either at home or abroad.

S. O. U. Riste Risteski Ričko – Prilep
dipl. soobr. inž. Sekuloska Violeta
dipl. Soobr. Inž. Jošeski Borče
pedagog mr. Pipidjanoska Irena

Tema:

Soobraќajna i urbana mobilnost



Međunaroden simpozium na soobraќajni inženeri
Slovenija - Portoroš Septemvri 2025

Abstrakt:

Soobraќajot pretstavuva dvigatel na ekonomskiot i socijalniot razvoj na poedinecot, no i na zaednicata. Toj ovozmožuva povrzuvanje pomeġu gradovi, državi, kontinenti..., ovozmožuva brz transport na luġe i stoki i e važen del od sekojdnevniot život na luġeto. Životot na luġeto od den vo den stanuva se poaktiven poradi brzoto tempo na živeenje. Luġeto za isto vreme moraat da napravat poveќe raboti. Toa nesomneno ќe se ovozmoži samo so zgolemuvanje na brzinata na soobraќajot, koja so sebe nosi niza na rizici.

Zgolemuvanjeto na brzinata vo soobraќajot od edna strana e rizik sam po sebe, no i potrebata od izvršuvanje na brojni aktivnosti za kratko vreme deluva na načinot na izvršuvanje na soobraќajot, koj od druga strana stanuva pohaotičen, a so toa i pomalku bezbeden. Od edna strana soobraќajot od den vo den stanuva se popotreben, a od druga strana se ponebezbeden. So samoto toa, pokraj pridobivkite, soobraќajot nosi i nekolku značajni štetni posledici koi vlijaam vrz čovekot, životnata sredina i opštestvoto vo celina. Svesnosta za ovie posledici e važna za prezemanje na merki za nivno namaluvajne.

Postojat golem broj na institucii koi se zanimavaat so organiziranje na soobraќajot vo celina kako na globalno, taka i na lokalno nivo, no mnogu malku od niv vo svoite godišni programi go opfakaat alternativniot način na organizirajne na soobraќajot, pa i samoto odvivajne na istiot.

Mnogu malku se prevzemaat merki za iznaoġanje na soodvetni rešenija koi ќe dovedat do promena na celokupniot način na vodenje na soobraќajot, kako na patničkiot taka i na tovarniot soobrajќaj. Često, nekoi rešenija se davaat samo kako idei koi ponatamu ne se sproveduvaat ili se sproveduvaat delumno, površno, no ne vo celost i ne soodvetno sprovedeni vo delo.

Pokraj golemiot broj institucii koi direktno ili indirektno se povrzani so soobraќajot, postojat i niza na rešenija i merki koi možat da gi namalat ili ublažat štetnite posledici od soobraќajot.

Edna od merkite za namaluvanje na štetnite posledici od soobraќajot e i soobraќajnata mobilnost.

Soobraќajnata mobilnost pretstavuva sposobnost na luġeto i stokite da se dvižat od edno do drugo mesto na efikasen, bezbeden i održliv način. Taa igra klućna uloga vo ekonomskiot, socijalniot i urbaniot razvoj na državata. Osobeno važna e urbanata mobilnost, odnosno načinom na koj se organizira soobraќajot vo gradskite sredini, zatoa što istata pretstavuva važen i neraskinliv del na soobraќajnata mobilnost.

Klučni zborovi:

Soobraќaj;

Mobilnost;

Proekt;

Bezbednost;

Analiza.

1 Štetni posledici od soobraќajot

Soobraќajot e našeto sekojdnevie. Ne možeme da zamislime ni eden den bez koristenje na soobraќajot, bilo toa da e direktno ili indirektno. Kolku poveќe go koristime soobraќajot, tolku pogolemi se i negovite štetni posledici. Štetnite posledici od soobraќajot gi čuvstvuvame site i site sme isto zasegnati, bez razlika na toa dali vo nego sme vklučeni kako vozači, pešaci i slično i bez razlika na pol, vera, nacionalnost... Kako da se svedat ovie dva fakti vo edna rezultanta koja ќe ima pozitiven efekt. Primenata na alternativni načini na prevoz e edno od rešenijata. Toa bi gi ublažilo barem malku štetnite posledici od soobraќajot, a bez pri toa da mora da go reducirame negovoto koristenje.

Del od štetnite posledici od soobraќajot bi gi klasificirale na sledniot način:

1.1 Soobraќajni nezgodi:

Najserioznata i najdirektna posledica od soobraќajot se soobraќajnite nezgodi, koi često imaat tragični posledici. Istite možat da bidat so:

- Smrtni slučai;
- Teški telesni povredi;
- Psihološki traumi kaj žrtvite i svedocite;
- Oštetuvanje na vozila i infrastruktura.
- Ovie nezgodi se najčesto rezultat na:
- Brzo vozenje (ne prilagodena brzina spored uslovite na patot);
- Nepočituvanje na pravilata;
- Vozenje pod dejstvo na alkohol ili drogi;
- Nevnimanie ili umor na vozačot.

1.2 Zagaduvanje na životnata sredina

Soobraќajot e značaen zagaduvač na životnata sredina: Vozilata ispuštaat štetni gasovi (CO_2, NO_X ,čestički od izduvnite gasovi, otpad od ošteteni vozila ili nivni delovi), koi ja zagaduvaat atmosferata.

Razlevanjeto na maslo i gorivo ja zagaduva počvata i podzemnite vodi so što se narušuva celiot biodiverzitet, a nekoi vidovi flora se uništuvaat trajno.

Uništuvanje na prirodni živeališta na životinskiot svet, zaradi izgradba na patišta i infrastruktura, e ušte edna štetna posledica koja ja rezultira soobraќajot.

1.3 Ekonomski posledici:

Soobraќajnite nezgodi i zagaduvanjeто nosat i visoki ekonomski trošoci kako što se: trošoci za lekuvanje na povredeni lica, ošteta na vozila i objekti, gubenje na rabotna sposobnost, trošoci za sanacija na oštetena patna mreža, zgolemeni zdravstveni trošoci zaradi zaboluvnja predizvikani od zagaduvanje i ušte mnogu drugi.

1.4 Socijalni posledici:

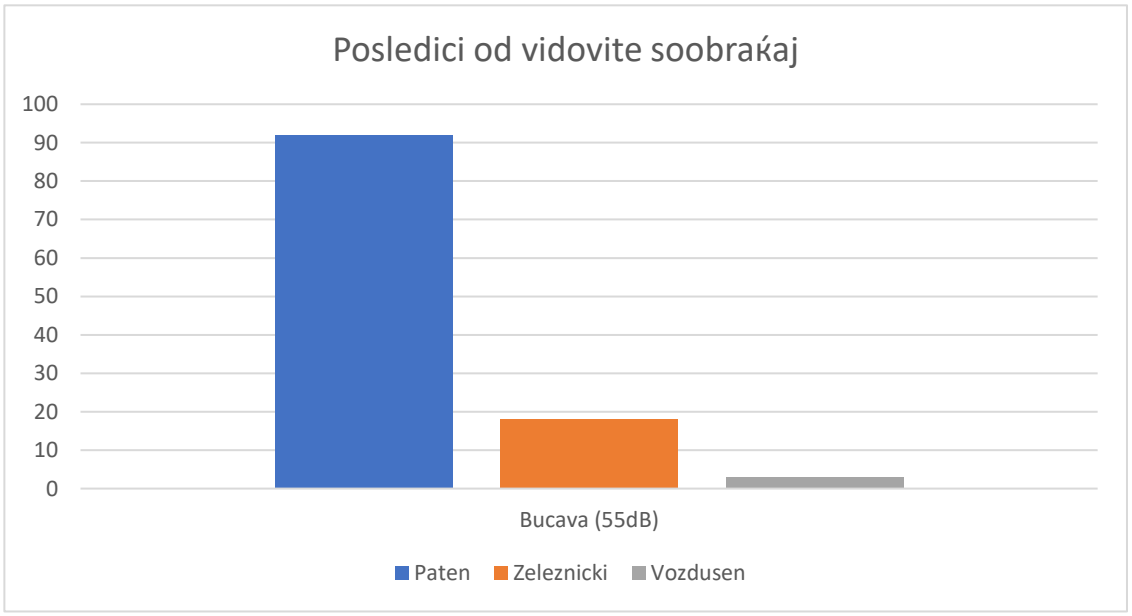
Soobraќajot često doveduva do zgolemen stres, osobeno kaj luѓeto koi sekojdnevno patuvaat. Problemite so parkiranje, metež, bučava i opasnosti od nezgodi sozdavaat negativno vlijanie vrz kvalitetot na životot.

Žrtvite na nezgodi i nivnite semejstva često se soočuvaat so psihološki i finansiski teškotii koi ponatamu se reflektiraat vo sekojdnevniot socijalen život kako na poedinecot, taka i na zaednicata.

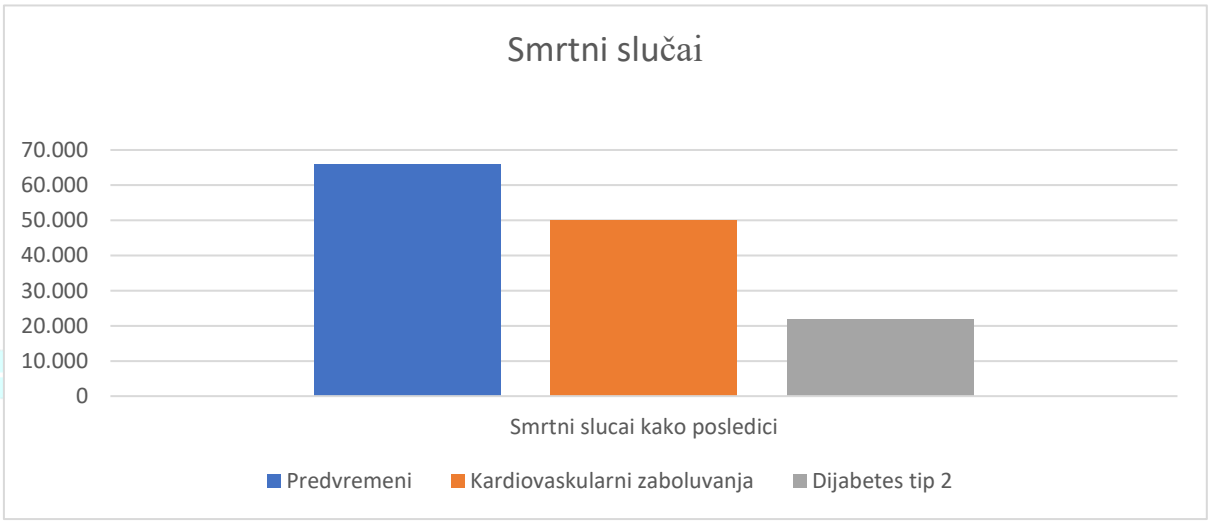
1.5 Potencijalni zakani po javnoto zdravje:

Vozduhot zagaden od soobraќajot predizvikuva astma, alergii, srcevi i belodrobni zaboluvanja. Aerozagaduvanjeto predizvikuva respiratorni bolesti kaj luѓeto, osobeno kaj decata i postarite lica.

Dijagram br 1-posledici od soobraќajot



dijagram br.2-broj na smrtni slučai kako posledica na sobraќajot



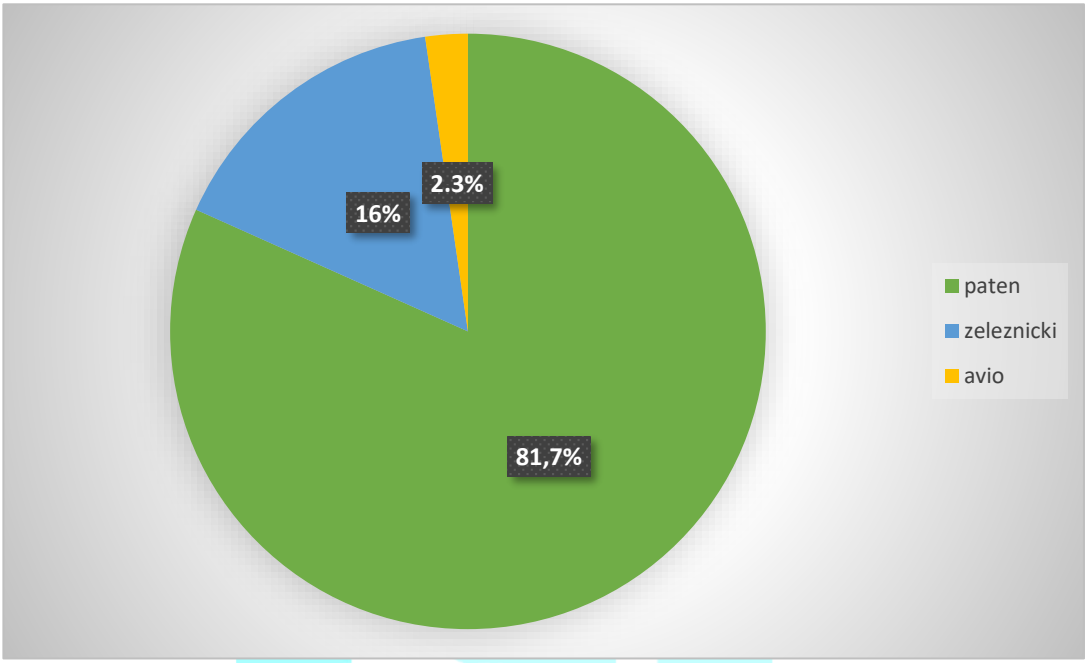
Dolgotrajna izloženost na bučava vodi do namaluvanje na sluhot, narušuvanje na koncentracijata i pokačen krven pritisok. Bučavata od soobraќajot e izvor na stres i

narušuvanje na sonot.

Patniot soobraќaj e najrasprostranetiot izvor na soobraќajna bučava, izložuvaќi okolu 92 milioni luǵe na nivo nad pragot od 55 decibeli vo tekot na denot, večerta i noќta, vo sporedba so 18 milioni luǵe izloženi na železničkata bučava i 2,6 milioni na avionska bučava.

Vo sporedba so drugite zakani za zdravjeto na životnata sredina, soobraќajnata bučava e meǵu trite glavni pričini za šteta, vednaš zad zagaduvanje na vozduhot i faktorite povrzani so temperaturata. Hroničnata izloženost na soobraќajna bučava pridonesuva za 66.000 predvremeni smrtni slučai vo Evropa sekoja godina, kako i za približno 50.000 novi slučai na kardiovaskularni zaboluvanja i 22.000 slučai na dijabetes tip 2.

Dijagram br3. Procentualna zastapenost na bučava od različni vidovi na soobraќaj



Iako soobraќajot e neophoden i korisen, negovite štetni posledici ne smeat da se zanemarat. Za da se namalat ovie negativni vlijanija, potrebno e:

- Odgovorno i vnimatelno učestvo vo soobrakjajot;
- Koristenje na ekološki prevozni sredstva (velosiped, električni vozila, javen prevoz);
- Počituvanje na soobraќajnite pravila;
- Redovno tehničko održuvanje na vozilata, kako i podrška na merki za održliva mobilnost.

Samo so svesnost i odgovornost možeme da gi namalime štetnite posledici i da sozdademe pobezbedna i pozdrava sredina za site.

2 Analiza na mobilnost

Vo denesniot brzo rastečki urban i ekonomski razvoj, analizata na mobilnosta pretstavuva suštinska alatka za dobro upravuvanje so soobraќajot i prostorot. Osobeno vo gradskite i

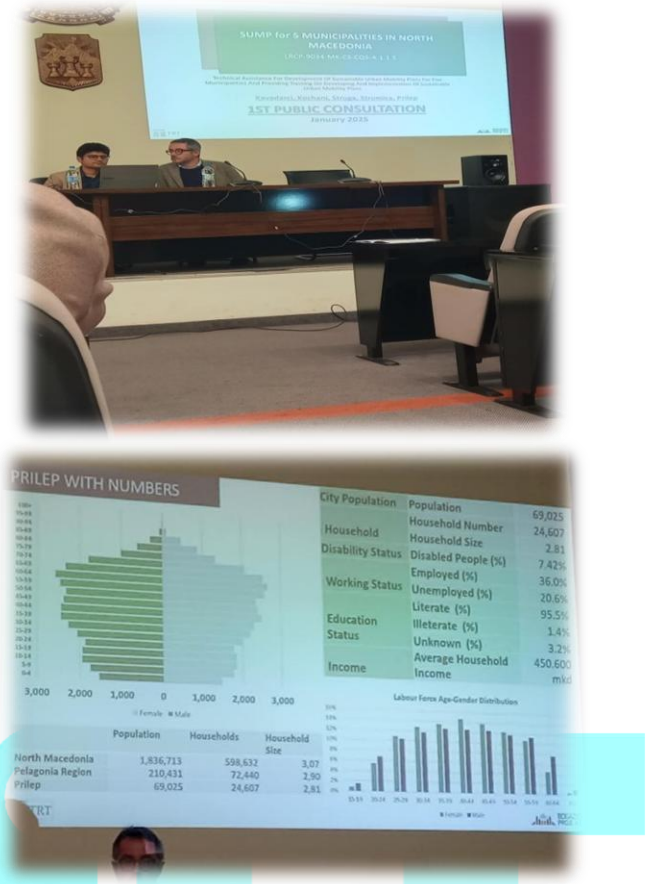
prigradskite sredini, kako što e opština Prilep, neophodno e da se razberat tekovnite naviki, potrebi i predizvici vo dviženjeto na luǵeto i stokite, za da može da se planira i da se postigne poefikasen, pobezbeden i poodržliv soobraќaen sistem.

Što predstavuva analiza na mobilnost?

Analizata na mobilnost opfaќa sistematsko sobiranje, proučuvanje i tolkuvanje na podatoci povrzani so:

- navikite na dvizenje na žitelite;
- izborot na prevozni sredstva, patuvačkite rutini(na primer, za na rabota, učilište, pazari itn.);
- sostojbata na infrastrukturata;
- vlijanieto na transportot vrz životnata sredina.
- Celta na ovaa analiza e da se dobijat realni i točni informacii, koi ќe poslužat kako osnova za:
- podobruvanje na javniot prevoz, razvoj na pešačka i velosipedstka mreža;
- reguliranje na soobraќajnite tekovi;
- sozdavanje na strategii za održliva urbana mobilnost.
- Urbanata mobilnost se odnesuva na sistemot na prevoz što ovozmožuva dviženje na luǵeto vo ramkite na gradovite i urbanie naselbi. Taa vklučuva:
- javen prevoz (avtobusi, taksi);
- individualen prevoz (avtomobili, velosipedi, pešačenje);
- parking prostorii;
- pešački i velosipedski pateki;
- uredenost na soobraќajnata infrastruktura.

Urbanata mobilnost e tesno povrzana so kvalitetot na žitvotot vo gradovite i dokolku istata e dobro organizirana, pridonesuva za namaluvanje na soobraќajniot metež, zagaduvanje na vozduhot i vremeto potrebno za patuvanje. Vo kontekst na ova, dve korporacii **TRT Trasporti e Territorio и Boǧaziçi Proje A.S.,**prvata od Italija vtorata od Turcija, ovaa godina, vo februar mesec, održaa javna debata vo prostoriite na opština Prilep kade svoe obraќanje imaa členovite na ovaa komisija. So svoj razmisluvanja, sugestii i kritiki učestvuvaa členovi na golem broj institucii koi se direktno ili indirektno povrzani so soobraќajot, odnosno so načinot na negovoto organiziranje, donesuvanje na merki i soodvetni rešenija. Na krajot na ovaa debata se donesoa zaklučoci koi ponatamu ќe rezultiraat so soodvetni rešenija za podobruvanje na urbanata mobilnost ne samo vo gradot Prilep,tuku i vo uште četiri gradovi na Republika Makedonja koi se opfateni so ovoj proekt. Toa se gradovite:Struga, Strumica, Kavadarci i Kocani.



Sl.br.1-javna debata

3 Urbana mobilnost vo Republika Makedonija

Republika Makedonija e suverena drzava locirana vo jugot na Balkanskiot Poluostrov. Taa pretstavuva krstosnica pomeǧu Istokot i Zapadot, kade što se vkrstuvaat važni patišta i kulturni vlijanija. So bogato kulturno istorisko nasledstvo, Makedonija e država so golem potencijal za ekonomski, turistički i soobraḱaen razvoj.

Republika Makedonija zafaḱa vkupna površina od 25.713km 2, što ja vbrojuva meǧu pomalite državi vo Evropa. Taa e kontinentalna zemja, bez izlez na more i e opkružena so Srbija i Kosovo na sever, Bugarija na istok, Grcija na jug i Albanija na zapad. Zemjišteto e pretežno planinsko so brojni rečni dolini, kotlini i ezera, kako što se Ohridskoto, Prespanskoto i Dojranskoto Ezero.

Spored poslednite procenki, Republika Makedonija ima približno 1.8 milioni žiteli. Naselenieto e neramnomerno rasporedeno –najgusto naseleni se urbanite podračja, osobeno glavniot grad Skopje vo koi živeaat 500.000 žiteli. Drugi značajni gradovi se Bitola, Prilep, Tetovo, Kumanovo, Ohrid, Struga, Strumica, Štip…

Soobraḱajnata mreža vo Makedonija se sostoi od paten, železnicki i vozdušen soobraḱaj. Vkupnata dolžina na patištata e okolu 14.000 kilometri, od koi del se avtopati. Najvazni avtopatski koridori se:

- Koridor 10 (Sever- Jug): Gi povrzuva Srbija i Grcija preku Makedonija.
- Koridor 8 (Istok-Zapad) : Gi povrzuva Bugarija i Albanija.

- Železnickata mreža e so vkupna dolžina od okulu 900 kilometri, no ne e celosno elektrificirana i bara modernizacija. Vozdušiot soobraќaj se odviva preku dva međunarodni aerodromi:
- Međunaroden aerodrom Skopje
- Aerodrom Sv. Apostol Pavle - Ohrid



Sl.br.2-patna infrastruktura vo R.Makedonija

Ovoj proekt vo koi ќe se vrši analiza za razvoj na mobilnosta na R.Makedonija, patniot soobraќaj ќe bide toj koi što ke bide analiziran, zatoa što istiot e najčesto primenuvan i najzastapen vid na prevoz, i e idealen za ovaa namena. Za taa cel ќe se targetiraat odredeni momenti koi se klučni za mobilnosta na našata zemja. Tuka pred se, se misli za razvivanje na planovi za podobruvanje и razvoj na javniot gradski prevoz, velosipedska infrastruktura и možnosta za primena na održliva mobilnost.

Javen prevoz: Vo pogolemite gradovi vo Makedonija, kako Skopje, Bitola, Prilep, Kumanovo i Tetovo, javniot prevoz glavno se bazira na avtobuskiot soobraќaj.

Vo Skopje funkcionira Javnoto soobraќajno pretprijatie (JSP), koe raspolaga so golem broj avtobusi koi pokrivat različni linii niz gradot. Sepak, postojat predizvici povrzani so:

- zastaren vozen park;
- neregulirani vozni redovi;
- nedovolen broj vozila vo špic- termini.
- Velosipedska infrastruktura:
- vo del od urbanite sredini postoi problem so nedovolno infrstruktura za alternativni vidovi prevoz;

- velosipedski pateki se retki ili ne se opfatni ;
- pešački zoni često se neprilagodeni za lica so poprecenost;
- nedostig od parking prostori sozdava haos i nebezbedni situacii.
- Urbani predizvici: urbanata mobilnost vo Makedonija se soočuva so nekolku kluči predizvici :
- zgolemen broj na avtomobili po glava na žitel ;
- slabo koristeni na javniot prevoz poradi nedoverba i neefikasnost;
- nedovolna svest kaj građanite za koristenje na ekološki i održlivi formi na transport.

Republika Makedonija, iako mala po teritorija, pretstavuva značajna točka vo Jugoistočna Evropa. So svojata raznovidnost demogravska struktura, prirodni bogatstva i povolno geogravska položba, taa ima kapacitet za ponatamošen razvoj, osobeno vo oblasta na infrastrukturata, soobraќajot i urbanata mobilnost. Stabilen i održliv razvoj može da se postigne so vložuvanje vo modernizacija na soobraќajnata mreža i zadržuvanje na mladata populacija.

Urbanata mobilnost kako idnina na bezbedniot i efikasen gradski život e eden klučen zafat koj ќe može vo novo da gi reši predhodno kažanite problemi koi se povrzani i so soobraќajot no i so sekojdnevnoto živeenje na luģeto.

Dobro organiziranata urbana mobilnost pretstavuva osnova za kvaliteten život vo urbanite sredini. Republika Makedonija ima golem potencijal za unapreduvanje na svojata soobraќajna mobilnost, no za toa e potrebna koordinacija pomeģu instituciite, lokalnite samoupravi i samite građani. Samo so vložuvanje vo održliv transport, digitalni rešenija i sovremena infrastruktura, može da se postigne bezbeden, efikasen i moderen urban soobraќaj.

4 Urbana mobilnost vo opština Prilep

Zošto e važna analizata na mobilnosta vo Prilep?

Opština Prilep, kako eden od pogolemite gradovi vo Republika Makedonija, se soočuva so brojni soobraќajni predizvici, kako na primer:

- zgolemen broj na motorni vozila;
- nedovolen kapacitet na soobraќajnata infrastruktura;
- slabo razvien javen prevoz;
- ograničeni možnosti za alternativen transport (velosipedski i pešački ruti);
- zagaduvanje na vozduhot i narušuvanje na životnata sredina.
- Poradi ovie pričini, postoi itna potreba od detalna analiza na mobilnosta vo opštinata, koja ќe ovozmoži:
- identifikuvanje na klučnite problemi;
- mapiranje na soobraќajnite tekovi, razbiranje na potrebite na različnite kategorii korisnici (učenici, rabotnici, stari lica, lica so poprečenost itn);
- definiranje na prioritetni intervencii.

- Podatocite koi ќe se sobiraat pri analiza na mobilnost bi bile slednite:
- broj i vid na vozila koi veguvaat i izleguvaat od gradot;
- najfrekfentni ulici i patni pravci;
- prosečno vreme na patuvanje i zastoj, dostapnost i frekfencija na javen prevoz;
- broj na pešaci i velosipedisti po delovi od gradot;
- socijalni i ekonomski naviki povrzani so transportot.
- Pridodbivki od analizata na mobilnost vo Prilep bi bile sledni:
- podobreno planiranje na soobraќajnata mreža;
- namaluvanje na soobraќajniot metež;
- pogolema bezbednost na site učesnici vo soobraќajot;
- pottiknuvanje na održlivi formi na transport;
- poddrška na ekonomskiot razvoj preku podobra povrzanost;
- zaštita na životnata sredina.

Analizata na mobilnost ne e samo tehnička postapka-taa e osnoven čekor za sozdavanje na pokvaliteten urban život. Za opština Prilep, toa znači razvoj na funkcionalen, dostapen i održliv soobraќaen sistem, koj ќe odgovara na potrebite na segašnoto naselenie, no i ќe bide podgotven za idni predizvici. Samo preku temelna analiza može da se kreiraat pametni rešenija za mobilnosta na idninata.

5 Prezemeni postapki za urbana mobilnost vo opština Prilep

Vo tesna sorabotka so **Porektiniot upraven komitet** (PSC), opštinskite sektori i zasegnatite strani, beše sproveden detalen proces na sobiranje i analiza na podatoci za da se identifikuvaat predizvicite i možnostite vo mobilnosta. Ovie naodi dovedoa do definiranje da deset strateški oblasti na politika i lista od nad 50 merki, grupirani vo tri scenarija za idninata:

„Biznis kako i do sega”(BAU) i dve alternativni scenarija so različno nivo na ambicija i intervencija. Sekoja od ovie pateki ќe bide oceneta na 5 i 10 godini preku modelot MOMOS – alatka za predviduvanje i analiza prilagodena za mali i sredni evropski gradovi.

Klučen moment za ovoj proekt e učestvoto na javnosta vo kreiranjeto na zaednička vizija za idninata na mobilnosta vo Prilep. Preku strukturirani sesii, online anketi so Mentimeter i javni konsultacii, građanite, sovetnicite i PSC – členovite odgovaraa na prašanja kako:

1. „Kakvo čustvo sakate da imate dodeka se dvižite niz gradot?”
2. „Koi prioriteti treba da gi ima urbata mobilnost?”
3. „Koi podobruvanja gi posakuvate vo slednite 10 godini?”

Rezultatite pokažaa jasna poddrška za pobezbedna, poinkluzivna i poekološki oddržliva urbana mobilnost vo gradot. Javniot prevoz, pešačenjeto i velosipedizmot bea prioriteteti za investicii, dodeka avtomobilskiot soobraќaj, metežot i nebezbednata insrastruktura bea identifikuvani kako elementi što treba da se namalat. Ispitanite često ja istaknuvaa važnosta na emocionalnite aspekti kako što se bezbednost, zdravje i udobnost.

Ovie viduvanja bea sintetizirani vo jasna i široko prifatena vizija koja suzbiena vo edna misla glasi: **„Prilep go zamilsluvame kako grad koj ќe bide bezbeden, inkluziven i orientiran kon luǧeto, kade što pešačenjeto, velosipedizmot i javniot prevoz se preferirani načini na dviženje i kade što mobilnosta ќe pridonese kon podobreno zdravje, ednakvi možnosti za koristenje na soobraќajot i otpornost na klimatskite promeni."**

Ovaa vizija služeše kako osnova za definiranje na nekolku straški celi:

1. Namaluvanje na zavisnosta od avtomobili;
2. Podobruvanje na pokrienosta i sigurnosta na javniot prevoz;
3. Zgolemuvanje na bezbednosta na pešacite i velosipedistite;
4. Poddrška na digitalizacijata vo služba na soobraќajot;
5. Unapreduvaje na nisko jaglerodn amobilnost, usoglasena so klimatskite celi.

Za da se ostvari ova vizija, bea definirani indikatori i celi što ќe ovozmožat sledenje i evaluacija. Izbranite indikatori opfakjaat performansi na transportot, vlijanie vrz životnata sredina, bezbednos i ekonomska efikasnost.

Na konsultaciite, grаǧanite gi rangiraa celite po prioritet spored nivni sogleduvanja, za postignuvanje na slednite pridobivki:

1. Zgolemuvanje na svesnosta i potrebata od pešačenje, velosipedizan i koristenje javen prevoz;
2. Namaluvanje na CO_2 (jagleroden dioksid) NO_x (azoten oksid i azoten dioksid) i PM10 emisii (čestički pomali od 10 mikrometri);
3. Namaluvanje na motorizacijata, posebno upotrebata na avtomobili;
4. Prepolovuvanje na smrtni slucai vo soobraќajot do 2037 godina.

So vgraduvanje na ovie celi vo modelot MOMOS, gradot ќe raspolaga so analitički alatki za sporedba na vlijanijata od različni scenarija i izbor na najsoodvetna strategija. Ova ovozmožuva planot za mobilnost na Prilep da bide ne samo ambiciozen, tuku i merliv i fleksibilen. Voedno, go zacvrstuva legitimitetot na SUMP bidejќi patot što se izbira e i tehnički opravdan i demokratski izgraden.

6 Pregled na napredokot na aktivnostite

Republika Makedonija se soočuva so značitelni predizvici vo unapreduvanjeto so svojata obemna lokalna patna mreža, koja se protega na približno 9.000 kilometri i pretežno e pod nadležnost na decentralizirani opštinski upravi. Mnogu od ovie opštini rabotat so ograničeni institucijalni kapaciteti i finansiski resursi, što go otežnuva održuvanjeto na infrastrukturata i obezbeduvanjeto na efikasni mobilni uslugi. Kako rezultat na toa, vloženite uslovi na patištata go ograničuvaat pristapot do osnovni uslugi i ekonomski moznosti, vlijaeќi vrz kvalitetot na životot na grаǧanite vo urbani i poluurbani podračja.

Vo ovaa nasoka, razvojot na planovi za održliva urbana moblnost taka narečen(SUMP) pretstavuva klučen čekor kon nadminuvanje na ovie strukturni problem i vodenje na opštinite-kako što e Prilep- kon pootporni, poinkluzivni i poodržlivi transportni sistemi.

Procesot započna so **Zadača 1.1.** – Organiziranje na rabotna struktura, utvrduvanje na

planski ramki i vklučuvanje na zasegnati strani, so fokus na vospostavuvanje institucionalni i procedurni mehanizmi potrebni za efikasno i učesničko kreiranje na SUMP. Kako klučni aktivnosti koi treba da se prevzemat za sproveduvanje na ovaa zadača bi bile slednite:

1. formiranje na Proektni Upravni Komiteti (PSC) vo sekoja opština;
2. dizajiranje na proces za fklučuvanje na građani i zasegnati strani;
3. gradenje na kapaciteti preku specijalizirani obuki.

So aktiviranje na ovie aktivnosti, se dobi zaključok deka lokalnite činiteli se podgotveni i ovlasteni aktivno da učestvuvaat vo procesot na planiranje.

Zadača 1.2.-Analiza na tekovnata sostojba na mobilnosta vo gradot Prilep so seopfatna dijagonistička procenka na postojanata urbana mobilnost.

Centralen del od ovaa zadača beše javniot nastan za konsultacii, održan vo početokot na 2025 godina za vreme na terenskata poseta na dvete golemi korporacii.

TRT Trasporti e Territorio i **Boğaziçi Proje A.Ş.**, vo gradot Prilep. Vo ovaa sesija bea prezentirani klučnite naodi od Zadača 1.2, a građanite bea pokaneti da dadat mislenje za idninata na mobilnosta vo gradot. Preku interaktivna anketa so Mentimeter, učesnicite gi spodelija svoite prioriteti vo odnos na:

- bezbednost vo soobraќajot;
- pešačenje;
- javen prevoz;
- velosipedska infrastruktura;
- parkiranje i dr.

Bideќi ovie problemi se identifikuvani kako najznačajni, fokusot za dosegašnite aktivnosti beše staven na niv i toa so sledniot raspored:

1. Dominacija na avtomobilite:

Golemata zavisnost od privatni vozila, povlekuva zgolemen stepen na motorizacija I niska upotreba na alternativni formi na transport kako što e javniot gradski prevoz, upotrebata na velosipedi ili pešačenje.

2. Nedostatok na javen prevoz:

Od druga strana malata frekfencija na gradskiot prevoz, zastareniot vozen park, slabata povrzanost kako I nedovolnata pokrienost na celoto gradsko područje so javniot prevoz doveduvaat do negovo necelosno koristenje.

3. Nedovolna infrastruktura za pešaci I velosipedisti:

Niski investicii vo kvalitetni I prostrani trotoari, čestata uzurpacija na trotoarite, nedostatok na velosipedski pateki I bezbedni pešački premini, vo centralnoto gradsko područje no I vo perifernite delovi na gradot go odvraќaat čovekot od koristenje na vakov vid na soobraќaj.

4. Parkiranje I soobraќaen metež vo centrarot na gradot:

Nedostigot na parking mesta, so što imame situacija na nekontrolirano parkiranje na trotoari, pešači zoni I zeleni površini, ušte poveќe ovozmožuvaat odvraќanje na luģeto od pešačenje.

5. Niska bezbednost vo soobraќajot:

Vo odnos na ovoj problem može da se kaže deka se prisutni točki kade ima česta pojava na soobraќajni nezgodi, posebno vo blizina na učilišta I klučni krstosnici, kako I vlezno/ izlezni kraci koi se spojuvaat so nekoi poglavni ulici.

6. Zagaduvanje I degradacija na životnata sredina:

Predhodno spomenatite 306roblem sami po sebe povlekuvaat zagaduvanje na životnata sredina I uništuvanje na celiot rastitelen I životinski svet koj se naoǧa vo taa sredina. So soobraќajnata mobilnost, so pomoš na niza na merki opfaten e I ovoj problem. Isto taka, prisutnite na konferencijata bea prašani: "vo kakov Prilep sakate da živeete do 2037 godina?".

Ova prašanje dobi povratna informacija I odkri zaednički želbi za počist vozduh, pobezbedni ulici, inkluzivna mobilnost I podobar pristap do javen prevoz.

Dopolnitelno, beše razvien I online prašalnik za mobilnost koj beše objaven preku komunikaciskite kanali na opštinata I socijalnite mreži, a so cel da se opfati poširok del od žitelite. Iako sobiranjeto na podatoci seušte trae, prvičnite odgovori veќe počnaa da go oblikuvaat strateškiot pravec I glavnite preioriteti.

Dosega se izvedeni samo del od planiranite analizi za celosno implementiranje na mobilnosta vo gradot Prilep I toa:

- Broenje na frekfencija na site krstosnici vo gradot Prilep;
- Broenje na vlezno – izlezni vozila vo I od gradot Prilep;
- Broj na korisnici na gradskiot prevoz vo gradot Prilep;
- Parkiranje na vozila vo centralnoto gradsko podračje.



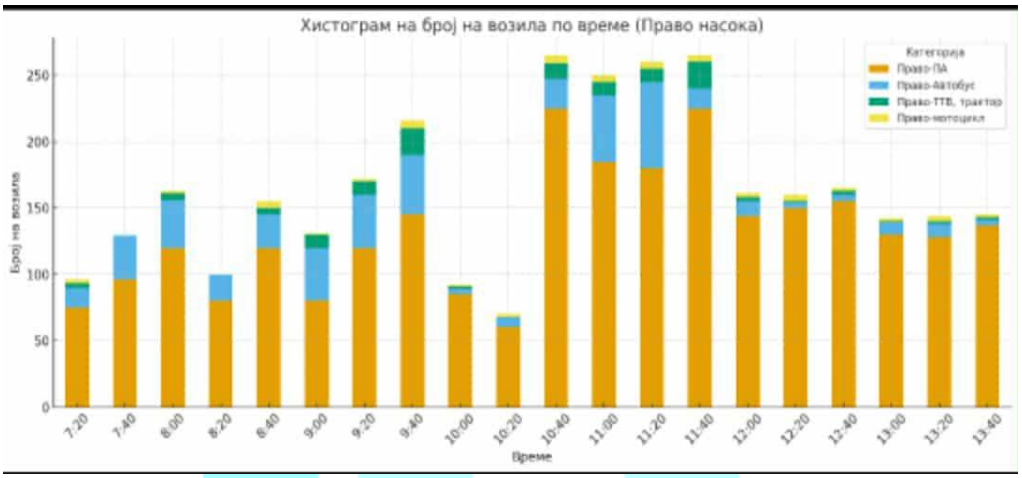
Sl.br.3-učenici-brojači

Pridobivkite od dosegašnite analizi se golemi i možat mnogu da ja dadat vizijata koja ќe go dovede gradot Prilep kon sigurna implementacija na urbanata mobilnost.

Broenjeto na vozilata na krstosnicite vo gradot beše izvedeno vo dve dena počnuvajќi od 7

часот nautro do 20 часот навечер. Za taa cel bea angažiranj golem broj na brojači koi napravija celokupna pokrijanost na skoro site krstosnici vo gradot (17 krstosnici). Brojačite dobivaa posebni formulari t.n. brojački livčina kade spored soodvetna selekcija gi dobivaa potrebnite podatoci. Ponatamošnata obrabotka na ovie brojački livčina beše so pomoš na excel tabeli koi so soodvetna matematička zavisnost i so pomoš na PA ekvivalentot, dadoa jasna slika za frekfencijata na krstosnicite po soodvetni kraci. Seto toa, za podobra slikovitost beše predstaveno i grafički so pomoš na histogram koj vednaš dava jasna slika za site potrebni podatoci.

Dijagram br 4-histogram



I Крак

IV Крак

II Крак

III Крак

1. Име на крстосницата _____
2. Место на броење _____
3. Датум на броење _____
4. Број на краци на крстосницата _____
5. Крак на броење _____
6. Други карактеристики на броењето _____
7. Временски интервал на броењето _____
8. Име и презиме на бројач _____

Насока	Влез	Излез	Десно					Право					Лево				
Час Време			Автобус	Камион	Автом.	Мотори	Велос.	Автобус	Камион	Автом.	Мотори	Велос.	Автобус	Камион	Автом.	Мотори	Велос.
Вкупно																	
ПА																	

Час Времe			Автобус	Камион	Автом.	Мотори	Велос.	Автобус	Камион	Автом.	Мотори	Велос.	Автобус	Камион	Автом.	Мотори	Велос.
Вкупно																	
ПА																	
Час Времe			Автобус	Камион	Автом.	Мотори	Велос.	Автобус	Камион	Автом.	Мотори	Велос.	Автобус	Камион	Автом.	Мотори	Велос.
Вк																	

упно																
ПА																
Час Времe			Автобус	Камион	Автом.	Мотори	Велос.	Автобус	Камион	Автом.	Мотори	Велос.	Автобус	Камион	Автом.	Мотори	Велос.
Вкупно																
ПА																
Час Времe			Автобус	Камион	Автом.	Мотори	Велос.	Автобус	Камион	Автом.	Мотори	Велос.	Автобус	Камион	Автом.	Мотори	Велос.

Вкупно																	
ПА																	

Brojačko livče so PA ekvivalent

So broenje na vozilata vo krstosnicite se dobijaja podatoci koi davaat jasna slika za visokofrekfentite krstosnici, za periodot na denot koga imame zgolemena frekfencija i za tesnite grla na nekoi od kracite na analiziranite krstosnici. So ovie podatoci se dobivaat i soodvetnite soobraќajni rešenija kako što se:

- Odreduvanje na minimalna i maksimalna brzina na nekoi krstosnici
- Odreduvanje na zabraneti, zadolžitelni i dozvoleni pravi na nekoi od kracite na krstosnicite
- Zgolemuvanje – namaluvanje na zeleniot signal na semaforskata signalizacija kaj nekoi od krstosnicite.

	Лево-ПА	Лево-Автобус	Лево-ТТВ, трактор	Лево-мотоцикл	Право-ПА	Право-Автобус	Право-ТТВ, трактор	Право-мотоцикл	Десно-ПА	Десно-Автобус	Десно-ТТВ, трактор	Десно-мотоцикл

7.00	10				25				5			
7.20	20	15		5	40	10		10				
7.40	10				10	10		15				
8.00	23			2	75	1	4					
8.20	63		1	2	103	1						
8.40	28			2	79	1	5	2				
9.00	32			1	133	1	2	2				
9.20	26		2		102	1	2					
9.40	37			2	100	1	1	3				
10.00	63		5		63							
10.20	37		1		63	1	2	3				
10.40	51			5	90	2	3	2				
11.00	42		3	1	67		9	7				
11.20	30		1	3	75		2	6				
11.40	34	1	4	3	84		5	3				
12.00					50	3		5	22			7
12.20					50	2		2	15			3
12.40					48	1		3	18			2
13.00					90	12		3	40			5

- Фурна Плетварец 1 приод од Бонита кон Центар

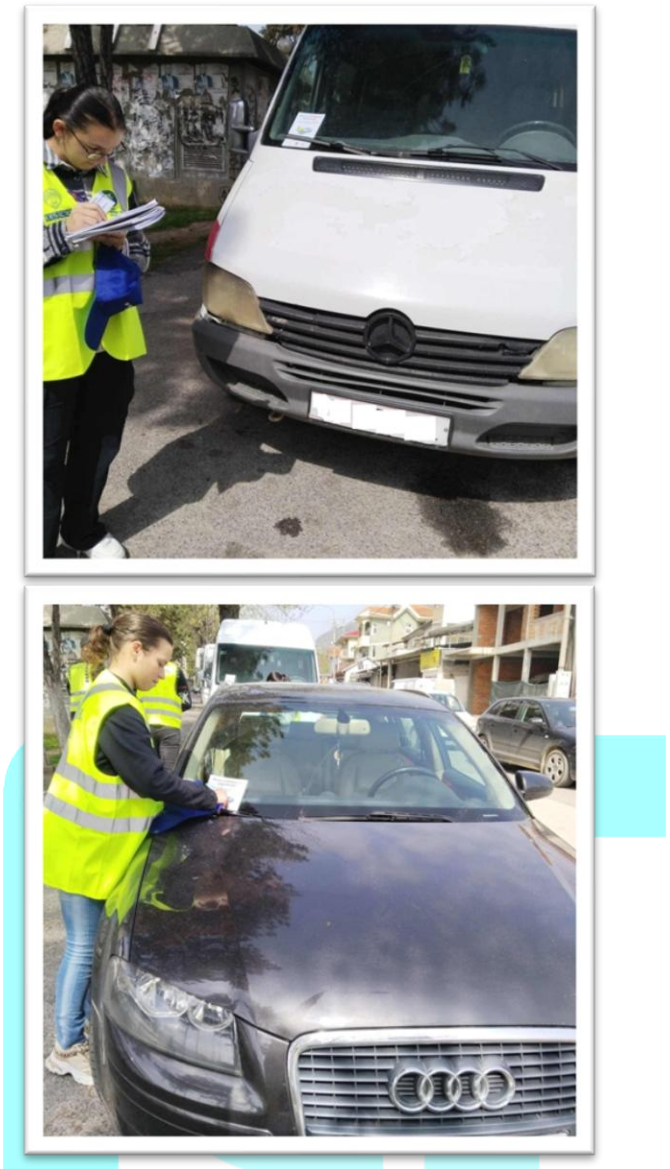
Slednata aktivnost beše izvedena posle edna nedela i se odnesuvaše na broenje na vlezovite – izlezite vo i od gradot. Na posebni brojački livčina, no ovoj pat so namalen broj na brojači, beše izvedena i ova akcija vo eden den vo vreme traenje od 12 časa počnuvajќi od 7 časot nautro pa se do 19 časot navečer. Ovie podatoci bea obraboteni vo excel tabeli koi davaat podatoci za visokofrekfenti vlezovi/ izlezi vo i od gradot. So ovie podatoci se doağaše do zaključok za iznaoğanje na soobraќajno rešenie vo smisla na izrabotka na obikolnica koja ќe gi eliminira brojot na tranzitnite vozila vo gradot.

Slednata aktivnost se odnesuvaše na broenje na korisnicite na grackiot prevoz i toa za sekoja linija zasebno. Sprovedena beše vo dva dena i toa vo vtornik i sreda, zatoa što beše potrebno da se napravi sporedba za koristenje na grackiot prevoz vo običen i pazaren den. Dobienite rezultati davaa jasna slika što se treba da se prevzeme so grackiot prevoz vo bliska idnina, kako na primer promena na vozniot red, dodavanje na linii i zajaknuvanje na postoečkite linii so pogolem broj na vozila.



Sl.br.4-broenje vo gradski prevoz

Poslednata aktivnost koja beše sprovedena vo ramkite na urbanata mobilnost e odreduvanje na parkirani vozila vo strogoto gradsko jadro. Izvedena beše povtorno vo dva dena, ponedelnik i sreda se so cel da se dobijaat podatoci kako vo običen i vo pazaren den. So ovie pdoatoci mozeše da se zakluči kolku e potrebno iznaoğanje na rešenie za parkiranite vozila koi vo mnogu ja namaluvaat možnosta za koristenje na alternative prevoz i pešački soobraќaj, zatoa što go uzurpiraat prostorot koj e namenet za niv. Na site vozila im bea postaveni flaeri so opomena deka sega se samo opomenati a sledniot pat ќe bidat kazneti. Za taa cel bea zabeležuvani registarskite tablički na vozilata, a vo slučaj koga istoto vozilo bi go napravilo istiot prekršok bi bilo kazneto bez predhodna opomena. Za taa cel bea potrebni pogolem broj na učesnici zatoa što akcijata beše sprovedena vo vremetraenje od 2 časa i toa za vreme na udrniot bran, koga ima najgolema potreba za dviženje. Podatocite dobieni od ova akcija ponatamu ќe bidat indikatori pri kreiranje na urbanata mobilnost vo gradot Prilep.



Sl.br.5-opomena na pogrešno parkirani vozila

7 Kreiranje na strategija

Kreiranjeto na strategijata ne se baziraše samo na javnite konsultacii. Redovnite sostanoci so PSC komitetite, tehničkite rabotni grupi i lokalnite eksperti pomognaa vo zaedničkoto oblikuvanje na strategijata. Obukite i neformalnite sredbi go pottiknaa institucionalnoto učenje i go zajaknaa lokalniot kapacitet za scenario bazirano na soodvetno planiranje. Gradot isto taka imaše korist od pregled na međunaroni dobri praktiki, osobeno od mali i sredni evropski gradovi so slični predizvici, osiguruvajќi deka predloženite merki se primenlivi bazirani na iskustva što veќe dale rezultati.

Zadača 1.3. vospostavi strateška osnova za ostatokot od procesot na planiranje. Vo kontekst na toa se dostavija slednite postapki:

- Vizija koja go reflektira unikatniot kontekst i ambicii na gradot;

- Celi usoglaseni so nacionalnite i EU strategii;
- Ramka zasnovana na indikatori za sledenje na napredokot.

Ovie rezultati ќe go vodat slednio čekor, a toa e zadača 1.4. (simulacija i evaluacija na scenarijata) i zadača 1.5. (definiranje na akciski plan i patokaz na implementacija). Izlezite od zadača 1.3. go pozicioniraat gradot Prilep kon počista, pobezbedna i poinkluzivna mobilna idnina, so jasno definirani prioriteti i alatki za nivno ostvaruvanje.

Rezultatite od zadača 1.3. go formiraa izveštajot koj vodi kon razvoj na strategija, razvivanje na scenarija, zaednička vizija, obrabotka na indikatori i celi koi se kako del od poširokata inicijativa za izrabotka na SUMP (plan za održliva urbana mobilnost) za gradot Prilep. Ova zadača predstavuva strateška presvrtnica vo procesot na planiranje, nadovrzuvajќi se na osnovnata postavenost preku zadača 1.1. i 1.2.

Preku terenski poseti se vika analiza na podatoci i multi- aktersko učestvo bea analizirani:

- Transportnata infrastruktura;
- Pobaruvačkata i ponudata na patuvanja;
- Ekološkite performansi;
- Institucionalnite angažmani.
- Analizirajќi gi dobienite rezultati se dobijaja i klučni predizvici koi se odnesuvaat na:
- Zavisnost od avtomobilite;
- Nedovolna pokrienost na gradot so javen prevoz;
- Nemotoriziran transport;
- Zagaduvanje I degradacija na životnata sredina.

Istovremeno bea identifikuvani i možnosti za intervencii koi bi se sproveduvale etapno kako vo bliska taka i vo dalečna idnina. Dijagnostikata se fokusiraše na funkcionalnata urbana oblast i predstavuvaše temel za fazata na strategijata za ponatamošen ravoj.

Slednata faza, koja treba da se sprovede e zadača 2.1. Vo ova faza, procesot na planiranje se prefrluva od dijagostika kon strateško nasočuvanje, fokusirajќi se na formuliranje na fizija, razvoj na alternativni scenarija, definiranje na celi i izbor na indikatori za sledenje na napredokot, no i za planiranje na ponatamošite aktivnosti.

Potočno izveštajot gi opfaќa slednive točki:

1. Razvivanje na vizija: fklučuvanje na zasegnatite strain i građanite vo zaedničko definiranje na vizija za mobilnosta vo gradot Prilep, preku aneti, javni konsultacii I rabotilnici.
2. Formiranje na strateški celi: izrabotka na glavni celi što ќe go nasočat razvojot na politikite i intervenciite vo transportot.
3. Definiranje na scenarija: razvoj na tri scenarija za idniot razvoj na mobilnosta i toa BAU (Business – As – Usual), alternativno konzervativno scenario i alternativno ambiciozno scenario.
4. Identifikacija na merki: izbor i grupiranje na poveќe od 50 merki vo različni oblasti na politika, bazirani na dobri praktiki i lokalno potrebi.

5. Izbor na indikatori i postavuvanje celi: definiranje na prioritetni indikatori za sledenje na performansite i postavuvanje SMART celi – specifični, merlivi, ostvarlivi, relevantni i vremenski odredeni.
6. Integracija so nacionalni i evropski politiki: obezbeduvanje usoglasenost so Nacionalnata transportna strategija na Republika Makedonija i Evropskata Strategija za pametna i održliva mobilnost.

Ovoj izveštaj e strukturiran na način koj gi sledi fazite na strateškiot razvoj spored SUMP metodologijata, kako i principite na učestvo zasnovani na soodvetni podatoci no i na transparentosnot. Toj e nameneza koristenje od strana na opštinskite tela, PSC, tehničkite eksperti, kako i poširokata javnost i zasegnatite strain. Istiot služi kako vodič za klučnite izbori koi treba da se napravat vo narednite fazi, fklučuvajќi detalno planiranje, implementacija i monitoring.

Koga stanuva zbor za prvoto scenario (Business – As – Usual) t.e. Biznis Kako i Dosega, se očekuva, biznis zaednicata da ima pridobivki od soobraќajnata mobilnost, a pogotovo od urbanata mobilnost. Dokolku pridobivkite se vo očekuvanite ramki biznis zaednicata ќe stane partner pri sproveduvanje na ova idea vo delo. So nivnoto učestvo se ovozmožuva priliv na parični sredstva koi ponatamu ќe se vraќaat so zgolemen procent vo biznis zaednicata, i toa vo postoečkite biznisi no i vo novi biznisi, a isto taka benefit ќe ima i samata opština.

Vtoroto scenario "alternativno - konzervativno", spored nekoi viduvanja od zasegnatite strain na ovoj proekt, ne samo što e realno izvodlivo tuku e i opšto prifatlivo. Pred se toa se dolži zaradi mentalitetot na samoto naselenie no i zaradi faktot deka faktiča sostojba vo soobraќajot vo ovoj moment može da go ovozmoži ova scenario.

Tretoto scenario "alternativno - ambiciozno", e scenario koe vo ovoj moment e posakuvano i kon koe bi se strmela sekoja urbana naselba. Tuka red se stanuva zbor za kompletno razgraničuvanje na različnite vidovi na soobraќaj, bez postoenje na konfliktni točki a so toa i eliminiranje na potencijalnata možnost za soobraќajni nezgodi. Se razbira iako navidum ova scenario izgleda kako nedostižno neznači i deka ne e vozmožno. So zalaganje na site činiteli, so primena na pravilni praktiki i iskustva od gradovi koi veќe uspešno implementirale vakvi praktiki, ova scenario ne izgleda kako nevozmožno.

Idnite nasoki za podobruvanje na urbanata mobilnost koj treba da se sprovedat bi bile slednite:

- Investiranje vo sovremen i ekološki javen prevoz, kako što se električni i hibridni avotbusi;
- Razvoj na velosipedska i peščka infrastruktura;
- Urbano planiranje koe ja vklučuva soobraќajnata održlivist kako prioritet;
- Digitalizacija i "pametni gradovi" t.e. voveduvanje na aplikacii za sledenje na avotmobilite, avotobusite i drugite vozila, voveduvanje na e – parking no i drugi tehnološki rešenija.

Soobraќajot pretstavuva eden od klučnite predizvici I dvigateli pri razvojot na urbanite pametni gradovi. Integracijata na intelegentnite transportni sistemi, digitalni tehnologii i održlivi rešenija ovozmožuva poegikasno upravuvanje so soobraќajnite tekovi, namaluvanje

na zagaduvanjeto i zgolemuvanje na bezbednosta. Pametnite gradovi se stremat kon optimizacija na mobilnata povrzanost, avtomatizacija na podatocite koi se dostapni, nameneti za planiranje i predviduvanje za ponatamošen razvoj na soobraќajot. Vakviot pristap ne samo što ja podobruva urbanata mobilnot na grаѓanite, tuku I pridonesuva kon ekonomski rast na gradovite i pokvalitetna životna sredina. Zaradi se prethodno kažano, razvojot na „pameten soobraќaj", e neophodna nasoka za idnite urbani zaednici koi sakaat da bidat održlivi, efikasni i humani.



8 Zaklučok

Soobraќajnata mobilnost predstavuva eden od najvažnite segmenti na sovremeniot urban i regionalen razvoj. Taa obezbeduva povrzanost pomeѓu luѓeto, stokite i uslugite, ovozmožuva ekonomski rast i socijalna integracija, no istovremeno bara vnimatelno planiranje za da se namalat negativnite posledici vrz životnata sredina i kvalitetot na životot.

Razvojot na efikasen i održliv transporten sistem e preduslov za podobra funkcionalnost na gradovite i opštinite. Toa podrazbira racionalno koristenje na site vidovi na transport, promoviranje na javniot prevoz, na alternativnite načini na dviženje (pešačenje, velosipedizam), kako i primena na sovremeni tehnologii za upravuvanje so soobraќajot.

Soobraќajnata mobilnost treba da se razviva vo nasoka na ramnoteža pomeѓu potrebite na naslenieto, ekonomskite celi i zaštitata na životnata sredina. Samo preku vakov integriran pristap može da se obezbedi poefikasen, pobezbeden i poodržliv soobraќaen sistem koj ќe pridonese za podobar kvalitet na životot na grаѓanite.

Soobrakjajnata mobilnost vo Republika Makedonija, a osobeno vo urbanite sredini kako Prilep, se soočuva so golemi predizvici povrzani so gužvi, zagaduvanje i neefiksen javen prevoz. No, istovremeno postojat golemi možnosti za napredok dokolku se sprovedat soodvetni merki. So kombinacija na modernizacija na infrastruktura, tehnološki inovacii, edukacija na graganite i silna politička volja, može da se postigne održliva i bezbedna mobilnost koja ke gi namali štetnite posledici od soobrakajot i ke obezbedi podobar kvalitet

na život za site gragani.

Opština Prilep, vo koordinacija so Ministerstvoto za transport e vo faza na izrabotka na plan za održliva urbana mobilnost (Sustainable Urban Mibility Plan-SUMP) čii rezultati vo idnina ќe pridonesat vo podobruvanje na pristapnosta, promoviranje na zdravjeto i bezbednosta na građanite, poddrška na ekonomskiot rast i obložuvanje na vlijanijata vrz životnata sredina. Seto ova ќe se postigne preku podobruvanje na patnata infrastruktura, promoviranje na održliv načini na transport i osvojuvanje na inicijativi so niska sodržina na jaglerod, nasočeni kon namaluvanje na emisiite i optimiziranje na protokot na soobraќaj, što za gradot Prilep ќe bide od golemo značenje.Za podobro indentifikuvanje i definiranje na problemite povrzani so soobraќajnata mobilnost a so koi se soočuvame vo gradot Prilep, za dobivanje na site informacii, za davanje na vaši zabeleški I sugestii možete da gi posetite slednite socijalni mreži:

facebook.com/mk5sumps

instagram.com/mk5sumps

linkedin/mk5sumps

Prašalnik: SUMP Vision Survey



ПРИМЕР ДОБРЕ ПРАКСЕ ЗА ПРИМЕНУ САВРЕМЕНИХ МЕТОДА И ТЕХНИКА УЧЕЊА КРОЗ ТЕМАТСКУ И ПРОЈЕКТНУ НАСТАВУ

ОЛИВЕРА ПРВИЋ ЕРАЦ, СТРУЧНИ САРАДНИК – ПСИХОЛОГ

САЊА МИЛОЈЕВИЋ, СТРУЧНИ САРАДНИК – ПЕДАГОГ

СРЕДЊА ШКОЛА „КНЕЗ АЛЕКСАНДАР КАРАЂОРЂЕВИЋ“

Сажетак

Средња школа "Кнез Александар Карађорђевић" је стручна школа која нуди разноврсне образовне профиле у пет подручја рада: машинство и обрада метала, шумарство и обрада дрвета, саобраћај, електротехника и култура, уметност и јавно информисање. Психолошко-педагошка служба активно доприноси осавремењивању наставе примењујући савремене методе и технике учење (рад у групама, дебата, дискусија, брејнсторминг, изокренута учионица, играње улога, учење кроз искуство и друго) у различитим облицима наставе укључујући пројектну и тематску наставу. Реализација тематске и пројектне наставе постала је пример добре праксе на манифестацијама Зимски дани просветних радника и Стварајмо заједно и може послужити као модел другим образовним системима у унапређивању метода и приступа.

1 Увод

У средњим школама тематска настава примењује се као савремена и иновативна метода. Омогућава да се садржаји различитих предмета повежу у једну целину кроз заједничку тему и разноврсне активности. Тиме ученици, у складу са наставним планом и програмом, стичу нова знања и вештине и уче како да решавају конкретне проблеме.

Тематски садржаји планирају се почетком године: годишњим, месечним, недељним и дневним планом рада наставника; планом Стручних актива и већа или Одељењског и Наставничког већа као и Годишњим планом рада школе.

Тематске активности могу бити планиране у краћим или дужим временским интервалима (дан, недеља, месец) и реализоване у различитим облицима наставног рада: посете, екскурзије, излети, амбијентално учење (у библиотеци, музеју, парку и сл.). Реализација се може одвијати у једном одељењу, у сарадњи са другим ученицима, наставним и ненаставним особљем школе, остварујући интердисциплинарни и интегрисани приступ настави.

1.1 Карактеристике тематске наставе:

1. **Интердисциплинарност**: Настава се не фокусира на један предмет, већ повезује више различитих области знања. На пример, тема као што је "енергија" може укључити физику, хемију, биологију и географију.
2. **Фокус на активном учењу**: Ученици нису само пасивни примаоци информација, већ активно уче кроз истраживање, рад у групама, презентације и друге интерактивне активности.
3. **Реални контекст**: Теме које се обрађују у оквиру тематске наставе често имају стварну примену и повезаност са животом, што ученицима омогућава да разумеју значај учења и како оно може бити корисно у свакодневном животу.
4. **Развој критичког размишљања и креативности**: Тематска настава подстиче ученике да разматрају различите аспекте неке теме, анализирају информације, постављају питања и развијају нове идеје и решења.

1.2 Предности тематске наставе:

- **Повезаност са животом**: Ученици лакше разумеју како се оно што уче у школи односи на стварни свет.
- **Развијање вештина**: Оснажује ученике у вештинама као што су тимски рад, комуникација, критичко размишљање и самостално учење.
- **Мотивисаност ученика**: Када су теме занимљиве и релевантне, ученици су више мотивисани да уче.

2 Реализација тематске недеље у Средњој школи Кнез Александар Карађорђевић

На основу Смерница за организацију и реализацију образовно-васпитног рада у средњој школи у школској 2023/2024. години током септембра настава је у Средњој школи „Кнез Александар Карађорђевић“ организована на следећи начин:

Први наставни дан у школској 2023/2024. години организован је кроз разговор и упознавање ученика са планом и програмом рада

Настава у недељи од 4. до 8. септембра 2023. године реализована је као тематска настава, у оквиру које су остваривање радионице и друге активности усмерене ка неговању вредности међусобног поштовања, сарадње и солидарности, уз уважавање различитости.

Стручни сарадници школе израдили су програм тематске недеље по данима:

Први дан КО САМ ЈА? ИЗГРАДЊА ИДЕНТИТЕТА

Први час: Израда беџа

Други час: Аутопортрет 1

Трећи час: Аутопортрет 2

Четврти час: Наша лична карта 1

Пети час: Наша лична карта 2

Шести час: Приватно и јавно ја

Седми час: Дијамант

Други дана ЕМОЦИОНАЛНО ОПИСМЕЊАВАЊЕ

Први час: Коцка осећања

Други час: Потребе и осећања

Трећи час: Да имам моћ

Четврти час: Жеље и потребе

Пети час: Хијерерхија потреба

Шести час: Вођена фантазија

Седми час: Како се осећамо кад се сукобљавамо

Трећи дана ТОЛЕРАНЦИЈА

Први час: Предрасуде – поруке на челу

Други час: Са ким путујете

Трећи час: Лично искуство са предрасудама

Четврти час: Дрво нетолеранције

Пети час: У туђим ципелама

Шести час: Толеранција у друштву

Седми час: Тражимо хитно решење

Четврти дан ДАН ДЕМОКРАТСКЕ КУЛТУРЕ

Први час: Људска права 1

Други час: Људска права 2

Трећи час: Права и одговорности 1

Четврти час: Права и одговорности 2

Пети час: Демократија и демократско одлучивање

Шести час: Насловна страна - права

Седми час: Насловна страна – одговорност

Пети дан ИНТЕРКУЛТУРАЛНОСТ

Први час: Погоди ко нам долази на вечеру

Други час: Поздрављање на различитим језицима

Трећи час: Поздрављање

Четврти час: Проблем девет тачака

Пети час: Тражимо сличности и откривамо разлике

Шести час: У мојој породици 1

Седми час: У мојој породици 2

Наставници су предложене наставне јединице реализовали прилагођавајући их специфичностима одељења. На састанцима одељењских већа дефинисани су начини реализације тематске наставе на нивоу одељења.

Након прве две недеље у петак 15. 09. 2023. у Галерији Средње школе „Кнез Александар Карађорђевић“ представљено је БОГАТСТВО РАЗЛИЧИТОСТИ кроз следеће активности:

- Галеријска шетња

- Презентација тематских продуката
- Презентација збирки радова
- Презентација експертски група
- Дефинисање идентитета школе – мото школе.

3 Продукти тематске и пројектне наставе у области саобраћаја

Стручни сарадник, педагог Сања Милојевић, и стручни сарадник психолог, наставник саобраћајне психологије, Оливера Првић Ерац, у сарадњи са наставницима саобраћајне струке, у одељењима техничар друмског саобраћаја у оквиру тематске недеље израдили су саобраћајне знаке са порукама које најбоље промовишу и одражавају праве вредности:

- Не галами- слушај!
- Стоп насиљу, агресији, бесу!
- Обавезан престанак свим предрасудама!
- Опасност од конфликта!

Тематска настава која се бави изградњом саобраћајних знакова, има важан педагошки и друштвени значај. Ученици су у оквиру овог пројекта створили саобраћајне знакове који носе снажне поруке које промовишу основне људске вредности, као што су сигурност, поштовање, толеранција и мирно решавање конфликата. Сваки од знакова представља кључну поруку која се односи не само на физички саобраћај, већ и на друштвену одговорност и етику.

- „Не галами- слушај!“

Ова порука подстиче на поштовање других учесника у саобраћају, али и у свакодневном животу. Уместо да се агресивно понашамо и галамимо, позива нас да се опустимо и пажљиво слушамо друге, како бисмо избегли сукобе и били свесни ситуација око нас. Она има широку примену у смислу развијања културе комуникације и поштовања, не само у саобраћају већ и у свакодневним интеракцијама.

- „Стоп насиљу, агресији, бесу!“

Ова порука се односи на значај контроле емоција, посебно када је у питању агресивно понашање које може бити опасно за све у окружењу. У контексту саобраћаја, агресивно понашање (као што је брза вожња, бесне реакције и нестрпљење) може довести до озбиљних несрећа. Порука ове врсте подстиче ученика и све учеснике саобраћаја да се уздрже од насилних акција и да уместо тога усмере своје емоције ка конструктивним решењима.

- „Обавезан престанак свим предрасудама!“

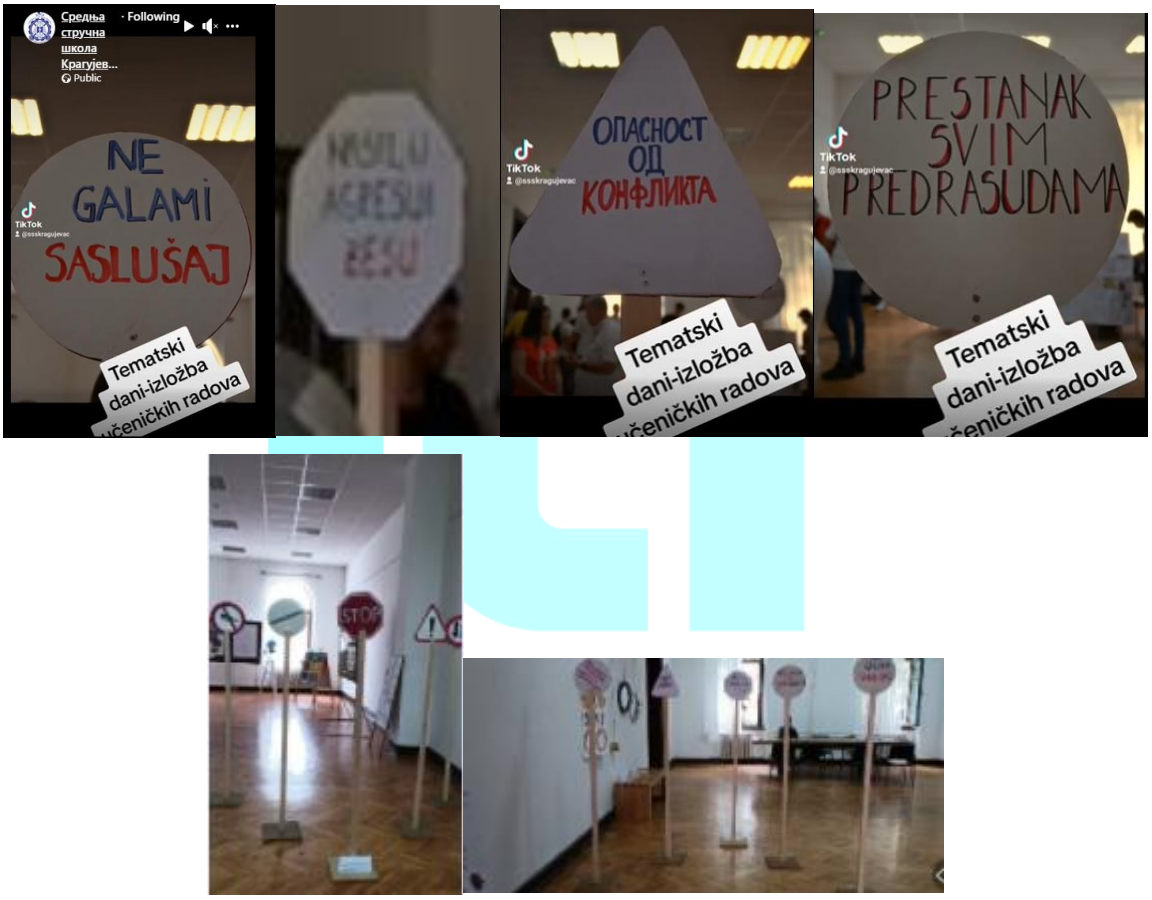
Ова порука указује на значај превазилажења предрасуда и дискриминације, што је кључно за стварање здраве и равноправне друштвене атмосфере. У саобраћају, као и у другим аспектима живота, важно је да не правимо разлике међу људима због њиховог изгледа, пола, расе или другог било ког облика дискриминације. Ова порука је знак да сви морамо да радимо на стварању инклузивног окружења где су сви

једнаки.

- „Опасност од конфликта!“

Конфликти у саобраћају (или у животу) често воде непријатним ситуацијама. Ова порука наглашава да је важно бити свестан потенцијалних опасности које су у вези са конфликтима, било да су они резултат несавесне вожње, непоштовања правила или неспоразума. Конфликт може брзо ескалирати у озбиљније последице, и зато је важно усмерити напоре ка превенцији и мирном решавању проблема.

Израда ових саобраћајних знакова има дубље значење и преноси важне друштвене поруке. Ученици који су их израдили не само да су се упознали са дизајном и техником израде знакова, већ су и развили свест о важности поштовања других и правих вредности у свим аспектима живота, како на путу тако и изван њега.



Слика 1: *Продукти тематске наставе у области саобраћаја*

На следећем линку се налазе продукти и презентација ученичких радова:

https://www.facebook.com/reel/988334489086924

4 Мобилност у саобраћају уз примену VR технологије

У области саобраћаја поред тематске у школи је ализована и пројектна настава на тему „Мобилност у саобраћају“, у организацији чланица школског КВиС тима, Оливере Првић Ерац и Сање Милојевић, у сарадњи са наставницима практичне наставе – инструкторима.

Ученици су кроз савремен и интерактиван приступ учествовали у реализацији пројектног задатка у сарадњи са Бизнис иновационим центром (BIC). Коришћењем VR наочара, упознали су се са средствима унутрашњег транспорта, развијајући вештине управљања и сналажења у симулираним саобраћајним условима.

Ова активност омогућила је ученицима да стечена теоријска знања примене у безбедном, али реалистичном окружењу, као и да кроз практичан рад стекну драгоцено искуство које ће им користити у даљем образовању и професионалном развоју.



Слика 2: *Реализација пројектне наставе*

5 Недостаци и изазови:

- Потреба за детаљном припремом наставника: Наставници морају пажљиво да припреме интегрисане активности и да имају добру организацију како би све области биле адекватно обрађене.
- Недостатак ресурса: У неким школама могу бити ограничени ресурси и материјали који су потребни за реализацију тематске наставе.
- Прилагођавање различитим ученицима: Како су ученици различити у својим способностима и интересовањима, може бити изазов прилагодити наставу тако да буде ефикасна за све.

6 Закључак

Школа има важну улогу у друштву и локалној заједници. Стручне школе имају задатак да ученике припреме за рад на савременом тржишту, али и да их науче како да активно уче и развијају своје способности. Тиме се не само побољшавају њихове стручне вештине, већ се развијају и кључне компетенције које су неопходне за живот у савременом друштву (компетенција за целоживотно учење, комуникација, рад с подацима и информацијама, дигитална компетенција, решавање проблема, сарадња, одговорно учешће у демократском друштву, одговоран однос према здрављу, одговоран однос према околини, естетичка компетенција, предузимљивост и

оријентација ка предузетништву).

Тематска и пројектна настава омогућују ученицима да стекну специфична стручна знања, развијају своје професионалне вештине, припремају их за будуће професионалне изазове, помажу у развоју критичког размишљања, решавања проблема и тимског рада. Реализација тематске недеље утицала је и на повећање свести о значају безбедности у саобраћају, помогла у креирању културе безбедности и одговорности у свакодневном животу, као и толеранцији међу ученицима, што касније може да утиче и на културу толеранције међу учесницима у саобраћају. Ученици се едукују о важности поштовања различитих учесника у саобраћају (пешака, бициклиста, возача) и уче како да комуницирају у ситуацијама стреса или конфликта. Развијање ових социјалних вештина помаже у стварању мирније и безбедније саобраћајне културе.

7 Литература:

1. **Књиге**

Милановић Дејан, Кордић-Николић Биљана, Безбедност и регулисање саобраћаја за 2.3. и 4. разред саобраћајне школе, Завод за уџбенике, Београд,2023.

С. Милошевић, „Перцепција, пажња и моторна активност”, Завод за уџбенике и наставна средства, Београд, 2002.

В. Вукадиновић, „Основе саобраћајне психологије”, „Завод за уџбенике и наставна средства, Београд,2015

2. **Правни извори**

„Смернице за организацију и реализацију образовно-васпитног рада у средњој школи у школској 2023/2024. години” — Министарство просвете, науке и технолошког развоја

3. Вебсајтови

https://euroguidance.rs/resursi/prirucnik/

https://jpd.rs/images/preuzmite/Prirucnik_za_nastavu.pdf

EXAMPLE OF GOOD PRACTICE FOR THE APPLICATION OF MODERN LEARNING METHODS AND TECHNIQUES THROUGH THEMATIC AND PROJECT-BASED TEACHING

OLIVERA PRVIĆ ERAC, PROFESSIONAL ASSOCIATE – PSYCHOLOGIST
SANJA MILOJEVIĆ, PROFESSIONAL ASSOCIATE – PEDAGOGIST
"KNEZ ALEXANDAR KARAĐORĐEVIĆ" SECONDARY SCHOOL

Summary

The Secondary School "Knez Aleksandar Karađorđević" is a vocational school offering a variety of educational profiles in five fields: mechanical engineering and metal processing, forestry and wood processing, traffic, electrical engineering, and culture, arts, and public information. The Psychological-Pedagogical Service actively contributes to modernizing teaching by applying contemporary learning methods and techniques (group work, debate, discussion, brainstorming, flipped classroom, role-playing, experiential learning, and more) in various forms of instruction, including project-based and thematic teaching. The implementation of thematic and project-based teaching has become an example of good practice at events such as "Winter Days of Educational Workers" and "Creating Together" and can serve as a model for other educational systems in improving methods and approaches.

1 Introduction

In secondary schools, thematic teaching is applied as a modern and innovative method. It allows the contents of different subjects to be connected into a single whole through a common theme and diverse activities. This enables students, in accordance with the curriculum, to acquire new knowledge and skills and to learn how to solve concrete problems.

Thematic content is planned at the beginning of the year: through annual, monthly, weekly, and daily teacher work plans; through the plan of Professional Committees and Councils or Class and Teachers' Councils; and through the School's Annual Work Plan.

Thematic activities can be planned for shorter or longer time intervals (day, week, month) and implemented in various forms of teaching: visits, excursions, field trips, and environmental learning (in libraries, museums, parks, etc.). Implementation can take place in a single class, in cooperation with other students, teaching, and non-teaching staff, achieving an interdisciplinary and integrated approach to teaching.

1.1 Characteristics of Thematic Teaching:

- **Interdisciplinarity:** Teaching does not focus on a single subject but connects multiple areas of knowledge. For example, a theme such as "energy" may include physics, chemistry, biology, and geography.
- **Focus on active learning:** Students are not just passive recipients of information but actively learn through research, group work, presentations, and other interactive activities.
- **Real-world context:** Themes addressed within thematic teaching often have practical application and connection to life, allowing students to understand the importance of learning and how it can be useful in everyday life.
- **Development of critical thinking and creativity:** Thematic teaching encourages students to consider different aspects of a topic, analyze information, ask questions, and develop new ideas and solutions.

1.2 Advantages of Thematic Teaching:

- **Connection to real life:** Students more easily understand how what they learn at school relates to the real world.
- **Skill development:** Strengthens students' abilities such as teamwork, communication, critical thinking, and independent learning.
- **Student motivation:** When the topics are interesting and relevant, students are more motivated to learn.

2 Implementation of Thematic Week at "Knez Aleksandar Karađorđević" Secondary School

Based on the Guidelines for organizing and implementing educational work in secondary schools in the 2023/2024 school year, in September, classes at the "Knez Aleksandar Karađorđević" Secondary School were organized as follows:

The first school day of the 2023/2024 school year was organized through discussions and introducing students to the work plan and curriculum.

Classes during the week of September 4–8, 2023, were conducted as thematic teaching, within which workshops and other activities were carried out aimed at nurturing values of mutual respect, cooperation, and solidarity, while respecting diversity.

The school's professional associates developed the thematic week program by day:

Day 1 – WHO AM I? BUILDING IDENTITY

- Lesson 1: Making a badge
- Lesson 2: Self-portrait 1
- Lesson 3: Self-portrait 2
- Lesson 4: Our ID card 1
- Lesson 5: Our ID card 2
- Lesson 6: Private and public self
- Lesson 7: Diamond

Day 2 – EMOTIONAL LITERACY

- Lesson 1: Feelings cube
- Lesson 2: Needs and feelings
- Lesson 3: If I had power
- Lesson 4: Wishes and needs
- Lesson 5: Hierarchy of needs
- Lesson 6: Guided imagination
- Lesson 7: How we feel when we conflict

Day 3 – TOLERANCE

- Lesson 1: Prejudices – messages on the forehead
- Lesson 2: Who are you traveling with?
- Lesson 3: Personal experience with prejudices

- Lesson 4: Tree of intolerance
- Lesson 5: In someone else's shoes
- Lesson 6: Tolerance in society
- Lesson 7: Finding an urgent solution

Day 4 – DAY OF DEMOCRATIC CULTURE

- Lesson 1: Human rights 1
- Lesson 2: Human rights 2
- Lesson 3: Rights and responsibilities 1
- Lesson 4: Rights and responsibilities 2
- Lesson 5: Democracy and democratic decision-making
- Lesson 6: Front page – rights
- Lesson 7: Front page – responsibility

Day 5 – INTERCULTURALITY

- Lesson 1: Guess who is coming to dinner
- Lesson 2: Greetings in different languages
- Lesson 3: Greeting
- Lesson 4: The nine-dot problem
- Lesson 5: Finding similarities and discovering differences
- Lesson 6: In my family 1
- Lesson 7: In my family 2

Teachers implemented the proposed teaching units by adapting them to the specific characteristics of each class. During class council meetings, methods of implementing thematic teaching at the class level were defined.

After the first two weeks, on Friday, September 15, 2023, the **RICHNESS OF DIVERSITY** was presented in the gallery of "Knez Aleksandar Karađorđević" Secondary School through the following activities:

- Gallery walk
- Presentation of thematic products
- Presentation of work collections
- Presentation by expert groups
- Defining the school's identity – school motto

3 Products of Thematic and Project-Based Teaching in the Field of Traffic

The professional associate, pedagogue Sanja Milojević, and the professional associate, psychologist and traffic psychology teacher Olivera Prvić Erac, in collaboration with traffic subject teachers, in the classes of traffic technicians during thematic week, created traffic signs with messages that best promote and reflect true values:

- "Don't shout – listen!"
- "Stop violence, aggression, and anger!"
- "Mandatory stop for all prejudices!"

- “Danger of conflict!”

Thematic teaching focused on creating traffic signs has significant pedagogical and social value. Within this project, students created traffic signs carrying powerful messages that promote fundamental human values, such as safety, respect, tolerance, and peaceful conflict resolution. Each sign conveys a key message relevant not only to physical traffic but also to social responsibility and ethics.

- **“Don’t shout – listen!”** This message encourages respect for other participants in traffic as well as in everyday life. Instead of behaving aggressively and shouting, it invites us to relax and listen carefully to others to avoid conflicts and be aware of situations around us. It has broad application in developing a culture of communication and respect, not only in traffic but also in everyday interactions.
- **“Stop violence, aggression, and anger!”** This message highlights the importance of emotional control, especially regarding aggressive behavior that can be dangerous to everyone around. In the context of traffic, aggressive behavior (such as speeding, angry reactions, and impatience) can lead to serious accidents. This type of message encourages students and all traffic participants to refrain from violent actions and instead direct their emotions toward constructive solutions.
- **“Mandatory stop for all prejudices!”** This message emphasizes the importance of overcoming prejudices and discrimination, which is key to creating a healthy and equitable social environment. In traffic, as in other aspects of life, it is important not to make distinctions among people based on appearance, gender, race, or any other form of discrimination. This message signals that we all must work toward creating an inclusive environment where everyone is equal.
- **“Danger of conflict!”** Conflicts in traffic (or in life) often lead to unpleasant situations. This message emphasizes the importance of being aware of potential dangers associated with conflicts, whether caused by reckless driving, rule violations, or misunderstandings. Conflicts can quickly escalate into more serious consequences, so it is essential to focus efforts on prevention and peaceful problem-solving.

Creating these traffic signs carries deeper significance and conveys important social messages. Students who made them not only learned about the design and techniques of sign-making but also developed awareness of the importance of respecting others and upholding core values in all aspects of life, both on and off the road.

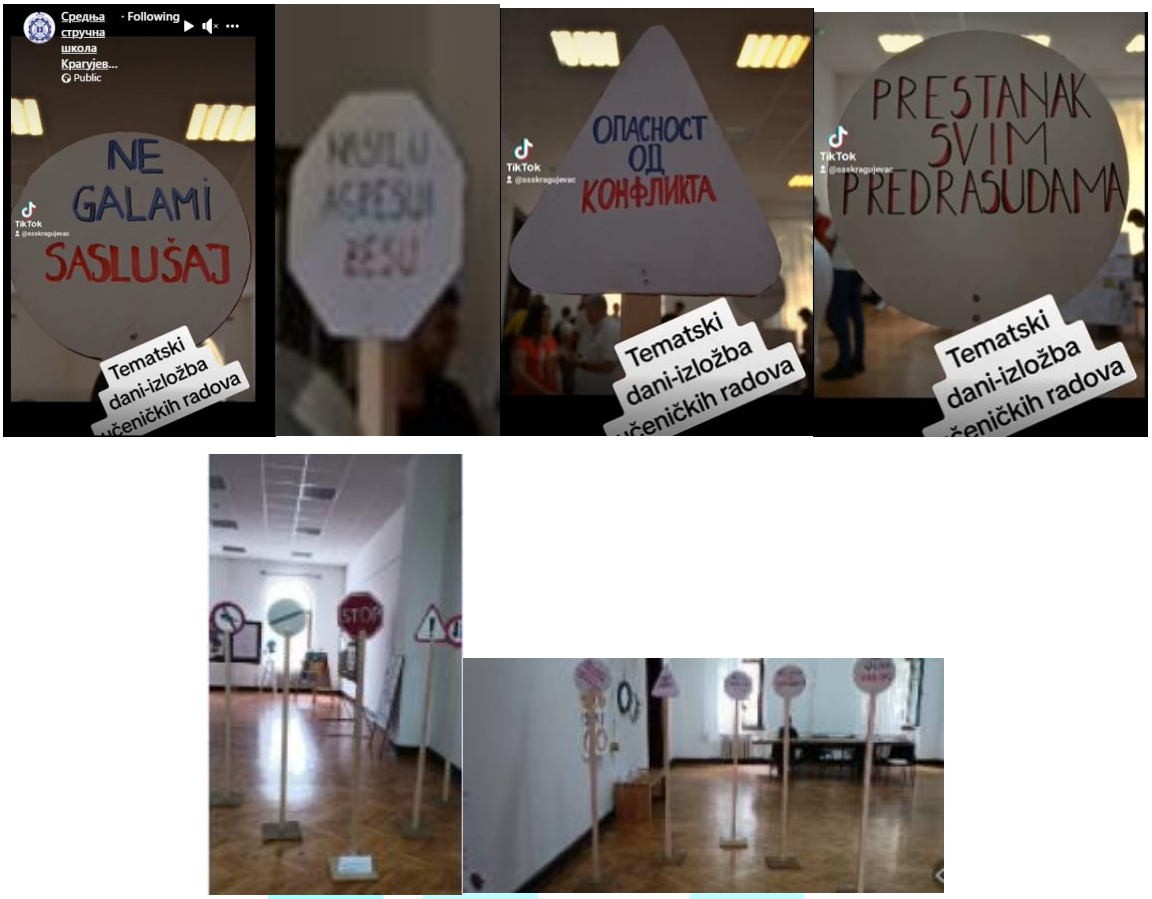


Figure 1: Products of Thematic Teaching in the Field of Traffic
The products and presentation of student works can be found at the following link: https://www.facebook.com/reel/988334489086924

4. Mobility in Traffic Using VR Technology

In the field of traffic, in addition to thematic teaching, project-based teaching on the topic *"Mobility in Traffic"* was implemented at the school. The project was organized by members of the school QViS team, Olivera Prvić Erac and Sanja Milojević, in cooperation with practical training instructors.

Through a modern and interactive approach, students participated in the implementation of the project task in collaboration with the Business Innovation Center (BIC). By using VR glasses, they became familiar with means of internal transport, developing management and navigation skills in simulated traffic conditions.

This activity enabled students to apply acquired theoretical knowledge in a safe yet realistic environment, as well as to gain valuable practical experience that will benefit them in further education and professional development.



Figure 2: Implementation of Project-Based Teaching

5. Challenges and Limitations:

- **Need for thorough teacher preparation:** Teachers must carefully prepare integrated activities and have good organization to ensure all areas are adequately covered.
- **Lack of resources:** Some schools may have limited resources and materials necessary for implementing thematic teaching.
- **Adapting to diverse students:** Since students have different abilities and interests, it can be challenging to adapt the lessons to be effective for all.

5. Conclusion

Schools play an important role in society and the local community. Vocational schools have the task of preparing students for the modern labor market, as well as teaching them how to learn actively and develop their abilities. This not only improves their professional skills but also develops key competencies necessary for life in contemporary society (lifelong learning competence, communication, data and information literacy, digital competence, problem-solving, collaboration, responsible participation in a democratic society, responsible health and environmental attitudes, aesthetic competence, initiative, and entrepreneurial orientation).

Thematic and project-based teaching enables students to acquire specific professional knowledge, develop professional skills, prepare for future professional challenges, and aid in the development of critical thinking, problem-solving, and teamwork. The implementation of thematic weeks also increased awareness of traffic safety, helped create a culture of safety and responsibility in everyday life, and promoted tolerance among students, which may later influence the culture of tolerance among all traffic participants. Students are educated on the importance of respecting different participants in traffic (pedestrians, cyclists, drivers) and learn how to communicate in stressful or conflict

situations. Developing these social skills contributes to creating a calmer and safer traffic culture.

7. References:

1. **Books**

- Milanović, Dejan & Kordić-Nikolić, Biljana. *Safety and Traffic Regulation for 2nd, 3rd, and 4th Grade Traffic School Students*. Zavod za udžbenike, Belgrade, 2023.
- S. Milošević, *Perception, Attention, and Motor Activity*, Zavod za udžbenike i nastavna sredstva, Belgrade, 2002.
- V. Vukadinović, *Basics of Traffic Psychology*, Zavod za udžbenike i nastavna sredstva, Belgrade, 2015.

2. **Legal Sources**

- *Guidelines for the Organization and Implementation of Educational Work in Secondary Schools for the 2023/2024 School Year* — Ministry of Education, Science and Technological Development

3. **Websites**

- https://euroguidance.rs/resursi/prirucnik/
- https://jpd.rs/images/preuzmite/Prirucnik_za_nastavu.pdf

JU SREDNJA STRUČNA ŠKOLA
IVAN USKOKOVIĆ
PODGORICA

Materijali za održavanje puteva u zimskim uslovima

Biljana Kljajić, dipl.ing.tehnologije-master

Srečko Kljajić, dipl.ing.saobraćaja-master

Portorož, septembar 2025.god.

Predgovor

Putevi sačinjavaju centralni nervni sistem svake zemlje jer skoro svaka društvena i ekonomska aktivnost je vezana za saobraćaj. Snijeg i led predstavljaju direktan uticaj na ravnomerno odvijanje saobraćaja.

Pet najčešće korišćenih hemikalija za otklanjanje i prevenciju stvaranja leda su: natrijum hlorid, NaCl; kalcijum hlorid, $CaCl_2$; magnezijum hlorid, $MgCl_2$; kalcijum magnezijum acetat, CMA i kalijum acetat, KAS. Natrijum hlorid, NaCl - putna so je najefikasniji i najjeftiniji materijal za uklanjanje leda kojim se lako rukuje. Navedene alternative, obično više koštaju, zahtjevaju posebnu pažnju tokom rukovanja i efikasne su samo pod određenim vremenskim uslovima. Putna so deluje do -21 °C, ali se njena primjena ne preporučuje ispod -10 °C. Razlog zbog koga se posipa putnu so je snižavanje tačke mržnjenja vode, kako bi se raskinula veza led-kolovoz.

Pravilnim i pravovremenim korišćenjem putne soli poboljšava se bezbjednost vožnje tokom zimskog perioda i smanjuje štetan uticaj na životnu sredinu i ekonomski troškovi.

Ključne riječi: hemijski materijali za zimsko održavanje puteva, putna so, sniženje tačke mržnjenja vode

1 Uvod

Zimsko održavanje puteva je od vitalnog značaja za sigurnost saobraćaja i sprečavanje nesreća tokom hladnih i snježnih perioda. Korišćenje adekvatnog materijala je ključno jer omogućava brzo i efikasno uklanjanje snijega i leda sa puteva, čime se obezbjeđuje bolja prohodnost i manji rizik od klizanja i nezgoda. Adekvatan materijal takođe može pomoći u očuvanju puteva i infrastrukture sprečavajući oštećenja. Upotreba pravilnog materijala za zimsko održavanje puta igra ključnu ulogu u očuvanju bezbjednosti i funkcionalnosti saobraćajne mreže.

So za posipanje puteva je hemijsko jedinjenje koje se koristi za topljenje snijega i leda na putevima tokom zimskih mjeseci radi održavanja prohodnosti i bezbjednosti saobraćaja. Najčešće korišćena so za posipanje puteva je natrijum hlorid (NaCl), poznat i kao kuhinjska so. Kada se raspe po površini puta, so privlači vlagu iz okoline i stvara rastvor koji snižava tačku smrzavanja vode, omogućavajući ledu i snijegu da se otope i olakšavajući čišćenje puteva.

2 Zimsko održavanje puteva kroz istoriju

Kada su se pojavili prvi automobili i asfaltirane ulice, tadašnji putari, puteve od snijega su čustili plugom, a potom posipali mješavinom pijeska i pepela, kako bi spriječili isklizavanje točkova, dok za poledicu nijesu imali rješenje.

So za puteve prvi put je eksperimentalno počela da se koristi u američkoj državi Nju Hempšir 1938. godine, kada se jedan od čelnika dosjetio da praktično primjeni otkriće da morska voda mrzne na znatno nižoj temperaturi nego obična. Tako je shvatio da se zasoljavanjem temperatura smrzavanja vode može spustiti i za desetak stepeni. So za posipanje puteva postala je standardna praksa u zimskom održavanju saobraćajnica zbog svoje sposobnosti da smanji tačku mržnjenja vode i brzo otopi snijeg i led. Danas se širom svijeta godišnje koriste milioni tona soli za bezbjednost na putevima tokom zimskih mjeseci.

Otkriće pozitivnog uticaja soli na topljenje snijega i leda umnogome je zaslužno za razvoj drumskog saobraćaja kakav danas znamo.

3 Značaj zimskog održavanja puteva

Zimsko održavanje puteva je značajno za bezbjednost saobraćaja, a samim tim i za ekonomiju. Cilj održavanja puteva u zimskom periodu, odnosno zimskim uslovima je održavanje prohodnosti puteva i bezbjednog odvijanja saobraćaja sa:

- minimalnim troškovima
- minimalnim štetnim uticajem na okolinu
- minimalnim ometanjem saobraćaja.

Ekonomske koristi od zimskog održavanja puteva su: direktne (smanjenje broja saobraćajnih nezgoda,skraćenje vremena putovanja, smanjenje troškova putovanja) i indirektne (ekonomska produktivnost, smanjenje broja odštetnih zahtjeva na osnovu smanjenja broja saobraćajnih nezgoda, smanjenje potreba za angažovanjem službi za hitne slučajeve - policija, vatrogasci).

Standard zimskog održavanja puteva predstavlja efektivnost tretmana u prevenciji stvaranja snijega i leda na putu (slika 1).



Slika 1. Standard zimskog održavanja puteva

4 Materijali za zimsko održavanje puteva

Materijali koji se koriste za zimsko održavanje puteva dijele se u dvije osnovne grupe, a to su:

1. hemijski materijali:

NaCl - natrijum hlorid

$CaCl_2$ - kalcijum hlorid

$MgCl_2$ – magnezijum hlorid

kalcijum magnezijum acetat, CMA

kalcijum acetat, KAC

urea

poliglikol

amonijum nitrat

amonijum sulfat

2. materijali koji smanjuju klizavost ili abrazivni materijali:

rizla

šljaka

kameni agregat.

Hemijski materijali usljed svojih fizičko-hemijskih osobina posjeduju mogućnost da smanjuju temperaturu zamrzavanja vode, te da snijeg i led otapaju na temperaturama nižim od temperature zamrzavanja vode. Od hemisjkih materijala najviše se upotrebljavaju hloridi, dok ostali uglavnom ne zadovoljavaju osnovne uslove za njihovu primjenu u pogledu ekonomičnosti i tehničkih karakteristika. Urea ima visok štetan uticaj na životnu sredinu , a poliglikol je toksičan za ljude i životinjski svijet, ukoliko se proguta i izuzetno skup. Hemikalije mogu da budu primenjene kao tečne, suve i čvrste ili čvrste, prethodno navlažene.

Abrazivni materijali nanose se na puteve sa ciljem da povećaju hrapavost kolovoza i obezbijede sigurniju vožnju. Od abrazivnih materijala najčešće se koriste: pijesak

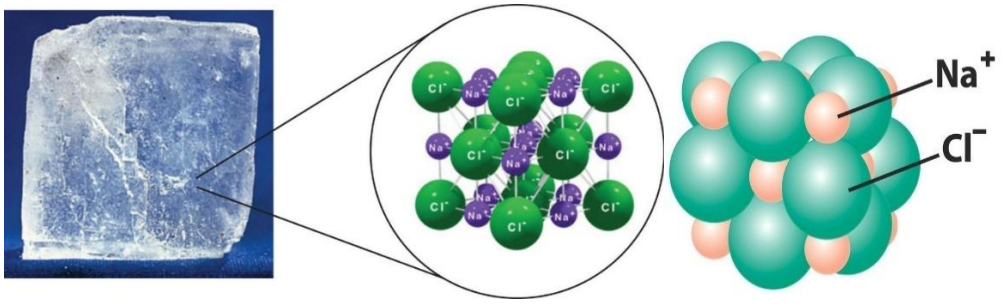
granulacije do 2 mm, kameni granulat veličine zrna do 8 mm, mljevena šljaka i šljunak. Potrebna količina abrazivnog materijala kreće se u intervalu od 600 – 1000 (kg/km).Smjesa hemijskih topitelja i abrazivnih materijala se primjenjuje za zimsko održavanje puteva zbog mogućnosti kombiniranja pozitivnih svojstava abrazivnih materijala (povećanje koeficijenta trenja tj. hrapavosti) i hemijskih topitelja (sniženje temperature mržnjenja).Odnos abrazivnog materijala i hemijskog topitelja se kreće u granicama od 9:1 do 1:1 u zavisnosti od vremenskih uslova i frekvencije saobraćaja. Abrazivni materijali se u svijetu sve manje koriste (zabranjeni su na autoputevima) dok je u nekim zemljama (V. Britanija) upotreba dozvoljena isključivo u mješavini sa hemijskim sredstvima.

4.1 Natrijum hlorid, NaCl

Natrijum hlorid, NaCl - putna so predstavlja najekonomičniji dostupan materijal za uklanjanje leda. Početni troškovi su niski u poređenju sa drugim hemikalijama; rukovanje i skladištenje su jednostavni, a posipanje je brzo i lako. Zahvaljujući prije svega povoljnijim uslovima nabavke za zimsko održavanje puteva najčešće se koristi natrijum hlorid, NaCl. Njegova zastupljenost u ukupnoj strukturi potrošnje hemijskih materijala je preko 90%.

Natrijum hlorid, koju zbog primjene nazivamo kuhinjska so, a prema načinu dobijanja može biti ili kamena ili morska. Kamena so se dobija iskopavanjem naslaga, koje su nastale taloženjem soli iz drevnih mora, dok se morska so dobija procesom uparavanja morske vode. Putna so je prirodni mineral halit, koji je po svom sastavu natrijum-hlorid, NaCl. Kuhinjska so je pročišćena, dok putna kamena so sadrži mineralne nečistoće, zbog čega je obično braon ili sive boje. Putna so ima ogromnu moć opstajanja. Nikada ne gubi svoja svojstva za uklanjanje leda, bez obzira koliko dugo je uskladištena. U trenutku vađenja, stara je između 210 i 320 miliona godina, a prenošenje na skladišne gomile za sljedeću godinu ili čak i duže, nikako ne umanjuje njenu moć odleđivanja. Važno je da putna so bude adekvatno zaštićena, kako ne bi došlo do gubitaka usljed dejstva vlage iz vazduha. Iako so počinje da apsorbuje vlagu kada vlažnost dostigne 75 procenata, svaka apsorbovana vlaga će isparavati kada vlažnost padne ispod ovog nivoa.

So u kamenom obliku sastoji se od pozitivnih jona natrijuma, Na^+ i negativnih jona hlora,Cl^- koji su vezani jonskom vezom i formiraju kristal (slika 2). Sve dok ostaju sjedinjeni nemaju nikakvog uticaja na led. Putna so funkcioniše tako što snižava tačku smrzavanja vode kroz proces koji se naziva depresija tačke smrzavanja .Natrijum hlorid se razlaže na jone u maloj količini vode.Nastali joni otežavaju smrzavanje vode u led, snižavajući tačku smrzavanja vode.Dakle, da bi topila led putna so mora da bude rastvorena u vodi u vidu vodenog rastvora.



Slika 2. Kristalna struktura NaCl

Temperatura površine kolovoza se mijenja u zimskim uslovima i vjerovatno je najbitnija promenljiva. Natrijum hlorid, NaCl snižava temperaturu kolovoza, ali ovaj efekat iznosi manje od 1 °C i dužina trajanja mu je 5 minuta ili manje, poslije čega efekat nestaje. Neki od konkurenata kamene soli podižu temperaturu kolovoza, ali i ovaj efekat takođe nestaje vrlo brzo. Nekada je posao putara bio jednostavan i sastojao se u tome da izađetu na teren u toku snežne oluje i pospu na put što je moguće više soli. Sada, pošto se zna da vodeni rastvor soli a ne so u kamenom obliku otapa led, moraju biti veoma pažljivi u vezi količine soli koju treba primjeniti i kada to uraditi. Kada je temperatura suviše niska natrijum hlorid, NaCl, deluje odlično kada je prethodno navlažen. Daleko je jeftinije primjeniti NaCl kao navlaženu, nego koristiti samo neku skupu alternativu.Sve više i više agencija koristi prethodno navlaženu so ili kao soni rastvor, tako da počinje da djeluje momentalno. Pošto je najveći broj sniježnih oluja praćen padom temperature sredstava za otklanjanje leda se primjenjuju neposredno, prije ili u ranoj fazi sniježne oluje. Neophodno je optimizovati efikasnost korišćenja soli primjenom prave količine, u pravo vrijeme i na pravom mjestu. Da bi napravili ovakvu odluku, neophodno je razumjeti hemijsko ponašanje putne soli.

4.1.1 Energetske promjene koje prate proces rastvaranja natrijum hlorida

Rastvaranje natrijum hlorida, NaCl u vodi prate dva procesa (slika 3):

1. proces razaranja kristalne resetke i
2. proces hidratacije jona

Pri rastvaranju natrijum hlorida prvo dolazi do razaranja kristalne rešetke, a za to je potrebna energija koja se "uzima" iz okoline (endoterman proces).Proces razaranja kristalne rešetke natrijum hlorida može se prikazati jednačinom:

$Na^+Cl^-_{(s)} \longrightarrow Na^+ + Cl^- \qquad \Delta H_r = +769{,}9$ kJ/mol

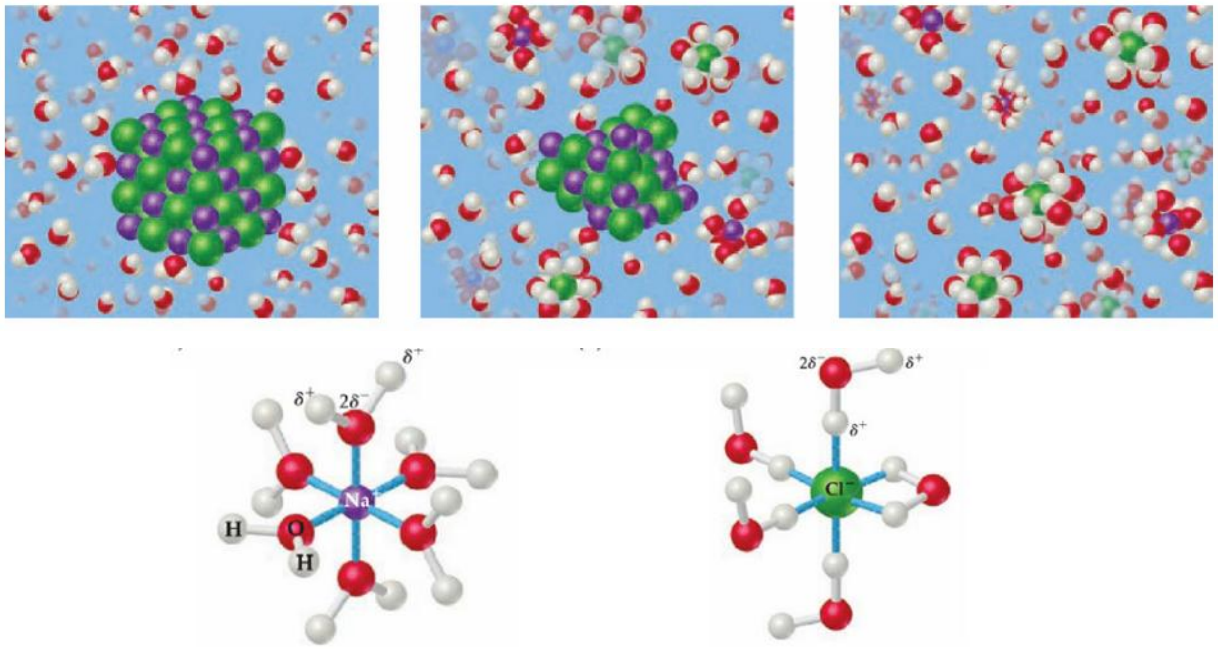
Entalpija razaranja, ΔH_r jednaka je entalpiji raskidanja jonske veze.

Kada se natrijum hlorid doda u vodu, molekuli vode, H_2O okružuju jone natrijuma, Na^+ i hlora, Cl^-. Molekuli vode su polarni, što znači da imaju djelimično negativan naboj na atomu kiseonika i djelimično pozitivan naboj na atomu vodonika. Ova polarnost omogućava molekulima vode da privuku jone soli. Djelimično negativni kiseonik privlači pozitivno naelektrisane jone natrijuma, dok djelimično pozitivni vodonik privlači negativno naelektrisane jone hlora. Ova privlačna sila između molekula vode i jona soli naziva se hidratacija. Energija se oslobađa tokom hidratacije (egzoterman proces), jer su joni stabilniji kada su okruženi molekulima vode nego kada su vezani u kristalnoj rešetki NaCl. Proces hidratacije nastalih jona se takođe može prikazati jednačinom:

$Na^+ + Cl^- \xrightarrow{H_2O} Na^+_{(aq)} + Cl^-_{(aq)} \qquad \Delta H_h = -765{,}7\ kJ/mol$

gdje je ΔH_h toplota hidratacije. Kako proces rastvaranja natrijum hlorida predstavlja zbir ova dva procesa: razaranja kristalne rešetke i hidratacije nastalih jona, to je ukupna promjena entalpije sistema ΔH_s :

$Na^+ Cl^- \xrightarrow{H_2O} Na^+_{(aq)} + Cl^-_{(aq)} \qquad \Delta H_s = \Delta H_r + \Delta H_h = 4{,}2\ kJ/mol$



Slika 3. Proces rastvaranja natrijum hlorida

Iz navedenog se može zaključiti da se za rastvaranje natrijum hlorida apsorbuje energija iz okoline, što dovodi do snižavanja tačke mržnjenja vode do temperature koja je niža od 0 °C“. U oblasti zimskog održavanja, supstanca koja odlaže početak stvaranja leda veoma je korisna i dobra stvar.

4.1.2. Djelovanje putne soli u zimskim uslovima

Jedini način na koji je moguće raskinutu vezu led-kolovoz je uz pomoć hemijskih sredstava kakva je putna so (slika 4).



a) b)

Slika 4. Putna so: pakovanje od 25 kg (a); pakovanje od 1000 kg (b)

Rastvor soli – a ne čvrsta so – topi snijeg i led. Da bi skratili vrijeme potrebno da čvrsta so pređe u vodeni rastvor, jedan od najefikasnijih načina za postizanje ovog cilja je primjena vodenog rastvora soli, zajedno sa čvrstom soli. Ovaj proces se zove "prethodno vlaženje". U čitavom Sjevernoameričkom snežnom pojasu, mnoge organizacije došle su do zaključka da mogu da smanje vrijeme reakcije soli i obezbjede topljenje leda na nižim temperaturama, tehnikom prethodnog vlaženja, poštujući sljedeće koncentracije:

23% rastvor tečnog natrijum hlorida

32% rastvor tečnog kalcijum hlorida

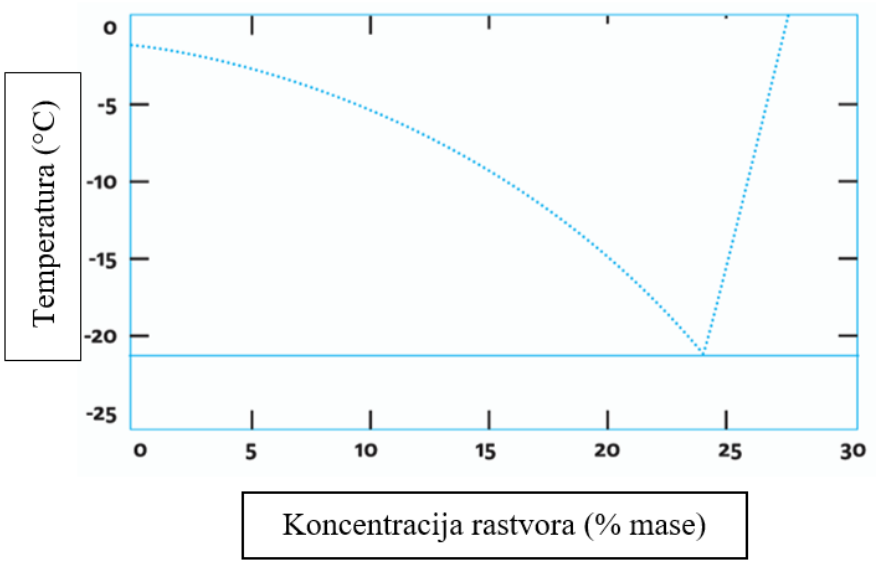
32% rastvor magnezijum hlorida

25% rastvor kalcijum magnezijum acetata

42% rastvor kalijum acetata

Prethodno navlažena so prelazi u rastvor brže ubrzavajući na taj način svoju misiju vraćanja zadovoljavajućeg trenja na kolovoz. Takođe, prethodno navlažena so bolje prianja za površinu kolovoza i kao takva, više ostaje u saobraćajnim trakama, nego što se odnosi sa kolovoza. Prethodno navlažena so redukuje zahtjevanu količinu soli. Samo 4% soli se gubi kada se put tretira prethodno navlaženom soli, nasuprot 30% gubitaka u slučaju kada je put tretiran suvom soli. Najbolji učinak se postiže kada se so vlaži u trenutku izlaska iz posipača.

Efekat putne soli, kao sredstva za topljenje leda, određuju tri faktora: temperatura,vlažnost i vrijeme. Fazni dijagram (slika 4) prikazuje tačku mržnjenja rastvora, soli i vode.



Slika 4. Fazni dijagram

Sve tačke ispod krive predstavljaju kristale leda i rastvor NaCl i H_2O. Sve tačke iznad krive i u sredini predstavljaju kristale NaCl i rastvor NaCl i H_2O. Na osnovu dijagrama zaključujemo da ukoliko koncentracija soli u rastvoru raste, tačka smrzavanja opada. Na primjer, čista voda smrzava na 0 °C, a 10%-rastvor soli neće smrznuti dok temperatura ne padne ispod -6 °C. Temperatura smrzavanja rastvora nastaviće da pada ukoliko se rastvoru doda još soli, odnosno ukoliko mu se poveća koncentracija. Najniža tačka smrzavanja rastvora NaCl i H_2O, koja se može dostići je, -21 °C, pri koncentraciji od 23,3%**.** Ova optimalna koncentracija koja obezbjeđuje najnižu moguću tačku mržnjenja rastvora, zove

se eutektička tačka, a svaki snižavač tačke mržnjenja ima svoju sopstvenu eutektičku tačku. Dakle, putna so deluje do -21 °C, ali se njena primena ne preporučuje ispod -10 °C.

Pored razumevanja principa fazne promjene, važno je znati koliko leda može da otopi putna so na različitim temperaturama.

KILOGRAMI LEDA KOJE OTOPI 1kg SOLI	
Temperatura (°C)	1 kg NaCl otopiće
-1	46,3 kg leda
-4	14,4 kg leda
-6,7	8,6 kg leda
-9,4	6,3 kg leda
-12	4,9 kg leda
-15	4,1 kg leda
-18	3,7 kg leda
-21	3,2 kg leda

Tabela 1. Odnos između temperature i količine otopljenog leda dejstvom putne soli

Tabela 1 pokazuje da na -1 °C, 1 kg soli otapa 46,3 kg leda. Međutim, kako temperatura pada do -4 °C, 1 kg soli otopiće 14,4 kg leda, a na -10 °C samo 5 kg leda. Cilj nije da se otopi sav led, već da se raskine veza led-kolovoz. Ovaj odnos i razumijevanje faznog dijagrama je osnov za određivanje standardnih količina primjene putne soli.

4.1.3 Primjena putne soli u zimskim uslovima

Putna so se primenjuje korišćenjem raznih alata i tehnika za posipanje. Ne postoji opšte prihvaćeni standard za količinu primjene putne soli. U zavisnosti od lokalnih uslova i politike, opseg primjene putne soli može varirati između 80-600kg/km puta sa dvije saobraćajne trake. U tabeli 2 predstavljna je količina putne soli koja se primjenjuje u različitim zimskim uslovima.

OPERACIJA	KOLIČINA PUTNE SOLI (g/m^2)
Preventivno soljenje	10
Jači mraz	20-40
Uklanjanje snijega	40-60

Tabela 2. Količina putne soli koja se primjenjuje u različitim zimskim uslovima

Da bi se putna so efikasnije koristila i stvorili bezbjedniji uslovi na putu, treba je upotrjebiti na početku snežne oluje, kako bi se preventivno djelovalo na pojavu smrzavanja i formiranja veze led-kolovoz. Ovakvo preventivno djelovanje zahtjeva primjenu manje količine soli u odnosu na primjenu soli u slučaju otklanjanja leda koji se već formirao. Prema tome, pravilno i pravovremeno korišćenje hemikalija kao što je putna so, presudno je za uspostavljanje bezbjednih uslova na putu kada dođe do pojave uslova za padanje snega i

stvaranje leda (slika 5).

Putna so se takođe primenjuje u slučaju padanja kiše koja se ledi i to često u kombinaciji sa abrazivima, kako bi se povećalo trenje i otopio led.



Slika 5. Primjena putne soli u zimskim uslovima

Dva su razloga što se ne preporučuje primjena čvrste putne soli na suvom kolovozu prije nailaska snežne oluje,. Prvi razlog zbog čega ne treba primjeniti čvrstu so na suvom kolovozu leži u činjenici da ona uzima toplotu sa površine kolovoza kroz endotermsku reakciju. U toj situaciji, putna so može sniziti temperaturu kolovoza i prouzrokovati da se vlaga koja dođe u kontakt sa površinom kolovozom pretvori u led. Drugi razlog je taj da se puno soli izgubi kao rezultat odskakanja i kotrljanja soli sa puta, po napuštanju posipača. Nešto soli što preostane na putu, biva uklonjeno dejlovanjem saobraćaja. Nerastvoreni kristali soli na putu i u jarkovima predstavljaju opasnost za životnu sredinu.

Tradicionalni postupak otklanjanja leda podrazumijeva upotrebu soli krupne granulacije koja proizvodi zahtjevanu količinu rastvora, što je preduslov za početak procesa topljenja leda, odnosno raskidanje veze snijeg/led–kolovoz. Veća zrna, iako imaju veću masu i nisu sklona da ih vjetar lako oduva sa puta, kotrljaće se i odskakati tokom posipanja i imaće manji koeficijent zadržavanja na putu. Takođe, krupnozrna so može se zadržati duže na kolovozu nego što se predviđa intervalom između dva čišćenja i posipanja. Zato se deševa, kada se čisti lapavica sa puta, na njemu se mogu naći i nerastvorena zrna soli, koja će prerano biti uklonjena sa puta u jarkove i na bankine. Sitnija zrna soli efikasnije djeluju tokom ranih primjena. Primjena sitnozrne soli obezbijediće da so manje odskače po putu, bolje se raspoređuje po njegovoj površini i brže djeluje pod datim okolnostima. Primjena manje količine sitnozrne soli ima dobar efekat pri sprečavanju smrzavanja, i u slučaju kiša koje se lede, pri čemu je primjena standardne aplikacije sa krupnozrnom soli nepotrebna.

Osim ukoliko nije neophodno da se rano primeni putna so kao preventivna aplikacija, najjeftiniji, najefikasniji i najmanje štetan po životnu sredinu je pristup fizičkog uklanjanja snijega, i to što je više moguće, a zatim korišćenje putne soli u cilju otapanja zaostalog snijega ili leda.Neke putne uprave propisuju da se na putevima ostavlja mala količina snijega prije primjene putne soli kako bi se spriječilo odnošenje putne soli sa puta djelovanjem vjetra ili saobraćaja. Putna so se ne uklanja prije vremena. Prerano uklanjanje soli sa površine kolovoza smanjuje efikasnost raskidanja veze led-kolovoz. To takođe ima i ekološke posljedice, u slučaju kada nerastvorena zrna soli završe u putnom pojasu, ugrožavajući na taj način biljni i životinjski svijet.

4.1.3Optimizacija korišćenja putne soli

Cilj preventivne strategije je korišćenje raspoloživih resursa na ekonomski najisplativiji način i uz minimalno korišćenje putne soli. U pogledu ostvarenja ovih ciljeva, neophodna su tri tipa informacija:

1. 1.**Informacije o vremenskoj prognozi** za predviđeno nadolazeće nevrjeme i potencijalne ledene događaje.
2. 2.**Tekuće informacije** obezbjeđuju informacije o temperaturi i uslovma površine kolovoza. Postoji nekoliko vrsta kolovoznih senzora koji su u upotrebi. Ono što im je zajedničko je to što su postavljeni u kolovozu i povezani sa meteorološkom stanicom. Senzori u kolovozu mogu da prate temperaturu površine kolovoza, vlažnost kolovoza, tačku mržnjenja rastvora na putu, prisustvo hemikalija i njihove koncentracije (za neke hemikalije), kao i temperature ispod površine kolovoza. Senzori postavljeni na određenoj visini mogu da daju lokalne informacije u realnom vremenu, o tipičnim atmosferskim prilikama, kao što su padavine, relativna vlažnost vazduha, tačka rose, temperatura vazduha i brzina i smer vetra.
3. **Statusne informacije** - snimanje onoga što se dogodilo uključujući informaciju o postignutom nivou usluge.

U zavisnosti od klime, kategorije puta i standarda zimskog održavanja, racionalizacija u korišćenju putne soli veoma varira. Bitan aspekt preventivne strategije je koordinacija čišćenja snijega i korišćenja hemikalija. Sve je u „pravovremenosti“. Ukoliko se snijeg čisti suviše rano nakon primene hemikalija, hemikalije će se ukloniti sa puta prije nego što postignu svoj puni efekat. Ukoliko se čeka predugo, rastvor se može razblažiti i kasnije zalediti, prouzrokujući problem.

4.1 Ostali hemijski materijali za zimsko održavanje puteva

Kalcijum hlorid, $CaCl_2$ se koristi kao sredstvo za sprečavanje leda na putu - pomaže u snižavanju tačke na kojoj mrzne voda. Koristi se kao suva ili ovlažena so sa 77-80% $CaCl_2$ ili u obliku 20-24% rastvora. Lako je rastvorljiv u vodi i vrlo higroskopan.Tokom rastvaranja u vodi oslobađa toplotu (egzotermna reakcija) –pogodan za preventivno djelovanje.Kalcijum hlorid topi led i snijeg do temperature od – 15 ^oC. Pokazuje manje štetno dejstvo po objekte i vozila, ali je dvostruko skuplji od natrijum hlorida.

Magnezijum hlorid, $MgCl_2$ koristi se kao suva ili ovlažena so u obliku ljuspica (47%) ili u obliku 20-30% rastvora. Njegova eutektička tačka je -36,6 °C. Može biti iskorišćen kao agens koji sprečava nastanak leda ili, ukoliko postoji veza led-kolovoz, efikasan je u njenom raskidanju. Sprečava pojavu crnog leda i takođe se koriste u slučaju kiša koje se lede. Primjenom magnezijum hlorida bezbednost je poboljšana a nezgode su smanjene. Njegova primjena može doprinjeti propadanju betona.

Kao hemijsko jedinjenje, **kalcijum magnezijum acetat (CMA)** je dolomitna krečnjačka stijena i acetatna kiselina.Može biti korišćen u tečnom obliku ili kombinovan sa solju i pijeskom. Kada se koristi kao tečnost, to je uglavnom za potrebe sprečavanja nastanka leda. CMA ne topi snijeg i led, već pretvara snijeg i led u brašnastu teksturu. To omogućava lagano čišćenje i odnošenje, a ukoliko je na putevima saobraćaj veoma intenzivan, on ima tendenciju da vrlo efikasno ukloni lapavicu. Ali u tom slučaju, mora da budem primenjen na početku snežne oluje prije akumulacije velike količine snijega.CMA je efikasniji u

sprječavanju nastanka leda nego u otklanjanju već nastalog leda. Sposoban je da spriječi pretvaranje utabanog snijega u led i zatim njegovo vezivanje za kolovoz, ali jednom kada se led stvori, treba koristiti neku drugu hemikaliju kako bi raskinuli ovu vezu.Biorazgradiv je i manje korozivan za metale nego so.

Kalijum acetat (KAS) se dobija reakcijom acetatne kiseline i kalijum karbonata. Primjenjuje se kao sredstvo za otklanjanje leda, ali takođe i za držanje pružnih skretnica otvorenim, sprečavanje zaleđivanja poklopaca na šahtama, čak i kao antifriz za vodu u toaletima.Glavna uloga je u otklanjanju i sprečavanju nastanka leda.Ukoliko se primjenjuje na početku snježne oluje, može spriječiti formiranje veze led-kolovoz. Poznat je po svom produženom djelovanju.Nekorozivan je i biorazgradiv, razlaže se na kalijum i acetat i menja u ugljenik i vodu, ali zahtjeva neznatnu količinu kiseonika za taj process. Toksičan je za ribe u rastućoj koncentraciji.

5 Hemijski materijali za odleđivanje i životna sredina

Kalcijum magnezijum acetat (CMA) i kalijum acetat (KAC) su hemikalije za odleđivanje koje najmanje ugrožavaju životnu sredinu zato što sadrže kiseline koje se raspadaju biološkim putem. Natrijum hlorid (NaCl), kalcijum hlorid ($CaCl_2$) i magnezijum hlorid ($MgCl_2$) s druge strane, pri rastvaranju oslobađaju jone hlorida koji ostaju na površini puta i mogu ne samo da zagade okolne podzemne vode, već i da korodiraju motorna vozila i mostove. Suština je da se sve hemikalije za odleđivanje ne stvaraju na isti način, niti imaju iste efekte na životnu sredinu: neke stvaraju više problema od drugih. Hemikalije za odleđivanje koje se nalaze u otekloj vodi sa puteva, nijesu ni jedini ni glavni izvor kontaminacije voda hloridima – one su jednostavno najvidljivije.Redovni postupci održavanja i habanje naših vozila takođe za rezultat imaju ispuštanje ulja, maziva, rđe, ugljovodonika, gumenih čestica i drugih čvrstih materijala na površinu puta. Ovi materijali često se speru sa puta za vrijeme kiše ili snježnih padavina. Najčešće kontaminirajuće materije u vodama koje otiču sa puteva su teški metali, neorganske soli, aromatični ugljovodonici i čvrste materije koje se akumuliraju na površini puta kao, rezultat redovnih aktivnosti na putu i aktivnosti na njegovom održavanju.

Soni rastvor, koji se sastoji od finih kapljica, može pasti na udaljenosti do 50 metara od ivica puta u zavisnosti od brzine vozila, vjetrova i konfiguracije terena. Zapljuskivanje soli obično se pruža od 8 do 40 metara od ivice puta, a na količinu zapljuskivanja utiče brzina vozila. Raspon nanosa soli vazduhom varira, a so može da putuje i do 500 metara.Ako postoje uticaji putne soli na životnu sredinu, oni će se najčešće javiti na udaljenosti do 30 metara od ivica puta. Iza ove udaljenosti uticaji soli su relativno beznačajni. Procjena o količini soli koja se primenjuje na putevima, a koja dospijeva u podzemne vode je u rasponu od 10% do 50%. Količina hlorida koji putuje kroz sistem podzemnih voda i ponovo ulazi u površinske vode procenjena je da iznosi između 20% i 45%.

Putna so može da uđe u životnu sredinu raznim putevima, od kojih svi uključuju vodu u jednom ili drugom obliku. Voda otekla sa kolovoza koja sadrži so, može ili da se odvodi kanalima za odvodnjavanje i da se ispusti u recipijente, ili da prodre u tlo i podzemne vode odakle biljke mogu da je koriste. So koja ulazi u podzemne vode kroz oticanje sa kolovoza kretaće se kroz tlo, pri čemu može da uđe u bunare, ili da ode u osnovni tok površinske vode. Putna so može da utiče direktno ili indirektno na tlo, vegetaciju, podzemne vode, vodena staništa i divlji svijet.

Putna so utiče na svojstva tla kroz proces poznat kao razmena katjona, gdje se joni kalcijuma i magnezijuma, koji su vezani za tlo, zamenjuju jonima natrijuma. Ova zamjena u određenim vrstama tla može da smanji propustljivost, aeraciju i plodnost tla. Kombinacija natrijuma i hlorida iz putne soli i oslobađanje kalcijuma, magnezijuma i vjerovatno teških metala iz tla kroz proces razmene katjona, može imati sljedeće efekate na podzemne vode:

-Povećanje tvrdoće u vodi zbog povećane koncentracije kalcijuma i magnezijuma. Povećana tvrdoća takođe može da prouzrokuje stvaranje kamenca u vodovodnim cijevima i prijevremeno propadanje vodovodnih instalacija i aparata koji koriste vruću vodu.

-Povišen nivo natrijuma i hlorida. Hloridi su prirodno prisutni u podzemnim vodama u malim koncentracijama, ali veće koncentracije mogu da budu rezultat djelovanja putne soli. Pošto su joni hlorida relativno mali i negativno naelektrisani, oni su veoma pokretljivi i putuju relativno brzo kroz površinske slojeve terena i prodiru u podzemne vode čak i u finijem tlu.

Soli za otklanjanje leda mogu da utiču na vegetaciju prouzrokujući niz simptoma oštećenja, koja u kombinaciji sa drugim faktorima mogu dovesti i do smrti biljke. Najčešće dolazi do procesa koji uklanja vodu iz korjena, pupoljaka ili lišća biljaka, prouzrokujući njihovo sušenje i u ekstremnim slučajevima, uginuće. Znaci sušenja javljaju se kroz oštećenja iglica kod četinara koji poprimaju braon boju i oštećenja pupoljaka i grančica kod lišćara.Tolerancija i osetljivost na jone, koje putne soli ostave u zemlji, varira među biljnim vrstama. Veću pažnju treba posvjetiti osetljivim biljnim vrstama, kao što su poljoprivredni zasadi, osjetljivi na putnu so. Putna so može da utiče i na lanac ishrane. U životnoj sredini postoji prirodni sistem po kome se životinje višeg reda hrane vrstama nižeg reda, a lanac ishrane oslabi ako se pokida jedna karika. So za uklanjanje leda pored puta dostupna je i životinjama.

Tokom dužih putovanja, važno je redovno se zaustavljati da se obrišu vjetrobran i farovi, jer tokom izrazito loših vremenskim prilikama, putna so lako može da isprlja vjetrobran i farove i tako umanji vidljivost za čak 40%. Industrijska so i rizla mogu da oštete auto ukoliko se ne čisti redovno, a može i da nasate korozija.

Oticanje hemijskih materijala sa puteva može da ima negativne efekte ako se ne preduzmu nikakve mjere za otklanjanje prekomjernih kontaminirajućih materija prije nego što otekla voda stigne do recipijenta, ali ukoliko se adekvatno postupi, to ne mora da bude ozbiljan problem. Jedini način da se ove posljedice u potpunosti eliminišu bio bi da se prekine sa korišćenjem putne soli. U nedostatku alternativnog sredstva za odleđivanje, koje djeluje isto tako efikasno po pitanju troškova kao i putna so, prestanak korišćenja soli nije moguća opcija. Ali kroz efikasne postupke upravljanja njenim korišćenjem, možete se smanjiti količina putne soli koja ulazi u životnu sredinu. Otekla voda sa puteva obično je čistija od oteklih voda iz zgrada, farmi, rudnika, luka ili nekih drugih netačkastih izvora. Postoje veoma efikasna aktivna i pasivna sredstva za tretiranje voda oteklih sa puta, prije nego što one prouzrokuju ikakvu štetu. Retenzioni bazeni za zadržavanje ili zaustavljanje veoma su efikasna sredstva za kontrolisanje prekomjernih tokova voda oteklih sa puta. Oni prihvataju vodu oteklu sa puta i ispuštaju je veoma sporo, omogućavajući dovoljno vremena da se teže čestice slegnu, ispare, filtriraju, ili da se apsorbuju.

6 Putevi u Crnoj Gori razvrstani po prioritetima održavanja u zimskom periodu

Putevi u zimskim uslovima po pravilu moraju biti stalno prohodni.

Pod stalnom prohodnošću podrazumijeva se nesmetano odvijanje saobraćaja uz pravilnu upotrebu zimske opreme.

Izuzetno, kada se pri intezivnijim i dužim sniježnim padavinama, mećavama i vijavicama ne može na svim putevima održati stalna prohodnost utvrđuju se, u zavisnosti od značaja puta, intenziteta saobraćaja, nadmorske visine, sljedeći prioriteti obezbjeđenja prohodnosti, i to:

I prioritet zimskog održavanja imaju putni pravci koji imaju najveću važnost za privredu, društvene i druge potrebe Crne Gore i putevi koji povezuju Crnu Goru sa drugim državama.

Putni pravci koji imaju I prioritet moraju biti u zimskom periodu osposobljeni za normalno odvijanje saobraćaja u svim uslovima. Izuzetno, na dionicama ovih puteva duž kanjona, kao i na visoravnima i prevojima, gdje je moguća pojava sniježnih lavina, usova, mećava i vijavica, može doći do kraćih prekida saobraćaja ali ne dužih od 4 sata.

I-a prioritet imaju putni pravci, koji takođe imaju najveću važnost za privredu, društvene i druge potrebe Crne Gore i putevi koji povezuju Crnu Goru sa drugim državama, međutim, izdvojeni su iz razloga što je pojava sniježnih padavina rijetka, a pojava leda samo povremeno na dionicama koje su izgrađene u osojnim (nesunčanim) padinama.

II prioritet zimskog održavanja imaju putevi značajni za privredu, društvene i druge potrebe Crne Gore, međutim, zbog stanja puta i njegovog visinskog položaja, realno nije moguće dostići i prioritet i prekidi saobraćaja su mogući i preko 6 sati, ali ne duže od 12 sati.

III prioritet zimskog održavanja imaju putevi koji povezuju naseljena područja Crne Gore sa putevima viših prioriteta. I na putevima ovog prioriteta, predviđa se blagovremen i stalan rad na održavanju prohodnosti, međutim, potrebnu pomoć mogu dobiti poslije normalizacije saobraćaja na putevima viših prioriteta, pa prekidi mogu trajati i duže od 12 sati, a ne preko 24 sata.

IV prioritet zimskog održavanja imaju putevi na kojima se snijeg čisti poslije normalizovanja saobraćaja na putevima prethodnih prioriteta a najkasnije 48 sati od prestanka padavina.

V prioritet zimskog održavanja imaju putevi koji se ne održavaju u toku zimskog perioda, već se otvaraju po isteku zime.

Uprava za saobraćaj na osnovu plana održavanja puteva u zimskom periodu, odnosno od 15. novembra tekuće godine do 31. marta sljedeće godine, definiše dinamiku uključivanja sredstava i radne snage. Plan je fleksibilan i prilagođava se intenzitetu padavina, temperaturama i vremenskim prognozama.Izvođač radova, “Crnagoraput” AD Podgorica, dužan je da obezbijedi prohodnost i van predviđenog perioda ako zimski uslovi to zahtijevaju. Uprava za saobraćaj Crne Gore je nadležna za održavanje puteva u zimskim uslovima, dok auto-putem “Princeza Ksenija” i tunelom Sozina rukovodi preduzeće “Monteput”. Cilj održavanja puteva u zimskom periodu, odnosno zimskim uslovima je održavanje prohodnosti i bezbjednog odvijanja saobraćaja. Prioritet imaju putni pravci koji

imaju najveću važnost za privredu, društvene i druge potrebe, kao i putevi koji povezuju Crnu Goru sa drugim državama

7 Zaključak

Putna so predstavlja najekonomičniji dostupan materijal za uklanjanje snijega i leda. Početni troškovi su niski u poređenju sa alternativama; rukovanje i skladištenje su jednostavni, a posipanje je brzo i lako. Putna so se posipa sa ciljem snižavanja tačke mržnjenja vode, kako bi raskinuli vezu led-kolovoz. Putna so deluje do –21 °C, ali se njena primjena ne preporučuje ispod -10 °C.Negativan uticaj putne soli se manifestuje na površinske vode, podzemne vode, vegetaciju,zemljište, građevinske objekte i vozila.Cilj putarskih službi je da održe puteve maksimalno bezbjednim tokom zime, korišćenjem minimalne količine soli u mjeri u kojoj je to moguće.

Efikasnim upravljanjem korišćenja putne soli, može se osigurati da u životnu sredinu ne uđe više soli od količine koja je neophodna. To podrazumijeva da se:

- putna so nanese preventivno, u optimalnim količinama, kako bi se spriječilo vezivanje leda za kolovoz;
- koristi tečni rastvor soli za sprečavanje nastanka leda ili prethodno navlaženu so, kako bi se smanjila količina soli izgubljena u jarku zbog strujanja vazduha ili odskakanja;
- nadgleda korišćenje soli u oblastima osetljivim na so, kako bi se osiguralo da se koristi samo željena količina;
- koristi efikasno čišćenje plugovima, kako bi se optimizovalo korišćenje soli;
- bilježi korišćenje soli, kako bi se pokazalo da se o tome vodi računa;
- koriste temperaturni senzori za merenje temperature kolovoza i dobre putne meteorološke informacije, kako bi se obezbijedilo da se so nanosi samo kada je to potrebno;
- stiče znanje o identifikovanju oblasti koje su osjetljive na putnu so i sprovodi najbolja praksa upravljanja korišćenjem soli u tim oblastima.

Uspješan program zimskog održavanja puteva zavisi od toga da li imamo osposobljene ljude, pravi materijal, pravu opremu uposlenu u pravo vrijeme i na pravom mjestu.

8 Literatura

Zakon o putevima, “Sl.list CG”, br.82/2020.god.

Opšta i neorganska hemija, G. Isaković, Lj. Lukić; M. Isaković, N. Panajotović, Zavod za udžbenike i nastavna sredstva, Beograd 2023.god.

Priručnik za obuku osoblja na zimskom održavanju puteva, Javno preduzeće “Putevi Srbije”, Beograd 2008.god.

Izvor:https://web1.grf.bg.ac.rs/p/learning/predavanje_12__zimsko_odr_avanje_1620506382160.pdf

Izvor: https://solanatuzla.nazif.mycpanel.rs/bosanski/tema_2.pdf

Izvor:https://www.nabavke.com/tdoc-cejn/documents/50261-2023-08-09-10-00-Zimska_sluzba.pdf

JU SREDNJA STRUČNA ŠKOLA
IVAN USKOKOVIĆ
PODGORICA

Materials for road maintenance in winter conditions

Biljana Kljajić, Bachelor of Technology - Master

Srečko Kljajić, B.Sc. Traffic - Master

Portorož, September 2025.

Foreword

Roads form the central nervous system of any country because almost every social and economic activity is related to traffic. Snow and ice have a direct impact on the smooth flow of traffic.

The five most commonly used chemicals for ice removal and prevention are: sodium chloride, NaCl; calcium chloride, $CaCl_2$; magnesium chloride, $MgCl_2$; calcium magnesium acetate, CMA and potassium acetate, KAS. Sodium chloride, NaCl - road salt is the most effective and cheapest de-icing material that is easy to handle. The listed alternatives usually cost more, require special attention during handling and are effective only under certain weather conditions. Road salt works up to -21 °C, but its use is not recommended below -10 °C. The reason for sprinkling road salt is to lower the freezing point of water, in order to break the ice-road bond.

Proper and timely use of road salt improves driving safety during the winter period and reduces the harmful impact on the environment and economic costs.

Keywords: chemical materials for winter road maintenance, road salt, lowering the freezing point of wate

1 Introduction

Winter road maintenance is vital for traffic safety and accident prevention during cold and snowy periods. The use of adequate material is crucial because it enables quick and efficient removal of snow and ice from the roads, thus ensuring better passability and a lower risk of slipping and accidents. Adequate material can also help preserve roads and infrastructure by preventing damage. The use of the correct material for winter road maintenance plays a key role in preserving the safety and functionality of the traffic network.

Road salt is a chemical compound that is used to melt snow and ice on roads during the winter months in order to maintain passability and traffic safety. The most commonly used road salt is sodium chloride (NaCl), also known as table salt. When spread over the road surface, salt attracts moisture from the environment and creates a solution that lowers the freezing point of water, allowing ice and snow to melt and making road cleaning easier.

2 Winter road maintenance throughout history

When the first cars and asphalted streets appeared, the road workers of that time cleared the roads of snow with a plow, and then sprinkled them with a mixture of sand and ash, to prevent the wheels from slipping, until they found a solution for the ice.

Road salt was first used experimentally in the American state of New Hampshire in 1938, when one of the leaders thought that in practical application he would discover that sea water freezes at a much lower temperature than normal. That's how he realized that by adding salt, the freezing temperature of water can be lowered by ten degrees. Road salt has become a standard practice in winter road maintenance due to its ability to lower the freezing point of water and quickly melt snow and ice. Today, millions of tons of salt are used worldwide annually for road safety during the winter months.

The discovery of the positive effect of salt on melting snow and ice is largely responsible for the development of road traffic as we know it today.

3 Significance of winter road maintenance

Winter road maintenance is important for traffic safety, and therefore for the economy. The goal of road maintenance in the winter period, i.e. winter conditions, is to maintain the passability of roads and the safe flow of traffic with:

- minimal costs
- minimal harmful impact on the environment
- minimal disruption of traffic.

The economic benefits of winter road maintenance are: direct (reduction in the number of traffic accidents, reduction in travel time, reduction in travel costs) and indirect (economic productivity, reduction in the number of compensation claims based on the reduction in the number of traffic accidents, reduction in the need to engage emergency services - police, firefighters).

The winter road maintenance standard represents the effectiveness of the treatment in preventing the formation of snow and ice on the road (Figure 1).



Figure 1. Winter road maintenance standard

4 Materials for winter road maintenance

The materials used for winter road maintenance are divided into two basic groups, namely:

1. chemical materials:

NaCl - sodium chloride

$CaCl_2$ - calcium chloride

$MgCl_2$ – magnesium chloride

calcium magnesium acetate, CMA

calcium acetate, KAC

urea

poliglikol

ammonium nitrate

ammonium sulfate

2. slip-reducing or abrasive materials:

rice

slag

stone aggregate.

Due to their physical and chemical properties, chemical materials have the ability to reduce the freezing temperature of water and to melt snow and ice at temperatures lower than the freezing temperature of water. Of the chemical materials, chlorides are used the most, while the others generally do not meet the basic conditions for their application in terms of economy and technical characteristics. Urea has a highly harmful effect on the environment, and polyglycol is toxic to humans and animals if ingested and extremely expensive. Chemicals can be applied as liquid, dry and solid or solid, pre-moistened.

Abrasive materials are applied to roads with the aim of increasing the roughness of the pavement and providing safer driving. The most commonly used abrasive materials are: sand with a grain size of up to 2 mm, stone granulate with a grain size of up to 8 mm, ground slag and gravel. The required amount of abrasive material ranges from 600 to 1000 (kg/km).

The mixture of chemical solvents and abrasive materials is used for winter road maintenance due to the possibility of combining the positive properties of abrasive materials (increasing the coefficient of friction, i.e. roughness) and chemical solvents (lowering the freezing temperature). The ratio of abrasive material and chemical solvent ranges from 9:1 to 1:1, depending on the weather conditions and traffic frequency. Abrasive materials are used less and less in the world (they are banned on highways), while in some countries (UK) their use is allowed only in a mixture with chemical agents.

4.1. Sodium chloride, NaCl

Sodium chloride, NaCl - road salt is the most economical de-icing material available. Initial costs are low compared to other chemicals; handling and storage are simple, and spreading is quick and easy. Thanks above all to more favorable procurement conditions, sodium chloride, NaCl, is most often used for winter road maintenance. Its representation in the overall structure of consumption of chemical materials is over 90%.

Sodium chloride, which we call table salt because of its application, and depending on the way it is obtained, it can be either rock or sea salt. Rock salt is obtained by excavating deposits, which were formed by the deposition of salt from ancient seas, while sea salt is obtained by the process of evaporating sea water. Road salt is a natural mineral halite, which in its composition is sodium chloride, NaCl. Table salt is purified, while road rock salt contains mineral impurities, which is why it is usually brown or gray in color. Road salt has tremendous staying power. It never loses its de-icing properties, no matter how long it is stored. At the time of extraction, it is between 210 and 320 million years old, and transferring it to storage piles for the next year or even longer does not in any way diminish its de-icing power. It is important that the road salt is adequately protected, so that losses do not occur due to the effect of moisture from the air. Although salt begins to absorb moisture when the humidity reaches 75 percent, any absorbed moisture will evaporate when the humidity drops below this level.

Rock salt consists of positive sodium ions, Na^+ and negative chlorine ions, Cl^- which are bound by an ionic bond and form a crystal (Figure 2). As long as they stay united they have no effect on the ice. Road salt works by lowering the freezing point of water through a process called freezing point depression .Sodium chloride breaks down into ions in a small amount of water.The resulting ions make it difficult for water to freeze into ice, lowering the freezing point water. So, in order to melt ice, road salt must be dissolved in water in the form of an aqueous solution.

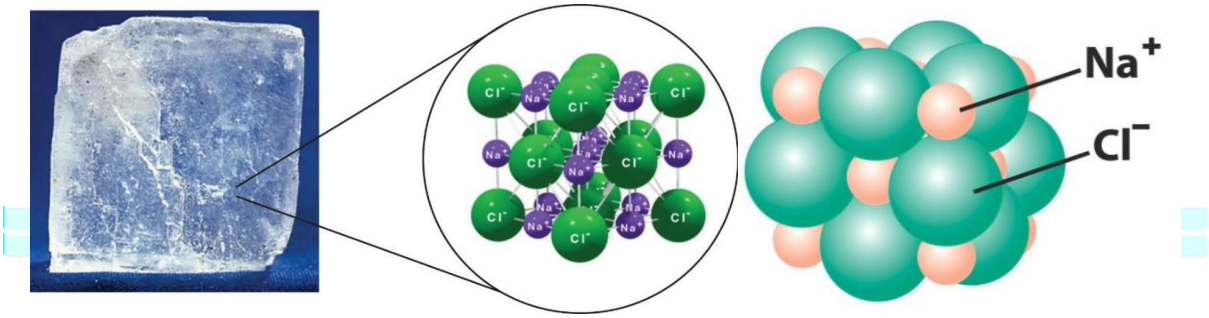


Figure 2. Crystal structure of NaCl

The pavement surface temperature changes in winter conditions and is probably the most important variable. Sodium chloride, NaCl lowers the pavement temperature, but this effect

is less than 1 °C and its duration is 5 minutes or less, after which the effect disappears. Some of the rock salt competitors raise the temperature of the pavement, but this effect also disappears very quickly. In the past, the job of a road worker was simple and consisted of going out into the field during a snowstorm and spreading as much salt as possible on the road. Now, since aqueous salt solution and not rock salt is known to melt ice, one must be very careful about how much salt to apply and when to apply it. When the temperature is too low sodium chloride, NaCl, works great when pre-moistened. It is far cheaper to apply NaCl as moistened, than to use only some expensive alternative. More and more agencies use pre-moistened salt or as a sodium solution, so that it starts to work immediately. Since most snow storms are accompanied by a drop in temperature, de-icing agents are applied immediately, before or in the early stages of a snow storm. It is necessary to optimize the efficiency of using salt by applying the right amount, at the right time and in the right place. To make such a decision, it is necessary to understand the chemical behavior of road salt.

4.1.1 Energy changes accompanying the process of dissolving sodium chloride

The dissolution of sodium chloride, NaCl in water follows two processes (Figure 3):

1. the process of destroying the crystal lattice i
2. ion hydration process

During the dissolution of sodium chloride, the crystal lattice is first destroyed, and for this energy is "taken" from the environment (endothermic process). The process of the destruction of the sodium chloride crystal lattice can be represented by the equation:

$Already^{+}Cl^{-}_{(s)} \rightarrow Already^{+} + Cl^{-} \qquad \Delta H_r = +769.9$ kJ/mol

Radiant enthalpy, ΔH_r is equal to the enthalpy of ionic bond breaking.

When sodium chloride is added to water, the water molecules, H_2O surround the sodium, Na^{+} and chlorine, Cl^{-} ions. Water molecules are polar, meaning they have a partially negative charge on the oxygen atom and a partially positive charge on the hydrogen atom. This polarity allows water molecules to attract salt ions. Partially negative oxygen attracts positively charged sodium ions, while partially positive hydrogen attracts negatively charged chlorine ions. This attractive force between water molecules and salt ions is called hydration. Energy is released during hydration (an exothermic process), because the ions are more stable when surrounded by water molecules than when bound in the NaCl crystal lattice. The hydration process of the formed ions can also be represented by the equation:

$Already^{+} + Cl^{-} \xrightarrow{H_2\,The} Already^{+}_{(aq)} + Cl^{-}_{(aq)} \qquad \Delta H_h = -765.7$ kJ/mol

where is it ΔH_h heat of hydration. As the process of dissolving sodium chloride represents the sum of these two processes: the destruction of the crystal lattice and the hydration of the formed ions, it is the total enthalpy change of the system ΔH_s :

$Already^{+}\,Cl^{-} \xrightarrow{H_2\,The} Already^{+}_{(aq)} + Cl^{-}_{(aq)} \qquad \Delta H_s = \Delta H_r + \Delta H_h = 4.2$ kJ/mol

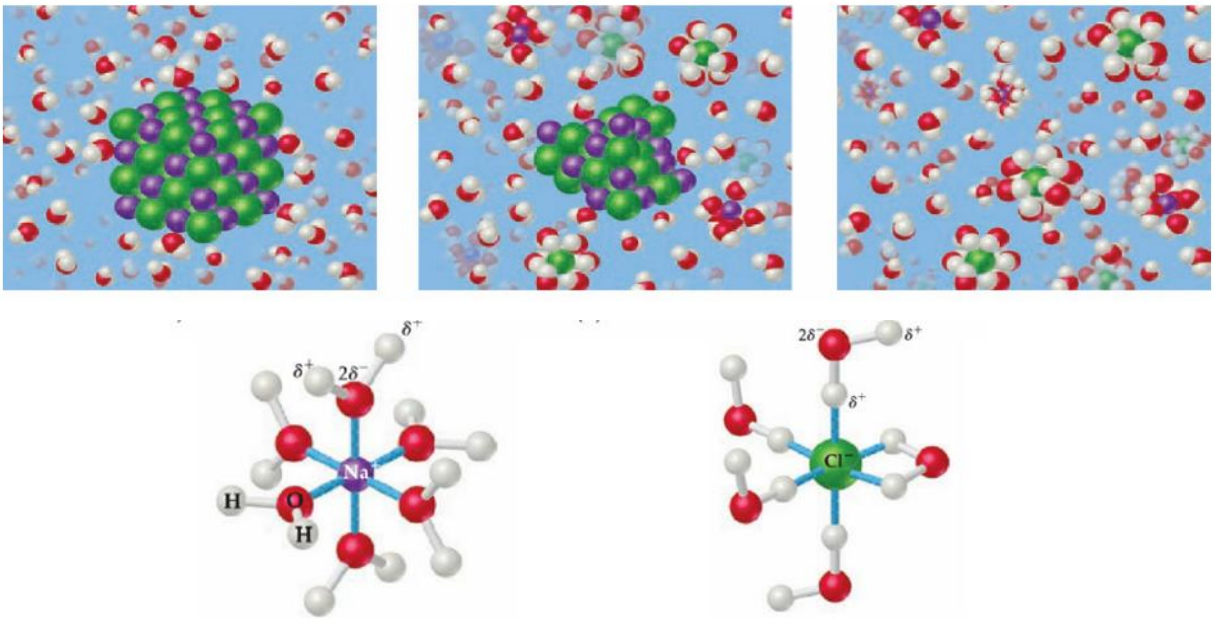


Figure 3. The process of dissolving sodium chloride

From the above, it can be concluded that to dissolve sodium chloride, energy is absorbed from the environment, which leads to the lowering of the freezing point of water to a temperature lower than 0 °C". In the field of winter maintenance, a substance that delays the onset of ice formation is very useful and a good thing.

4.1.2. Action of road salt in winter conditions

The only way in which it is possible to break the ice-road connection is with the help of chemical agents such as road salt (picture 4).



a) b)

Figure 4. Road salt: 25 kg package (a); 1000 kg package (b)

Salt solution – not solid salt – melts snow and ice. To shorten the time it takes for the solid salt to go into aqueous solution, one of the most effective ways to achieve this goal is to use an aqueous salt solution along with the solid salt. This process is called "pre-wetting". Throughout the North American Snow Belt, many organizations have found that they can reduce the salt reaction time and provide ice melting at lower temperatures by using the prewetting technique, respecting the following concentrations:

23% liquid sodium chloride solution

32% solution of liquid calcium chloride

32% magnesium chloride solution

25% calcium magnesium acetate solution

42% potassium acetate solution

The pre-moistened salt goes into solution faster, thus accelerating its mission of restoring satisfactory friction to the pavement. Also, pre-moistened salt adheres better to the surface of the roadway and as such, more remains in the traffic lanes than it is removed from the roadway. Pre-moistened salt reduces the required amount of salt. Only 4% of salt is lost when the road is treated with pre-moistened salt, as opposed to 30% loss when the road is treated with dry salt. The best effect is achieved when the salt is moistened when it comes out of the spreader.

The effect of road salt, as a means of melting ice, is determined by three factors: temperature, humidity and time. The phase diagram (Figure 4) shows the freezing point of the solution, salt and water.

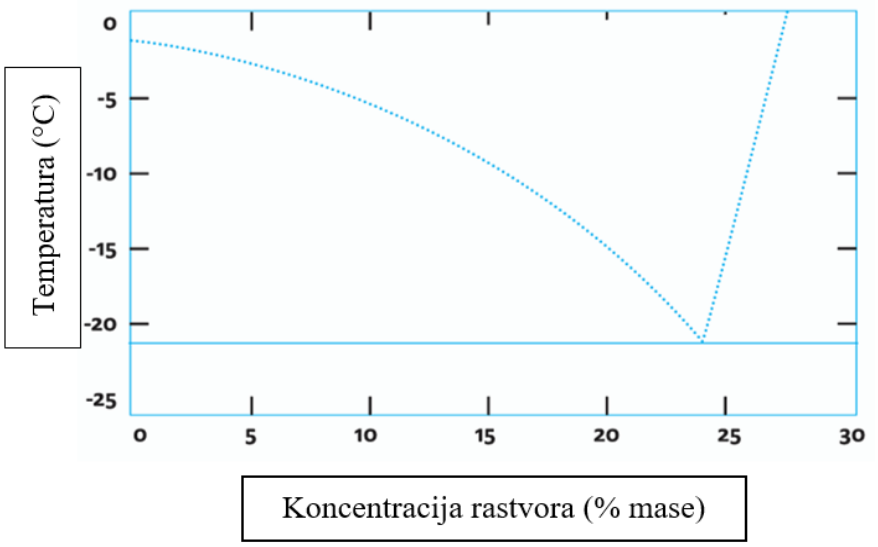


Figure 4. Phase diagram

All points below the curve represent ice crystals and NaCl and H solution$_2$A. All points above the curve and in the middle represent NaCl crystals and NaCl and H solution$_2$A. Based on the diagram, we conclude that if the concentration of salt in the solution increases, the freezing point decreases. For example, pure water freezes at 0 °C, and a 10% salt solution will not freeze until the temperature drops below -6 °C. The freezing point of the solution will continue to fall if more salt is added to the solution, i.e. if its concentration is increased. The lowest freezing point of NaCl and H solutions$_2$O, which can be reached is -21 °C, at a concentration of 23.3%**.** This optimal concentration, which provides the lowest possible freezing point of the solution, is called the eutectic point, and each freezing point depressant has its own eutectic point. Therefore, road salt works up to -21 °C, but its application is not recommended below -10 °C.

In addition to understanding the principle of phase change, it is important to know how much ice can melt road salt at different temperatures.

KILOGRAMS OF ICE DISSOLVED BY 1KG OF SALT	
Temperature (°C)	1 kg of NaCl will dissolve
-1	46.3 kg of ice
-4	14.4 kg of ice
-6,7	8.6 kg of ice
-9,4	6.3 kg of ice
-12	4.9 kg of ice
-15	4.1 kg of ice
-18	3.7 kg of ice
-21	3.2 kg of ice

Table 1. Relationship between temperature and the amount of melted ice due to the effect of road salt

Table 1 shows that at -1 °C, 1 kg of salt melts 46.3 kg of ice. However, as the temperature drops to -4 °C, 1 kg of salt will melt 14.4 kg of ice, and at -10 °C only 5 kg of ice. The goal is not to melt all the ice, but to break the ice-ice bond. This relationship and understanding of the phase diagram is the basis for determining the standard amounts of road salt application.

4.1.3 Application of road salt in winter conditions

Road salt is applied using various tools and spreading techniques. There is no generally accepted standard for the amount of road salt application. Depending on local conditions and policies, the extent of road salt application can vary between 80-600kg/km of a two-lane road. Table 2 shows the amount of road salt used in different winter conditions.

OPERATION	AMOUNT OF ROAD SALT (g/m^2)
Preventive salting	10
Stronger frost	20-40
Snow removal	40-60

Table 2. Amount of road salt applied in different winter conditions

In order to use road salt more efficiently and create safer conditions on the road, it should be used at the beginning of a snowstorm, in order to act preventively against the occurrence of freezing and the formation of an ice-road connection. This preventive action requires the application of a smaller amount of salt compared to the application of salt in case of removal of ice that has already formed. Therefore, the correct and timely use of chemicals such as road salt is crucial for establishing safe conditions on the road when conditions for falling snow and ice formation occur (Figure 5).

Road salt is also used in freezing rain, often in combination with abrasives, to increase friction and melt the ice.



Figure 5. Application of road salt in winter conditions

There are two reasons why it is not recommended to apply solid road salt on dry pavement before the arrival of a snowstorm. The first reason why solid salt should not be applied on dry pavement lies in the fact that it takes heat from the surface of the pavement through an endothermic reaction. In this situation, road salt can lower the temperature of the pavement and cause moisture that comes in contact with the surface of the pavement to turn into ice. Another reason is that a lot of salt is lost as a result of salt bouncing and rolling off the road after leaving the spreader. Some salt that remains on the road is removed by traffic calming. Undissolved salt crystals on the road and in ditches are a danger to the environment.

The traditional procedure for removing ice implies the use of coarse-grained salt that produces the required amount of solution, which is a prerequisite for the beginning of the ice melting process, i.e. breaking the snow/ice-augment connection. Larger grains, although they have more mass and are not prone to being easily blown off the road by the wind, will roll and bounce during spreading and have a lower coefficient of retention on the road. Also, coarse salt can stay on the road longer than predicted by the interval between two cleaning and spreading. That's why it happens that, when slush is cleaned from the road, undissolved grains of salt can be found on it, which will be removed from the road prematurely into the ditches and on the banks. Smaller grains of salt are more effective during early applications. Application fine-grained salt will ensure that the salt bounces less on the road, is better distributed on its surface and acts faster under the given circumstances. The application of a small amount of fine-grained salt has a good effect in preventing freezing, and in the case of freezing rain, where the application of a standard application with coarse-grained salt is unnecessary.

Unless it is necessary to apply road salt early as a preventive application, the cheapest, most effective and least environmentally harmful approach is to physically remove the snow, as much as possible, and then use road salt to melt the remaining snow or ice. Some road authorities prescribe that a small amount of snow be left on the roads before applying road salt to prevent road salt from being blown off the road by wind or traffic. Road salt is not removed ahead of time. Premature removal of salt from the pavement surface reduces the effectiveness of breaking the ice-pavement bond. It also has ecological consequences, in the event that undissolved grains of salt end up in the roadway, thus endangering plant and animal life.

4.1.3 Optimizing the use of road salt

The goal of the preventive strategy is to use available resources in the most economically

profitable way and with minimal use of road salt. In order to achieve these goals, three types of information are necessary:

1. **Weather forecast information** for predicted upcoming storms and potential ice events.

2. **Current information** provide information about temperature and road surface conditions. There are several types of pavement sensors in use. What they have in common is that they are installed in August and connected to a weather station. Sensors in the pavement can monitor the temperature of the pavement surface, humidity of the pavement, the freezing point of the solution on the road, the presence of chemicals and their concentration (for some chemicals), as well as the temperature below the pavement surface. Sensors placed at a certain height can provide real-time local information about typical atmospheric conditions, such as precipitation, relative humidity, dew point, air temperature, and wind speed and direction.

3. **Status information** - recording of what happened, including information about the level of service achieved.

Depending on the climate, road category and winter maintenance standards, the rationalization of using road salt varies greatly. An important aspect of the preventive strategy is the coordination of snow removal and the use of chemicals. It's all about "timeliness". If the snow is cleared too soon after the chemicals are applied, the chemicals will be removed from the road before they reach their full effect. If you wait too long, the solution can become diluted and later freeze, causing a problem.

4.2 Other chemical materials for winter road maintenance

Calcium chloride, $CaCl_2$ is used as a means of preventing ice on the road - it helps to lower the freezing point of water. It is used as dry or moistened salt with 77-80% $CaCl_2$ or in the form of a 20-24% solution. It is easily soluble in water and very hygroscopic. During dissolution in water, it releases heat (exothermic reaction) - suitable for preventive action. Calcium chloride melts ice and snow to a temperature of - 15 ^{the}C. It shows a less harmful effect on buildings and vehicles, but it is twice as expensive as sodium chloride.

Magnesium chloride, $MgCl_2$ it is used as dry or moistened salt in the form of flakes (47%) or in the form of a 20-30% solution. Its eutectic point is -36.6 °C. It can be used as an agent that prevents the formation of ice or, if there is an ice-road connection, it is effective in breaking it. It prevents the appearance of black ice and is also used in case of freezing rain. By using magnesium chloride, safety is improved and accidents are reduced. Its application can contribute to concrete deterioration.

As a chemical compound, **calcium magnesium acetate (CMA)** is dolomite limestone rock and acetic acid. It can be used in liquid form or combined with salt and sand. When used as a liquid, it is mainly for anti-icing purposes. CMA does not melt snow and ice, it turns snow and ice into a floury texture. This allows for easy cleaning and removal, and if there is heavy traffic on the roads, it tends to remove the slush very effectively. But in that case, it must be applied at the beginning of a snowstorm before the accumulation of a large amount of snow. CMA is more effective in preventing the formation of ice than in removing ice that has already formed. It is capable of preventing compacted snow from turning into ice and then bonding to the road, but once the ice forms, some other chemical must be used to break this

bond. It is biodegradable and less corrosive to metals than salt.

Potassium acetate (KAS) is obtained by the reaction of acetic acid and potassium carbonate. It is used as a means of removing ice, but also for keeping railway switches open, preventing ice caps on manholes, even as antifreeze for water in toilets. The main role is in removing and preventing the formation of ice. If it is applied at the beginning of a snow storm, it can prevent the formation of an ice-road connection. It is known for its prolonged action. It is non-corrosive and biodegradable, it decomposes into potassium and acetate and changes into carbon and water, but it requires a small amount of oxygen for that process. It is toxic to fish in increasing concentration.

5 Chemical deicing materials and the environment

Calcium magnesium acetate (CMA) and potassium acetate (KAC) are the least environmentally hazardous deicing chemicals because they contain biodegradable acids. Sodium chloride (NaCl), calcium chloride ($CaCl_2$) and magnesium chloride ($MgCl_2$) on the other hand, when dissolved, they release chloride ions that remain on the road surface and can not only pollute the surrounding groundwater, but also corrode motor vehicles and bridges. The bottom line is that not all deicing chemicals are created equal, nor do they have the same effects on the environment: some create more problems than others. De-icing chemicals found in swollen road water are neither the only nor the main source of water contamination with chlorides - they are simply the most visible. Regular maintenance and wear and tear of our vehicles also result in the release of oil, lubricants, rust, hydrocarbons, rubber particles and other solid materials onto the road surface. These materials are often washed off the road during rain or snowfall. The most common contaminating substances in road runoff are heavy metals, inorganic salts, aromatic hydrocarbons and solids that accumulate on the road surface as a result of regular road activities and maintenance activities.

Soni solution, which consists of fine droplets, can fall at a distance of up to 50 meters from the edges of the road, depending on the speed of the vehicle, winds and terrain configuration. Salt spray usually extends from 8 to 40 meters from the edge of the road, and the amount of spray is affected by vehicle speed. The range of salt deposition by air varies, and salt can travel up to 500 meters. If there are effects of road salt on the environment, they will most often occur at a distance of up to 30 meters from the edges of the road. Beyond this distance, the effects of salt are relatively insignificant. Estimates of the amount of salt that is applied on roads and that reaches the groundwater range from 10% to 50%. The amount of chloride that travels through the groundwater system and re-enters the surface water is estimated to be between 20% and 45%.

Road salt can enter the environment through a variety of pathways, all of which involve water in one form or another. Water swollen from roadways containing salt can either be drained through drainage channels and discharged into recipients, or seep into the soil and groundwater where plants can use it. Salt that enters groundwater through roadway runoff will move through the soil, where it can enter wells, or go into the base stream of surface water. Road salt can directly or indirectly affect soil, vegetation, groundwater, aquatic habitats and wildlife.

Road salt affects soil properties through a process known as cation exchange, where calcium and magnesium ions, which are bound to the soil, are replaced by sodium ions. This

replacement in certain soil types can reduce permeability, aeration and soil fertility. The combination of sodium and chloride from road salt and the release of calcium, magnesium and possibly heavy metals from the soil through the cation exchange process can have the following effects on groundwater:

- Increase in water hardness due to increased concentration of calcium and magnesium. Increased hardness can also cause scale formation in water pipes and premature failure of plumbing fixtures and appliances that use hot water.
- Increased level of sodium and chloride. Chlorides are naturally present in groundwater in low concentrations, but higher concentrations can be the result of the action of road salt. Because chloride ions are relatively small and negatively charged, they are highly mobile and travel relatively quickly through the surface layers of the terrain and seep into groundwater even in finer soils.

De-icing salts can affect vegetation causing a number of damage symptoms, which in combination with other factors can lead to the death of the plant. Most often, there is a process that removes water from the roots, buds or leaves of plants, causing them to dry out and in extreme cases, die. Signs of drying appear through damage to the needles of conifers, which turn brown and damage to buds and twigs of deciduous trees. Tolerance and sensitivity to ions, which road salts leave in the ground, varies among plant species. Greater attention should be paid to sensitive plant species, such as agricultural plants, sensitive to road salt. Road salt can also affect the food chain. In the environment, there is a natural system according to which animals of a higher order feed on species of a lower order, and the food chain weakens if one link is broken. Roadside deicing salt is also available to animals.

During long trips, it is important to stop regularly to wipe the windshield and headlights, because during extremely bad weather conditions, road salt can easily stain the windshield and headlights, reducing visibility by as much as 40%. Industrial salt and paddy can damage the car if it is not cleaned regularly, and it can cause corrosion.

Runoff of chemical materials from roads can have negative effects if no measures are taken to remove excessive contaminating materials before the runoff reaches the recipient, but if handled appropriately, it need not be a serious problem. The only way to completely eliminate these consequences would be to stop using road salt. In the absence of an alternative de-icing agent that is as cost-effective as road salt, stopping the use of salt is not an option. But through effective procedures for managing its use, you can reduce the amount of road salt entering the environment. Runoff from roads is usually cleaner than runoff from buildings, farms, mines, ports, or other non-point sources. There are very effective active and passive means of treating road runoff before it causes any damage. Detention basins are very effective means of controlling excessive flows of road runoff. They take in road-swell water and release it very slowly, allowing enough time for heavier particles to settle, evaporate, filter, or be absorbed.

6 Roads in Montenegro classified by maintenance priorities in the winter period

As a rule, roads in winter conditions must be permanently passable.

Permanent passability means the smooth flow of traffic with proper use of winter equipment.

Exceptionally, when during more intense and longer snowfalls, blizzards and blizzards, it is not possible to maintain constant passability on all roads, depending on the importance of the road, traffic intensity, altitude, the following priorities for ensuring passability are established, namely:

I - priority winter maintenance have road routes that have the greatest importance for the economy, social and other needs of Montenegro and roads that connect Montenegro with other countries.

Routes that have I priority must be equipped for normal traffic flow in all conditions during the winter period. Exceptionally, on sections of these roads along canyons, as well as on plateaus and passes, where snow avalanches, avalanches, blizzards and blizzards are possible, there may be shorter traffic interruptions, but no longer than 4 hours.

I-a - priority have road routes, which also have the greatest importance for the economy, social and other needs of Montenegro, and the roads that connect Montenegro with other countries, however, they are singled out for the reason that the occurrence of snowfall is rare, and the occurrence of ice only occasionally on sections that are built on shady (non-sunny) slopes.

II - priority winter maintenance have roads important for the economy, social and other needs of Montenegro, however, due to the condition of the road and its altitude, it is realistically not possible to reach priority and traffic interruptions are possible for more than 6 hours, but not longer than 12 hours.

III - priority winter maintenance have roads that connect populated areas of Montenegro with higher priority roads. Even on the roads of this priority, timely and constant work is planned to maintain the passability, however, the necessary help can be received after the normalization of traffic on the roads of higher priorities, so interruptions can last longer than 12 hours, and not over 24 hours.

IV - winter maintenance priority have roads on which the snow is cleared after the normalization of traffic on the roads of previous priorities and no later than 48 hours after the end of precipitation.

V - priority winter maintenance they have roads that are not maintained during the winter period, but are opened after the end of winter.

On the basis of the road maintenance plan in the winter period, that is, from November 15 of the current year to March 31 of the following year, the Traffic Administration defines the dynamics of the inclusion of funds and labor. PFlax is flexible and adapts to the intensity of precipitation, temperatures and weather forecasts. Contractor, "Crnagoraput" AD Podgorica is obliged to provide access even outside the scheduled period if winter conditions require it. The Traffic Administration of Montenegro is responsible for the maintenance of roads in winter conditions, while the "Princesa Ksenija" highway and the Sozina tunnel are managed by the "Monteput" company. The goal of road maintenance in the winter period, i.e. winter conditions, is to maintain the passability and safe flow of traffic. Priority is given to road routes that have the greatest importance for the economy, social and other needs, as well as roads that connect Montenegro with other countries.

7 Conclusion

Road salt is the most economical material available for removing snow and ice. Initial costs

are low compared to alternatives; handling and storage are simple, and spreading is quick and easy. Road salt is sprinkled with the aim of lowering the freezing point of water, in order to break the ice-road connection. Road salt works up to -21 °C, but its use is not recommended below -10 °C. The negative impact of road salt manifests itself on surface water, underground water, vegetation, land, construction facilities and vehicles. The goal of road services is to keep roads as safe as possible during the winter, using the minimum amount of salt to the extent possible.

By effectively managing the use of road salt, it can be ensured that no more salt enters the environment than is necessary. This implies that:

- road salt is applied preventively, in optimal quantities, in order to prevent ice from binding to the road;
- uses a liquid salt solution to prevent the formation of ice or pre-moistened salt, in order to reduce the amount of salt lost in the ditch due to air flow or bouncing;
- monitor the use of salt in salt-sensitive areas, to ensure that only the desired amount is used;
- uses efficient cleaning with plows, in order to optimize the use of salt;
- records the use of salt, in order to show that it is taken care of;
- use temperature sensors to measure pavement temperature and good road meteorological information, to ensure that salt is applied only when necessary;
- acquires knowledge on identifying areas that are sensitive to road salt and implements best practices for managing salt use in those areas.

A successful winter road maintenance program depends on whether we have trained people, the right material, the right equipment employed at the right time and in the right place.

8 Literature

- Law on Roads, "Official Gazette of Montenegro", No. 82/2020.
- General and inorganic chemistry, G. Isaković, Lj. Lukic; M. Isaković, N. Panajotović, Institute for Textbooks and Teaching Aids, Belgrade 2023.
- Manual for training staff on winter road maintenance, Public Company "Roads of Serbia", Belgrade, 2008.
- Source: https://web1.grf.bg.ac.rs/p/learning/predavanje_12___zimsko_odr_avanje_1620506382160.pdf
- Source: https://solanatuzla.nazif.mycpanel.rs/bosanski/tema_2.pdf
- Source: https://www.nabavke.com/tdoc-cejn/documents/50261-2023-08-09-10-00-Zimska_sluzba.pdf

Stručno usavršavanje nastavnika iz oblasti saobraćaja kroz programe usavršavanja

Srečko Kljajić, dipl.ing.saobraćaja-master

Vesko Rašković, dipl.ing.saobraćaja

Predgovor

Formalno obrazovanje za nastavnike ne uspijeva da isprati sve promjene koje prate obrazovnu praksu, zahtjevi za dodatnim usavršavanjem nastavnika konstantno rastu.

Pored potrebe da konstantno prate obrazovne trendove i razvoj, nastavnici pred sobom imaju i veliki zadatak da kroz cjeloživotno učenje i nastavnu praksu objedine različite oblike i programe formalnog, neformalnog i informalnog obrazovanja, a spoj navedenog daje najveći učinak na razvoj digitalnih, socio-emocionalnih, medijskih, finansijskih i drugih kompetencija.

U obrazovnom sistemu Crne Gore, zaposleni u prosvjeti na godišnjem nivou imaju obavezu pohađanja akreditovanih i neakreditovanih oblika usavršavanja, koji razvijaju kompetencije za uže stručnu oblast, poučavanje i učenje, podršku razvoju ličnosti djeteta i učenika, za komunikaciju i saradnju.

Ključne riječi : cjeloživotno učenje; formalno, neformalno i informalno obrazovanje

1 Koncept cjeloživotnog učenja

Pojam cjeloživotnog učenja sve se više pominje u današnje doba modernizacije i globalizacije.

U našoj kulturi zastupljena je izreka da se čovjek uči dok je živ. Ako imamo na umu da je ovo tema o kojoj svjedoče i narodne izreke, možemo zaključiti da doživotno učenje i nije novost, nije izum XXI vijeka.

Cjeloživotno učenje predstavlja jedan od ključnih elemenata razvoja savremenog društva, posebno u kontekstu obrazovanja.Cjeloživotno učenje predstavlja dinamičan i kontinuiran proces sticanja znanja, vještina i kompetencija tokom cijelog života pojedinca.

U modernom društvu postoje tri osnovne forme obrazovanja i to:

1. Formalno obrazovanje
2. Neformalno obrazovanje i
3. Informalno obrazovanje.

Formalno obrazovanje podrzumijeva znanje stečeno u strukturisano-obrazovanim sistema – predškolske, osnovnoškolske, srednjoškolske ustanove i ustanove višeg i visokog obrazovanja. Po završetku škole u ovim ustanovama dobijaju se diplome ili svjedočanstva.

Neformalno obrazovanje se može definisati kao želja osobe da stekne nova znanja i vještine shodno interesovanju i potrebama. Ta znanja se stiču van formalnog sistema (van obrazovnog sistema). Neformalno obrazovanje se često fokusira na sticanje praktičnih znanja i vještina dok se formalno obrazovanje često usredsređuje na informacije koje nemaju značaja u praktičnoj primjeni. Neformalno se obrazujemo na raznim specijalizovanim seminarima i obukama koje organizuju nevladine organizacije ili specijalizovane agencije koje se bave edukacijom.

Informalno obrazovanje – termin kojim se podrazumijeva učenje iz svakodnevnog života, kombinacija života i učenja; smatra se doživotnim procesom u kojem svaki pojedinac stiče stavove, vrijednosti, vještine i znanja iz svakodnevnih iskustava i vaspitno-obrazovnih uticaja iz svoje okoline. To je, kako se u narodu kaže "škola života".

Cjeloživotno učenje se ne ograničava isključivo na formalno obrazovanje, već obuhvata i neformalne i informalne oblike učenja.

Cjeloživotno učenje utiče na samu ličnost čovjeka da bude otvorenija, tolerantnija i plemenitija. Kombinacijom formalnog i neformalnog obrazovanja, pojedinac dobija jedinstvenu priliku da na najbolji način usvaja znanje i stiče mudrost. Cjeloživotno obrazovanje nije projekat koji smjestimo u jednu fazu svog životnog puta, to je proces koji traje koji nas čini mladima, živima, jer dok god učimo mijenjamo sebe, rastemomž, stremimo nečem što je pred nama.

Nema prekida, samo promjena "učionice"

Cjeloživotno učenje nije rezervisano samo za one koji teže tituli akademika ili žele zvanje ispred svog imena, ovj tip učenja je za sve one koji osluškuju svijet oko sebe i žele da budu na putu ličnog i profesionalnog razvoja. Znači da učimo stalno – nekad iz knjige, nekad s TikToka, nekad kroz greške. Učimo jer želimo da budemo bolji, brži, sigurniji, slobodniji.

2 Cjeloživotno učenje nastavnika

Koncept cjeloživotnog učenja ima posebno značenje u kontekstu profesionalnog razvoja nastavnika u osnovnim i srednjim školama. Nastavnička profesija zahtijeva neprestano prilagođavanje novim saznanjima, tehnologijama i pedagoškim metodama, pa se od nastavnika očekuje da i sami budu cjeloživotni učenici. Prema istraživanju Korucua i Şahana (2024), cjeloživotno učenje danas se smatra nužnim za nastavničku karijeru – ono je preduslov da bi obrazovno-vaspitni radnici mogli kontinuirano obnavljati svoja znanja i vještine te odgovoriti na promjene u obrazovanju. U tom smislu, nastavnici su istovremeno učitelji i učenici. Od njih se očekuje da neprestano uče kako bi održali korak s globalnim promjenama i bili pokretači inovacija u školstvu.

Cjeloživotno učenje omogućava nastavnicima da unaprijede svoje kompetencije, ostanu u toku s najnovijim obrazovnim trendovima i pruže kvalitetno obrazovanje koje odgovara savremenim potrebama učenika. Od nastavnika se očekuje da budu ne samo stručnjaci u svojim predmetnim područjima, već i sposobni da vode učenike kroz izazove modernog doba, uključujući digitalizaciju, inkluziju i različite obrazovne reforme. Ovo zahtijeva kontinuiranu prilagođavanje i sticanje novih znanja i vještina, što je moguće samo kroz cjeloživotno učenje.

Kontinuirano stručno usavršavanje nastavnika – koje je sastavni dio cjeloživotnog učenja – prepoznato je kao jedan od ključnih mehanizama unapređenja kvaliteta obrazovnog sistema. Profesionalni razvoj pruža nastavnicima priliku za trajno unapređenje nastavničkih kompetencija.

3 Usavršavanje i napredovanje nastavnika

Nastavnici imaju pravo i obavezu da se stručno usavršavaju iz različitih oblasti kroz programe stručnog usavršavanja i druge oblike kontinuiranog profesionalnog rada nastavnika.

Programe stručnog usavršavanja nastavnika donosi Nacionalni savjet, na predlog Zavoda za školstvo, odnosno Centra za stručno obrazovanje. Autor programa za stručno usavršavanje nastavnika može biti pravno ili fizičko lice koje obavlja obrazovno-vaspitnu ili naučno-istraživačku djelatnost, licencirane ustanove visokog obrazovanja i strukovna udruženja nastavnika.

Prioritetne oblasti stručnog usavršavanja nastavnika za pet godina određuje Ministarstvo prosvjete, nauke i inovacija Crne Gore, na predlog ustanova, Zavoda za školstvo i Centra za stručno obrazovanje. Organizaciju stručnog usavršavanja nastavnika i način izbora autora programa propisuje Ministarstvo prosvjete, nauke i inovacija Crne Gore.

Pored potrebe da konstantno prate obrazovne trendove i razvoj, nastavnici pred sobom imaju i veliki zadatak da kroz celoživotno učenje i nastavnu praksu objedine različite oblike i programe formalnog, neformalnog i informalnog obrazovanja, a spoj navedenog daje najveći učinak na razvoj digitalnih, socio-emocionalnih, medijskih, finansijskih i drugih kompetencija.

U obrazovnom sistemu Crne Gore, zaposleni u prosvjeti na godišnjem nivou imaju obavezu pohađanja akreditovanih i neakreditovanih oblika usavršavanja, koji razvijaju kompetencije za uže stručnu oblast, poučavanje i učenje, podršku razvoju ličnosti djeteta i učenika, za komunikaciju i saradnju.

Licenciranje i relicenciranje nastavnika se sprovodi u skladu sa Pravilnikom o bližim uslovima, načinu i postupku izdavanja i obnavljanja dozvole za rad nastavniku, direktoru i pomoćniku direktora obrazovno-vaspitne ustanove.

Licenca se obnavlja ukoliko se uspješno završe akreditovani programi stručnog usavršavanja koji se nalaze u važećem Katalogu programa stručnog usavršavanja Zavoda za školstvo /Centra za stručno obrazovanje koji je odobren od strane Nacioonalnog savjeta za obrazovanje. Akreditovani programi stručnog usavršavanja mogu biti iz **prioritetnih oblasti** i **drugih programa** stručnog usavršavanja nastavnika. Za obnavljanje licence potrebno je ispuniti sljedeće zahtjeve:

- nastavnici koji realizuju predškolsko vaspitanje i obrazovanje, osnovno obrazovanje i vaspitanje, opšte srednje obrazovanje, vaspitanje i obrazovanje u resursnom centru i vaspitanje u domu učenika – 16 sati iz prioritetnih oblasti i 8 sati iz drugih programa – Katalog Zavoda za školstvo;
- nastavnici iz opšteobrazovnih predmeta u srednjim stručnim školama – 16 sati iz prioritetnih oblasti i 8 sati iz drugih programa – Katalog Zavoda za školstvo
- nastavnici stručnih modula iz srednjih stručnih škola – 16 sati iz prioritetnih oblasti, 16 sati iz oblasti psihologije, pedagogije, metodike, didaktike, 8 sati iz drugih programa- Katalog Centra za stručno obrazovanje.

4.1. Obrazovni i profesionalni razvoj nastavnika iz oblasti saobraćaja

U profesionalni razvoj nastavnika i stručnih saradnika iz oblasti saobraćaja spada stalno stručno usavršavanje, razvijanje kompetencija radi boljeg obavljanja posla i unapređivanje nivoa postignuća učenika.

Stalno stručno usavršavanje ostvaruje se:

- Pohađanjem akreditovanih seminara koji se nalaze u Katalogu,
- Izlaganjem programa i seminara na sastancima aktiva sa obaveznom diskusijom i analizom,
- Realizacijom ogledno/uglednih časova sa diskusijom i analizom,
- Realizacijom takmičenja iz oblasti saobraćaja; učešće na Simpozijumu saobraćajnih inženjera; stručne posjete i ekskurzije.

Interno usavršavanje nastavnika definisano je Planom i programom rada Stručnog aktiva uz saglasnost Direktora škole. Evidencija internog usavršavanja vodi se u sveskama Stručnih aktiva.

4.2. Seminari iz oblasti saobaćaja

Na osnovu Opšteg zakona o obrazovanju i vaspitanju, na predlog Centra za stručno obrazovanje, Nacionalni savjet za obrazovanje je donio Odluku o izboru programa stručnog usavršavanja nastavnika za školsku 2023/2024. i 2024/2025. godinu.

U Katalogu programa stručnog usavršavanja nastavnika za školsku 2023/2024. i 2024/2025. godinu u okviru prioritetnog područja stručnog usavršavanja 1.4. Saobraćaj, uvršten je seminar pod nazivom Metode i oblici rada sa učenicima i kandidatima za uspješnu

realizaciju modula iz oblasti saobraćaja (tabela br.1):

Opšti podaci	
Naziv programa	Metode i oblici rada sa učenicima i kandidatima za uspješnu realizaciju modula iz oblasti saobraćaja
Autori programa	mr Srećko Kljajić, Vesko Rašković
Realizatori programa	mr Srećko Kljajić, Vesko Rašković
Kontakt osoba	mr Srećko Kljajić
E-mail	srasko@t-com.me
Broj telefona	067 254 778
Informacije o programu	
Ciljevi programa	**Opšti cilj programa:** Unapređivanje nastave i učenja u modulima obrazovnih programa iz sektora saobraćaja kroz uvođenjem savremenih metoda i oblika rada, digitalizacije učenja, i unapređivanje obuke nastavnika i isntruktora u sektoru saobraćaja u formalnom sistemu i obrazovanju odraslih polaznika. Specifični ciljevi programa: ● Sticanje znanja i vještina nastavnika i instruktora za primjenu metoda i oblika rada sa učenicima i kandidatima u toku realizacije modula nastave iz saobraćaja ● Savremene tehnologije kao podrška nastavi i učenju u sektoru saobraćaja
Sadržaji obuhvaćeni programom	1. Obrazovni porgrami u sektrou saobraćaja, struktura i ciljevi 2. Katalozi znanja, uslovi za realizaciju 3. nastavni sadržaj, ishodi, znanja i vještine u kontekstu metoda za realizaciju nastave 4. Oblici rada usklađeni sa ciljevima programa 5. Metodika izvođenja teorijske obuke 6. Planiranje nastavnih sredstava u kontekstu dostizanja ishoda predmetnih programa 7. Efektna nastavna sredstva i izbor sredstava 8. Struktura – elementi nastavnog časa

<table>
<tr><td></td><td colspan="2">9. Struktura i elementi časa obuke vožnje
10. Nastavno okruženje
11. Ocjenjivanje ishoda, modula i predmeta
12. Evaluacija nastave i praćenje napredovanja učenika/polaznika</td></tr>
<tr><td>Očekivani ishodi po završetku programa obuke</td><td colspan="2">Nakon završetka programa obuke očekuje se da nastavnici
● Budu u mogućnosti da na metodički adekvatan način realizuju nastavne ciljeve i postinu ishode definisane katalozima strčno-teroijskihi premdeta i praktične nastave.</td></tr>
<tr><td rowspan="2">Povezanost programa sa obrazovnim programom/programom obrazovanja, odnosno predmetom/modulom</td><td>Naziv obrazovnog programa / programa obrazovanja</td><td>Naziv predmeta/modula u okviru obrazovnog programa</td></tr>
<tr><td>● Nautički tehničar
● Špeditersko agencijski i carinski tehničar
● Tehničar drumskog saobraćaja
● Vozač/Vozačica motornog vozila
● Saobraćajno transportni tehničar
● Tehničar tehničko kolske djelatnosti
● Tehničar vuče
● Instruktor vožnje motornih vozila
● Izvođač tehničkih pregleda</td><td>Stručni moduli iz oblasti saobraćaja</td></tr>
<tr><td>Ciljna grupa</td><td colspan="2">● Nastavnici stručnih modula iz oblasti saobraćaja
● Organizatori praktičnog obrazovanja
● Stručni saradnici
● Saradnici u nastavi
● Instruktori vožnje u auto školama
● Instruktori praktičnog obrazovanja</td></tr>
</table>

	• Članovi komisija za polaganje vozačkih ispita • Nastavni kadar kod organizatora obrazovanja odraslih
Uslovi za uključivanje u program	Prijava, Licenca, Potvrda da je polaznik instruktor vožnje u auto-školi
Minimalni i maksimalni broj učesnika u grupi	Minimalno 15; Maksimalno 25
Trajanje programa	2 dana po 8 sati
Materijalno-tehnički uslovi i didaktičko-metodički pristup	
Metode, tehnike i oblici rada	Usmeno izlaganje, demonstracija, problemski zadaci, rad na konkretnim zadacijma, saradničko učenje
Prostorni uslovi za realizaciju programa	Učionica, prilagođena grupnom radu. Poligon za obuku kandidata
Materijalno-tehnički uslovi za realizaciju programa (tehnička oprema i nastavna sredstva)	Flip-čart, table, kreda, LCD projektor, laptop. Auto namijenjeno za obuku kandidata
Online realizacija programa	Računar ili laptop sa mogućnošću podrške Zoom ili Teams aplikacija, ppt- prezentacije

Tabela 1. Seminar pod nazivom Metode i oblici rada sa učenicima i kandidatima za uspješnu realizaciju modula iz oblasti saobraćaja

Navedeni seminar je realizovan:

-4. i 5.03.2022.god. u Srednjoj pomorskoj školi u Kotoru. Obuku je slušalo 20 polaznika(slike br.1. i 2.).

-25. i 26.12.2023.god. u Srednjoj stručnoj školi u Bijelom Polju za nastavnike saobraćajne grupe predmeta te škole kao i iz Srednje stručne škole "Vukadin Vukadinović" iz Berana i Srednje stručne škole iz Pljevlja. Obuku je slušalo 23 polaznika

-23. i 24.02.2024.god. U prostoriji Trening centra JUSSŠ “Ivan Uskoković” u Podgorici realizovana je obuka za dostizanje nedostajućeg broja sati, u cilju obnove licence nastavnika iz stručnih škola iz Bara, Nikšića i Podgorice. Obuku je slušalo 23 polaznika (slike br.3. i 4.).

Plan rada predstavljen je u tabeli br 2.



Slika 1. Obuka nastavnika saobraćajne grupe predmeta u Kotoru



Slika 2. Obuka nastavnika saobraćajne grupe predmeta u Kotoru



Slika 3. Obuka nastavnika saobraćajne grupe predmeta u Podgorici

Plan rada za 1.dan obuke:

	
9.00 – 10.30	• Predstavljanje realizatora programa • Predstavljanje učesnika programa • Očekivanja i pravila za rad • Upoznavanje s programom, konceptom, rasporedom i ciljevima obuke
10.30 – 11.00	Pauza
11.00 – 12.30	• Obrazovni programi u sektoru saobraćaja, struktura i ciljevi • Katalozi znanja, uslovi za realizaciju
12.30 – 13.30	Ručak
13.30 – 15.00	• Nastavni sadržaj, ishodi, znanja i vještine u kontekstu metoda za realizaciju nastave
15.00 – 15.30	Pauza
15.30 – 17.00	• Oblici rada usklađeni sa ciljevima programa • Metodika izvođenja teorijske obuke • Nastavne metode u radu sa učenicima i kandidatima u oblasti saobraćaja (Tradicionalne metode)

Plan rada za 2.dan obuke

	
8.00 – 9.30	• Nastavne metode u radu sa učenicima i kandidatima u oblasti saobraćaja (Interaktivne metode)
9.30 – 10.00	Pauza
10.00 – 11.30	• Planiranje nastavnih sredstava u kontekstu dostizanja ishoda predmetnih programa
11.30 – 12.00	Pauza
12.00 – 13.30	• Efektna nastava sredstva i izbor sredstava • Struktura – elementi nastavnog časa • Struktura i elementi časa obuke vožnje • Nastavno okruženje
13.30 – 14.30	Ručak
14.30 – 16.00	• Ocjenjivanje ishoda, modula i predmeta • Evaluacija nastave i praćenje napredovanja učenika/polaznika • Plan aktivnosti nakon programa usavršavanja, neophodnih za uspješan završetak programa • Rezime i zaključci programa usavršavanja • Evaluacija programa usavršavanja

Učesnici seminara međusobno su podijeli različita iskustva u radu sa učenicima i kandidatima, diskutovali o bezbjednosti saobraćaja u Crnoj Gori i kako je unaprijediti, pokazali kreativnost i maštovitost. Na jednom mjestu bila je koncentrisana riznica znanja, iskustva i pozitivne energije.

Obuku je organizovao Centar za stručno obrazovanje, a izvođači su bili treneri Srećko Kljajić i Vesko Rašković.

4.3. Dokumentacija nakon realizovane obuke

U skladu sa Smjernicama za realizaciju programa stručnog usavršavanja koji su akreditovani u Katalogu Zavoda za školstvo i Centra za stručno obrazovanje organizatori obuke navedenim institucijama dostavljaju dokumentaciju koristeći isključivo propisane obrasce:

1. Program rada obuke (agenda)
2. Scenario obuke-radionice
3. Potpisi učesnika/ica obuke-potpis odgovorne osobe u ustanovi i zavedeni u ustanovi u kojoj se realizuje obuka
4. Evaluacioni upitnik za učesnike/ice programa stručnog usavršavanja
5. Izvještaj o realizaciji aktivnosti profesionalnog razvoja nakon održanog programa stručnog usavršavanja-potpis koordinator za PRNŠ/V(obrazac)
6. Evidencija izvještaja o realizaciji aktivnosti PR nakon obuke potpis realizator/koordinator
7. Izvještaj o realizaciji obuke- potpis organizatora/ke i zaveden u instituciji u kojoj se realizuje obuka
8. Potvrda o pohađanom programu stručnog usavršavanja (sertifikat)-potpisani od organizatora/ke obuke

5 Zaključak

Obnavljanje licence za rad u prosvjeti kao i sticanje viših zvanja zahtijeva više aktivnosti koje treba uraditi u određenom vremenskom periodu. Pored obaveza redovnog držanja nastave i postizanja zahtjeva koji su pred nastavnicima u učionici nastavnici imaju obavezu praćenja savremenih trendova iz oblasti za koju obučavaju učenike i njihovo uklapanje u nastavni proces. Nastavnici imaju obavezu saradnje na nivou aktiva kao i na nivou više aktiva i na nivou škole.

Za obnavljanje licence i sticanje viših zvanja postoje pravilnici koji propisuju aktivnosti koje treba uraditi da bi nastavnik mogao konkurisati za iste.

Svijest o neophodnosti kontinuiranog profesionalnog razvoja nastavnika postoji, te da se njegov uticaj na poboljšanje sopstvene prakse i uspjeh učenika prepoznaje. Jedan broj nastavnika pohađa obuku na sopstvenu inicijativu; na nivou škole izdvajaju se sredstva i ulažu u profesionalni razvoj nastavnika kroz izbor programa obuke koje škole procjenjuju kao neophodne. Nastavnici i sami osmišljavaju načine i aktivnosti profesionalnog razvoja u svojim školama.

U periodu od 2022. do 2024. godine realizovali smo seminare iz oblasti saobraćaja u tri srednje škole u Crnoj Gori.



Profesionalno se razvijamo ne zato što nismo dovoljno dobri u svom poslu već zato što uvijek možemo biti bolji.

Hvala na pažnji!

6 Literatura

- Katalog programa stručnog usavršavanja nastavnika za školsku 2023/2024. i 2024/2025. god., Centar za stručno obrazovanje, Podgorica, 2024.god.
- Opšti zakona o obrazovanju i vaspitanju , Podgorica 2020. god.
- Pravilnik o bližim uslovima, načinu i postupku izdavanja i obnavljanja dozvole za rad nastavniku,direktoru i pomoćniku direktora obrazovno-vaspitne ustanove, Podgorica, 2014.god.

Professional training of teachers in the field of traffic through training programs

Srečko Kljajić, B.Sc. Traffic - Master

Vesko Rašković, BSc in Traffic

Professional training of teachers in the field of traffic

through training programs

Foreword

Formal education for teachers fails to keep up with all the changes accompanying educational practice, the demands for additional teacher training are constantly growing.

In addition to the need to constantly monitor educational trends and development, teachers have a big task ahead of them to combine different forms and programs of formal, non-formal and informal education through lifelong learning and teaching practice, and the combination of the above gives the greatest effect on the development of digital, socio-emotional, media, financial and other competencies.

In the education system of Montenegro, employees in education are obliged to attend accredited and non-accredited forms of training on an annual basis, which develop competencies for a narrow professional field, teaching and learning, support for the development of the personality of children and students, for communication and cooperation.

Keywords: lifelong learning; formal, non-formal and informal education

1 The concept of lifelong learning

The concept of lifelong learning is being mentioned more and more in today's era of modernization and globalization.

In our culture, there is a saying that a person learns while he is alive. If we keep in mind that this is a topic that is also witnessed by folk sayings, we can conclude that lifelong learning is not a novelty, it is not an invention of the XXI century.

Lifelong learning represents one of the key elements of the development of modern society, especially in the context of education. Lifelong learning represents a dynamic and continuous process of acquiring knowledge, skills and competences throughout an individual's life.

In modern society, there are three basic forms of education:

1. Formal education
2. Non-formal education i
3. Informal education.

Formal education it includes knowledge acquired in structured educational systems - preschool, elementary, high school and institutions of higher and higher education. Upon completion of school in these institutions, diplomas or certificates are obtained.

Non-formal education can be defined as a person's desire to acquire new knowledge and skills according to interests and needs. That knowledge is acquired outside the formal system (outside the educational system). Informal education often focuses on the acquisition of practical knowledge and skills, while formal education often focuses on information that has no practical application. We are informally educated at various specialized seminars and trainings organized by non-governmental organizations or specialized agencies dealing with education.

Informal education - a term that implies learning from everyday life, a combination of life and learning; it is considered a lifelong process in which each individual acquires attitudes, values, skills and knowledge from everyday experiences and educational influences from his environment. It is, as the people say, the "school of life".

Lifelong learning is not limited exclusively to formal education, but also includes non-formal and informal forms of learning.

Lifelong learning influences the very personality of a person to be more open, tolerant and noble. By combining formal and informal education, an individual gets a unique opportunity to acquire knowledge and gain wisdom in the best way. Lifelong education is not a project that we place in one phase of our life path, it is an ongoing process that makes us young, alive, because as long as we learn, we change ourselves, we grow, we strive for something that is in front of us.

No breaks, just a change of "classroom"

Lifelong learning is not reserved only for those who aspire to an academic title or want a title before their name, this type of learning is for all those who listen to the world around them and want to be on the path of personal and professional development. It means that we

learn constantly - sometimes from a book, sometimes from TikTok, sometimes through mistakes. We learn because we want to be better, faster, safer, freer.

2 Lifelong learning of teachers

The concept of lifelong learning has a special meaning in the context of the professional development of teachers in primary and secondary schools. The teaching profession requires constant adaptation to new knowledge, technologies and pedagogical methods, so teachers are expected to be lifelong learners themselves. According to the research of Korucu and Şahan (2024), lifelong learning is now considered necessary for a teaching career - it is a prerequisite for educational workers to be able to continuously renew their knowledge and skills and to respond to changes in education. In this sense, teachers are both teachers and students. They are expected to learn continuously in order to keep pace with global changes and to be drivers of innovation in education.

Lifelong learning enables teachers to improve their competences, stay abreast of the latest educational trends and provide quality education that meets the modern needs of students. Teachers are expected to be not only experts in their subject areas, but also able to guide students through the challenges of the modern age, including digitization, inclusion and various educational reforms. This requires continuous adaptation and acquisition of new knowledge and skills, which is only possible through lifelong learning.

Continuous professional development of teachers - which is an integral part of lifelong learning - is recognized as one of the key mechanisms for improving the quality of the education system. Professional development provides teachers with the opportunity for permanent improvement of teaching competencies.

3 Training and promotion of teachers

Teachers have the right and obligation to improve professionally in various fields through professional development programs and other forms of continuous professional work of teachers.

Professional training programs for teachers are adopted by the National Council, on the proposal of the Institute for Education, i.e. the Center for Vocational Education. The author of the professional training program for teachers can be a legal or physical person who performs educational or scientific research activities, licensed institutions of higher education and professional associations of teachers.

The priority areas of professional development of teachers for five years are determined by the Ministry of Education, Science and Innovation of Montenegro, on the proposal of institutions, the Institute of Education and the Center for Vocational Education. The organization of professional training of teachers and the method of selection of program authors are prescribed by the Ministry of Education, Science and Innovation of Montenegro.

In addition to the need to constantly monitor educational trends and development, teachers have a great task ahead of them to combine different forms and programs of formal, non-formal and informal education through lifelong learning and teaching practice, and the combination of the above gives the greatest effect on the development of digital, socio-emotional, media, financial and other competencies.

In the education system of Montenegro, employees in education are obliged to attend

accredited and non-accredited forms of training on an annual basis, which develop competencies for a narrow professional field, teaching and learning, support for the development of the personality of children and students, for communication and cooperation.

Licensing and relicensing of teachers is carried out in accordance with the Regulations on detailed conditions, methods and procedures for issuing and renewing work permits for teachers, directors and assistant directors of educational institutions.

The license is renewed upon successful completion of accredited professional development programs found in the valid Catalog of professional development programs of the Institute of Education / Vocational Education Center approved by the National Council for Education. Accredited professional development programs can be from **priority authorities** i **other programs** professional training of teachers. To renew a license, the following requirements must be met:

- teachers who provide preschool education and education, primary education and education, general secondary education, education and education in the resource center and education in the student's home - 16 hours from priority areas and 8 hours from other programs - Catalog of the Institute of Education;
- teachers of general education subjects in secondary vocational schools - 16 hours from priority areas and 8 hours from other programs - Catalog of the Institute of Education
- teachers of vocational modules from secondary vocational schools – 16 hours from priority areas, 16 hours from the areas of psychology, pedagogy, methodology, didactics, 8 hours from other programs - Catalog of the Center for Vocational Education.

4.1. Educational and professional development of teachers in the field of traffic

The professional development of teachers and professional associates in the field of traffic includes constant professional training, developing competencies for better job performance and improving the level of student achievement.

Continuous professional development is achieved:

- By attending accredited seminars found in the Catalogue,
- By presenting programs and seminars at asset meetings with mandatory discussion and analysis,
- Realization of exemplary/reputable classes with discussion and analysis,
- Realization of competitions in the field of traffic; participation in the Traffic Engineers Symposium; expert visits and excursions.

The internal training of teachers is defined by the Plan and work program of the Professional Asset with the consent of the School Director. The record of internal training is kept in the notebooks of Professional assets.

4.2. Seminars in the field of communication

Based on the General Law on Education and Training, at the proposal of the Center for Vocational Education, the National Council for Education adopted the Decision on the selection of the professional training program for teachers for the 2023/2024 school year. and 2024/2025. year.

In the Catalog of professional training programs for teachers for the school year 2023/2024. and 2024/2025. year within the priority area of professional development 1.4. Traffic, a seminar entitled Methods and forms of work with students and candidates for the successful implementation of modules in the field of traffic was included (table no. 1):

General data	
Name of the program	Methods and forms of work with students and candidates for the successful implementation of modules in the field of traffic
Authors of the program	MSc Srećko Kljajić, Vesko Rašković
Producers of the program	MSc Srećko Kljajić, Vesko Rašković
Contact person	MSc Srećko Kljajić
Email	srasko@t-com.me
Phone number	067 254 778
Program information	
Objectives of the program	**General goal of the program:** Improvement of teaching and learning in the modules of education programs from the transport sector through the introduction of modern methods and forms of work, digitization of learning, and improvement of the training of teachers and instructors in the transport sector in the formal system and education of adult participants. Specific goals of the program: ● Acquiring knowledge and skills of teachers and instructors for the application of methods and forms of work with students and candidates during the implementation of traffic teaching modules ● Modern technologies as support for teaching and learning in the transport sector
Contents covered by the program	1. Educational programs in the transport sector, structure and goals 2. Catalogs of knowledge, conditions for implementation 3. teaching content, outcomes, knowledge and skills in the context of teaching methods 4. Forms of work aligned with the objectives of the program 5. Methodology of theoretical training

<table>
<tr><td></td><td colspan="2">6. Planning teaching aids in the context of achieving the outcomes of the subject programs
7. Effective teaching aids and selection of aids
8. Structure - elements of the lesson
9. Structure and elements of the driving training class
10. Teaching environment
11. Assessment of outcomes, modules and subjects
12. Evaluation of classes and monitoring of student/participant progress</td></tr>
<tr><td>Expected outcomes upon completion of the training program</td><td colspan="2">After completing the training program, teachers are expected to
● They will be able to implement teaching goals in a methodically adequate manner and meet the outcomes defined by the catalogs of professional and theoretical subjects and practical classes.</td></tr>
<tr><td rowspan="2">Connection of the program with the educational program/educational program, i.e. subject/module</td><td>Name of the educational program / education program</td><td>Name of the subject/module within the educational program</td></tr>
<tr><td>● Nautical technician
● Freight forwarding agency and customs technician
● Road traffic technician
● Motor vehicle driver
● Traffic and transport technician
● Technician of technical vehicle activity
● Towing technician
● Motor vehicle driving instructor
● Performer of technical inspections</td><td>Professional modules in the field of traffic</td></tr>
<tr><td>Target group</td><td colspan="2">● Teachers of professional modules in the field of traffic
● Organizers of practical education
● Professional associates
● Associates in teaching
● Driving instructors in driving schools</td></tr>
</table>

	• Instructors of practical education • Members of commissions for taking driving tests • Teaching staff at the organizer of adult education
Conditions for inclusion in the program	Login, license, Confirmation that the student is a driving instructor at a driving school
Minimum and maximum number of participants in the group	Minimum 15; Maximum 25
Program duration	2 days for 8 hours
Material-technical conditions and didactic-methodical approach	
Methods, techniques and forms of work	Oral presentation, demonstration, problem tasks, work on concrete tasks, collaborative learning
Spatial conditions for program implementation	Classroom, adapted to group work. Training ground for candidates
Material and technical conditions for the implementation of the program (technical equipment and teaching aids)	Flip chart, blackboard, chalk, LCD projector, laptop. Car intended for candidate training
Online implementation of the program	A computer or laptop with the ability to support Zoom or Teams applications, ppt-presentations

Table 1. Seminar entitled Methods and forms of work with students and candidates for the successful implementation of modules in the field of traffic

The mentioned seminar was implemented:

-4. and March 5, 2022. at the Maritime High School in Kotor. The training was attended by 20 participants (pictures no. 1 and 2).

-25. and 26.12.2023. in the Secondary Vocational School in Bijelo Polje for teachers of the traffic group of subjects of that school as well as from the Vocational Secondary School "Vukadin Vukadinović" from Beran and the Vocational Secondary School from Pljevlja. The training was attended by 23 participants

-23 and 24 February 2024. In the room of the "Ivan Uskoković" JUSSŠ Training Center in Podgorica, training was carried out to reach the missing number of hours, with the aim of renewing the license of teachers from vocational schools in Bar, Nikšić and Podgorica. The training was attended by 23 participants (pictures no. 3 and 4).

The work plan is presented in table no. 2.



Figure 1. Training of teachers of the traffic group of subjects in Kotor



Figure 2. Training of teachers of the traffic group of subjects in Kotor





Figure 3. Training of teachers of the traffic group of subjects in Podgorica

Work plan for the 1st day of training:

	
9.00 – 10.30	• Presentation of the program implementer • Presentation of program participants • Expectations and rules for work • Getting to know the program, concept, schedule and goals of the training
10.30 – 11.00	Break
11.00 – 12.30	• Educational programs in the transport sector, structure and objectives • Catalogs of knowledge, conditions for implementation
12.30 – 13.30	Lunch
13.30 – 15.00	• Teaching content, outcomes, knowledge and skills in the context of teaching methods
15.00 – 15.30	Break
15.30 – 17.00	• Forms of work aligned with the objectives of the program • Methodology of theoretical training • Teaching methods in working with students and candidates in the field of traffic (Traditional methods)

Work plan for the 2nd day of training

	
8.00 – 9.30	• Teaching methods in working with students and candidates in the field of traffic (Interactive methods)
9.30 – 10.00	Break
10.00 – 11.30	• Planning teaching aids in the context of achieving the outcomes of the subject programs
11.30 – 12.00	Break
12.00 – 13.30	• Effective teaching of means and choice of means • Structure - elements of the lesson • Structure and elements of the driving training class • Teaching environment
13.30 – 14.30	Lunch
14.30 – 16.00	• Assessment of outcomes, modules and subjects • Evaluation of classes and monitoring of student/participant progress • Plan of activities after the training program, necessary for the successful completion of the program • Summary and conclusions of the training program • Evaluation of training programs

The participants of the seminar shared different experiences in working with students and candidates, discussed traffic safety in Montenegro and how to improve it, showed creativity and imagination. A treasure trove of knowledge, experience and positive energy was concentrated in one place.

The training was organized by the Center for Vocational Education, and the performers were trainers Srećko Kljajić and Vesko Rašković.

4.3. Documentation after completed training

In accordance with the Guidelines for the implementation of professional training programs accredited in the Catalog of the Institute for Education and the Center for Vocational Education, the training organizers submit documentation to the mentioned institutions using only the prescribed forms:

1. Training work program (agenda)
2. Training-workshop scenario
3. Signatures of training participants - signature of the responsible person in the institution and recorded in the institution where the training is conducted
4. Evaluation questionnaire for participants of the professional development program
5. Report on the realization of professional development activities after the held professional development program - signature of the coordinator for PRNŠ/V (form)
6. Records of reports on the implementation of PR activities after the training, signature of the implementer/coordinator
7. Report on the implementation of the training - signature of the organizer and filed in the institution where the training is implemented
8. Confirmation of the professional training program attended (certificate) - signed by the training organizer

5 Conclusion

The renewal of the license to work in education as well as the acquisition of higher titles requires several activities that need to be done in a certain period of time. In addition to the obligations of regular teaching and meeting the requirements that teachers face in the classroom, teachers have the obligation to follow modern trends in the field for which they train students and their integration into the teaching process. Teachers have an obligation to cooperate at the asset level as well as at the level of several assets and at the school level.

For the renewal of the license and the acquisition of higher titles, there are rules that prescribe the activities that must be done in order for the teacher to be able to apply for the same.

There is an awareness of the necessity of continuous professional development of teachers, and that its influence on the improvement of one's own practice and the success of students is recognized. A number of teachers attend training on their own initiative; at the school level, funds are allocated and invested in the professional development of teachers through the selection of training programs that the schools deem necessary. Teachers themselves design ways and activities of professional development in their schools.

In the period from 2022 to 2024, we implemented seminars in the field of traffic in three secondary schools in Montenegro.



Profesionalno se razvijamo ne zato što nismo dovoljno dobri u svom poslu već zato što uvijek možemo biti bolji.

Hvala na pažnji!

6 Literature

- Catalog of professional training programs for teachers for the school year 2023/2024. and 2024/2025. year, Vocational Education Center, Podgorica, 2024.
- General Law on Education and Training, Podgorica 2020.
- Rulebook on the detailed conditions, method and procedure for issuing and renewing work permits for teachers, directors and assistant directors of educational institutions, Podgorica, 2014.

Autori: Karlo Klobučar, mag. ing. traff.
Stefanija Malović Žmegač, dipl. ing.

UTJECAJ ERGONOMIJE NA SIGURNOST MLADIH VOZAČA U CESTOVNOM PROMETU

Sažetak:

Stradavanje mladih vozača u prometu na cestama problem je u svim državama svijeta. Ciljevi prometnih politika svih zemalja svijeta usmjerene su prema smanjenju broja nesreća, stradalih u prometu i ublažavanje posljedica prometnih nesreća.

Prometne politike u osnovnom obliku svode se na preventivne mjere i represivne mjere prometne politike. Kako je rad usmjeren prvenstveno na populaciju mladih vozača, zbog specifičnosti promatranih subjekata izneseni prijedlozi biti će orijentirani na preventivni aspekt, budući da zbog psihologije mladih vozača, represivni pristup rješavanju problema prometnih nesreća i stradavanja može imati obrnuti učinak.

Cilj ovog rada je ukazati na važnost ergonomije kao bitnog faktora u sigurnosti prometa, skrenuti pažnju na negativne elemente i navike kod vozača s ciljem ispravljanja pogrešaka i povećanja sigurnosti svih sudionika u prometu.

Ključne riječi: *Mladi vozači, sigurnost, prometne nesreće, ergonomija*

Uvod

Stradavanje mladih vozača u cestovnom prometu vrlo je značajan problem gotovo svih država u svijetu. Kako bi se smanjio broj prometnih nesreća, ozljeda i smrtnog stradavanja u kojima sudjeluju i koje izazivaju mladi vozači, provode se posebne preventivne i zakonske mjere koje se odnose isključivo na populaciju spomenutih sudionika u prometu.

Uzrok prometnih nesreća može biti čovjek, vozilo ili infrastruktura. Čovjek je ključan element u održavanju sigurnosti, kao takav u ovom radu poseban naglasak biti će na skupini mladih vozača.

Analizirajući podatke Biltena o sigurnosti cestovnog prometa, vidljiv je porast broja nesreća u kojima sudjeluju mladi vozači.

Razvojem aktivnih i pasivnih elemenata sigurnosti, sigurnijih vozila i napretkom društva općenito, očekivalo bi se smanjenje broja nesreća, teških posljedica i stradavanja sudionika, no događa se upravo suprotno. Posebnu pozornost usmjerit će se prema utjecaju mladih

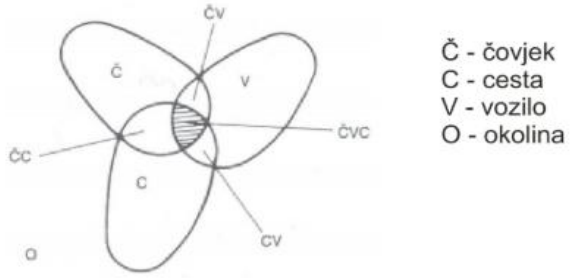
vozača na sigurnost u prometu promatranu s aspekta ergonomije te s aspekta modela ponašanja mladih vozača prilikom upravljanja motornim vozilom.

Osnovni čimbenici sigurnosti cestovnog prometa

Promet je složeni sustav u kojemu često dolazi do konfliktnih situacija. Smanjenje konfliktnih situacija postiže se provođenjem različitih sigurnosnih mjera na čimbenike sigurnosti, a koje čine čovjek, vozilo i prometnica [1]. Utjecaj čimbenika vidljiv je iz Venovog dijagrama (slika 1). Na temelju pokazatelja, smatra se da je kao faktor za oko 85% nesreća kriv čovjek.

Slika 1.: Venov dijagram

Izvor (1)



Čovjek kao čimbenik sigurnosti cestovnog prometa

Čovjek predstavlja najveći čimbenik sigurnosti cestovnog prometa i kao vozač svojim osjetilima percipira obavijesti vezane za prilike na cesti te uzevši u obzir vozilo i prometne propise, određuje način kretanja vozila [2].

Na ponašanje čovjeka kao čimbenika u prometu utječu:

a) Osobne značajke vozača

b) Psihofizička svojstva

c) Obrazovanje i kultura

Osobne značajke vozača

Osobnost predstavlja skup svih osobina, svojstava i ponašanja kojima se svaka ljudska individualnost izdvaja od svih drugih pojedinaca društvene zajednice.

Psihički i skladno razvijena osoba je preduvjet uspješnog i sigurnog odvijanja prometa.

Pod pojmom osobe, u užem smislu mogu se obuhvatiti sljedeće osobine:

1. Sposobnost: skup prirođenih i stečenih uvjeta koji omogućuju obavljanje aktivnosti
2. Stajalište: stajalište vozača prema vožnji rezultat su odgoja u školi i obitelji, društva i učenja a mogu biti privremena i stalna.
3. Temperament: predstavlja urođenu osobinu pojedinca koja se očituje u mobiliziranju psihičke energije kojom određena osoba raspolaže. Prema temperamentu ljudi se mogu podijeliti na kolerike, sangvinike, melankolike i flegmatike.

4. Osobne crte: predstavljaju specifične strukture pojedinca zbog kojih on u različitim situacijama reagira na isti način. Izdvajaju se odnos pojedinca prema sebi, prema drugima i prema radu.

5. Karakter: očituje se u moralu čovjeka i njegovom odnosu prema ljudima te prema poštivanju društvenih normi i radu

Sve sposobnosti čovjeka razvijaju se u prosjeku do 18-te godine i do 30-te ostaju uglavnom nepromijenjene. Od 30-te do 50-te godine dolazi do blagog padanja tih sposobnosti, a od 50-te godine taj pad je znatno brži.

Psihofizičke osobine čovjeka

Pomoću osjetilnih organa koji podražuju živčani sustav nastaje osjet vida, sluha, ravnoteže, mirisa. Percepciju okoline omogućuju organi osjeta koji putem fizikalnih i kemijskih procesa daju obavijest o vanjskom svijetu i promjenama unutar tijela. Za sigurno upravljanje vozilom uz navedene osjete vida (raspoznavanje boja, oštrina vida, stereoskopsko zamjećivanje), sluha, ravnoteže i mirisa, također bitnu ulogu imaju i mišići.

Psihomotoričke sposobnosti su sposobnosti koje omogućuju uspješno izvođenje pokreta koji zahtijevaju brzinu, preciznost i usklađen rad raznih mišića. Za upravljanje vozilom važne su sljedeće psihomotoričke sposobnosti: - brzina reagiranja - brzina izvođenja pokreta - sklad pokreta i opažanja.

Mentalne sposobnosti su mišljenje, pamćenje, inteligencija, učenje i slično. Osoba s razvijenim mentalnim sposobnostima bolje upoznaje svoju okolinu i uspješnije se prilagođuje novonastalim okolnostima.

Obrazovanje i kultura

Vozač koji je stekao određeno obrazovanje poštuje prometne propise i odnosi se ozbiljno prema ostalim sudionicima u prometu. Učenjem se postiže znanje koje je nužno za normalno odvijanje prometa. To podrazumijeva:

- poznavanje zakona i propisa o reguliranju prometa (vozačka dozvola)
- poznavanje kretanja vozila
- poznavanje vlastitih sposobnosti

Utjecaj ergonomije na sigurno sudjelovanje mladih vozača u cestovnom prometu

Ergonomija je složenica grčkih riječi ergon (djelo, čin, rad) i nomos (običaj, red, zakon) što ergonomiju svrstava u znanstvenu disciplinu (znanost o radu) kojoj je glavni cilj istražiti ljudski organizam i ponašanje u određenim uvjetima u kojima se čovjek nalazi. Ergonomija proučava anatomske, fiziološke i druge parametre ljudskog tijela i predstavlja interdisciplinarnu znanost koja obuhvaća medicinu, psihologiju, matematiku, optiku, akustiku i ostale znanosti [4].

Ergonomija ima značajan utjecaj i prilikom upravljanja vozilom. Elementi ergonomije istraživani su provođenjem testnog modela na osobnom vozilu. Tom prilikom istraživanje je usmjereno na bitne parametre za sigurno i pravilno upravljanje vozilom, a to su:

1. Smještaj vozača u vozačkom sjedalu
2. Uporaba kočionog sustava
3. Položaj ruku za vrijeme vožnje
4. Psihofizičko stanje vozača i percepcija

Smještaj vozača u vozačkom sjedalu

Pravilan položaj za upravljačem vozila veoma je važan čimbenik koji utječe na sigurnost u vožnji. Površan i rastresen pristup pokazuje nezainteresiranost i nepažnju prilikom vožnje što u konačnici može dovesti do neželjenih posljedica i nesreće. Pravilnim položajem za upravljačem umanjuje se vrijeme reakcije što je bitan čimbenik sigurnosti u opasnim situacijama, sprječava se nastanak ozljeda uslijed nesreće te se povećava komfor prilikom upravljanja vozilom.

U zavoju, kao i u svim situacijama skretanja, naše tijelo je izloženo centrifugalnim silama što rezultira bočnim klizanjem vozača na sjedalu. Prilikom djelovanja centrifugalne sile najjednostavniji način kako da se spriječi klizanje po sjedalu bilo bi čvrsto držanje za upravljač vozila, no time se gubi osjetljivost na upravljaču te lakoća upravljanja. Školjka sjedala napravljena je tako da bočnim stranicama podupire vozača i sprječava klizanje uslijed bočnih sila. Udaljenost sjedala od upravljača i nožnih komandi također predstavlja važan faktor sigurnosti u smislu lakšeg i sigurnijeg upravljanja, ali i prevencije potencijalnih ozljeda prilikom prometne nezgode.

Pravilna pozicija sjedala trebala bi biti na udaljenosti na kojoj vozač nema mogućnost potpuno ispružiti noge, već je koljeno savijeno i nakon pritiska papučica (slika 2).

Slika 2.: Pravilan položaj sjedenja za upravljačem vozila Izvor [4]

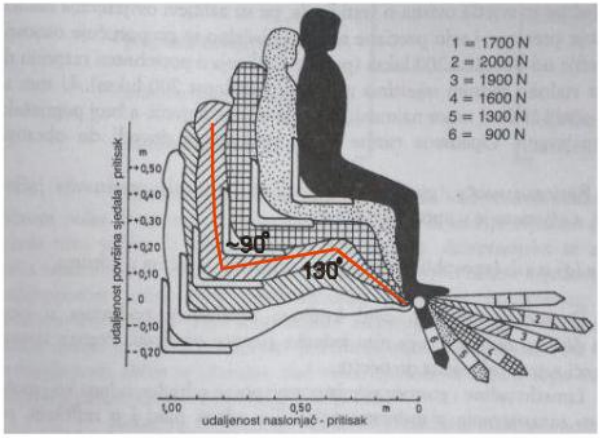


Pravilnim sjedenjem prilikom prometne nezgode, izbjegava se mogućnost loma kukova. Primjerice, pri brzini od 50 km/h, na tijelo djeluje sila od 6G. Ukoliko vozač prilikom udara ima ispružene noge, instinktivno će se odupirati udarcu pritiskanjem nožnih komandi, te postoji mogućnost loma kukova zbog prijenosa sile. Prilikom udara, dobro pozicioniran naslonjač za glavu umanjit će vjerojatnost ozljede ili puknuća vratne kralježnice. Pravilno podešavanje naslona za glavu trebalo bi biti takvo da naslon podupire glavu za vrijeme vožnje, ali da je ipak malo izdignut. Razlog tome je što se neposredno prije udara refleksno odupiremo rukama i nogama te se tako podižemo. Ukoliko nemamo dobro podešen naslon za glavu, prilikom naleta vozila na stražnji dio u kojem se nalazi osoba sa neadekvatno podešenim naslonom za glavu vrlo vjerojatna je ozljeda kralježnice odnosno puknuće [5].

Uporaba kočionog sustava s ergonomskog aspekta

Položaj sjedenja ima bitnu ulogu prilikom brzine reakcije i intenziteta kojim pritišćemo nožnu kočnicu. Na temelju ergonomskih istraživanja utvrđeno je da se prilikom blago savinute potkoljenice i natkoljenice ostvaruje najveća sila pritiska na kočnicu.

Slika 3.: Ovisnost udaljenosti površine sjedenja i udaljenosti naslonjača na silu pritiska Izvor [4]



Iz slike 3 vidljiv je intenzitet sila kojom čovjek djeluje na radnu kočnicu u ovisnosti o pozicioniranju upravljačkog sjedala u odnosu na samu kočnicu. Najveća sila pritiska nožne kočnice ostvaruje se kada je natkoljenica savijena u zglobu kuka pod kutom od približno 90 stupnjeva, a kut kojeg zatvaraju natkoljenica i potkoljenica 130 stupnjeva. U takvom položaju, sila koja se prenosi na nožnu kočnicu je najveća i iznosi približno 2000 N. Odstupanje od spomenutog položaja rezultira smanjenjem pritisne sile koja se može ostvariti te se ujedno produžuje vrijeme reakcije što produžuje zaustavni put vozila.

Položaj ruku na upravljaču za vrijeme vožnje

Podešavanje udaljenosti upravljača ima bitnu ulogu za jednostavnije i sigurnije upravljanje vozilom. Također i položaj ruku na upravljaču vozila nije zanemariv. Idealan položaj ruku na upravljaču trebao bi biti u položaju kazaljki na satu koje pokazuju 9 i 15 sati. Idealna udaljenost procjenjuje se na način tako da prilikom posezanja za vrh upravljača podlaktica i nadlaktica budu pod blagim kutom. To je uvjetovano udaljenošću od upravljača. Pravilno pozicioniranje ruku na upravljaču te optimalna udaljenost upravljača, povećavaju vrijeme reakcije i štite vozača od ozljeda ramenog zgloba [6]. Prilikom nesreće, ukoliko su ruke potpuno ispružene, vozač se instinktivno podupire o upravljač, te ne postoji mogućnost amortizacije udara zbog ispruženih ruku i u tom trenutku stradava rameni zglob. S ergonomskog stajališta pozicioniranje ruku u položaj 9 i 15 sati u blago savinutom položaju te oslonjenim na krakove upravljača predstavlja najidealniji položaj za upravljanje u kojem se ruke ne izlažu naprezanju kao primjerice prilikom vožnje gdje se upravljač drži jednom rukom na njegovom samom vrhu [7].

Slika 5.: Prikaz nepravilnog i pravilnog položaja ruku na upravljaču vozila

Izvor: [8]



Zaključak:

Smanjenje broja prometnih nesreća i ublažavanje njihovih posljedica, glavni je cilj u svim zemljama svijeta. Čovjek kao ključni sudionik u prometu svojim ponašanjem i pristupom prema vožnji velikim dijelom utječe na učestalost i posljedice samih nesreća. Zanemareni čimbenik sigurnosti je ergonomski položaj vozača za vrijeme vožnje. On proizlazi iz nedovoljne edukacije, društvenih stereotipa i osobnih afiniteta svakog vozača. Nepridržavanje ergonomskih načela korištenja motornog vozila za prijevoz ljudi doprinosi pogoršanju tehnike vožnje i posljedicama koje nastaju u prometnoj nesreći. Osvješćivanje vozača i edukacija predstavlja ključan element u razumijevanju posljedica nesreća povezanih s nepridržavanjem ergonomskih načela prilikom vožnje s ciljem promjene pristupa i usvajanja pozitivne prakse kod vozača.

LITERATURA:

Knjige:

[1] Cerovac, V.: Tehnika i sigurnost prometa. Zagreb: Fakultet prometnih znanosti, Zagreb, 2001. [2] Rotim, F.: Sigurnost cestovnog prometa i prevencija nezgoda. // Suvremeni promet, 3-4, Zagreb, 2000, str.218.-224.

[3] Ministarstvo unutarnjih poslova: Bilten o sigurnosti cestovnog prometa, Zagreb, 2014.

[4] Mikšić, D.: Uvod u ergonomiju. Zagreb: Fakultet strojarstva i brodogradnje, Zagreb,1997.

[5] Vodinelić, V. i grupa autora: Saobraćajna kriminalistika: metodika obrade saobraćajnih nesreća na putevima, vodi i u vazduhu. Savremena administracija, Beograd, 1986.

[6] Gledec, M.: Defanzivna vožnja.: Središte napredne vožnje d.o.o., Zagreb, 2000.

[7] Stohr, S.: Umijeće vožnje, Media Design, Labin, 2004.

Web:

[8] https://pakistanautotechnics.com/

Authors: Karlo Klobučar, mag. ing. traff.
Stefanija Malović Žmegač, dipl. ing.

THE INFLUENCE OF ERGONOMICS ON THE SAFETY OF YOUNG DRIVERS

Summary:

Injuries and deaths of young drivers are a worldwide problem. The goals of traffic policies in all countries are targeted towards reducing the number of accidents, deaths and injuries as well as minimizing the consequences of accidents.

Those policies can be divided into preventive and represive activities.

This paper targets the population of young drivers and will therefore be mostly oriented towards the prevention of undesired outcomes, due to the fact that the represive approach might have a reversed effect on youg drivers taking into consideration their psychological development and traits.

The aim of this paper is to point out the importance of ergonomics in safety of the drivers, the negative elements and habits of their behaviour and to correct the most common mistakes in order to raise the safety of all participants.

***Key words**: young drivers, safety, traffic accidents, ergonomics*

Introduction

Casualties in young drivers are a major problem in every country in the world. In order to reduce the number of accidents, injureis and death tolls in this population, many preventive measures are conducted which are aimed pricisely at the mentioned population.

The cause of accident can be: human error, vehicle or infrastructure. The driver is the key element in maintaining safety and as such, the emphasis on young drivers will be the core of this paper. Research shows that the number of accidents caused by young drivers is increasing.

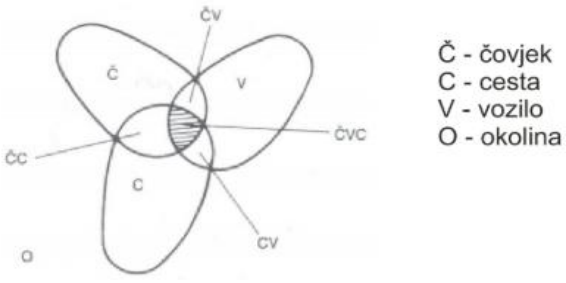
Due to the development of active and passive safety elements, safer vehicles and progress of the society in general, one should expect lower numbers of accident, when in reality, the situation is quite the opposite.

The authors will show the influcence of ergonomics and personal behaviour on the safety of young drivers.

Basic elements of road traffic

Traffic is a complex system with many conflicting situations. In order to reduce them, different safety measures need to be implemented and they involve the driver, the vehicle and the roads. The diagram shows that the vast majority of all accidents (85%) is caused by the driver.

Picture 1.: Venn diagram, Reference (1)



Driver as the factor in road safety

The driver represents the biggest factor in road safety, because he/she determines the movements of the vehicle based on his/her senses, perception, road conditions, taking into account the vehicle itself and traffic regualtions. [2].

The behaviour of the driver is influenced by:

a) Personal traits

b) Psychological and physical abilites

c) Education and cultural background

3.1. Personal traits

Our personality represents our traits and behavioral patterns which make each indivudual a uinique member of the society. A mature individual is one of the most important factors of safety in road traffic.

The essential traits that represent each individual come down to:

1. Abilities: ones we are born with or have aquired and which enable us to perform different activites
2. Attitude towards driving which is the result of upbringing, social background, education and society and which can be permanent or temporary
3. Temperament which is our innate characteristic of mobilising our psychological energies. Based on this concept, people can be divided into four groups: sanguine, phlegmatic, melancholic and choleric.
4. Personality traits which make individuals react in a similar way in different situations, and are represented in a way in which the individual treats himself, other people and his/her work.
5. Character of an indivudual which is shown through our sense of morality and the way he/she treats other people and accepts social norms and standards.

All these traits usually develop by the age of 18, and remain the same till the age of 30. In the period between 30 and 50 they drop slightly and after the age of 50 they start dropping more rapidly.

3.2. Psychologial and physical ablities

Sight, hearing, balance and sense are created with the help of organs and nervous system. The perception of our surroundings is enabled thorugh the mentioned senses, which give us information about the surroundings but also about the changes within our bodies. All of these senses – sight, hearing, balnce and smell but also our muscles contribute to the overall safety while driving.

Psychomotor skills are skills which enable the movements that require speed, precision and muscle coordination. In driving, the essential psychomotor skills are – speed of reaction and movement, movement fluidity and awareness.

Mental capabilities include thoughts process, memory, intelligence, learning etc. A person with fully developed mental capabilites is more aware of their surrounding and adapts to different cicrumstances more quickly.

Education and cultural background

A driver that has aquired sufficient knowledge about traffic respects traffic regulations and takes into consideration all participnats in the process.

By learning about traffic, drivers secure the level of knowledge necessary for participating in the process. This includes

- laws and regulations (licence)
- understanding the process of driving and vehicle operating
- being aware of personal skills and capabilities

The effect of ergonomic on the safety of young drivers in road traffic

The word ergonomics comes from the Greek words ergon (act) i nomos (customm, law), describing a scientific discipline with the aim of determining the behaviour and body reactions under different circumstances. It looks into human antomy, physiological and other parameters of human bodies and combines medcine, psychology, mathematics, optics, acustics and other scientific fields. [4].

Ergonimics plays a significant role while driving. The research is done through tests on different car models, and revolves around crucial element for a safe and right way of driving. Those are:

1. The position of the driver in the seat
2. Brake systems
3. Hand position while driving
4. Physical and mental state of the driver and perception

The postion of the driver in the seat

The right postion of the driver is a crucial safety element. A careless approach shows lack of interest and attention while driving which could lead to unwanted consequences and accidents. The right position of the driver in the seat minimizes the time of the reaction which is vital in dangerous situations and prevents injuries while also ensuring a more comfortable driving experience..

While driving thorugh curves, our bodies are exposed to centrifugal force which cuases the driver to slide sideways in the seat. In order to minimize this movement caused by the centrifugal force, the easiest way is to hold the wheel tighter. But, by doing so, you lose the the ability to fully steer the vehicle. The seats are made so that they support the driver and prevent the sliding in curves. The right distance between the seat and the wheel and foot pedals also contribute to the safety while driving as well as minimzing possible injuries in accidents,

The right position of the seat is the one where the driver cannot fully extend the legs, and where the knee remains slightly bent even when pushing the foot pedals. (picture 2).

Picture 2.: The right position of the driver Reference(4)

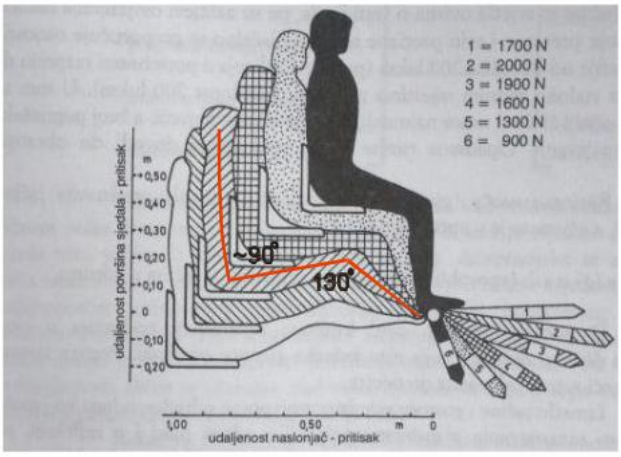


By sitting in the right way, in case of an accident, the driver can avoid serious hip injuries. For example, when driving at 50 km/h the force on the body is 6G. If the legs are fully extended on impact, the driver will instinctively push harder on the foot pedals which could lead to severe hip injuries due to transition of the force. Furthemore, on impact, the correctly positioned head rest in the car will minimize the possibility of neck injuries. The correct position of the head rest should be such that it supports the head during driving but remains slightly raised. The reason for this is that before the impact we tend to push away with our arms and legs, which lifts the body higher. If the head rest is not correctly positioned and our vehicle is hit by another, a spine injury is very likely to occur. [5].

Brake systems

The way we sit plays a significant role in reacting and intensity of hitting the brakes while driving. Based on ergonomics research, the biggest force on the brakes is created if the leg is slightly bent in the knee while driving.

Picture 3.: The relationship between the distance of the seat and the head rest Reference [4]



As the picture 3 shows, the pressure on the brakes depends greatly on the position of the seat and the brakes. The strongest pressure is applied when the upper part of the leg is bent at the hip at 90 degrees angle, and the knee at approx 130 degrees. In this postion, the force that is transmitted to the brakes is the strongest – approx. 2000 N. In any other postion, the strength of the pressure on the brakes is reduced and the reaction time is prolonged resulting in a prolonged halt time of the vehicle.

Hand postion while driving

The correct postion of the steering wheel has a significant role in simpler and safer driving. This applies to hand position as well. The ideal postion should be the 9 and 3 o'clock postion. The distance is determined in the way that the lower and upper arm should be slightly angled with the top of the steering wheel. If the hands are positioned correctly and at the right distance from the steering wheel, the shoulders are protected from injuries in case of an accident [6]. In an accident, if the arms are fully extended, the driver pushes against the steering wheel, so the force of the impact cannot be minimized which leads to shoulder injuries. From the ergonomic standpoint, the 9 and 3 o'clock position, with slightly bent arms at the steering wheel provides less strain on the arms than if the driver steers the wheel with only one arm at the top. [7].

Picture 5.: Correct and incorrect hand positions on the steering wheel

Reference: [8]



Conclusion

Reducing the number of traffic accidents and/or minimizing their consequences is the primary goal in countries throughout the world. Being the main factor in traffic safety, the behaviour and the approach of each individual driver can influence the frequency and the severity of the outcome in each accident.

One of the neglected contributing factors to the overall safety is the body position of the driver while driving.

It is the result of lack of knowledge, social sterotypes and personal preferences of the driver. By not applying ergonomic principles when operating a vehicle with passengers, drivers reduce their driving skills and negatively influence the consequences of the accidents.

Rising awareness and education are the key elements in understanding the consequences of the accidents linked with not applying the ergonomic principles while driving, with the goal of changing the approach to driving and implementing positive habits and behaviour among drivers.

References:

Books

[1] Cerovac, V.: Tehnika i sigurnost prometa. Zagreb: Fakultet prometnih znanosti, Zagreb, 2001. [2] Rotim, F.: Sigurnost cestovnog prometa i prevencija nezgoda. // Suvremeni promet, 3-4, Zagreb, 2000, str.218.-224.

[3] Ministarstvo unutarnjih poslova: Bilten o sigurnosti cestovnog prometa, Zagreb, 2014.

[4] Mikšić, D.: Uvod u ergonomiju. Zagreb: Fakultet strojarstva i brodogradnje, Zagreb,1997.

[5] Vodinelić, V. i grupa autora: Saobraćajna kriminalistika: metodika obrade saobraćajnih nesreća na putevima, vodi i u vazduhu. Savremena administracija, Beograd, 1986.

[6] Gledec, M.: Defanzivna voţnja.: Središte napredne voţnje d.o.o., Zagreb, 2000.

[7] Stohr, S.: Umijeće voţnje, Media Design, Labin, 2004.

Web:

[8] https://pakistanautotechnics.com/

Aleš Kos, učitelj praktičnega pouka Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko

Korelacija med izvajanjem praktičnega pouka in strokovnimi moduli v programu Avtoservisni tehnik

Povzetek

Izobraževalni program avtoservisni tehnik je zasnovan kot odgovor na potrebe sodobne avtomobilske industrije, ki se nenehno razvija. Dijakom omogoča pridobivanje tako teoretičnih kot praktičnih znanj, ki jih potrebujejo za uspešno delo v stroki. Program se opira na kataloge znanj CPI, ki jasno določajo informativne cilje (znanje in razumevanje) ter formativne cilje (uporaba znanja v praksi). Teorija in praksa sta medsebojno povezani, kar dijakom omogoča celovit razvoj strokovnih kompetenc. Program dijakom prinaša dodano vrednost, saj jih pripravi na delo v realnem okolju in jim hkrati odpira možnosti nadaljnjega študija.

***Ključne besede**: Avtoservisni tehnik, praktični pouk, formativni cilji, informativni cilji*

1 Uvod

Program avtoservisni tehnik se je razvil kot odgovor na hitro razvijajočo se avtomobilsko industrijo, ki zahteva strokovnjake z interdisciplinarnim znanjem s področij mehanike, elektrotehnike, računalništva in diagnostike. Dijaki, ki se vpišejo in uspešno zaključijo program, pridobijo poleg temeljnih tehničnih znanj tudi ključne kompetence, kot so timsko delo, komunikacija, kritično mišljenje in digitalne spretnosti. Naziv *avtoservisni tehnik* jim zagotavlja uradno priznano izobrazbo, skladno z evropskim ogrodjem kvalifikacij, kar jim odpira vrata na domači in tuji trg dela.

Program zagotavlja dodano vrednost tudi v smislu nadaljnjega izobraževanja, saj omogoča vertikalne prehode na višje strokovne šole, fakultete ter specializirana izobraževanja za sodobne tehnologije, kot so hibridna in električna vozila. Poseben poudarek je na povezovanju teorije in prakse, kar se odraža v katalogih znanj za strokovne module, kjer se informativna znanja (teoretične osnove) neposredno povezujejo s formativnimi (praktične veščine). Dijaki svoje znanje pridobivajo pri naslednjih strokovnih modulih: pogonski agregati, podvozja motornih vozil, električni in elektronski sistemi, popravilo in vzdrževanje karoserij, organizacija poslovanja in dela, diagnostika na motorjih, zavorni sistemi na motornih vozilih in karoserijska oprema z diagnostiko. Povezava med teoretičnim delom in praktičnim je ogromna. Vsak prej omenjen predmet se izvaja nekje 1-2 uri na teden v teoretični učilnici, sledi mu še enkrat toliko ur pri praktičnem pouku.

Dijaki, ki uspešno opravijo dvoletno poklicno tehniško izobraževanje, šolanje zaključijo s poklicno maturo. Sestavljena je iz slovenščine, matematike ali angleščine, avtomehatronike in storitve z zagovorom. Po uspešno opravljeni poklicni maturi se dijakom odpro mnoga vrata kje lahko nadaljujejo šolanje ali se zaposlijo. Zaključen program omogoča zaposlitev

v servisih, delavnicah in tehničnih pregledih, obenem pa je odlična osnova za višješolsko in visokošolsko izobraževanje.

Bistvenega pomena za uspešno izvajanje programa avtoservisni tehnik je tudi povezanost šole z lokalnim okoljem. V našem primeru so to delodajalci v avtoindustriji. Brez njih dijaki ne bi osvojili pomembnega znanja iz realnih primerov na vozilih. Na praktičnem usposabljanju pri delodajalcih dijaki spoznajo tudi delo izven delavnice, kako se komunicira s strankami, kakšno delo opravlja sprejemnik vozila in ostale pomembne funkcije, v tem poklicu.

2 Pregled strokovnih modulov

Vsi sklopi se izvajajo v tesni povezavi med teoretičnim in praktičnim poukom. Dijaki najprej posamezne komponente in zakonitosti spoznajo v učilnici. Tam spoznajo vse podrobnosti kako posamezen sklop deluje, kako je sestavljen in podobno. Pri praktičnem delu v delavnici pa jih naučimo kako se stvar popravlja, kako se na posameznem sklopu naredijo potrebne meritve, kakšne so delavniške zahteve glede popravila, montaže in demontaže posamezne komponente in vse potrebno. Dijakom omogočim tudi, da si glede na obravnavano temo po učnem načrtu pripeljejo svoje vozilo. S tem dosežem večjo motiviranost za učenje novih veščin. Dijaki na tak način pridobivajo znanje na realnih primerih s katerimi se bodo srečali, ko bodo zapustili šolsko okolje in se odpravili na poklicno pot.

2.1 Pogonski agregati

Modul pogonski agregati je eden najpomembnejših temeljev v programu avtoservisni tehnik, saj se nanaša na srce vsakega vozila – motor. V okviru modula dijaki najprej pridobijo temeljna informativna znanja o zgradbi motorjev z notranjim zgorevanjem, njihovih sestavnih delih ter različnih tipih motorjev, kot so bencinski, dizelski, hibridni in električni pogoni. Pomemben poudarek je na poznavanju termodinamičnih zakonitosti, ki pojasnjujejo procese zgorevanja, pretvorbo energije in vpliv različnih goriv na delovanje motorja. Prav tako se seznanijo z materiali, iz katerih so narejeni glavni deli motorja, ter njihovim vplivom na zmogljivost, vzdržljivost in ekološko sprejemljivost.

Ob teoretičnem ozadju pa so ključni tudi formativni cilji, saj dijaki razvijajo konkretne praktične spretnosti. Naučijo se uporabljati diagnostične naprave, sistematično iskati napake, prepoznavati simptome nepravilnega delovanja ter izvajati popravila in vzdrževalna dela. Pri tem uporabljajo tehnično dokumentacijo, servisna navodila in sodobne digitalne pripomočke, ki so standard v avtomobilski industriji. Poseben poudarek je na odgovornem delu – od spoštovanja varnostnih pravil do okoljsko prijaznega ravnanja z olji, gorivi in izpušnimi plini.

2.2 Podvozja motornih vozil

Modul podvozja motornih vozil je ključen za razumevanje stabilnosti, vodljivosti in varnosti vozila. Zajema vsa področja, ki so povezana z vožnjo, od vzmetenja in krmiljenja do koles in pnevmatik. V okviru informativnih ciljev dijaki spoznajo osnovna načela delovanja podvozja, konstrukcijske rešitve vzmetnih in krmilnih sistemov ter zakonitosti, ki vplivajo na gibanje vozila. Naučijo se, kako obraba ali poškodba posamezne komponente vpliva na celotno vozilo in s tem neposredno na varnost potnikov. Poleg tega razumejo tudi pomen zakonodaje, tehničnih pregledov in standardov, ki zagotavljajo brezhibno delovanje vozila na cesti.

Formativni cilji pa se osredotočajo na praktično usposabljanje. Dijaki izvajajo nastavitve geometrije podvozja, preglede in menjave obrabljenih delov ter popravila sistemov vzmetenja in krmiljenja. Pri tem uporabljajo sodobne naprave za meritve in prilagoditve, ki omogočajo natančno diagnostiko stanja podvozja. S tem razvijajo spretnosti, ki so neposredno povezane z zagotavljanjem prometne varnosti, hkrati pa pridobijo sposobnost dela po navodilih proizvajalcev in upoštevanja standardov kakovosti.

2.3 Električni in elektronski sistemi

Sodobna vozila so vse bolj prepletena z električnimi in elektronskimi sistemi, kar modul električni in elektronski sistemi postavlja v osrčje izobraževanja. Informativni cilji vključujejo poznavanje osnov elektrotehnike, zakonitosti električnih vezij, delovanja akumulatorjev, alternatorjev, zaganjalnikov ter naprednih elektronskih modulov, kot so krmilne enote motorja, varnostni sistemi in sistemi za udobje. Dijaki razumejo, kako so ti sistemi povezani med seboj in kakšen je njihov vpliv na celotno delovanje vozila.

Na drugi strani formativni cilji zahtevajo, da dijaki razvijejo praktične spretnosti za delo z električnimi sistemi. To vključuje uporabo diagnostičnih naprav, merjenje električnih veličin, iskanje napak v vezjih ter izvajanje popravil in menjav komponent. Naučijo se brati električne sheme in uporabljati tehnično dokumentacijo, kar jih usposobi za delo v realnih servisnih delavnicah. Poseben poudarek je na natančnosti, saj že manjša napaka lahko povzroči motnje v varnostno občutljivih sistemih, kot sta ABS ali airbag.

2.4 Popravilo in vzdrževanje karoserij

Modul popravilo in vzdrževanje karoserij dijakom omogoča, da razvijejo celovit pogled na zgradbo vozila. Informativni cilji vključujejo spoznavanje različnih tipov karoserijskih konstrukcij, uporabljenih materialov (jeklo, aluminij, kompoziti) in njihovega vpliva na varnost ter vzdržljivost. Dijaki se seznanijo tudi z varnostnimi conami, ki so oblikovane za zaščito potnikov, in pomenom ohranjanja karoserijske celovitosti pri trkih. Razumejo tudi standarde kakovosti in zakonodajne zahteve, ki urejajo popravila karoserij.

V okviru formativnih ciljev pa dijaki izvajajo konkretna popravila – ravnanje pločevine, varjenje, menjavo poškodovanih delov in pripravo površin za barvanje. Pri tem se naučijo uporabljati specializirano orodje ter upoštevati varnostne in okoljevarstvene standarde. Razvijajo natančnost, potrpežljivost in občutek za kakovostno izvedbo.

2.5 Diagnostika na motorjih

Modul diagnostika na motorjih je neposredno povezan z iskanjem napak in optimizacijo delovanja pogonskih sistemov. Informativni cilji vključujejo spoznavanje osnov delovanja motorjev, značilnosti posameznih komponent in sistemov (vbrizgavanje, vžig, nadzor emisij), tipične napake in njihovo prepoznavanje. Dijaki razumejo pomen diagnostičnih parametrov in kako vplivajo na delovanje motorja. Naučijo se uporabljati tehnično dokumentacijo proizvajalcev ter interpretirati rezultate meritev.

Formativni cilji pa zahtevajo, da dijaki znajo uporabiti diagnostične naprave, izvesti meritve, analizirati dobljene podatke in izvesti popravila. Naučijo se logično razmišljati, postavljati hipoteze o možnih vzrokih napak in jih preverjati v praksi. Pri tem razvijajo sistematičnost, kritično mišljenje in tehnično prilagodljivost, saj morajo hitro prepoznati in rešiti težave v realnih razmerah.

2.6 Zavorni sistemi motornih vozil

Ker zavore predstavljajo enega najpomembnejših varnostnih sistemov, je modul zavorni sistemi motornih vozil ključnega pomena. Informativni cilji obsegajo razumevanje konstrukcije mehanskih, hidravličnih, pnevmatskih in elektronskih zavornih sistemov (ABS, ESP), zakonitosti zaviranja in vpliva fizikalnih sil na varnost vožnje. Dijaki spoznajo pomen rednega vzdrževanja in zakonodajnih zahtev, ki urejajo delovanje zavor.

V okviru formativnih ciljev dijaki izvajajo diagnostiko zavor, menjajo in popravljajo obrabljene dele, nastavljajo sisteme in preverjajo njihovo učinkovitost. Naučijo se uporabljati diagnostične naprave za elektronsko podprte zavore ter izvajati meritve, ki potrjujejo brezhibno delovanje. Poseben poudarek je na odgovornosti, saj že majhna nepravilnost v zavorah lahko povzroči resne posledice.

2.7 Karoserijska oprema in elektronika

Modul karoserijska oprema in elektronika združuje področja udobja, varnosti in estetike vozila. Informativni cilji vključujejo razumevanje delovanja svetlobnih in signalnih naprav, sistemov klimatizacije, varnostnih pasov, elektronsko krmiljenih komponent udobnostnih sistemov, centralnega zaklepanja in sodobnih asistenčnih sistemov. Dijaki spoznajo povezavo teh sistemov z varnostjo potnikov ter udobjem pri vožnji.

Formativni cilji se nanašajo na praktično diagnostiko in popravilo teh sistemov. Dijaki izvajajo meritve električnih veličin, menjavajo elektronske module, nastavljajo opremo po specifikacijah proizvajalcev in odpravljajo motnje. Pri tem uporabljajo specializirana orodja in diagnostične naprave, ki so standard v sodobnih servisih. Razvijajo natančnost, potrpežljivost in sistematičnost, saj so sistemi pogosto kompleksno povezani med seboj.

3 Povezava med informativnim in formativnim znanjem

V programu avtoservisni tehnik sta teoretični in praktični pouk neločljivo povezana. Teorija ponuja razumevanje zakonitosti, principov in sistemov, medtem ko praksa omogoča, da dijaki to znanje uporabijo in preverijo v realnih okoliščinah. Šele združitev obeh prinaša celovito usposobljenost, ki je nujna za opravljanje poklica.

Pri modulu pogonski agregati dijaki v teoriji spoznajo zgradbo motorjev, procese zgorevanja in vpliv različnih goriv. Povezava s prakso se vzpostavi, ko z meritvami kompresije in analizo izpušnih plinov ugotavljajo napake ter z uporabo diagnostičnih naprav preizkušajo delovanje motorja. Razumevanje teoretičnih zakonitosti jim omogoča, da napako prepoznajo in jo učinkovito odpravijo.

V modulu podvozja motornih vozil je poudarek v teoriji na razumevanju prenosa sil, obremenitev in naloge vzmetenja. V praksi se to znanje uporabi pri nastavitvi geometrije koles, menjavi blažilnikov ter preizkušanju stabilnosti vozila. Dijaki tako neposredno spoznajo, kako napačna nastavitev vpliva na varnost vožnje.

Pri električnih in elektronskih sistemih teorija zajema osnove tokokrogov, senzorjev in krmilnih enot. V praksi se to pokaže pri merjenju napetosti, odpravljanju napak v vezjih in uporabi diagnostičnih testerjev. Teoretično razumevanje shem jim omogoča, da uspešno sledijo električnim tokovom v vozilu in rešujejo težave.

V modulu popravilo in vzdrževanje karoserij dijaki teoretično spoznajo lastnosti kovin, postopke spajanja in varnostne standarde. Praktični pouk pa vključuje varjenje, ravnanje

pločevine in pripravo za lakiranje. Razumevanje materialov jim omogoča izbiro najustreznejše metode popravila, ki zagotavlja trdnost in varnost vozila.

Pri diagnostiki na motorjih teorija obsega diagnostične metode in delovanje senzorjev, praksa pa uporabo testerjev, analizo napak in njihovo odpravljanje. Povezava je očitna: brez razumevanja signala senzorja dijaki ne bi mogli pravilno interpretirati podatkov na diagnostični napravi.

V modulu zavorni sistemi dijaki v teoriji spoznajo fizikalne zakonitosti zaviranja, hidravlične prenose in elektronske varnostne sisteme. V praksi pa menjajo komponente zavornega sistema, odzračujejo hidravlični sistem in preizkušajo ABS, ESP. Teoretično znanje jim pojasni pomen brezhibnosti sistema, praksa pa jih nauči, kako to v resnici doseči.

Pri karoserijski opremi in elektroniki se teorija osredotoča na varnostne in udobnostne sisteme (zračne blazine, klimatske naprave, centralno zaklepanje). V praksi dijaki izvajajo meritve, polnijo klimatske naprave in diagnosticirajo okvare. Razumevanje delovanja sistema jim omogoča, da popravila izvedejo natančno in varno.

Skupna značilnost vseh modulov je, da teorija gradi širše razumevanje, praksa pa omogoča razvoj konkretnih spretnosti. Ko dijaki obvladajo oboje, ne ostanejo pri rutinskem delu, temveč znajo razumeti vzrok, pojasniti rešitev in jo strokovno izvesti. Tako postanejo strokovnjaki, pripravljeni na sodobne izzive avtomobilske industrije.

4 Zaključek

Izobraževalni program avtoservisni tehnik je zasnovan kot odgovor na potrebe sodobne avtomobilske industrije, ki združuje hitro razvijajočo se tehnologijo, zahteve po varnosti in trajnostnem razvoju. Analiza modulov in katalogov znanj kaže, da je program premišljeno oblikovan v smeri povezovanja teoretičnih znanj in praktičnih spretnosti. Prav ta preplet predstavlja največjo dodano vrednost dijakom, saj jih ne pripravi le na opravljanje rutinskih servisnih del, temveč na razumevanje zakonitosti, samostojno iskanje napak in odgovorno reševanje tehničnih izzivov.

Pogonski agregati, podvozja, električni in elektronski sistemi, diagnostika motorjev, zavorni sistemi ter področji karoserije in karoserijske elektronike skupaj tvorijo celovit okvir strokovnih kompetenc. Dijaki se ne učijo zgolj posameznih postopkov, temveč razvijajo celostni pristop: najprej razumejo delovanje sistema, nato ga analizirajo v praksi in na koncu izvedejo ustrezno delovno operacijo. Ta proces jim omogoča, da ob zaključku šolanja obvladajo ne le osnovna popravila, ampak tudi kompleksnejše naloge, povezane z elektroniko, sodobno diagnostiko in varnostnimi sistemi.

Program dijakom odpira široke možnosti. Po eni strani omogoča takojšnje vključevanje v delovno okolje, ker so usposobljeni za delo v avtomehaničnih delavnicah, servisih in tehničnih pregledih. Po drugi strani pa predstavlja odlično podlago za nadaljnje izobraževanje, bodisi na višjih strokovnih šolah bodisi na fakultetah tehniške usmeritve. Prav ta fleksibilnost dokazuje, da je program uspešno usklajen z evropskimi izobraževalnimi standardi in potrebami trga dela.

Program avtoservisni tehnik dijakom omogoča razvoj strokovne identitete – postanejo odgovorni, samostojni in kompetentni strokovnjaki, ki znajo povezovati teorijo in prakso, obvladovati sodobno tehnologijo in se prilagajati spremembam. S tem ne pridobijo le formalnega naziva, ampak znanja in spretnosti, ki jim zagotavljajo uspeh tako na poklicni

poti kot tudi v nadaljnjem izobraževanju.

5 Viri in literatura

- https://cpi.si/wp-content/uploads/2020/08/KZ_OM_PogonskiAgregati.pdf, 10. 7. 2025
- Zakon o poklicnem in strokovnem izobraževanju. (2017). Uradni list RS, št. 79/2017
- European Qualifications Framework (EQF). (2008). Recommendation of the European Parliament and of the Council on the establishment of the European Qualifications Framework for lifelong learning. Official Journal of the European Union. 11. 07. 2025

Aleš Kos, učitelj praktičnega pouka Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko

Correlation between practical training and professional modules in the Car Service Technician program

Summary

The automotive service technician training program is designed to meet the needs of the modern automotive industry, which is constantly evolving. It enables students to acquire both the theoretical and practical knowledge they need to work successfully in the field. The program is based on CPI knowledge catalogs, which clearly define informational objectives (knowledge and understanding) and formative objectives (application of knowledge in practice). Theory and practice are interlinked, enabling students to develop their professional competencies in a comprehensive manner. The program brings added value to students by preparing them for work in a real-world environment while opening up opportunities for further study.

***Keywords**: Car service technician, practical training, formative goals, informative goals*

1 Introduction

The automotive service technician program was developed in response to the rapidly developing automotive industry, which requires professionals with interdisciplinary knowledge in the fields of mechanics, electrical engineering, computer science, and diagnostics. Students who enrol and successfully complete the programme acquire not only basic technical knowledge but also key competences such as teamwork, communication, critical thinking and digital skills. The title of car service technician provides them with an officially recognized education in line with the European Qualifications Framework, which opens doors to the domestic and foreign labor markets.

The program also provides added value in terms of further education, as it enables vertical transitions to higher vocational colleges, faculties, and specialized education for modern technologies, such as hybrid and electric vehicles. Particular emphasis is placed on linking theory and practice, which is reflected in the knowledge catalogs for professional modules, where informative knowledge (theoretical foundations) is directly linked to formative knowledge (practical skills). Students acquire their knowledge in the following professional modules: drive units, motor vehicle chassis, electrical and electronic systems, body repair and maintenance, business and work organization, engine diagnostics, motor vehicle braking systems, and body equipment with diagnostics. There is a strong link between the theoretical and practical parts. Each of the above-mentioned subjects is taught for 1-2 hours per week in a theory classroom, followed by.

Students who successfully complete two years of vocational technical education finish their

schooling with a vocational matriculation examination. It consists of Slovenian language, mathematics or English, automotive mechanics, and services with a defense. After successfully completing the vocational matriculation examination, students have many opportunities to continue their education or find employment. The completed program enables employment in service centers, workshops, and technical inspections, while also providing an excellent foundation for higher education.

The school's connection with the local community is also essential for the successful implementation of the car service technician program. In our case, these are employers in the automotive industry. Without them, students would not acquire important knowledge from real-life examples on vehicles. During practical training with employers, students also learn about work outside the workshop, how to communicate with customers, what work a vehicle receptionist does, and other important functions in this profession.

2 Overview of professional modules

All modules are taught in close connection between theoretical and practical lessons. Students first learn about individual components and principles in the classroom. There, they learn all the details about how each module works, how it is constructed, and so on. During the practical work in the workshop, we teach them how to repair things, how to take the necessary measurements on individual modules, what the workshop requirements are for repairing, assembling, and disassembling individual components, and everything else they need to know. I also allow students to bring their own vehicles, depending on the topic covered in the curriculum. This helps me get them more excited about learning new skills. This way, students gain knowledge from real-life examples that they'll encounter when they leave school and start their careers.

2.1 Power units

The power units module is one of the most important foundations of the car service technician program, as it relates to the heart of every vehicle – the engine. Within the module, students first acquire basic knowledge about the structure of internal combustion engines, their components, and different types of engines, such as gasoline, diesel, hybrid, and electric drives. There is a strong emphasis on understanding the thermodynamic laws that explain combustion processes, energy conversion, and the impact of different fuels on engine performance. Students also learn about the materials used to make the main parts of an engine and their impact on performance, durability, and environmental friendliness.

In addition to the theoretical background, formative goals are also key, as students develop specific practical skills. They learn to use diagnostic equipment, systematically search for faults, recognize symptoms of malfunction, and perform repairs and maintenance work. In doing so, they use technical documentation, service manuals, and modern digital tools that are standard in the automotive industry. Special emphasis is placed on responsible work—from compliance with safety rules to environmentally friendly handling of oils, fuels, and exhaust gases.

2.2 Motor vehicle chassis

The motor vehicle chassis module is key to understanding vehicle stability, handling, and safety. It covers all areas related to driving, from suspension and steering to wheels and tires. As part of the informational objectives, students learn the basic principles of chassis

operation, the design solutions of suspension and steering systems, and the laws that affect vehicle movement. They learn how wear or damage to individual components affects the entire vehicle and thus directly affects passenger safety. In addition, they understand the importance of legislation, technical inspections, and standards that ensure the proper functioning of vehicles on the road.

The formative objectives focus on practical training. Students perform chassis geometry adjustments, inspections and replacements of worn parts, and repairs to suspension and steering systems. They use modern measuring and adjustment devices that enable accurate diagnosis of the condition of the chassis. In doing so, they develop skills that are directly related to ensuring road safety, while also acquiring the ability to work according to manufacturers' instructions and comply with quality standards.

2.3 Electrical and electronic systems

Modern vehicles are increasingly intertwined with electrical and electronic systems, which places the electrical and electronic systems module at the heart of education. Informative objectives include knowledge of the basics of electrical engineering, the principles of electrical circuits, the operation of batteries, alternators, starters, and advanced electronic modules such as engine control units, safety systems, and comfort systems. Students understand how these systems are interconnected and how they affect the overall performance of the vehicle.

On the other hand, the formative objectives require students to develop practical skills for working with electrical systems. This includes using diagnostic equipment, measuring electrical quantities, troubleshooting circuits, and performing repairs and component replacements. They learn to read electrical diagrams and use technical documentation, which qualifies them to work in real service workshops. Particular emphasis is placed on accuracy, as even a minor error can cause malfunctions in safety-sensitive systems such as ABS or airbags.

2.4 Car body repair and maintenance

The car body repair and maintenance module enables students to develop a comprehensive understanding of vehicle construction. Informative objectives include learning about different types of body structures, the materials used (steel, aluminum, composites) and their impact on safety and durability. Students also learn about safety zones designed to protect passengers and the importance of maintaining body integrity in collisions. They also understand the quality standards and legal requirements governing body repairs.

As part of the formative objectives, students perform specific repairs – sheet metal straightening, welding, replacement of damaged parts, and preparation of surfaces for painting. In doing so, they learn to use specialized tools and comply with safety and environmental standards. They develop precision, patience, and a sense of quality workmanship.

2.5 Engine diagnostics

The engine diagnostics module is directly related to troubleshooting and optimising the operation of drive systems. Informative objectives include learning about the basics of engine operation, the characteristics of individual components and systems (injection,

ignition, emission control), typical faults and how to identify them. Students understand the importance of diagnostic parameters and how they affect engine performance. They learn to use manufacturers' technical documentation and interpret measurement results.

The formative objectives require students to be able to use diagnostic equipment, perform measurements, analyze the data obtained, and carry out repairs. They learn to think logically, hypothesise about possible causes of faults and test them in practice. In doing so, they develop systematicity, critical thinking and technical adaptability, as they have to quickly identify and solve problems in real-life situations.

2.6 Motor vehicle braking systems

As brakes are one of the most important safety systems, the motor vehicle braking systems module is of key importance. The informative objectives include understanding the design of mechanical, hydraulic, pneumatic, and electronic braking systems (ABS, ESP), the principles of braking, and the influence of physical forces on driving safety. Students learn about the importance of regular maintenance and the legal requirements governing the operation of brakes.

As part of the formative objectives, students perform brake diagnostics, replace and repair worn parts, adjust systems, and check their effectiveness. They learn to use diagnostic devices for electronically supported brakes and to perform measurements that confirm proper operation. Special emphasis is placed on responsibility, as even a minor irregularity in the brakes can have serious consequences.

2.7 Bodywork equipment and electronics

The bodywork equipment and electronics module combines the areas of vehicle comfort, safety, and aesthetics. Informative objectives include understanding the operation of lighting and signaling devices, air conditioning systems, seat belts, electronically controlled components of comfort systems, central locking, and modern assistance systems. Students learn about the connection between these systems and passenger safety and driving comfort.

The formative objectives relate to the practical diagnosis and repair of these systems. Students perform electrical measurements, replace electronic modules, adjust equipment according to manufacturer specifications, and troubleshoot malfunctions. In doing so, they use specialized tools and diagnostic devices that are standard in modern service centers. They develop precision, patience, and systematicity, as the systems are often complexly interconnected.

3 The link between informative and formative knowledge

In the auto service technician program, theoretical and practical instruction are inextricably linked. Theory provides an understanding of laws, principles, and systems, while practice allows students to apply and test this knowledge in real-life situations. Only the combination of both provides the comprehensive skills necessary to perform the job.

In the powertrain module, students learn about engine design, combustion processes, and the effects of different fuels in theory. The link to practice is established when they identify faults by measuring compression and analyzing exhaust gases and test engine performance using diagnostic equipment. Understanding the theoretical principles enables them to identify faults and rectify them effectively.

In the motor vehicle chassis module, the theoretical focus is on understanding force transmission, loads, and the role of suspension. In practice, this knowledge is applied in wheel alignment, shock absorber replacement, and vehicle stability testing. Students thus learn firsthand how incorrect settings affect driving safety.

In electrical and electronic systems, the theory covers the basics of circuits, sensors, and control units. In practice, this is demonstrated in voltage measurement, troubleshooting circuits, and using diagnostic testers. A theoretical understanding of diagrams enables them to successfully track electrical currents in a vehicle and solve problems.

In the body repair and maintenance module, students learn about the properties of metals, joining processes, and safety standards. Practical lessons include welding, sheet metal working, and preparation for painting. Understanding materials enables them to choose the most appropriate repair method to ensure the strength and safety of the vehicle.

In engine diagnostics, the theory covers diagnostic methods and sensor operation, while the practical part covers the use of testers, fault analysis, and troubleshooting. The connection is obvious: without understanding the sensor signal, students would not be able to correctly interpret the data on the diagnostic device.

In the braking systems module, students learn about the physical laws of braking, hydraulic transmissions, and electronic safety systems in theory. In practice, they replace brake system components, bleed the hydraulic system, and test ABS and ESP. Theoretical knowledge explains the importance of system integrity, while practice teaches them how to achieve it in reality.

In the case of bodywork equipment and electronics, the theory focuses on safety and comfort systems (airbags, air conditioning, central locking). In practice, students perform measurements, fill air conditioning systems, and diagnose faults. Understanding how the system works enables them to carry out repairs accurately and safely.

A common feature of all modules is that theory builds a broader understanding, while practice enables the development of specific skills. Once students have mastered both, they do not stick to routine work, but are able to understand the cause, explain the solution, and implement it professionally. This makes them experts who are ready for the modern challenges of the automotive industry.

4 Conclusion

The automotive service technician training program is designed to meet the needs of the modern automotive industry, which combines rapidly developing technology with safety and sustainability requirements. An analysis of the modules and knowledge catalogs shows that the program is carefully designed to combine theoretical knowledge and practical skills. It is precisely this combination that represents the greatest added value for students, as it not only prepares them to perform routine service work, but also to understand the principles, independently search for faults, and responsibly solve technical challenges.

Powertrains, chassis, electrical and electronic systems, engine diagnostics, braking systems, and bodywork and body electronics together form a comprehensive framework of professional competencies. Students do not just learn individual procedures, but develop a comprehensive approach: first, they understand how the system works, then they analyze it in practice, and finally they perform the appropriate work operation. This process enables

them to master not only basic repairs but also more complex tasks related to electronics, modern diagnostics, and safety systems by the end of their schooling.

The program opens up a wide range of opportunities for students. On the one hand, it enables them to immediately enter the workforce, as they are trained to work in auto repair shops, service centers, and technical inspection facilities. On the other hand, it provides an excellent foundation for further education, either at higher vocational schools or at technical faculties. It is this flexibility that proves that the program is successfully aligned with European educational standards and labor market needs.

The auto service technician program enables students to develop their professional identity—they become responsible, independent, and competent professionals who know how to combine theory and practice, master modern technology, and adapt to change. In this way, they not only obtain a formal title, but also knowledge and skills that ensure their success both in their professional careers and in further education.

5 Sources and literature

- https://cpi.si/wp-content/uploads/2020/08/KZ_OM_PogonskiAgregati.pdf, 10.7.2025
- Zakon o poklicnem in strokovnem izobraževanju. (2017). Uradni list RS, št. 79/2017
- European Qualifications Framework (EQF). (2008). Recommendation of the European Parliament and of the Council on the establishment of the European Qualifications Framework for lifelong learning. Official Journal of the European Union. 11. 07. 2025

Jasmina Kovač, prof.

Šolski center Celje

Srednja šola za storitvene dejavnosti in logistiko

POMEN ERASMUS+ IZMENJAV ZA IZOBRAŽEVANJE DIJAKOV LOGISTIKE

Povzetek

V prispevku je opisana izkušnja mobilnosti naših dijakov logističnega programa na Finskem v okviru projekta Erasmus+. Problematika, ki jo naslavlja, je razlika v obsegu praktičnega usposabljanja in tehnološki opremljenosti šol v Sloveniji v primerjavi s Finsko. Namen prispevka je predstaviti dobre prakse, ki so jih dijaki spoznali na Finskem, ter spodbuditi razmislek o možnih izboljšavah domačega izobraževalnega sistema. Dijaki so se na mobilnosti vključili v različne dejavnosti: simulatorji vožnje, upravljanje viličarjev in tovornjakov, delo v sodobno opremljenih skladiščih ter spoznavanje avtomatiziranih procesov in okoljsko odgovornih rešitev. Način reševanja problema temelji na neposrednem prenosu dobrih praks, opazovanju in aktivnem sodelovanju dijakov. Bistvene ugotovitve kažejo na pomen večje usmerjenosti v praktično delo, uporabo sodobne tehnologije in pomen povezovanja šole z gospodarstvom. Mobilnosti v tujino tako pomembno prispevajo k strokovni in osebni rasti dijakov ter omogočajo pridobivanje dragocenih izkušenj, ki jih lahko prenesejo v domače okolje.

***Ključne besede**: Erasmus+ mobilnosti, praktično usposabljanje, primeri dobre prakse*

1 Kaj je Erasmus+?

Erasmus+ je program Evropske unije, namenjen podpori izobraževanja, usposabljanja, mladine in športa v Evropi. Njegov glavni cilj je spodbujanje mobilnosti posameznikov za učenje in delo v tujini, krepitev znanja in veščin udeležencev ter razvoj kakovostnega in vključujočega izobraževanja. Program dijakom omogoča, da se v realnem okolju preizkusijo v strokovnih in praktičnih nalogah ter s tem izboljšajo svoje strokovne in osebnostne kompetence.

Ocenjeni proračun programa znaša 26,2 milijarde evrov. To je skoraj dvakrat več v primerjavi s predhodnim programom, ki je bil med letoma 2014 in 2020.

Program za obdobje 2021-2027 namenja velik poudarek implementaciji okolju prijaznih praks in vprašanjem trajnostnega razvoja. Okolje in boj proti podnebnim spremembam sta ključni prednostni nalogi EU. Šole in izobraževalne ustanove imajo pomembno vlogo pri prehodu k podnebni nevtralnosti do leta 2050 (evropski zeleni dogovor). Tako se povečuje mobilnost na zelenih področjih (trajnostno kmetovanje, varstvo naravnih virov) ter spodbuja ogljično nevtralnost s trajnostnimi načini prevoza. Prednost bodo imeli projekti, ki razvijajo okoljske kompetence in spreminjajo vedenjske vzorce za trajnostno prihodnost.

Drugi velik poudarek je vključevanje in raznolikost, to pomeni povečati dostopnost programa in enake možnosti za udeležence z manj priložnostmi. Evropska komisija je pripravila strategijo, ki opredeljuje osem vrst ovir: posebne potrebe, zdravstvene težave, ovire v izobraževalnem sistemu, kulturne razlike, družbene in ekonomske ovire, diskriminacijo ter geografsko odročnost. Strategija poudarja pomen individualnega pristopa in razumevanja osebnega konteksta udeležencev.

Tretji poudarek je participacija v demokratičnem življenju, skupne vrednote in državljanska angažiranost. Poleg formalnega izobraževanja program podpira tudi neformalno učenje, ki krepi socialne in medkulturne kompetence, kritično razmišljanje, medijsko pismenost ter etiko vseživljenjskega učenja.

Četrti poudarek je digitalna preobrazba, ki prinaša sodobne izobraževalne metode in orodja, hkrati pa odpira številne izzive. Ključno bo razviti učinkovit digitalni izobraževalni ekosistem, ki vključuje digitalno kompetentne izobraževalce, kakovostne vsebine ter varna in etična orodja.

Erasmus+ v skladu z Akcijskim načrtom za digitalno izobraževanje 2021–2027 podpira digitalno preobrazbo z dvema strateškima prednostnima nalogama: razvoj digitalnega izobraževalnega ekosistema in krepitev digitalnih spretnosti in pismenosti na vseh ravneh družbe.

Tudi številke iz uradnega letnega poročila 2023 nakazujejo obseg in vpliv programa. Velik finančni vložek, kar 12,5% več kot leto pred tem, mobilnosti so ponudile 1,3 milijone priložnosti za učenje (študijsko, delovno, izobraževalno) od tega več kot 200.000 udeležencev z manj priložnostmi in 23% mobilnosti je bilo izvedenih z nizkoogljičnim prevozom (vlak, avtobus, souporaba avtomobila).

Ni dvoma, da ta program pozitivno vpliva tudi na srednje poklicno izobraževanje. Krepi ključne kompetence dijakov, kot so jezikovne, digitalne in strokovne, spodbuja povezovanje šol z gospodarstvom ter prispeva k večji zaposljivosti in mobilnosti mladih. Hkrati pa podpira uvajanje inovacij ter trajnostnih praks v izobraževanje in delo.

2 Finski šolski sistem

Ena izmed destinacij, kjer opravljajo dijaki naše šole mobilnost, torej opravljanje delovne prakse v podjetju ali v ustanovi za poklicno izobraževanje, je Finska. Zdaj je že splošno znano, da nordijske države, zlasti Finska, so zgled visokokakovostnega izobraževalnega sistema, saj učenci dosegajo mednarodne uspehe, šole pa uporabljajo inovativne poučevalne pristope.

Finski izobraževalni sistem vključuje predšolsko vzgojo, predšolsko izobraževanje,

osnovnošolsko izobraževanje, splošno srednješolsko izobraževanje, poklicno izobraževanje in visokošolsko izobraževanje. Odlikuje se po celostnem in vključujočem pristopu, ki učencem na različnih stopnjah zagotavlja uravnoteženo rast in razvoj.

Vzgoja in varstvo v zgodnjem otroštvu (kot razvidno na sliki spodaj, Early Childhood Education and Care – ECEC) zagotavlja univerzalno pravico za otroke, stare od 0 do 6 let, ter združuje varstvo, vzgojo in poučevanje z možnostjo udeležbe s polnim ali krajšim delovnim časom. Predšolska vzgoja je obvezna pri šestih letih in traja eno leto.

Devetletno eno strukturno osnovnošolsko in nižje sekundarno izobraževanje poteka v splošnih šolah od sedmega leta starosti, in je brezplačno in obvezno za vse.

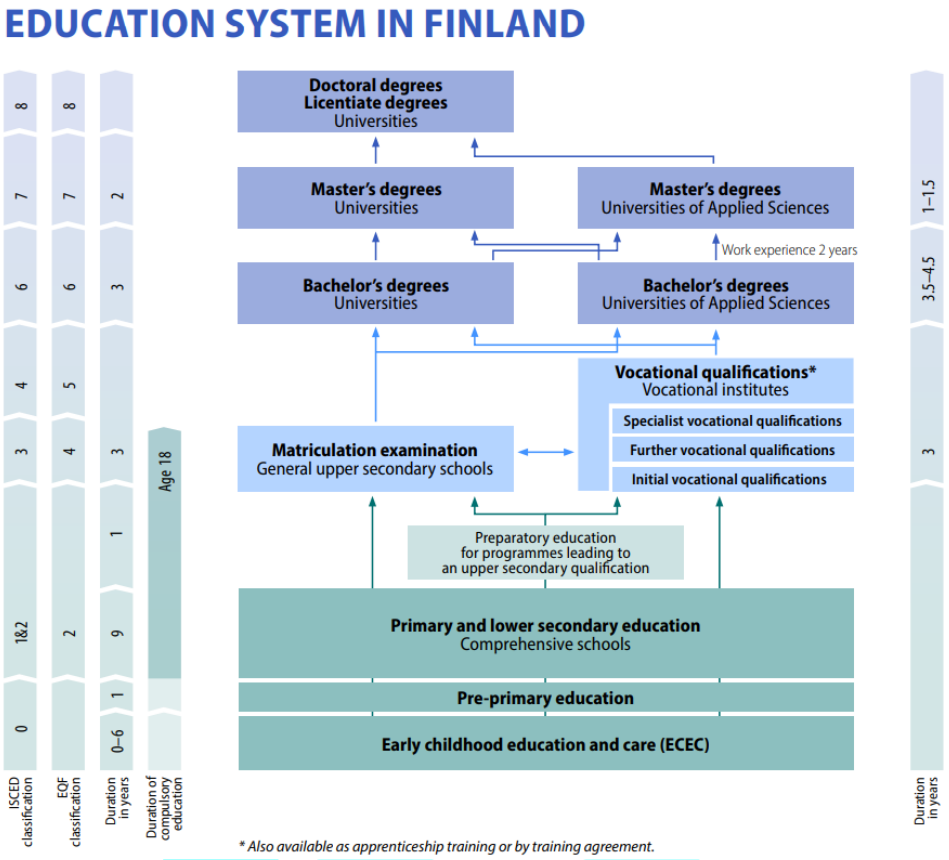
Višje sekundarno izobraževanje ponuja splošne in poklicne programe, ki so brezplačni in po končanem izobraževanju omogočajo vpis v visokošolsko izobraževanje.

Sistem visokega šolstva sestavljajo univerze in univerze uporabnih znanosti (UAS), ki imajo različne namene.

Finski izobraževalni sistem odlikujejo številne značilnosti. Pred vstopom v osnovno šolanje se otroci udeležijo enoletne obvezne priprave na šolo, ki prispeva k njihovemu uravnoteženemu razvoju. Osnovno šolanje na Finskem poteka od 7. do 16. leta starosti, pri čemer se razlikuje med razredno in višjo stopnjo. Učenci so organizirani v skupine različnih starosti, kar spodbuja medsebojno sodelovanje in omogoča učenje od starejših. Pouk poteka v 60-minutnih učnih urah, ki vključujejo odmore in čas za obrok. Ocenjevanje poteka opisno do 5. razreda, kar omogoča bolj celostno spremljanje učenčevega napredka.

Finski izobraževalni sistem vključuje tudi svetovalne ure za seznanjanje s poklici in prakso, ki učencem omogoča vpogled v različne poklice. Jezikovna raznolikost se odraža v tem, da so otroci deležni predšolskega izobraževanja v svojem maternem jeziku, bodisi v finščini, švedščini ali v laponskem jeziku. Šolska hrana je subvencionirana za vse učence, prav tako je brezplačen prevoz. Zvezki, učbeniki in računalniki so subvencionirani.

Slika 1: *Šolski sistem na Finskem* (Finsko ministrstvo za izobrazbo in kulturo, 2025)



Srednje poklicno izobraževanje ima na Finskem skoraj enako veljavo kot gimnazijsko, saj skoraj polovica učencev po osnovni šoli izbere poklicno pot.

Značilnosti poklicnih šol:

- Individualizacija učnih poti – svetovanje in usmerjanje učencev, oblikujejo si izobraževalno pot glede na svoje interese, karierne cilje in potrebe trga dela.
- Poudarek na praktičnih znanjih: več kot 50% izobraževanja poteka v obliki praktičnega usposabljanja pri delodajalcih. To je del koncepta »učenja z delom« (work-based learning).
- Fleksibilnost – programi so modularni, kar omogoča prilagoditev glede na dijakove potrebe in predhodno pridobljena znanja.
- Ocenjevanje – temelji na doseganju poklicnih standardov, ki jih oblikujejo delodajalci v sodelovanju s šolami.

Vrste poklicnih programov (tri ravni kvalifikacij):

- Osnovna poklicna kvalifikacija (initial vocational qualification)
- Nadaljnja poklicna kvalifikacija (further vocational qualification)
- Specializirana poklicna kvalifikacija (specialist vocational qualification)

Programi trajajo običajno dve do tri leta in vključujejo nacionalno določene standarde ter lokalno prilagoditev vsebin.

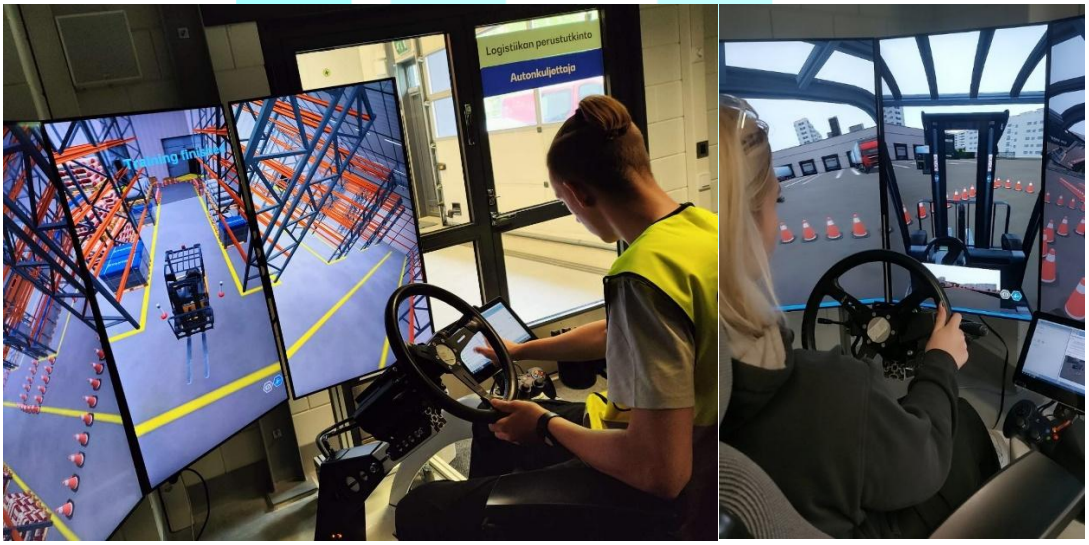
3 Izkušnja naših dijakov logistike na Finskem

Eden vidnejših primerov sodobnega poklicnega izobraževanja na Finskem je Šolski center Gradia (Jyväskylä Educational Consortium Gradia). Ponuja tako splošno izobrazbo kot različne poklicne programe kot so logistika, mehatronika, mediji, gastronomija, zdravstvo, poslovanje, izobraževanje odraslih in druga področja. Delujejo na devetih kampusih v Jyväskyläju, Jämsäju in Lievestuoreju. Imajo 22.000 študentov in 1000 zaposlenih. Šolski center sestavljajo tudi upravne in razvojne storitve, nepremičnine Gradia in restavracije Gradia. Njihov letni promet znaša približno 100 milijonov evrov.

Preko projekta Erasmus+ so naši dijaki programa logistični tehnik, v spremstvu učiteljev, opravljali 14-dnevno praktično usposabljanje z delom v šoli Gradia, Logistiikka. Dijaki so si ogledali šole Gradia v Jyväskylä, Laukaa in Jämsä. Navdušeni so bili nad sodobno opremljenimi delavnicami, skladišči, učilnicami in simulatorji.

Med aktivnostmi so izstopale vaje simulacij vožnje z viličarjem in tovornjakom, kjer so spoznali pomen pravilne uporabe kontrol in gumbov na delovnih strojih ter se preizkusili v nalogah, kot so natovarjanje in razkladanje tovora. Še posebej zanimivo je bilo natovarjanje kontejnerjev z bagrom, opazovanje delovanja avtodvigala in simulacija izpitne vožnje za kategorijo B. Prisostvovali so mestni dostavi hrane in pošte, ki jo izvajajo dijaki Gradie.

Slika 2 in 3: *Dijaki na simulatorjih* (lasten vir, 2024)



V nadaljevanju so iz simulatorjev presedlali na poligon, kjer so lahko vozili tovornjake v realnem okolju in spoznali osnovne postopke vzdrževanja vozil (pregled tekočin, čiščenje). Z viličarjem so vadili nalagati in razlagati Euro palete.

Sliki 4 in 5: Vožnja tovornjaka na poligonu in vožnja viličarja v skladišču (lasten vir, 2024)



V okviru pouka so spoznali pomen pravilne zaščitne opreme in varnostnih postopkov v skladiščih, poslovno komuniciranje v logistiki, razdeljevanje nalog, timsko delo ter pomen informacijske podpore v sodobnih logističnih sistemih. Ob tem so dijaki ugotovili, da so delovni pogoji in oprema na Finskem pogosto bolj avtomatizirani in naprednejši. Obisk logističnega sejma v Jyväskylä je to dodatno potrdil, saj so se seznanili z najnovejšimi tehnološkimi rešitvami v industriji: elektronsko vodenimi tovornjaki, avtomatiziranimi skladišči ter okoljskimi standardi, ki prispevajo k čistejšemu okolju.

Slika 6: *Logistični sejem* (lasten vir, 2024)



Erasmus+ mobilnost pa ni bila le delovna temveč tudi kulturna izkušnja. Spoznavali so znamenitosti mesta, jezera, se udeležili orientacijskih dejavnosti, športnih aktivnosti, se družili s finskimi dijaki in obiskali podjetja, kjer oni opravljajo prakso. Ob tem so ugotovili, da na Finskem namenjajo veliko večji poudarek praktičnemu usposabljanju kot v Sloveniji in imajo več možnosti, da si sami izberejo, kaj jih zanima in v čem se želijo usposabljati.

4 Zaključek

Na Finskem izobraževanje na področju logistike dijakom omogoča celovit pregled nad transportno industrijo ter jih pripravlja na delo v različnih vlogah – od voznikov

tovornjakov, avtobusov in kombiniranih vozil do strokovnjakov za notranjo logistiko in skladiščenje. Poseben poudarek je na varni uporabi strojev in opreme, upoštevanju predpisov ter usmerjenosti v storitve za stranke. Finska izobraževalna politika spodbuja tudi samostojno podjetništvo in vključevanje diplomantov v vodstvene ali nadzorne funkcije z dodatnimi kvalifikacijami.

Finski model srednjega poklicnega izobraževanja predstavlja primer dobre prakse za druge države, saj združuje visoko kakovost izobraževanja, praktično usmerjenost, povezavo s trgom dela ter prilagodljivost potrebam posameznika in družbe. Dijaki ob zaključku šolanja pridobijo kompetence, ki jim omogočajo takojšnjo zaposlitev kot nadaljevanje izobraževanja na višji ravni.

Mobilnost na Finskem je dijakom omogočila neprecenljivo izkušnjo: seznanili so se z uspešnim izobraževalnim sistemom, sodobnimi tehnološkimi rešitvami ter pridobili praktične izkušnje, ki jim bodo koristile v nadaljnji karieri. Primerjava slovenskega in finskega sistema kaže na številne priložnosti za izboljšave, predvsem na področju praktičnega usposabljanja, tehnološke posodobitve in okoljske odgovornosti. Izpostavili so pomen večje povezanosti šole z industrijo in možnost izbire specializacije že v času šolanja. Na primer na Finskem je poudarek tudi na specializaciji glede na posamezne segmente logistike: vozniki, skladiščni delavci, nadzorniki, strokovnjaki za informacijske sisteme v logistiki ter prometni inštruktorji.

Hkrati pa takšne mednarodne izmenjave na splošno nosijo velik pomen za razvoj dijakov kot posameznikov in strokovnjakov. Z obiskom tujih šol, podjetij in praks imajo dijaki priložnost spoznavati dobre prakse, nove metode poučevanja in dela, različne kulturne pristope ter vrednote. To jim omogoča širjenje obzorij, krepitev strpnosti, izboljšanje jezikovnih in komunikacijskih veščin ter razvoj samostojnosti. Znanja in izkušnje, pridobljene skozi mobilnosti, so dragocena popotnica za njihovo prihodnost in prispevajo k večji kakovosti izobraževalnih ustanov doma.

5 VIRI

https://erasmus-plus.ec.europa.eu/sl/about-erasmus/what-is-erasmus, 26. 6. 2025.

https://www.cmepius.si/mednarodno-sodelovanje/moznosti-sodelovanja/prioritete-programa-erasmus/, 26. 6. 2025.

https://erasmus-plus.ec.europa.eu/programme-guide/part-a, 26. 6. 2025.

https://www.consilium.europa.eu/en/policies/erasmus-plus-programme/, 26. 6. 2025.

https://www.oph.fi/en/education-system, 26. 6. 2025.

https://okm.fi/documents/1410845/15514014/Education+system+in+Finland/7c5a920b-47a5-c3ce-cbca-818ff3a5f848/Education+system+in+Finland.pdf?t=1663149888663, 26. 6. 2025.

https://eurydice.sio.si/tema-meseca/slovenija-finska-primerjava-sistemov-izobrazevanja-v-stevilkah/, 26. 6. 2025.

https://www.sviz.si/datot/finska-v-vrhu-znanja-nov2014.pdf, 26. 6. 2025.

https://www.gradia.fi/en, 2. 7. 2025.

Jasmina Kovač, prof.

School centre Celje, Secondary School of Services and Logistics

THE IMPORTANCE OF ERASMUS+ EXCHANGES FOR THE EDUCATION OF LOGISTICS STUDENTS

Abstract

This paper describes the mobility experience of our logistics technicians in Finland as part of the Erasmus+ project. The issue addressed is the difference in the extent of practical training and technological equipment of schools in Slovenia compared to Finland. The purpose of the paper is to present good practices that the students learnt in Finland and to encourage reflection on possible improvements to our education system. The mobility involved students in various activities: driving simulators, operating forklifts and trucks, working in modern warehouses, and learning about automated processes and environmentally responsible solutions. The problem-solving approach is based on the direct transfer of good practices, observation and active participation of the students. The key findings show the importance of a greater focus on practical work, the use of modern technology and the importance of connecting schools with industry. Mobility abroad thus makes an important contribution to students' professional and personal growth, and provides valuable experience that can be transferred to their home environment.

Keywords: *Erasmus+ mobility, practical training, examples of good practice*

1 What is Erasmus+?

Erasmus+ is the European Union's programme to support education, training, youth and sport in Europe. Its main objective is to promote the mobility of individuals to learn and work abroad, to strengthen the knowledge and skills of participants and to develop quality and inclusive education. The programme gives students the opportunity to experience professional and practical tasks in a real-life environment, thus improving their professional and personal competences.

The programme has an estimated budget of €26.2 billion. This is nearly double the funding compared to its predecessor programme, which was from 2014 to 2020.

The 2021-2027 programme places a strong emphasis on the implementation of environmentally friendly practices and sustainable development issues. The environment and the fight against climate change are key priorities for the EU. Schools and educational

institutions have an important role to play in the transition towards climate neutrality by 2050 (European Green Deal). This increases mobility in green areas (sustainable farming, protection of natural resources) and promotes carbon neutrality through sustainable modes of transport. Priority will be given to projects that develop environmental competences and change behavioural patterns for a sustainable future.

The second major focus is inclusion and diversity i.e., making the programme more accessible and providing equal opportunities for participants with fewer opportunities. The European Commission has drawn up a strategy which identifies eight types of barriers: special needs, health problems, barriers in the education system, cultural differences, social and economic barriers, discrimination and geographical remoteness. The strategy stresses the importance of an individual approach and of understanding the personal context of the participants.

The third focus is participation in democratic life, shared values and civic engagement. In addition to formal education, the programme also supports non-formal learning, which strengthens social and intercultural competences, critical thinking, media literacy and an ethics of lifelong learning.

The fourth focus is the digital transformation, which brings modern educational methods and tools, but also brings many challenges. The key will be to develop an effective digital education ecosystem that includes digitally competent educators, quality content and safe and ethical tools.

In line with the Digital Education Action Plan 2021-2027, Erasmus+ supports digital transformation with two strategic priorities: developing a digital education ecosystem and strengthening digital skills and literacy at all levels of society.

The figures from the official 2023 Annual Report also give an indication of the scope and impact of the programme. A large financial investment, 12.5% more than the year before, the mobilities offered 1.3 million learning opportunities (study, work, education) of which more than 200,000 were for participants with fewer opportunities, and 23% of the mobilities were carried out by low-carbon transport (train, bus, car sharing).

There is no doubt that this programme also has a positive impact on secondary vocational education. It strengthens students' key competences such as linguistic, digital and professional skills, promotes the link between schools and industry, and contributes to increasing young people's employability and mobility. At the same time, it supports the introduction of innovation and sustainable practices in education and work.

2 The Finnish School System

One of the destinations where our students do their mobility i.e., work placements in a company or vocational training institution, is Finland. It is now widely recognised that the Nordic countries, and Finland in particular, are a model of a high-quality education system, with students achieving international success, and schools using innovative teaching approaches.

The Finnish education system includes early childhood education and care, pre-primary education, primary and lower secondary education, general upper secondary education, vocational education and higher education. It is distinguished by its comprehensive and inclusive approach, ensuring balanced growth and development for pupils at different

stages.

Early Childhood Education and Care (ECEC) provides a universal entitlement for children aged 0-6 years and combines care, education and teaching with the possibility of full-time or part-time participation, as shown in the figure below. Pre-primary education is compulsory at the age of six and lasts for one year.

Comprehensive school education (primary and lower secondary education) consists of school year 1 to 9 and it is free of charge and compulsory for all.

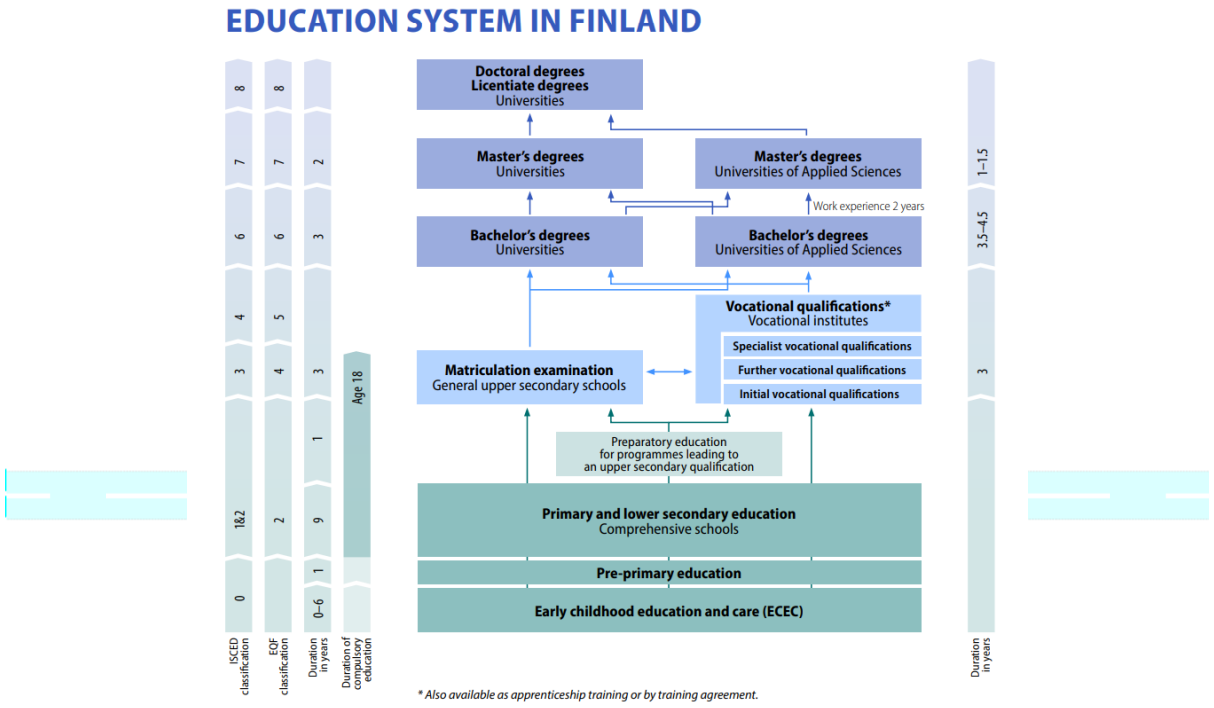
Upper secondary education offers general and vocational programmes, which are free of charge and lead to entry into higher education.

The higher education system consists of universities and universities of applied sciences (UAS), each have different purposes.

The Finnish education system is characterised by a number of features. Before entering primary school, children have a year of compulsory school preparation, which contributes to their balanced development. Primary schooling in Finland runs from 7 to 16 years of age, with a distinction between primary and secondary school. Pupils are organised in groups of different ages, which encourages interaction and enables them to learn from older pupils. Lessons are taught in 60-minute periods, including breaks and meal times. Assessment is descriptive up to grade 5, allowing for a more comprehensive monitoring of pupils' progress.

The Finnish education system also includes career guidance and practice classes, giving them an insight into different professions. Linguistic diversity is reflected in the fact that children receive pre-primary education in their mother tongue, whether Finnish, Swedish or Sami language. School meals are subsidised for all pupils and transport is free. Notebooks, textbooks and computers are also subsidised.

Figure 1: *Education system in Finland* (Ministry of Education and Culture, 2025)



Secondary vocational education is almost as important as grammar school in Finland, with almost half of pupils choosing a career after primary school.

Characteristics of vocational schools:

- Individualisation of learning pathways - students are advised and guided, they design their educational pathway according to their interests, career goals and labour market needs.
- Emphasis on practical skills: more than 50% of education takes the form of practical training with employers. This is part of the concept of "work-based learning".
- Flexibility - the programmes are modular, allowing them to be tailored to the student's needs and prior knowledge.
- Assessment - based on the achievement of vocational standards, which are developed by employers in collaboration with schools.

Types of vocational programmes (three levels of qualifications):

- Initial Vocational Qualification
- Further vocational qualification
- Specialist vocational qualification

Programmes usually last two to three years and include nationally defined standards and local adaptation of content.

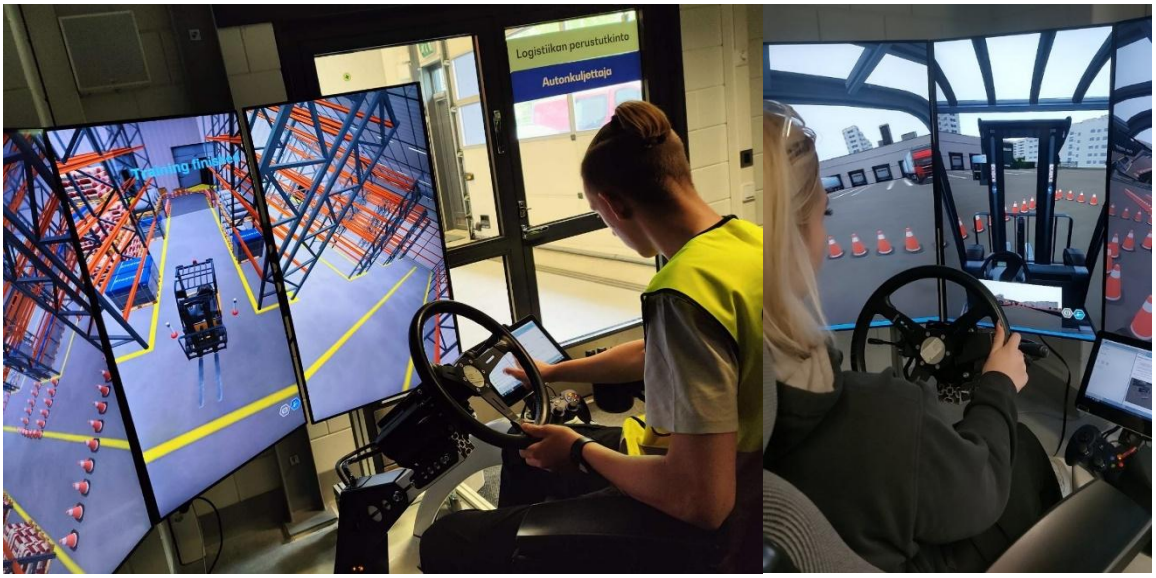
3 The experience of our logistics students in Finland

One of the most prominent examples of modern vocational education in Finland is the Gradia School Centre (Jyväskylä Educational Consortium Gradia), which offers general education as well as a variety of vocational programmes such as logistics, mechatronics, media, gastronomy, healthcare, business, adult education and other areas. They operate on nine campuses in Jyväskylä, Jämsä and Lievestuore. They have 22,000 students and 1,000 staff members. The school centre also consists of administrative and development services, Gradia properties and Gradia restaurants. Their annual turnover is approximately €100 million.

As part of the Erasmus+ project, our Logistics Technician students, accompanied by their teachers, completed a 14-day practical training with work at Gradia School, Logistiikka. The students visited Gradia schools in Jyväskylä, Laukaa and Jämsä. They were impressed by the modern workshops, warehouses, classrooms and simulators.

Among the activities, the forklift and truck driving simulation exercises stood out, where they learnt the importance of the correct use of the controls and buttons on the working machines and test their selves at tasks such as loading and unloading cargo. Particularly interesting were loading containers with an excavator, observing the operation of an auto-truck and simulating the driving test for category B. They witnessed a city food and mail delivery by Gradia students.

Figure 2 and 3*: Students on simulators* (own source, 2024)



Next, they moved from the simulators to the training ground where they could drive trucks in a real environment, and learn basic vehicle maintenance procedures (checking fluids, cleaning). And with a forklift, they practised loading and unloading Euro pallets.

Figures 4 and 5: Driving a truck on the training ground, and driving a forklift in the warehouse (own source, 2024)



During the lessons, they learnt about the importance of proper protective equipment and safety procedures in warehouses, business communication in logistics, task distribution, teamwork and the importance of IT support in modern logistics systems. In doing so, the students discovered that working conditions and equipment in Finland are often more automated and advanced. A visit to the logistics fair in Jyväskylä further confirmed this, as they learned about the latest technological solutions in the industry: electronically controlled trucks, automated warehouses, and environmental standards that contribute to a cleaner environment.

Figure 6: *Logistics fair* (own source, 2024)



Erasmus+ mobility was not only a work experience but also a cultural one. The students explored the sights of the city and its lakes, took part in orientation and sports activities, socialised with Finnish students, and visited companies where their Finnish peers do their internships. They also found out that in Finland, there is much more emphasis on practical training than in Slovenia, and that they have more opportunities to choose what interests them, and in which areas they wish to gain skills.

4 Conclusion

In Finland, education in the field of logistics provides students with a comprehensive overview of the transport industry and prepares them for a variety of roles - from truck, bus and forklift drivers to in-house logistics and warehousing professionals. Particular emphasis is placed on the safe use of machinery and equipment, compliance with regulations and customer service orientation. Finnish education policy also encourages self-employment and the integration of graduates into managerial or supervisory roles with additional qualifications.

The Finnish model of secondary vocational education is an example of good practice for other countries, combining high quality education, practical orientation, links to the labour market and adaptability to the needs of the individual and society. After graduation, students acquire competences that enable them to find immediate employment as a continuation of their education at a higher level.

Mobility in Finland provided an invaluable experience for the students: they were introduced to a successful education system, modern technological solutions, and gained practical experience that will benefit them in their future careers. A comparison of the Slovenian and Finnish systems shows many opportunities for improvement, especially in the areas of practical training, technological modernisation and environmental responsibility. The importance of greater links between schools and industry and the possibility of choosing a specialisation during school were highlighted. In Finland, for example, there is also an emphasis on specialisation according to the different segments of logistics: drivers, warehouse workers, supervisors, logistics information systems specialists and driving instructor.

At the same time, such international exchanges are generally of great importance for the development of students as individuals and professionals. By visiting foreign schools, companies and practices, students have the opportunity to learn about good practices, new teaching and working methods, different cultural approaches and values. This allows them to broaden their horizons, build tolerance, improve their language and communication skills and develop their independence. The knowledge and experience gained through mobility is a valuable asset for their future and contributes to the quality of educational institutions at home.

SOURCES

https://erasmus-plus.ec.europa.eu/sl/about-erasmus/what-is-erasmus, 26. 6. 2025.

https://www.cmepius.si/mednarodno-sodelovanje/moznosti-sodelovanja/prioritete-programa-erasmus/, 26. 6. 2025.

https://erasmus-plus.ec.europa.eu/programme-guide/part-a, 26. 6. 2025.

https://www.consilium.europa.eu/en/policies/erasmus-plus-programme/, 26. 6. 2025.

https://www.oph.fi/en/education-system, 26. 6. 2025.

https://okm.fi/documents/1410845/15514014/Education+system+in+Finland/7c5a920b-47a5-c3ce-cbca-818ff3a5f848/Education+system+in+Finland.pdf?t=1663149888663, 26. 6. 2025.

https://eurydice.sio.si/tema-meseca/slovenija-finska-primerjava-sistemov-izobrazevanja-v-stevilkah/, 26. 6. 2025.

https://www.sviz.si/datot/finska-v-vrhu-znanja-nov2014.pdf, 26. 6. 2025.

https://www.gradia.fi/en, 2. 7. 2025.

Danica Kozel, prof.
Šolski center Celje
Srednja šola za storitvene dejavnosti in logistiko

VPLIV MASE TOVORNEGA VOZILA NA ZAVORNO POT:

ZAKAJ JE PREOBREMENITEV VOZILA NEVARNA

Povzetek

Ta prispevek raziskuje vpliv mase tovornega vozila na zavorno pot, s posebnim poudarkom na preobremenjenih tovornih vozilih.

Fizikalno je dokazano, da se zavorna pot veča s kvadratom začetne hitrosti vozila, z manjšanjem pojemka in z manjšimi koeficienti trenja.

Pri preobremenjenih tovornih vozilih je zavorna pot odvisna tudi od mase vozila zaradi večje začetne kinetične energije ter preobremenjenosti in pregrevanja zavornega sistema.

Pomembno je spoštovanje omejitev mase tovornega vozila, ker ima masa vozila velik vpliv na prometno varnost.

Ključne besede: *promet, fizika, reakcijska pot, zavorna pot, pot ustavljanja*

1 UVOD

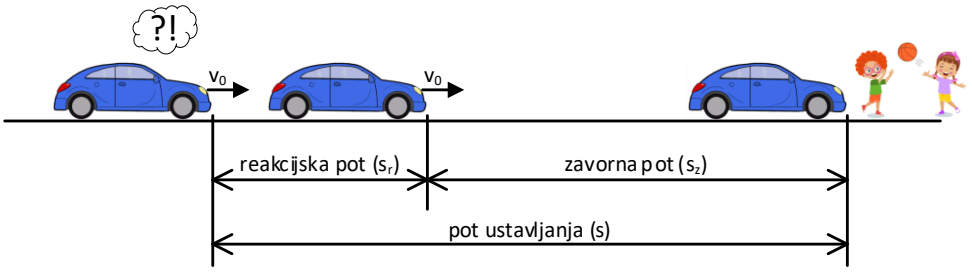
Na Srednji šoli za storitvene dejavnosti in logistiko Celje izobražujemo za poklica logistični tehnik in avtoservisni tehnik. Dijaki, ki obiskujejo program logistični tehnik, imajo v učnem načrtu predvidenih 140 ur, avtoservisni tehniki pa 70 ur fizike.

V obeh programih obravnavamo dve veliki poglavji; Premo in krivo gibanje ter Sile in gibanje.

Veliko pozornosti posvetimo vsebinam iz področja varnosti v prometu. Te vsebine so dijakom privlačne, saj so tesno povezane z njihovim poklicnim področjem.

2 ZAVORNA POT V TEORIJI

- Pot ustavljanja (s) na Sliki 1 je razdalja, ki jo vozilo prevozi od trenutka, ko voznik zazna oviro, do trenutka, ko se vozilo ustavi.
- Reakcijska pot (s_r) je razdalja, ki jo vozilo prevozi od trenutka, ko voznik zazna oviro do trenutka, ko voznik pritisne na stopalko zavore.
- Vozilo prevozi reakcijsko pot v reakcijskem času t_r, ki je sestavljen iz reakcijskega časa voznika in odzivnega časa zavornega sistema.
- Zavorna pot (s_z) je razdalja, ki jo vozilo prevozi od trenutka, ko je voznik z nogo pritisnil na stopalko zavore, do popolne ustavitve vozila. Odvisna je od hitrosti vozila, stanja zavor in pnevmatik ter stanja prometne površine. Zavorno pot prevozi v času t_z.



Slika 1: Prikaz osnovnih pojmov (vir: lastni)

Pri pouku fizike izpeljemo zavorno pot avtomobila (vozila) po spodnjem postopku, pri čemer predpostavimo, da ima vozilo v trenutku, ko voznik zazna oviro hitrost v_0 in da je gibanje enakomerno pojemajoče.

Pot ustavljanja izračunamo po enačbi:

$$s = v_0 \cdot t_r + \frac{a \cdot {t_z}^2}{2} . \qquad (1)$$

Zavorno pot predstavlja drugi člen v zgornji enačbi in jo izračunamo po enačbi:

$$s_z = \frac{a}{2} \cdot {t_z}^2 . \qquad (2)$$

Čas zaviranja t_z izračunamo iz hitrosti in pojemka:

$$v = v_0 - a \cdot t_z , \; v_0 = a \cdot t_z \rightarrow t_z = \frac{v_0}{a} . \qquad (3)$$

Če v enačbo $s_z = \frac{a}{2} \cdot {t_z}^2$ vstavimo $t_z = \frac{v_0}{a}$, dobimo enačbo za zavorno pot:

$$s_z = \frac{{v_0}^2}{2a} . \qquad (4)$$

Ugotovimo, da je zavorna pot odvisna od hitrosti vozila v_0 in od pojemka a.

Dijaki so presenečeni nad ugotovitvijo, da zavorna pot narašča s kvadratom hitrosti.

Pojemek a izpeljemo iz II. Newtonovega zakona $F_{tr} = m \cdot a , \; k_{tr} \cdot m \cdot g = m \cdot a , \; a = k_{tr} \cdot g.$

Če enačbo, s katero izračunamo pojemek, vstavimo v enačbo s katero izračunamo zavorno pot, dobimo:

$$s_z = \frac{{v_0}^2}{2 \cdot k_{tr} \cdot g} . \qquad (5)$$

Koeficient trenja med pnevmatiko in asfaltom je odvisen od vrste in kvalitete pnevmatik, kvalitete asfalta in vremenskih okoliščin. Povprečni koeficienti trenja med pnevmatiko in asfaltom so 0,7 za suh asfalt 0,4 za moker asfalt in 0,1 za poledeneli asfalt. [1]

Iz izpeljane enačbe za zavorno pot sledi, da lahko zavorno pot skrajšamo z zmanjšanjem hitrosti ali z velikimi pojemki. Maksimalni pojemek je odvisen od stanja prometne površine (suha, mokra, poledenela, posuta) in vozila (vrsta pnevmatik, obrabljenost pnevmatik, zavorni sistem) in ni odvisen od voznika. Od voznika je odvisna samo hitrost vozila.

V spodnji Tabeli 1 so navedene vrednosti pojemkov za osebne avtomobile in motorna kolesa

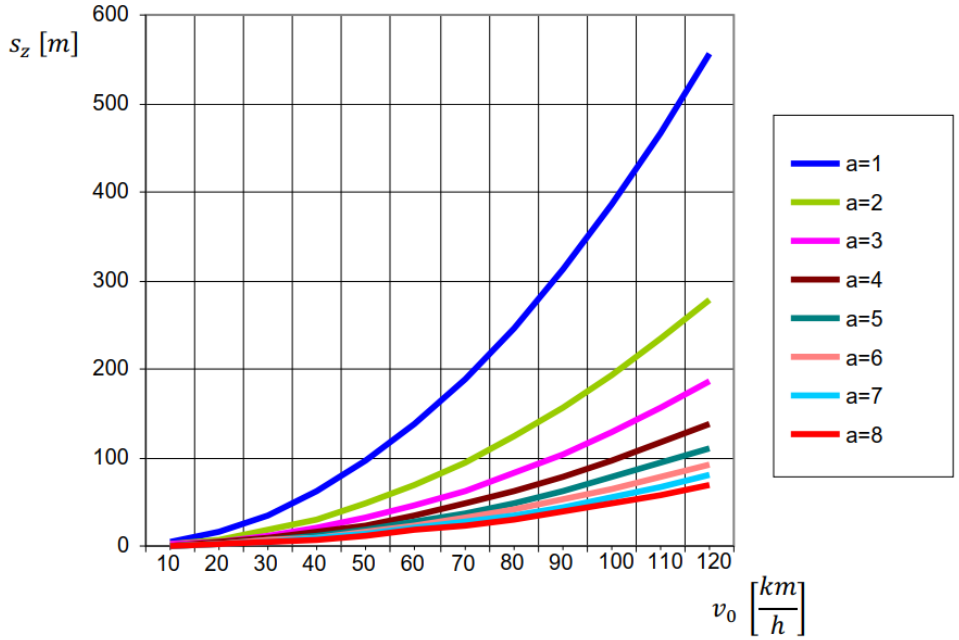
pri različnih voznih pogojih in maksimalnem zaviranju.

za osebni avtomobil	a $\left[\frac{m}{s^2}\right]$
suh beton, kvalitetne letne pnevmatike	≈ 8
suh beton, zimske pnevmatike	≈ 7
moker beton, čist	≈ 4
moker beton, umazan	≈ 3
novo zapadel sneg, letne pnevmatike	≈ 2
novo zapadel sneg, zimske pnevmatike	≈ 3
led, zvožen sneg, letne ali zimske pnevmatike	≈ 2
gladek led, letne ali zimske pnevmatike	≈ 1
za motorno kolo (dobri vozni pogoji)	≈ 4 - 6

Tabela 1: Vrednosti pojemkov pri maksimalnem zaviranju [2]

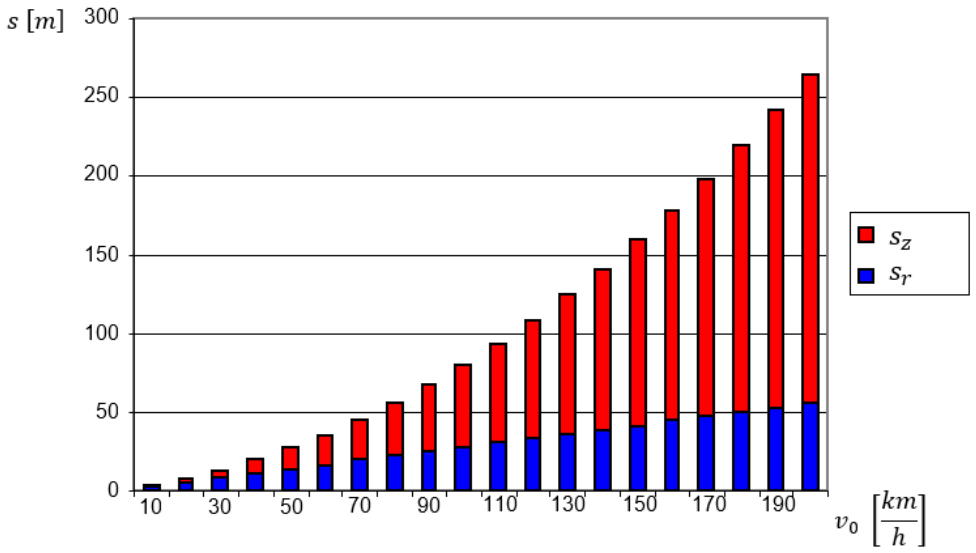
Za tovorna vozila, ki so obravnavana v tem članku, je v literaturi [3] podana povprečna vrednost pojemka v območju $0{,}45g$ - $0{,}55g$. V tuji literaturi so pojemki včasih podani v enotah g, kjer je 1 g =9,81 $\frac{m}{s^2}$. To pomeni, da je povprečna vrednost pojemka tovornega vozila v območju približno 4 - 5 $\frac{m}{s^2}$.

Zavorno pot lahko izračunamo po enačbi (4): $s_z = \frac{{v_0}^2}{2a}$. Spodnji Graf 1 nam prikazuje zavorne poti pri različnih hitrostih in različnih pojemkih. Pojemki a so podani v $\frac{m}{s^2}$.



Graf 1: Zavorna pot pri različnih hitrostih in različnih pojemkih (vir: lastni)

Spodnji Graf 2 kaže, da pri poti ustavljanja večji delež poti predstavlja zavorna pot.



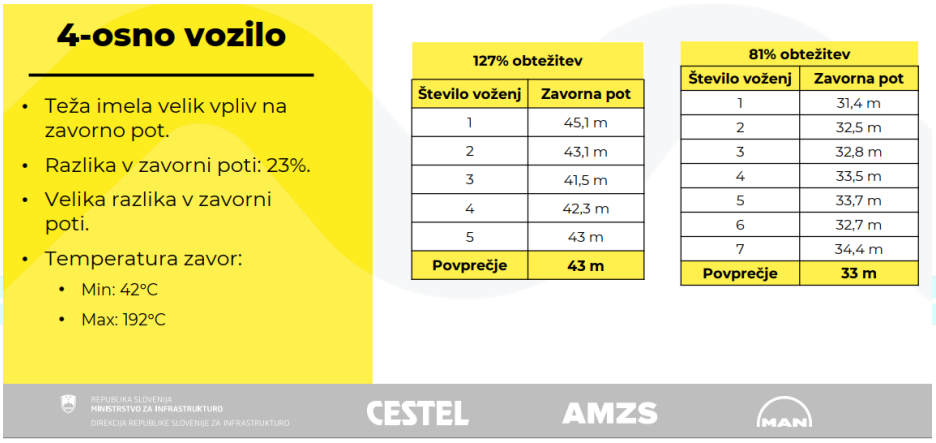
Graf 2: Pot ustavljanja pri različnih hitrostih (vir: lastni)

3 ZAVORNA POT V PRAKSI

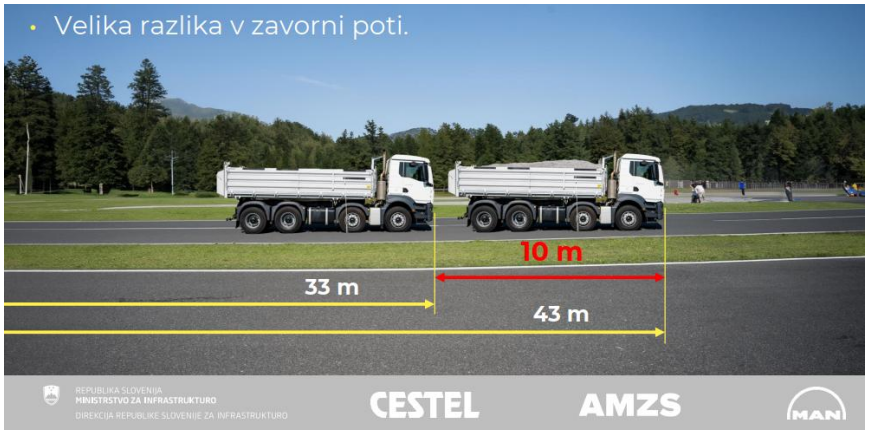
V teoriji velja, da masa vozila ne vpliva na zavorno pot vozila. Direkcija Republike Slovenije za infrastrukturo (Ministrstvo za infrastrukturo) je leta 2024 izvedla projekt na temo zavorne poti preobremenjenih tovornih vozil in z eksperimentom ugotovila, da se zavorna pot preobremenjenih tovornih vozil daljša [4].

Opravili so testne vožnje z 2-osnimi, 4-osnimi in 5-osnimi tovornimi vozili, ki so najbolj pogosti tipi vozil in so tudi največkrat preobtežena. Meritve so opravili pri najboljših možnih voznih pogojih, pri približno 80 % in pri približno 130 % obtežitvi ter pri začetni hitrosti približno 80 km/h. Ugotovili so, da pri preobremenjenih 2-osnih vozilih masa nima pomembnega vpliva na zavorno pot, medtem, ko pri 4-osnih in 5-osnih vozilih masa pomembno vpliva na zavorno pot tovornega vozila.

Rezultati meritev pri 4-osnem vozilu so podani v tabelah na spodnji Sliki 2. Grafični prikaz razlike v zavorni razdalji v odvisnosti od obtežitve vozila je prikazan na Sliki 3.



Slika 2: Zavorne poti 4-osnega tovornega vozila pri različni obtežitvi [4]



Slika 3: Zavorna pot 4-osnega tovornega vozila [4]

V zaključnem poročilu projekta so med drugim zapisali, da je nujno potrebno izobraževanje vseh udeležencev v prometu in izobraževanje odločevalcev.

Ker bodo naši dijaki v bodoče zelo verjetno v obeh omenjenih skupinah, smo pri pouku poskušali razčleniti in opisati, zakaj masa vozila vpliva na zavorno pot.

Kinetično energijo tovornega vozila izračunamo po enačbi:

$$W_k = \frac{mv^2}{2} . \qquad (6)$$

Za pojemajoče gibanje vozila, ki se na koncu ustavi, se izrek o kinetični energiji zapiše:

$$W_{k1} + A_{vseh} = 0 . \qquad (7)$$

V delu vseh zunanjih sil je zastopano delo sile trenja in delo sile zračnega upora, ki zavirata gibanje vozila. Obe sili opravljata negativno delo, zato se kinetična energija vozila manjša.

Ko voznik pritisne na zavorni pedal, zavorni sistem ustvari silo trenja med zavornimi ploščicami in diski ali bobni. Sila trenja znotraj zavornega sistema je notranja sila, ki upočasni vrtenje koles ali jih zablokira, kar povzroči zmanjšanje hitrosti vozila.

Med pnevmatikami in cesto deluje sila trenja, ki je pri zaviranju najpomembnejša zunanja sila, deluje v nasprotni smeri gibanja in povzroča pojemek.

Izrek o kinetični energiji iz enačbe (7) lahko v nadaljevanju zapišemo v obliki:

$$W_{k1} + A_{tr} = 0 . \qquad (8)$$

Delo A_{tr}, ki ga mora opraviti sila trenja na zavorni poti s_z izračunamo po enačbi:

$$A_{tr} = F_{tr} \cdot s_z \cdot \cos 180^\circ . \qquad (9)$$

Izrek o kinetični energiji dobi obliko:

$W_{k1} + F_{tr} \cdot s_z \cdot \cos 180^\circ = 0$ oziroma

$$W_{k1} = F_{tr} \cdot s_z . \qquad (10)$$

Pri preobremenjenem vozilu se zaradi povečane mase poveča začetna kinetična energija, katero mora celotni zavorni sistem zmanjšati na nič.

To pomeni, da je za ustavitev vozila potrebna večja sila trenja F_{tr} oziroma daljša zavorna pot s_z.

Po zakonu o ohranitvi energije se celotna energija sistema (vozilo + zavorni sistem + cesta + zrak) ohranja. V tem primeru se kinetična energija vozila pretvori v druge oblike energije. Kinetična energija vozila se zaradi trenja pretvori predvsem v toploto. Majhen del energije se lahko sprosti tudi kot zvok (škripanje zavor).

Zakon o ohranitvi energije lahko zapišemo:

$$W_{k1} = Q. \qquad (11)$$

Ta primer jasno kaže, kako se mehanska energija (kinetična energija) pretvori v toploto Q zaradi dela, ki ga opravi sila trenja. Energija ni izginila, temveč se je le spremenila njena oblika.

Pri daljšem ali intenzivnem zaviranju pride v zavornih elementih zavornega sistema vozila do povečanega sproščanja toplote in segrevanja zavor. Pregrevanje zmanjša koeficient trenja zavornega materiala, kar zmanjša zavorno učinkovitost in podaljša zavorno pot.

Dodatna masa tovora, še posebej, če ni pravilno porazdeljena, lahko premakne težišče vozila. Če se težišče vozila premakne, se spremeni obremenjenost posameznih osi, kar vpliva tudi na učinkovitost zaviranja.

Dodatna masa oziroma preobremenjenost vozila lahko vpliva na stabilnost vozila med zaviranjem in lahko povzroči, da se vozilo nagne ali da voznik celo izgubi nadzor nad njim.

Čeprav se reakcijski čas voznika ne spremeni, se lahko zavorni sistem zaradi preobremenitve odzove počasneje, kar lahko še podaljša zavorno pot.

4 ZAKLJUČEK

V tem prispevku je fizikalno dokazano, da je zavorna pot vozila odvisna od kvadrata hitrosti vozila, od pojemka in od koeficienta trenja med pnevmatikami in vozišče.

Kljub temu, da v enačbi za zavorno pot masa vozila ne nastopa, ta pri preobremenjenem tovornem vozilu pomembno vpliva na zavorno pot, zaradi večje začetne kinetične energije, preobremenjenosti zavornega sistema, pregrevanja zavor in drugih dejavnikov.

Zato je pomembno, da dijake v okviru učnega procesa, ki ga izvajamo na naši šoli, seznanimo tako s teoretičnimi kot tudi praktičnimi znanji s tega področja.

5 LITERATURA IN VIRI

1. https://www.tecajcpp.com/cpp/hitrost.php, 5. 6. 2025.
2. Kunze H., Tentschert H. H.; Projekt Verkehr, Verlag Hölder-Pichler-Tempsky, Wien, 1999.
3. https://www.ccmta.ca/web/default/files/PDF/Report-20.pdf, 5. 6. 2025.
4. https://www.gov.si/assets/organi-v-sestavi/DRSI/Novice-DRSI/2024/Zavorna-pot/Zavorna-Pot.pdf, 1. 6. 2025.

Danica Kozel, professor
SCHOOL CENTRE CELJE
Secondary school for service activities and logistics

IMPACT OF TRUCK WEIGHT ON BRAKING DISTANCE:

WHY OVERLOADING A VEHICLE IS DANGEROUS

Abstract

This paper explores the impact of truck weight on braking distance, with a particular focus on overloaded trucks.

It has been physically proven that braking distance increases with the square of the vehicle's initial speed, with decreasing deceleration and with lower coefficients of friction.

In overloaded trucks, the braking distance also depends on the vehicle's mass due to higher initial kinetic energy and overloading and overheating of the braking system.

It is important to comply with truck weight limits because vehicle mass has a significant impact on traffic safety.

Keywords: *traffic, physics, reaction distance, braking distance, stopping distance*

1 INTRODUCTION

At the Secondary school for service activities and logistics in Celje, we train students for careers as logistics technicians and car service technicians. Students enrolled in the logistics technician program have 140 hours of physics in their curriculum, while car service technicians have 70 hours.

In both programs, we cover two major topics: Straight and Curved Motion and Forces and Motion.

We devote a lot of attention to topics related to traffic safety. These topics are appealing to students because they are closely related to their professional field.

2 BRAKING DISTANCE IN THEORY

The stopping distance (s) in Figure 1 is the distance travelled by the vehicle from the moment the driver perceives an obstacle to the moment the vehicle stops.

The reaction distance (s_r) is the distance travelled by the vehicle from the moment the driver perceives an obstacle to the moment the driver presses the brake pedal.

The vehicle travels the reaction distance in the reaction time t_r, which consists of the driver's reaction time and the response time of the braking system.

The braking distance (s_z) is the distance travelled by the vehicle from the moment the driver presses the brake pedal until the vehicle comes to a complete stop. It depends on the speed of the vehicle, the condition of the brakes and tyres, and the condition of the road surface. The braking distance is travelled in time t_z.

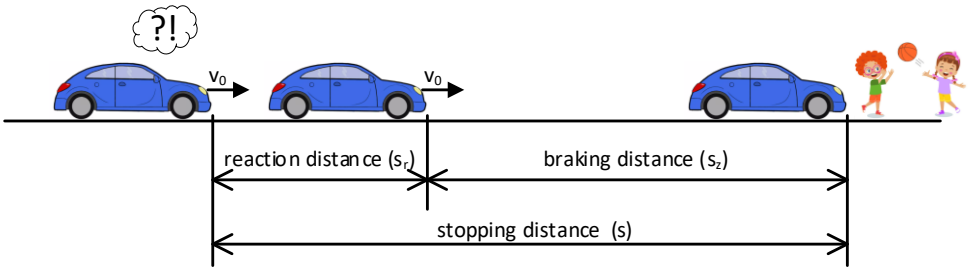


Figure 1: Illustration of basic concepts (source: own)

In physics class, we calculate the braking distance of a car (vehicle) using the procedure below, assuming that the vehicle has a speed v_0 at the moment the driver detects an obstacle and that the movement is uniformly decelerating.

The stopping distance is calculated using the equation:

$$s = v_0 \cdot t_r + \frac{a \cdot {t_z}^2}{2} . \qquad (1)$$

The braking distance is the second term in the above equation and is calculated using the equation:

$$s_z = \frac{a}{2} \cdot {t_z}^2 . \qquad (2)$$

We calculate the braking time t_z from the speed and deceleration:

$$v = v_0 - a \cdot t_z , \; v_0 = a \cdot t_z \rightarrow t_z = \frac{v_0}{a} . \qquad (3)$$

If we insert $t_z = \frac{v_0}{a}$ into the equation $s_z = \frac{a}{2} \cdot {t_z}^2$, we obtain the equation for the braking distance:

$$s_z = \frac{{v_0}^2}{2a} . \qquad (4)$$

We find that the braking distance depends on the speed of the vehicle v_0 and on the deceleration a.

Students are surprised to find that the braking distance increases with the square of the speed.

We derive deceleration a from Newton's second law $F_{tr} = m \cdot a$, $k_{tr} \cdot m \cdot g = m \cdot a$, $a = k_{tr} \cdot g$.

If we insert the equation used to calculate the deceleration into the equation used to calculate the braking distance, we get:

$$s_z = \frac{{v_0}^2}{2 \cdot k_{tr} \cdot g} . \qquad (5)$$

The coefficient of friction between the tire and the asphalt depends on the type and quality of the tires, the quality of the asphalt, and the weather conditions. The average coefficients of friction between the tire and the asphalt are 0.7 for dry asphalt, 0.4 for wet asphalt, and 0.1 for icy asphalt. [1]

From the derived equation for braking distance, it follows that the braking distance can be

shortened by reducing speed or by applying heavy deceleration. The maximum deceleration depends on the condition of the road surface (dry, wet, icy, covered with debris) and the vehicle (type of tires, tire wear, braking system) and does not depend on the driver. Only the speed of the vehicle depends on the driver.

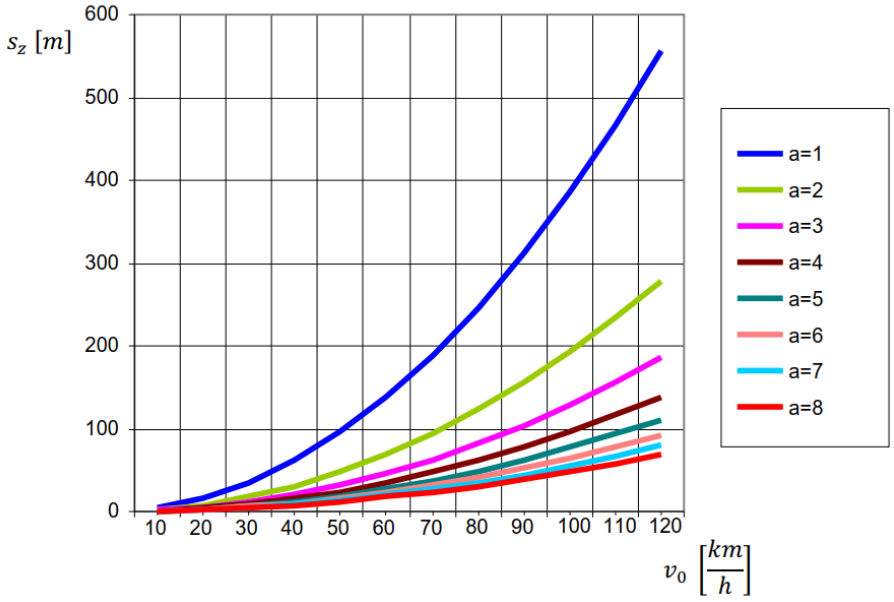
Table 1 below shows the deceleration values for passenger cars and motorcycles under various driving conditions and maximum braking.

For passenger cars	a $\left[\frac{m}{s^2}\right]$
dry concrete, high-quality summer tires	≈ 8
dry concrete, winter tires	≈ 7
wet concrete, clean	≈ 4
wet concrete, dirty	≈ 3
freshly fallen snow, summer tires	≈ 2
freshly fallen snow, winter tires	≈ 3
ice, packed snow, summer or winter tires	≈ 2
Smooth ice, summer or winter tires	≈ 1
For motorcycles (good driving conditions)	≈ 4 - 6

Table 1: Deceleration values at maximum braking [2]

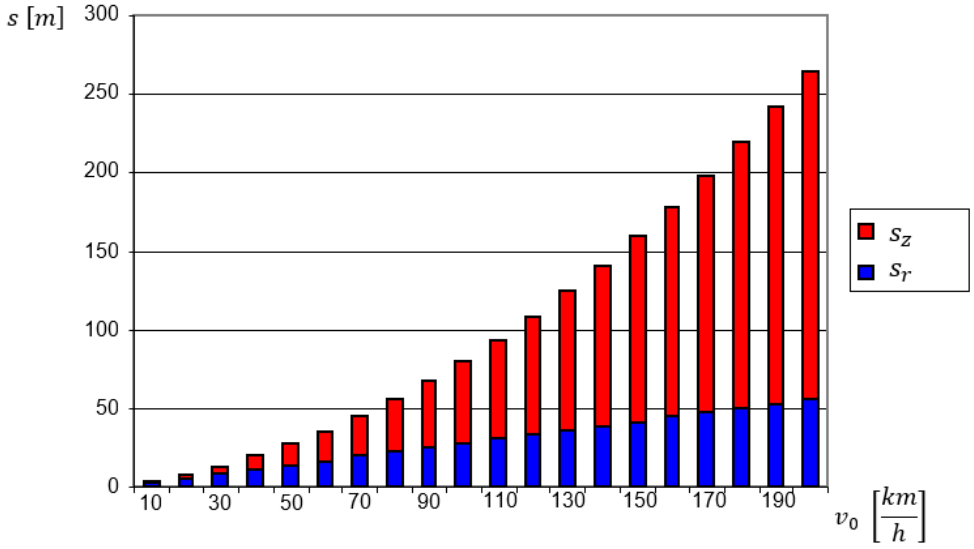
For the trucks discussed in this article, the literature [3] gives an average deceleration value in the range of 0,45g - 0,55g. In foreign literature, deceleration values are sometimes given in g units, where 1 g =9,81 $\frac{m}{s^2}$. This means that the average deceleration value for a truck is in the range of approximately 4 - 5 $\frac{m}{s^2}$.

The braking distance can be calculated using equation (4): $s_z = \frac{{v_0}^2}{2a}$. Graph 1 below shows the braking distances at different speeds and different decelerations. The decelerations a are given in $\frac{m}{s^2}$.



Graph 1: Braking distance at different speeds and different decelerations (source: own)

The Graph 2 below shows that the braking distance accounts for a larger proportion of the stopping distance.



Graph 2: Stopping distance at different speeds (source: own)

3 BRAKING DISTANCE IN PRACTICE

In theory, the mass of a vehicle does not affect its braking distance. In 2024, the Infrastructure Directorate of the Republic of Slovenia (Ministry of Infrastructure) carried out a project on the braking distance of overloaded trucks and found through experimentation that the braking distance of overloaded trucks is longer [4].

Test drives were carried out with 2-axle, 4-axle, and 5-axle trucks, which are the most common types of vehicles and are also the most frequently overloaded. The measurements were taken under the best possible driving conditions, at approximately 80% and 130% load, and at an initial speed of approximately 80 km/h. It was found that in overloaded 2-axle vehicles, mass has no significant effect on braking distance, while in 4-axle and 5-axle

vehicles, mass has a significant effect on the braking distance of the truck.

The measurement results for the 4-axle vehicle are shown in the tables in Figure 2 below. A graphical representation of the difference in braking distance depending on the vehicle load is shown in Figure 3.

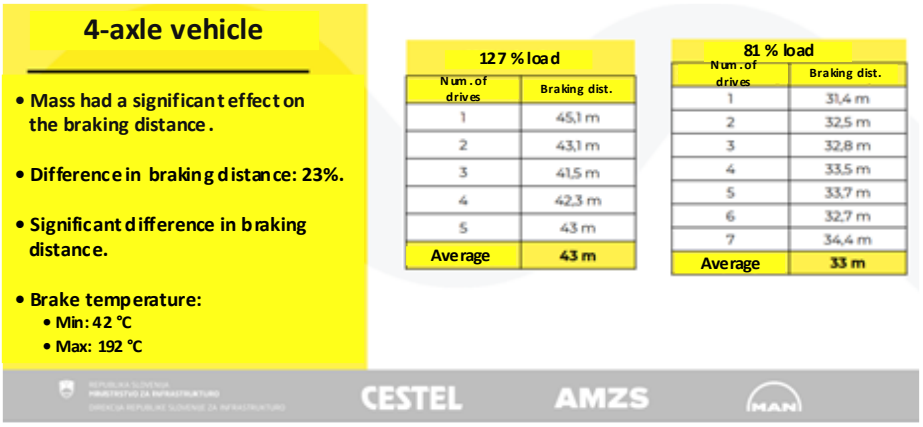


Figure 2: Braking distances of a 4-axle truck at different loads [4]

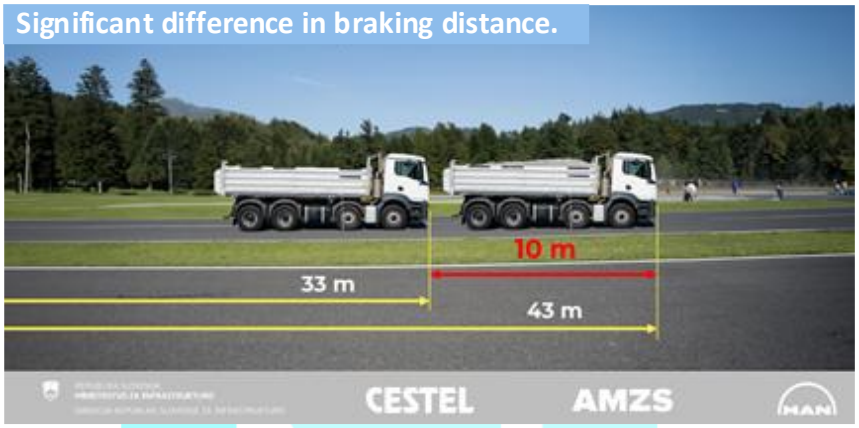


Figure 3: Braking distance of a 4-axle truck [4]

The final project report states, among other things, that it is essential to educate all road users and decision-makers.

Since our students will most likely be in both of these groups in the future, we tried to analyze and describe in class why the mass of a vehicle affects its braking distance.

The kinetic energy of a truck is calculated using the following equation:

$$W_k = \frac{mv^2}{2} . \qquad (6)$$

For a decelerating vehicle that comes to a stop, the kinetic energy is expressed as follows:

$$W_{k1} + A_{vseh} = 0 . \qquad (7)$$

The work of all external forces includes the work of friction and the work of air resistance, which slow down the vehicle. Both forces perform negative work, so the kinetic energy of the vehicle decreases.

When the driver presses the brake pedal, the brake system creates friction between the brake pads and discs or drums. The friction force within the brake system is an internal force that

slows down or locks the wheels, causing the vehicle to slow down.

A frictional force acts between the tires and the road, which is the most important external force during braking, acting in the opposite direction of movement and causing deceleration.

The kinetic energy theorem from equation (7) can be written in the following form:

$$W_{k1} + A_{tr} = 0\ . \qquad (8)$$

The work A_{tr} that must be done by the friction force on the braking distance s_z is calculated using the equation:

$$A_{tr} = F_{tr} \cdot s_z \cdot \cos 180^{\circ}\ . \qquad (9)$$

The kinetic energy theorem takes the form:

$W_{k1} + F_{tr} \cdot s_z \cdot \cos 180^{\circ} = 0$ respectively

$$W_{k1} = F_{tr} \cdot s_z\ . \qquad (10)$$

In an overloaded vehicle, the increased mass increases the initial kinetic energy, which the entire braking system must reduce to zero.

This means that a greater friction force F_{tr} or a longer braking distance s_z is required to stop the vehicle.

According to the law of conservation of energy, the total energy of the system (vehicle + braking system + road + air) is conserved. In this case, the kinetic energy of the vehicle is converted into other forms of energy. Due to friction, the kinetic energy of the vehicle is mainly converted into heat. A small part of the energy can also be released as sound (brake squeal).

The law of conservation of energy can be written as:

$$W_{k1} = Q. \qquad (11)$$

This example clearly shows how mechanical energy (kinetic energy) is converted into heat Q due to the work done by the friction force. The energy has not disappeared, but only changed its form.

During longer or more intense braking, the brake components of the vehicle's braking system generate increased heat and cause the brakes to heat up. Overheating reduces the coefficient of friction of the brake material, which reduces braking efficiency and increases the braking distance.

Additional load weight, especially if it is not distributed correctly, can shift the vehicle's centre of gravity. If the vehicle's centre of gravity shifts, the load on the individual axles changes, which also affects braking efficiency.

The additional weight or overloading of the vehicle can affect the stability of the vehicle during braking and can cause the vehicle to tilt or even cause the driver to lose control of it.

Although the driver's reaction time does not change, the braking system may respond more slowly due to overloading, which can further increase the braking distance.

4 CONCLUSION

This article has physically proven that a vehicle's braking distance depends on the square of the vehicle's speed, the deceleration and the coefficient of friction between the tyres and the

road surface.

Although the mass of the vehicle does not appear in the equation for the braking distance, it has a significant effect on the braking distance of an overloaded truck due to higher initial kinetic energy, overloading of the braking system, overheating of the brakes and other factors.

It is therefore important that, as part of the teaching process at our school, we familiarise students with both the theoretical and practical knowledge in this field.

5 LITERATURE AND REFERENCES

1. https://www.tecajcpp.com/cpp/hitrost.php, 5. 6. 2025.
2. Kunze H., Tentschert H. H.; Projekt Verkehr, Verlag Hölder-Pichler-Tempsky, Wien, 1999.
3. https://www.ccmta.ca/web/default/files/PDF/Report-20.pdf, 5. 6. 2025.
4. https://www.gov.si/assets/organi-v-sestavi/DRSI/Novice-DRSI/2024/Zavorna-pot/Zavorna-Pot.pdf, 1. 6. 2025.

Metka Krunič

Prometna šola Maribor

VPLIV UPORABE PROGRAMOV UMETNE INTELIGENCE PRI POUČEVANJU VSEBIN TRAJNOSTNE MOBILNOSTI IN TRAJNOSTNEGA RAZVOJA

Povzetek

Vpliv uporabe umetne inteligence se v današnji družbi in načinu življenja ne bomo mogli izogniti tudi na področju izobraževanja. Ker s seboj prinaša veliko pasti in s tem povezanih tveganj, je nujno potrebno usposabljanje in izobraževanje izvajalcev pouka ter iskanje praktičnih smernic pri poučevanju. Uporabili smo različne didaktične pristope in učne metode ter jih nato preizkusili in ovrednotili pri obravnavi poglavij trajnostne mobilnosti in trajnostnega razvoja, s katerimi smo dijake spodbudili h kritičnemu razmišljanju in odgovorni uporabi umetne inteligence na tem področju.

1 Uvod

Uporaba umetne inteligence postaja v naši družbi, kot tudi v izobraževanju, vse bolj prisotna. Prinaša koristi za reševanje družbenih, gospodarskih, okoljskih problemov. Omogoča analizo ogromnih količin podatkov, odkrivanje vzorcev in napovedovanje stanj v prihodnost iz veliko natančnostjo. Zato se pričakuje, da bo v pomoč vladam in podjetjem za sprejemanje okolju prijaznih rešitev.

Prinaša tudi veliko negativnih posledic, s katerimi se kot družba moramo spopasti. Za uporabo umetne inteligence je potrebna tudi ustrezna infrastruktura. Vse več je podatkovnih centrov s strežniki umetne inteligence. Elektronika v njih je odvisna od velike količine redkih elementov, ki se pridobivajo na okolju škodljive načine. Potrebujejo velike količine električne energije, ki je v večini pridobljena iz fosilnih goriv, kar povzroča dodatne emisije toplogrednih plinov. Podatkovni centri proizvajajo tudi elektronske odpadke, ki pogosto vsebujejo nevarne snovi, na primer živo srebro in svinec. Za hlajenje električnih komponent pa potrebujejo tudi velike količine vode.

Pričakovati je, da bo vpliv teh tehnologij na okolje še večji. Na primer za ustvarjanje napačnih informacij o podnebnih spremembah. Večji razvoj avtomobilov z umetno inteligenco, ki se vozijo sami, bi lahko povzročil povečanje emisij toplogrednih plinov. Učinkovitejše aplikacije umetne inteligence ter ustrezno ravnanje z odpadki tehnoloških podjetij, bi seveda imelo manjši negativni vpliv na okolje.

Umetna inteligenca lahko učinkovito prispeva k uporabi tehnologij za čistejše okolje,

uporabo redkih virov, napovedovanjem in upravljanjem vplivov na okolje ali poskrbi za boljše optimiranje proizvodnih procesov. Pojavljajo pa se različna tveganja varovanja podatkov, pristranskosti in dezinformacije.

Zaradi tehnološkega napredka na vseh področjih, je potrebno usposabljanje in izpopolnjevanje delavcev, da pridobijo potrebna digitalna znanja in spretnosti.

Veliko držav je sprejelo kar nekaj nezavezujočih priporočil o etični uporabi umetne inteligence na področju varstva okolja. Evropska unija in Združene države Amerike sta prav tako uvedli zakonodajo

za ublažitev vpliva umetne inteligence na okolje. Tudi ostale države bi morale sprejeti predpise, ki od podjetij zahtevajo, da razkrijejo neposredne okoljske posledice izdelkov in storitev, ki temeljijo na umetni inteligenci.

Umetna inteligenca postaja vseprisotna v naši družbi in vpliva na obveščenost in sprejemanje odločitev. Njenemu vplivu ne moremo izogniti tudi na področju izobraževanja in usposabljanja. V prihodnosti pa se bo ta še povečeval. Zaradi tega se pri uporabi umetne inteligence in obdelavi velikih količin podatkov pojavljajo specifični etični izzivi. Zavedati se moramo potenciala, ki ga lahko ima umetna inteligenca v izobraževanju, prav tako pa tveganj, ki so posledica le tega.

Evropska komisija je predlagala celovit pravni okvir za umetno inteligenco - Akt o umetni inteligenci. Ta določa obvezne zahteve za umetnointeligenčne sisteme velikega tveganja na več področjih, prav tako na področju izobraževanja.

2 Umetna inteligenca

Umetna inteligenca je znanstveno področje, ki se osredotoča na ustvarjanje sistemov, sposobnih opravljati naloge, ki običajno zahtevajo človeško inteligenco. Te naloge vključujejo razmišljanje, učenje, reševanje problemov, zaznavanje in razumevanje jezika. Prvi je leta 1956 uporabil izraz umetna inteligenca John McCarthy, in jo opisal kot »znanost in inženirstvo ustvarjanja inteligentnih strojev« . Tehnologija umetne inteligence omogoča strojem, da se učijo iz preteklih podatkov in izkušenj, medtem ko opravljajo naloge, podobne tistim, ki jih opravlja človek.

Glede na zmogljivost poznamo različne vrste sistemov umetne inteligence:

1. splošna umetna inteligenca ali močna umetna inteligenca ima sposobnost razmišljanja, delovanja in sprejemanja odločitev z nekaj človeške inteligence. Uporablja se za robotiko, obdelavo naravnega jezika, prepoznavanje govora in prepoznavanje slik brez človeškega vmešavanja.

2. Ozka umetna inteligenca se osredotoča na specifične naloge ali področja. Uporablja se pri delovanju virtualnih asistentov, avtomobilih brez voznika, programski opremi za prepoznavanje obrazov in podobno.

3. Super umetna inteligenca ima zmogljivosti, ki presegajo človeško inteligenco, se uporabljajo za reševanje problemov, kritično mišljenje, odločanje v realnem času in razlago človeških čustev.

Pomembna področja umetne inteligence zajemajo manipulativno inteligenco, ki se uporablja na primer za nadzor gibanja robotske roke, vizualno za prepoznavanje oblik, obrazov, prstnih odtisov in racionalno pri obvladovanju zbirk podatkov. Govorna

inteligenca pa se uporablja za prepoznavanje govora. Obstaja kar nekaj različnih oblik umetne inteligence, vključno z računalniškim vidom, globokim učenjem, evolucijsko umetno inteligenco, generativno umetno inteligenco, modeli velikih jezikov, strojnim učenjem, multimodalno umetno inteligenco, obdelavo naravnega jezika, napovedno analitiko za napovedovanje na primer denarnih tokov, potreb po osebju in podobno ter robotiko, ki se ukvarja z integracijo umetne inteligence v robote. Vsaka tehnologija izkorišča različne zmogljivosti in funkcionalnosti.

Vsakdanjem življenju uporabljamo umetnointeligenčne sisteme, včasih ne da bi se tega zavedali. Na primer aplikacije za jezikovno prevajanje, navigacijske aplikacije, spletne videoigre, pametne ure in budilke, ki imajo vgrajeno umetno inteligenco, samodejne popravke in filtre za neželeno pošto ter podobno. Umetnointeligenčni sistemi temeljijo na podatkih, kot so zvok, slike, besedilo, objave, kliki in skupaj tvorijo naše digitalne sledi. Za pisanje besedil, ustvarjanje slik, videoposnetkov pa se v glavnem uporablja generativna umetna inteligenca, ki lahko daje tudi nepravilne rešitve. Na primer, ChatGPT je bil modeliran z uporabo podatkov iz interneta, kjer se nahajajo tudi napačne informacije. Tudi te lahko zajame pri oblikovanju rešitve, ki jo poda. Generatorji besedil, ki simulirajo človeški dialog, lahko vplivajo tudi na čustva, razpoloženja in mnenja ljudi.

Močnejši kot je generativni model, večja je možnost manipulacije. Modeli ustvarjajo vsebine, ki so videti prepričljive in pravilne, a so dejansko napačne. To še posebej velja za generatorje besedila. ChatGPT lahko ustvari besedilo, ki je videti zelo prepričljivo in temelji na dejstvih, vendar vsebuje dejanske napake.

Generativna umetna inteligenca ne bo nadomestila ljudi, kljub temu da omogoča večjo ustvarjalnost in inovativnost ter zahteva večjo odgovornost in kritičnost pri presoj pridobljeni podatkov.

3 Uporaba umetne inteligence v izobraževanju

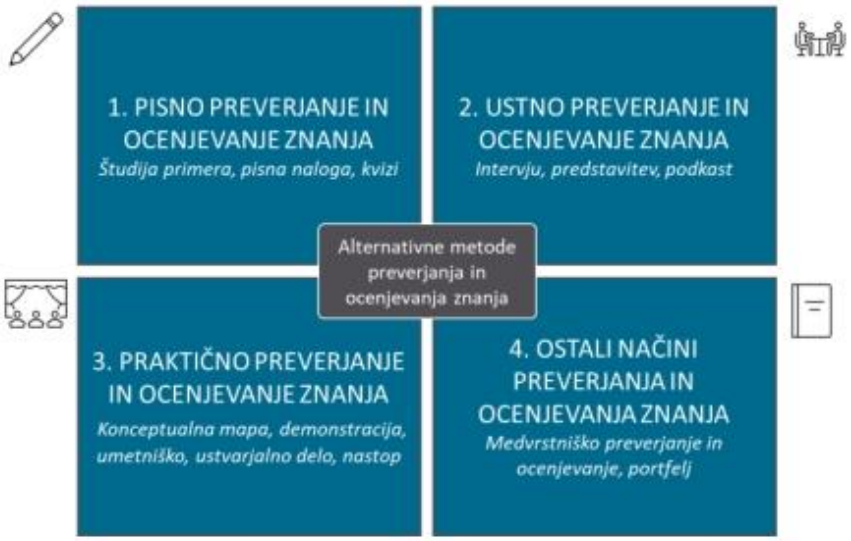
Na področju izobraževanja prinaša določene koristi kot tudi slabosti. Je dostopna, ne zahteva velikih stroškov, je tudi brezplačna. Uporablja se v podporo poučevanju, učenju in ocenjevanju. Pomaga lahko izboljšati prakse poučevanja in učenja ter je v pomoč šolam pri izboljšanju načina organizacije in delovanja.

Nudi velik potencial za izboljšanje izobraževanja in usposabljanja za učence, učitelje in vodstvene delavce šol. Pomaga prepoznavati posebne učne potrebe, učencem zagotavljajo prilagojene učne izkušnje, ki so jim na voljo. Uporablja se lahko kot dodatno orodje oz. podpora učenju, omogoča točkovanje esejev, za napovedovanje morebitnega osipa, upravljanje vpisa in načrtovanje virov pri učenju tujih jezikov in podobno. Ker se umetnointeligenčni sistemi še naprej razvijajo in uporaba podatkov povečuje, je izjemno pomembno, da bolje razumemo njihov vpliv, zlasti na področju izobraževanja in usposabljanja. Učitelji in vodstveni delavci šol morajo imeti vsaj osnovno znanje o uporabi umetne inteligence in podatkov, da lahko pozitivno, kritično in etično uvajajo to tehnologijo ter jo pravilno uporabljajo.

Prinaša pa kar nekaj pasti in težav. Poleg netočnih ali zavajajočih informacij, še problem plagiatorstva. Pojavi se problem avtentičnosti naloge in posledično ustrezno ocenjevanje znanja dijakov. Uporabi aplikacij umetne inteligence v te namene se ne bomo mogli izogniti, zato je zelo pomembno, da dijake poučimo v katerem primeru in kakšnem obsegu jih uporabljati.

Da bi preverili znanje dijakov, lahko uporabimo različne metode in oblike učenja, ki temeljijo na reševanju problemov, kreativnem razmišljanju, s spodbujanjem izkustveno usmerjenega pouka, skupinskega in sodelovalnega učenja ter ostalih načinov, kjer se spodbuja razumevanje vsebine in kritično mišljenje (slika 1).

Slika 1: Alternativne metode preverjanja in ocenjevanja znanja



Umetna inteligenca bi lahko imela ključno vlogo pri izboljšanju praks poučevanja, učenja in ocenjevanja. Pomembna pa je stalna etična uporaba umetnointeligenčnih in podatkovnih sistemov.

4. Primera uporabe umetne inteligence pri poučevanju vsebin trajnostnega razvoja

Tudi na področju varstva okolja se uporabljajo sistemi umetne inteligence. Na primer pri zmanjševanju emisij toplogrednih plinov, izboljšanju energetske učinkovitosti, spremljanju sprememb v okolju, optimiziranju virov, zmanjševanju količin odpadkov in podobno.

V logistiki se lahko umetna inteligenca uporablja za nadzor dobavnih verig, boljšo optimizacijo izkoriščenost sredstev, pri skladiščenju, delovanje skladiščnih robotov, avtomatizaciji procesov in drugih procesih. Uporabi se lahko v različnih prometnih panogah, transportu, distribuciji, v pristaniščih, na letališčih, pri prevoznih sredstvih kot so na primer avtomatizirana vozila in digitalizirani vlaki ter omogoča večjo učinkovitost in natančnost.

Prinaša pa tudi določene težave. Na primer posledica njene uporabe so visoki stroški za naložbe v strojno in programsko opremo ter usposabljanje zaposlenih. Obstaja tudi možnost, da pri velikih količinah podatkov, potrebnih za delovanje tehnologij z umetno inteligenco, so le ti ogroženi.

V prometu se uporablja v aplikacijah pri avtomatiziranih vozilih, optimiziranem polnjenju in uporabi baterij za električna vozila, kontroliranju vzdrževanja vozil, izboljšanju poti za potnike in prevozu blaga in podobno.

Ker se za reševanje različnih problemov, predvsem pa pisanju seminarskih nalog, dijaki

vse bolj poslužujejo programov umetne inteligence, največ ChatGPT, se pojavlja vprašanje avtentičnosti nalog. Zato je v tem primeru težko ustrezno oceniti delo in znanje dijakov.

Program smo preizkusili pri obravnavi določenih vsebin trajnostnega razvoja v programu Logistični tehnik. Za primerjavo in testiranje avtentičnosti dobljenih rezultatov smo uporabili različne metode in oblike učenja, ki temeljijo na reševanju problemov spodbijajo kreativno razmišljanje, skupinsko in sodelovalno učenje, razumevanje vsebine in kritično mišljenje. Predstavljena sta dva primera.

4.1 Obrnjeno učenje (Flipped Classroom)

S pomočjo te metode so dijaki spoznali uporabo in lastnosti avtonomnih vozil ter njihov vpliv na okolje. Osnovne informacije in gradivo o avtomatsko vodenih ter avtonomnih vozilih, so dijaki dobili v naprej. K pouku so prišli z določenim predznanjem, snov predstavili in jo analizirali skupaj z učiteljem in sošolci. Prav tako pa so preizkusili program ChatGPT, informacije primerjali in ugotavljali ustreznost dobljenih podatkov. Seveda pa tak način predstavlja večjo odgovornost dijakov za učenje. Zavzetost in potreben čas sta odvisna od interesa posameznika, ki si sam določi tempo učenja. Če je ustrezno načrtovano in dovolj pogosto uporabljeno, obrnjeno poučevanje spodbuja aktivno učenje, razvoj višjih ravni mišljenja in daje trajnejše ter bolj poglobljeno znanje.

4.2 Projektno učenje

Za obravnavo vpliva prometa na okolje smo izbrali metodo projektnega učenja. Pri tem dijaki načrtujejo dejavnosti in sodelujejo v realnih, smiselnih, pomembnih projektih za okolico, rešujejo resnične probleme in pridobijo znanje ter spretnosti iz vsakdanjega življenja. Dijaki programa Logistični tehnik so pri obravnavi vsebin trajnostne mobilnosti analizirali različne vplive prometa na okolje in nastale posledice. Predstavili so vplive emisij škodljivih snovi in hrupa, ki jih povzroča promet na okolje. S pomočjo ustreznih aplikacij so računali ogljični odtis predstavi ustrezne ukrepe za varstvo okolja. Raziskali so uporabo alternativnih virov energije v prometu, uporabo hibridnih in električnih vozil, njihove dobre in slabe lastnosti. Poiskali so informacije o dodatnih ukrepih za zmanjševanje onesnaževanja kot je ustrezno načrtovanje poti in načinih varčne vožnje. Uporabili so tudi aplikacijo Chat GPT in proučili ustreznost dobljenih podatkov.

Način dela spodbuja kritično mišljenje in sposobnosti reševanja različnih problemov, razvijanje komunikacijskih veščin in sodelovanje v skupini.

5. Zaključek

Izzivi, s katerimi se soočamo pri razvoju umetne inteligence, zajemajo veliko področij. Pojavljajo se vprašanja etike, varnosti, interpretacij odločitev umetne inteligence in upravljanjem s podatki. Pomembno je, da se ustrezno obravnavajo in rešujejo ter s tem zagotovijo odgovorno in trajnostno uporabo umetne inteligence v prihodnosti. Potrebno je določiti in dopolniti smernice, ki bodo omogočile etično uporabo umetne inteligence in zagotovile zaščito uporabnikov. Prav tako pa bi razvoj ustreznih varnostnih mehanizmov zaščitil pomembne in občutljive podatke pred zlorabo. Z vlaganjem v raziskave in razvoj za izboljšanje tehnologij se lahko doseže, da umetna inteligenca postane močno orodje za izboljšanje našega življenja.

Informacije, dobljene s pomočjo generativnih orodij, kot je ChatGPT, so lahko pristranske

in njihovo nekritično sprejemanje lahko povzroči uporabo in širjenje napačnih ali zavajajočih vsebin. Zato je potrebno opozoriti in učiti dijake kdaj, v katerem primeru in kakšnem obsegu si pomagati s temi orodji. Spodbuditi je potrebno njihovo kritično razmišljanje. To se lahko doseže z uporabo različnih didaktičnih pristopov in učnih metod kot so projektno učenje, obrnjeno učenje, oblikovalsko razmišljanje in pouk izven učilnice ter podobnimi, s katerimi lahko preverimo razumevanje snovi in kritično mišljenje dijakov ter tudi na ta način zmanjšamo negativni vpliv uporabe programov umetne inteligence.

6. Literatura

1. Ličen N, Bajec J.F., Ličen M: Katero metodo naj izberem, da bo zeleno izobraževanje učinkovito? (Elektronska knjiga).[Oneline], Ajdovščina Ljudska univerza, Ajdovščina, 2015.

2. Ferk Savec V: Projektno učno delo pri učenju naravoslovnih vsebin, (El. učbenik)[Oneline], Fakulteta za naravoslovje in matematiko, Maribor, 2010.

3. Štemberger T., Čotar Konrad S., Rutar S., Žakelj A.: Oblikovanje inovativnih učnih okolij, Constructing Innovative Learning Environme nts.)[Oneline], Založba Univerze na Primorskem, Koper, 2022.

4. Maurovič Anžur D.: Z dizajnerskim razmišljanjem do rešitev kompleksnih težav, Glas gospodarstva, [Oneline].3(6),str.68-69, 2018.

5. Marta Licardo ...: GENERATIVNA umetna inteligenca v izobraževanju: analiza stanja v primarnem, sekundarnem in terciarnem izobraževanju, e-knjiga, Univerza v Mariboru, Univerzitetna založba, Maribor, 2025.

6. Pičman Štefančič P.: Etika umetne inteligence v sistemu izobraževanja, Vodenje v vzgoji in izobraževanju 55 št. 2/2023, ZRSŠ, Ljubljana, 2023.

7. www.e-mP, obilni.eu/e-mobilnost, 15.5.2025.

8. www.timocom.si/blog/freight-tech-umetna-inteligenca-avtomatizacija-v-logistiki-414338, 15.5.2025.

9. www.ekodezela.si/eko-revija-promet/avtonomna-tovorna-vozila-bodo-vse-manj-znanstvena-fantastika, 15.5.2025.

10. www.trajnostnamobilnost.si/prihodne-smeri-inovacije-elektricna-vozila, 15.5.2025.

11. www.learning-corner.learning.europa.eu/learning-materials/use-artificial-intelligence-ai-and-data-teaching-and-learning_sl, 15.5.2025.

12. www.gen-ui.si/generativna-ui, 15.5.2025.

13. www.didakt.um.si/oprojektu/projektneaktivnosti/Documents/Strokovna%20podlaga_projektno_27feb.pdf , 15.5.2025.

Metka Krunič

Traffic School Maribor

THE IMPACT OF ARTIFICIAL INTELLIGENCE APPLICATIONS ON TEACHING SUSTAINABLE MOBILITY AND SUSTAINABLE DEVELOPMENT

Abstract:

In today's society and way of life, the impact of artificial intelligence is unavoidable, including in the field of education. Due to the associated risks and pitfalls, it is crucial to provide teachers with training and education, as well as practical teaching guidelines. We applied various didactic approaches and teaching methods in the context of sustainable mobility and development, then tested and evaluated them. This encouraged students to think critically and use artificial intelligence responsibly in this field.

1 Introduction

The use of artificial intelligence is becoming increasingly prevalent in our society and in education. It offers solutions to social, economic and environmental problems. AI enables the analysis of vast amounts of data, the discovery of patterns and highly accurate predictions of future conditions. Consequently, it is expected to help governments and businesses make environmentally friendly decisions.

However, it also has many negative consequences that society must address. The use of AI requires appropriate infrastructure. A growing number of data centres are hosting AI servers. The electronics within these centres depend on large quantities of rare elements, which are often extracted in environmentally harmful ways. These data centres also require vast amounts of electricity, most of which is generated from fossil fuels, contributing to additional greenhouse gas emissions. Data centres produce electronic waste that often contains hazardous substances such as mercury and lead. Furthermore, cooling the electronic components requires large quantities of water.

It is expected that the environmental impact of these technologies will continue to grow. For instance, AI could be used to generate misleading information about climate change. The greater development of self-driving cars powered by AI could lead to an increase in greenhouse gas emissions. However, more efficient AI applications and proper waste management by technology companies would have a smaller negative environmental impact.

Artificial intelligence can also contribute effectively to the use of cleaner technologies, the

management of scarce resources, the prediction and control of environmental impacts, and the optimisation of production processes. However, issues such as data protection, bias and disinformation also arise.

Technological progress in all areas makes it essential to provide workers with training and continuous education to help them acquire the necessary digital knowledge and skills.

Many countries have adopted non-binding recommendations on the ethical use of artificial intelligence for environmental protection. The European Union and the United States have introduced legislation to mitigate the environmental impact of AI. Other countries should likewise adopt regulations requiring companies to disclose the direct environmental consequences of AI-based products and services.

Artificial intelligence is becoming increasingly pervasive in our society, influencing awareness and decision-making. It cannot be avoided in education and training either, and its impact will only grow stronger in the future. This raises specific ethical challenges regarding the use of AI and the processing of large amounts of data. It is important to recognise both the potential that AI holds for education and the risks it entails.

The European Commission has proposed a comprehensive legal framework for AI — the Artificial Intelligence Act. This legislation sets out mandatory requirements for high-risk AI systems in several areas, including education.

2 Artificial intelligence

Artificial intelligence (AI) is the scientific field that focuses on creating systems capable of performing tasks that typically require human intelligence. These include reasoning, learning, problem solving, perception and language understanding. The term 'artificial intelligence' was first coined in 1956 by John McCarthy, who defined it as "the science and engineering of making intelligent machines". AI technology enables machines to learn from past data and experiences while performing tasks similar to those carried out by humans.

Depending on their capabilities, AI systems can be categorised into different types:

1. General AI, also known as Strong AI, has the ability to think, act and make decisions with a degree of human-like intelligence. It is used in robotics, natural language processing, speech recognition and image recognition, all without human intervention.

2. Narrow AI focuses on specific tasks or domains. Examples of its application include virtual assistants, self-driving cars, and facial recognition software.

3. Super AI possesses capabilities that exceed human intelligence, and is used for problem solving, critical thinking, real-time decision making and interpreting human emotions.

Key areas of artificial intelligence include manipulative intelligence, which is used to control robotic arms, for example; visual intelligence, which is applied to recognise shapes, faces and fingerprints; and rational intelligence, which is used to manage databases. Speech intelligence is used for speech recognition.

Several different forms of AI exist, including computer vision, deep learning, evolutionary AI, generative AI, large language models, machine learning, multimodal AI, natural language processing and predictive analytics, which is used for forecasting cash flows or staffing needs, for example. Robotics focuses on integrating AI into robots. Each technology leverages different capabilities and functionalities.

In everyday life, we use AI systems — sometimes without realising it. Examples include language translation applications, navigation apps, online video games, smartwatches and alarms with built-in AI, autocorrect features, and spam filters. AI systems are based on data such as sounds, images, text and posts, as well as clicks — all of which form our digital footprints.

Generative artificial intelligence is mainly used for writing texts, creating images and producing videos, though it can also provide incorrect solutions. ChatGPT, for example, was trained using data from the internet, which contains incorrect information. This can result in incorrect information being incorporated into the answers it generates. Text generators that simulate human dialogue can influence people's emotions, moods and opinions.

The more powerful the generative model, the greater its potential for manipulation. These models generate content that seems convincing and accurate, but is actually incorrect. This is particularly true of text generators. ChatGPT, for example, can produce text that appears persuasive and fact-based, but which may contain errors.

Generative artificial intelligence will not replace humans. While it enables greater creativity and innovation, it also necessitates increased responsibility and critical thinking when evaluating the information obtained.

3 The use of artificial intelligence in education

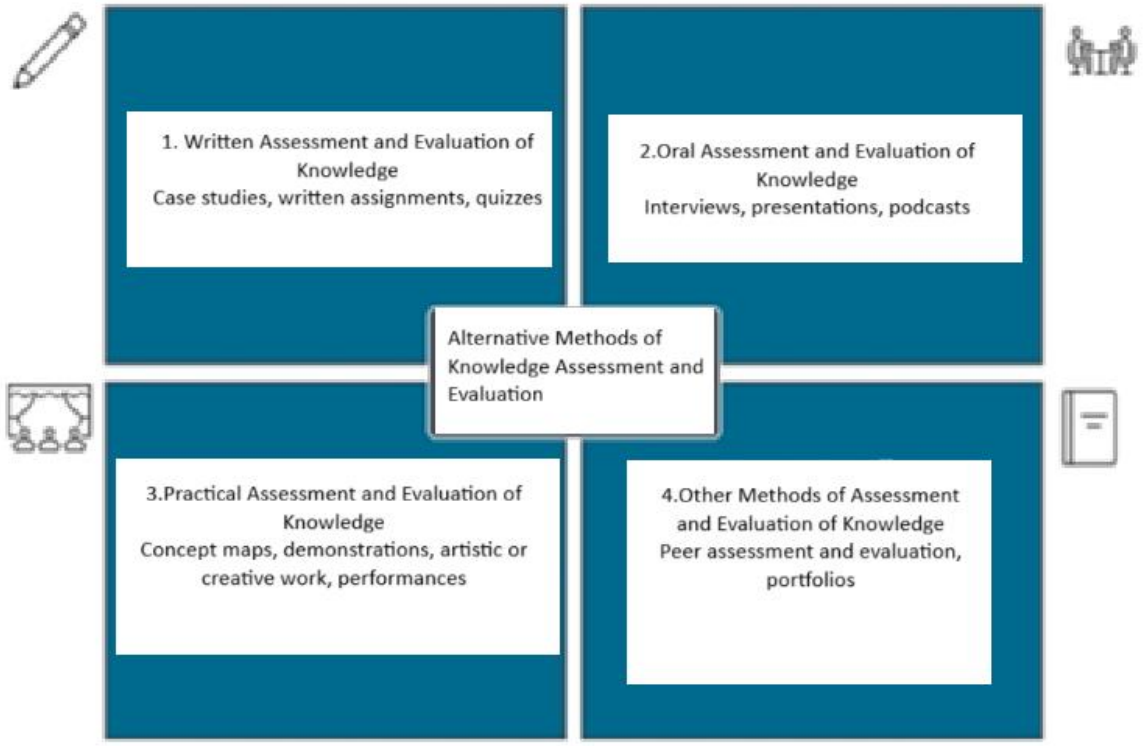
In education, AI offers certain advantages and drawbacks. It is accessible and often free of charge, and does not require high costs. It can support teaching, learning and assessment. AI can improve teaching and learning practices, as well as helping schools to enhance their organisation and functioning.

AI offers great potential for improving education and training for students, teachers and school leaders. It can help to identify special learning needs and provide students with personalised learning experiences. AI can be used as an additional learning support tool, enabling essay scoring, predicting potential dropout rates, managing enrolment, and planning language learning resources, among other things. As AI systems continue to develop and data usage increases, it becomes increasingly important to understand their impact, particularly in education and training. Teachers and school leaders need to have at least a basic knowledge of AI and data usage to be able to introduce this technology in a positive, critical and ethical way, and to apply it appropriately.

However, AI also brings certain pitfalls and challenges. In addition to inaccurate or misleading information, plagiarism becomes an issue. Issues of task authenticity arise, which in turn affect the assessment of students' knowledge. As the use of AI applications for such purposes is unavoidable, it is crucial to educate students on when and to what extent these toolsshould be used.

Various methods and forms of learning can be employed to assess students' knowledge, such as problem-solving, creative thinking, experiential learning, group learning and collaborative learning, and other approaches that promote an understanding of the content and critical thinking (see Figure 1).

Figure 1: Alternative Methods of Knowledge Assessment and Evaluation



Artificial intelligence has the potential to transform teaching, learning and assessment practices. However, it is essential that it and the associated data systems are deployed in an ethical and responsible manner.

4. Examples of using artificial intelligence in teaching sustainable development content

AI systems are also used in environmental protection. These include reducing greenhouse gas emissions, improving energy efficiency, monitoring environmental changes, optimising resources and minimising waste.

In logistics, AI can be used for supply chain management, optimising resource utilisation, managing warehouses, operating warehouse robots, automating processes, and performing other operational tasks. AI can be applied across various transport sectors, including distribution, ports and airports, as well as transportation modes such as automated vehicles and digitalised trains, to enable greater efficiency and accuracy.

However, the use of AI also brings certain challenges. For instance, it requires significant investment in hardware, software and employee training. Additionally, the large volumes of data required for AI technologies may be vulnerable to security risks.

In the transport sector, AI is used for automated vehicles, optimised charging and battery usage for electric vehicles, monitoring vehicle maintenance, improving passenger routes and freight transport.

As students increasingly rely on AI programmes, particularly ChatGPT, for solving problems and writing seminar papers, questions are being raised about the authenticity of their work. This makes it difficult to assess students' efforts and knowledge adequately.

We tested the programme while studying specific topics on sustainable development within the Logistics Technician curriculum.

To compare and verify the authenticity of the results obtained, we applied various learning methods and approaches that focus on problem-solving, encourage creative thinking, promote group and collaborative learning, enhance content understanding and foster critical thinking. Two examples are presented below.

4.1 Flipped classroom

Using this method, students explored the use, characteristics and environmental impact of autonomous vehicles. Basic information and materials on automated and autonomous vehicles were provided to the students in advance. They came to class with this prior knowledge and presented and analysed the content together with the teacher and classmates. They also tested the ChatGPT programme, compared the information and evaluated the accuracy of the obtained data.

This approach naturally requires greater responsibility from students for their own learning. Engagement and the time invested depend on each individual's interest, as students set their own learning pace. When planned properly and used frequently, flipped classroom methods promote active learning and the development of higher-order thinking skills, providing more lasting and in-depth knowledge.

4.2 Project-based learning

To address the impact of transportation on the environment, we opted for a project-based learning method. In this approach, students plan and participate in meaningful and socially relevant activities and projects that solve real-world problems, thereby acquiring knowledge and skills applicable to everyday life.

Students on the Logistics Technician programme analysed the various environmental impacts of transportation and their consequences while studying sustainable mobility topics. They presented the effects of harmful emissions and noise generated by traffic on the environment. Using relevant software, they calculated the carbon footprint and suggested appropriate environmental protection measures. They also explored alternative energy sources for transportation and the pros and cons of hybrid and electric vehicles. They also sought information on further pollution reduction measures, such as efficient route planning and eco-friendly driving techniques. They also used the ChatGPT application to verify the accuracy of the information obtained.

This approach fosters critical thinking, problem-solving, communication and teamwork skills.

5. Conclusion:

The challenges associated with the development of artificial intelligence (AI) are numerous and span many areas. Questions arise concerning ethics, security, the interpretation of AI decisions and data management. To ensure the responsible and sustainable use of AI in the future, it is essential to address and resolve these issues. Guidelines must be established and refined to promote ethical AI usage and safeguard users. Furthermore, the development of appropriate security mechanisms would protect critical and sensitive data from misuse. Investing in research and development to improve these technologies could make AI a

powerful tool for enhancing our lives.

However, information obtained from generative tools such as ChatGPT can be biased, and uncritical acceptance may lead to the use and dissemination of incorrect or misleading content. Therefore, students must be educated on when, in what context and to what extent these tools should be used. Encouraging critical thinking is crucial. This can be achieved through various didactic approaches and learning methods, such as project-based learning, the flipped classroom method, design thinking and outdoor or experiential learning. These methods allow students' understanding and critical thinking skills to be assessed, while also mitigating the potential negative impacts of AI tool usage.

6. References

1. Ličen, N., Bajec, J. F., & Ličen, M. (2015). *Which method should I choose to make green education effective?* [E-book]. Ljudska univerza Ajdovščina, Ajdovščina.
2. Ferk Savec, V. (2010). *Project-based learning in teaching science subjects* [E-textbook]. Faculty of Natural Sciences and Mathematics, Maribor.
3. Štemberger, T., Čotar Konrad, S., Rutar, S., & Žakelj, A. (2022). *Constructing innovative learning environments* [E-book]. University of Primorska Press, Koper.
4. Maurovič Anžur, D. (2018). "Through design thinking to solutions for complex problems." *Glas gospodarstva*, 3(6), 68–69. [Online].
5. Licardo, M., et al. (2025). *Generative Artificial Intelligence in Education: An Analysis of Primary, Secondary, and Tertiary Education* [E-book]. University of Maribor, University Press, Maribor.
6. Pičman Štefančič, P. (2023). "Ethics of Artificial Intelligence in the Education System." *Leadership in Education*, 55(2). ZRSŠ, Ljubljana.
7. e-mP. (2025, May 15). *e-mobilnost*. Retrieved from https://obilni.eu/e-mobilnost.
8. Timocom. (2025, May 15). *Freight Tech: Artificial Intelligence and Automation in Logistics*. Retrieved from https://www.timocom.si/blog/freight-tech-umetna-inteligenca-avtomatizacija-v-logistiki-414338.
9. Ekodežela. (2025, May 15). *Autonomous trucks will be less and less science fiction*. Retrieved from https://www.ekodezela.si/eko-revija-promet/avtonomna-tovorna-vozila-bodo-vse-manj-znanstvena-fantastika.
10. Trajnostna Mobilnost. (2025, May 15). *Future trends and innovations in electric vehicles*. Retrieved from https://www.trajnostnamobilnost.si/prihodne-smeri-inovacije-elektricna-vozila.
11. Learning Corner. (2025, May 15). *Use of Artificial Intelligence (AI) and Data in Teaching and Learning*. Retrieved from https://learning-corner.learning.europa.eu/learning-materials/use-artificial-intelligence-ai-and-data-teaching-and-learning_sl.
12. GEN-UI. (2025, May 15). *Generative AI*. Retrieved from https://www.gen-ui.si/generativna-ui.
13. University of Maribor, Didactics Department. (2025, May 15). *Project Activities – Professional Basis* [PDF]. Retrieved from https://www.didakt.um.si/oprojektu/projektneaktivnosti/Documents/Strokovna%20podlaga_projektno_27feb.pdf.

asist. Martin Fale, red. prof. dr. Borut Jereb, asist. Mirjana Lazarević, izr. prof. dr. Matevž Obrecht, doc. dr. Maja Rosi, asist. Bojana Slomšek Šlamberger

Univerza v Mariboru Fakulteta za logistiko

ODPORNOST TRANSPORTNE INFRASTRUKTURE NA NARAVNE NESREČE V SLOVENIJI: PRIMER SEVESO OBRATOV

Iz vidika delovanja podjetij je odpornost transportne infrastrukture ključnega pomena za nemoteno delovanje, saj omogoča nemoten tok ljudi, blaga in energije. To velja tudi za SEVESO obrate, ki se zaradi hranjenja določene količine nevarnih snovi uvrščajo med obrate, ki predstavljajo tveganje za okolje. V raziskavi nas je zanimalo ali poplave in plazovi ogrožajo dostop do SEVESO obratov. Raziskava je vključevala uporabo geografskega informacijskega sistema ArcGIS Pro. Za pripravo kart poplavne in plazovite ogroženosti smo uporabili sloje opozorilne karte poplav in območni sloj plazovitih območij. Analizirali smo dostopnost v neposredni okolici SEVESO obrata in dostopnost SEVESO obrata do najbližjega avtocestnega priključka. Rezultati kažejo, da dostop v neposredni okolici do 31 SEVESO obratov ogrožajo poplave, do 6 obratov pa plazovi. Posebej so izpostavljeni obrati Lecana, d. o. o., TAB d. d. in TAB d. d. (Topla). Analiza dostopnosti SEVESO obrata do najbližjega avtocestnega priključka je prikazala, da 5 najkrajših poti prečka plazovita območja, 9 poti poteka prek območij pogostih poplav, 27 poti prečka območja redkih poplav ter 26 poti poteka prek območij zelo redkih (katastrofalnih) poplav. Izmed vseh SEVESO obratov izstopata Lecana, d. o. o. in TKK, d. o. o., saj najkrajša dostopna pot do obeh obratov poteka prek vseh štirih tipov ogroženih območij.

1 Uvod

1.1 Motnje

Poplave, ki so avgusta 2023 prizadele Slovenijo, so povzročile ogromno škodo na infrastrukturi. Prizadet je bil cestni in železniški transport, pri čemer bi izpostavili neprevoznost avtoceste pri Šempetru v Savinjski dolini, kar je ob dejstvu, da so bile neprevozne tudi vzporedne ceste, pomenilo, da je bil cestni transport na relaciji Ljubljana-Maribor prekinjen (delo.si, 2023). Že dogodki na mikro - ravni, kot je npr. zalitje podvoza pri parku Tivoli v Ljubljani ob močnejših nalivih, lahko močno vplivajo na spremembo transportnih tokov v neposredni okolici dogodka, dogodki na makro – ravni pa ohromijo delovanje celotnega transportnega sistema. Treba se je zavedati, da imajo med izrednimi razmerami cestna omrežja ključno vlogo pri izvajanju evakuacije in razdeljevanju pomoči (Zhou et al., 2019). Neprevoznost transportnih povezav pomeni tudi povečano obremenitev vzporednih cest, kar zmanjšuje pretočnost in v primeru daljših obvozov ter zastojev na vzporednih cestah močno podaljša potovalni čas.

1.2 SEVESO obrati

Iz vidika delovanja podjetij je prevoznost ključnega pomena za nemoteno delovanje, vključujoč tok ljudi, blaga in energije. To velja tudi za SEVESO obrate, ki se zaradi

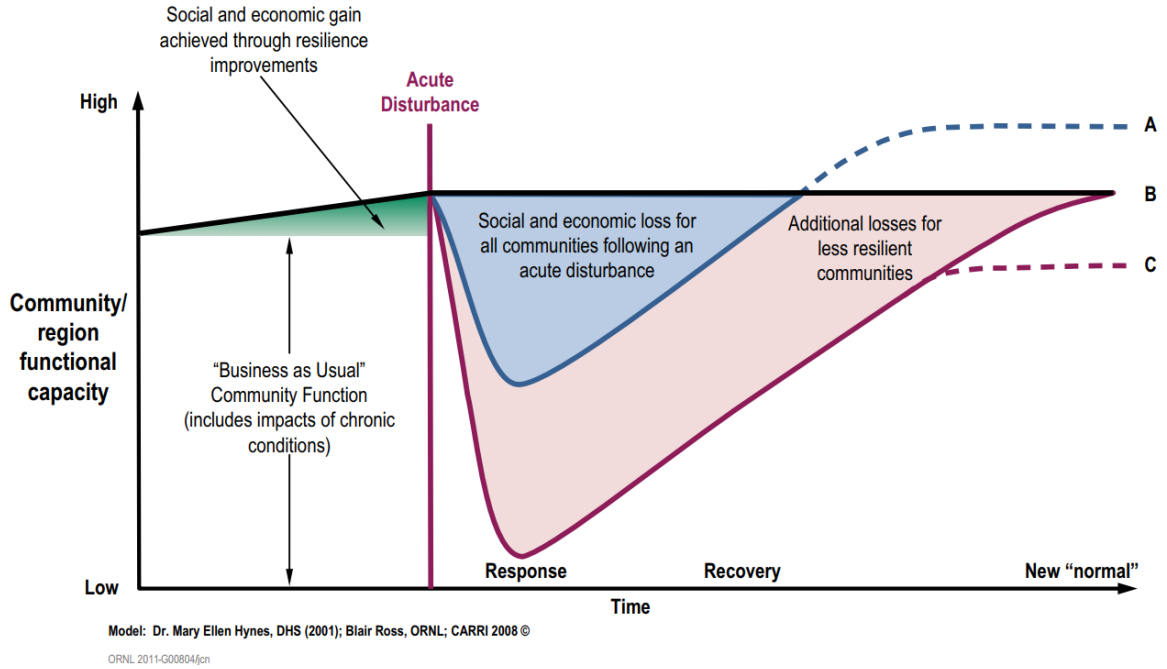
hranjenja določene količine nevarnih snovi uvrščajo med obrate, ki predstavljajo tveganje za okolje (»Uredba o preprečevanju večjih nesreč in zmanjševanju njihovih posledic«, 2016). V Sloveniji je na dan, 15. 10. 2024, 60 SEVESO obratov. Največ SEVESO obratov se uvršča med obrate za shranjevanje in distribucijo na debelo in drobno (razen utekočinjenega naftnega plina) (15 obratov), kemične obrate (14 obratov) in obrate za proizvodnjo, polnjenje in distribucijo utekočinjenega naftnega plina (12 obratov). Glede na količino nevarnih snovi jih razvrstimo ali med obrate večjega tveganja za okolje ali med obrate manjšega tveganja za okolje. Izmed 60 SEVESO obratov v Sloveniji, se jih 29 uvršča med SEVESO obrate večjega tveganja za okolje, 31 pa med SEVESO obrate manjšega tveganja za okolje (Ministrstvo za okolje, podnebje in energijo, 2023). Že v osnovi so obrati postavljeni pred izbiro: ali hraniti večje količine nevarne snovi v obratu, kar zmanjšuje potrebe po oskrbi ali pa zmanjšati količine nevarnih snovi na raven, ki še zagotavlja nemoteno delovanje obrata in s tem povečati potrebo po oskrbi. Oskrba do SEVESO obratov poteka po cestah. Sicer imajo nekateri obrati tudi možnost dostopa po železnici, ampak cestni transport predstavlja prevladujoči tip transporta za oskrbo SEVESO obratov. Odpornost transportne infrastrukture je torej ključnega pomena.

1.3 Odpornost

Vse pogostejši vremenski ekstremi zahtevajo od nas prilagajanje. Krepitev ključnih sistemov družbe, kamor transport zagotovo spada, mora postati vodilo pri načrtovanju sodobne družbe. Odpornost pomeni sposobnost transportnih sistemov, da prenesejo in si hitro opomorejo po motnjah, kot so naravne nesreče, ter pri tem ohranijo ključne storitve za uporabnike. Dobro zasnovani sistemi lahko absorbirajo manjše motnje, ob večjih pa zmanjšajo obseg in trajanje odstopanj od normalnega delovanja. Njihova ključna značilnost je prilagodljivost, ki temelji na premišljenem načrtovanju, upravljanju in vzdrževanju z mislijo na odpornost. Podnebne spremembe s svojimi posledicami, kot so dvig morske gladine, poplave in neurja, ogrožajo transportne sisteme, zato je vse večji poudarek na njihovi odpornosti proti skrajnim vremenskim pojavom in dolgoročnim vplivom podnebja (Chen et al., 2023). Merila za ocenjevanje odpornosti transportnih sistemov delimo na topološka, atributna in zmogljivostna, pri čemer prva temeljijo na mrežni strukturi, druga na posameznih vidikih odpornosti, tretja pa omogočajo celovito oceno sistema (Zhou et al., 2019).

Slika 1 prikazuje, kako akutne motnje (npr. potresi, kemična razlitja, teroristični napadi, orkanski vetrovi ipd.) povzročijo izrazit upad funkcionalnosti skupnosti. Pri manj odpornih skupnostih se posledice stopnjujejo, medtem ko se odpornejše skupnosti hitreje prilagodijo, povrnejo ključne funkcije in oblikujejo novo stanje normalnosti. Podobna dinamika velja tudi za transportne sisteme: izrazita motnja, zaznana kot močan impulz, takoj zmanjša njihovo sposobnost izvajanja storitev. Obseg upada je odvisen od njihove odpornosti – bolj odporni sistemi utrpijo manjše izgube, pri neodpornih ali navidezno odpornih sistemih pa se razkrije njihova ranljivost (White et al. 2015).

***Slika 1**: Model odpornosti skupnosti*



Rosi et al. (2023) so preučevali odpornost italijanskega železniškega omrežja. Najprej so identificirali ranljive železniške povezave. Železniško omrežje – vključno z različnimi vrstami prog, postaj in glavnih linij – so primerjali s poplavnimi kartami, da bi ugotovili morebitna prekrivanja. Tem povezavam so na podlagi statističnih podatkov pripisali uteži: število potnikov pri potniških vlakih in količino prepeljanega tovora pri tovornih vlakih. S pomočjo toplotne karte so izpostavili ključne točke v omrežju, ki so najbolj ogrožene pred poplavami, glede na dodane uteži. Metodologija je vključevala postopke dela, ki jih izvajamo v geografskih informacijskih sistemih. Med posebej tveganimi območji je bila prepoznana tudi pokrajina Emilia-Romagna, ki so jo leta 2023 prizadele hude poplave. V dveh zaporednih vremenskih dogodkih z intenzivnimi padavinami, med 1. in 4. majem in 16. in 18. majem, so namerili ogromne količine dežja. Med 16. in 18. majem so zabeležili kar 200 mm padavin – zabeležen rekord za to območje (Arrighi & Domeneghetti, 2023).

Odporna transportna infrastruktura lahko omili negativne posledice ekstremni vremenskih dogodkov. Japonska je s kulturo prilagajanja na naravne nesreče lahko vzor drugim, a lahko se zgodi, da tudi najbolj odporni sistemi ne vzdržijo. Leta 2013 je japonski otok Honšu prizadel tajfun Hagibis. V 72 urah je ponekod padlo več kot 1.000 mm padavin. Infrastruktura ni vzdržala – močno je bil prizadet železniški promet, poškodovano je bilo cestno omrežje. Analiza nesreče je pokazala, da obstoječa infrastruktura kljub velikanskim finančnim sredstvom, ki jih Japonska namenja v izgradnjo odporne družbe, ni bila in v prihodnosti ne bo sposobna vzdržati vse silovitejših ekstremnih dogodkov (Orense, 2022). Raziskave (Rosi et al., 2023) nam omogočajo, da prepoznamo tveganja, ki jih moramo minimizirati, da bomo lahko vzpostavili odporen družbeni sistem. Mi smo se v raziskavi omejili na mikro – problem: Odpornost transportne infrastrukture SEVESO obratov, pri čemer smo se osredotočili na poplavno in plazovito ogroženost.

2 Metodologija

V raziskavi smo se osredotočili na javno dostopne podatke. Pri predstavitvi okolja smo članke na informativnih portalih podkrepili z izvedenimi raziskavami. Iskanje sorodnih raziskav je potekalo v znanstvenih podatkovnih bazah IEEE Xplore, Web of Science in ScienceDirect, pri čemer smo uporabili ključni besedi »transport« in »resilence«. Analiza je vključevala uporabo geografskega informacijskega sistema ArcGIS Pro, verzija 3.4.0. Za pripravo kart poplavne in plazovite ogroženosti smo uporabili sloje: opozorilna karta poplav, ki vključuje območni sloj območja zelo redkih (katastrofalnih) poplav (datum objave: 15. 11. 2023, D96/TM), območni sloj območja redkih poplav (datum objave: 12. 11. 2020, D96/TM) in območni sloj območja pogostih poplav (datum objave: 12. 11. 2020, D96/TM). Poleg tega smo uporabili tudi območni sloj plazovitih območij – območij pojavljanja snežnih plazov – iz NUV1 (datum objave: 3. 4. 2019 D48/GK). Predpostavili smo, da so sloji poplavnih območij in plazovitih območij, pridobljeni iz javno dostopnih virov, natančni (Ministrstvo za naravne vire in prostor, 2022a; Ministrstvo za naravne vire in prostor, 2022b).

Analizirali smo dostopnost v neposredni okolici SEVESO obrata in dostopnost SEVESO obrata do najbližjega avtocestnega priključka. Če je poplavno ali plazovito območje glede na opozorilno karto poplav ali glede na plazovito območje prečkalo transportne povezave v neposredni okolici območja obrata, ali cestno ali železniško, smo za ta obrat predpostavili, da je dostop do obrata ogrožen. S pomočjo satelitskih posnetkov smo ustvarili območni sloj, ki prikazuje območja obratov SEVESO. Pri tem smo izkoristili vizualne značilnosti posameznega območja (vidna ograja obrata, vidne instalacije obrata, košnja trave, naravne značilnosti). Predpostavili smo, da bomo lahko z uporabo zbranih podatkov in satelitskih posnetkov ustvarili natančni območni sloj SEVESO obratov.

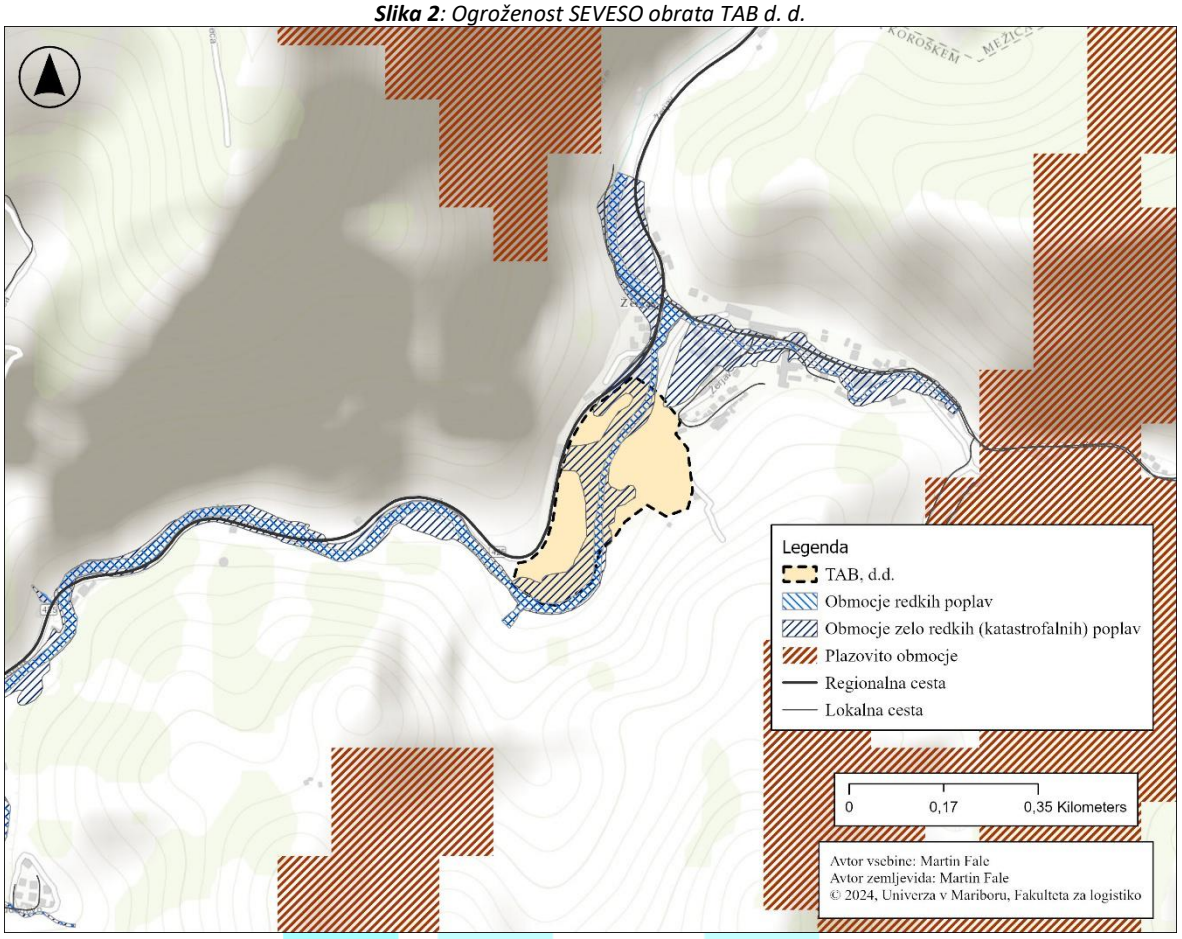
Pri analizi dostopnosti do najbližjega avtocestnega priključka smo predpostavili vožnjo tovornega vozila, ki se pelje po najkrajši poti od SEVESO obrata do najbližjega avtocestnega priključka. Uporabljen je bil tip mrežne analize OD Cost-Matrix. Kot vir podatkov za mrežno analizo smo uporabili ArcGIS Online. Origins predstavlja točkovni sloj SEVESO obratov, Destinations pa točkovni sloj avtocestnih priključkov. Iz spletne strani Atlasa okolja (2025) smo pridobili vnaprej pripravljen točkovni sloj SEVESO obratov. Avtocestne priključke smo določili na podlagi Google Maps. Ustvarili smo točkovni sloj s 170 avtocestnimi priključki. Rezultat mrežne analize OD Cost-Matrix nam je prikazal najbližji avtocestni priključek za vsak SEVESO obrat. Z orodjem Clip smo nato določili poti, Lines, ki prečkajo plazovita območja, območja pogostih poplav, območja redkih poplav in območja zelo redkih (katastrofalnih) poplav. Pod terminom najkrajša pot v kontekstu te analize pojmujemo cestno povezavo med obratom SEVESO in najbližjim avtocestnim priključkom.

3 Rezultati

Upoštevajoč neposredno okolico območja obrata, dostop do 31 SEVESO obratov ogrožajo poplave, dostop do šestih SEVESO obratov pa plazovi. Dostop do obratov Lecana, d. o. o. TAB d. d. in TAB d. d. (Topla) ogrožajo tako poplave kot plazovi. Na Sliki 2 je kot primer podana neposredna okolica obrata večjega tveganja za okolje TAB d. d., obrata za obdelavo neželeznih kovin. Že območje obrata je na območju redkih in območju zelo redkih (katastrofalnih) poplav. Dostop do območja obrata je ogrožen, saj cestne povezave potekajo

prek območja redkih in območja zelo redkih (katastrofalnih) poplav, cestna povezava iz vzhodne smeri pa poteka tudi prek plazovitega območja.

***Slika 2**: Ogroženost SEVESO obrata TAB d. d.*

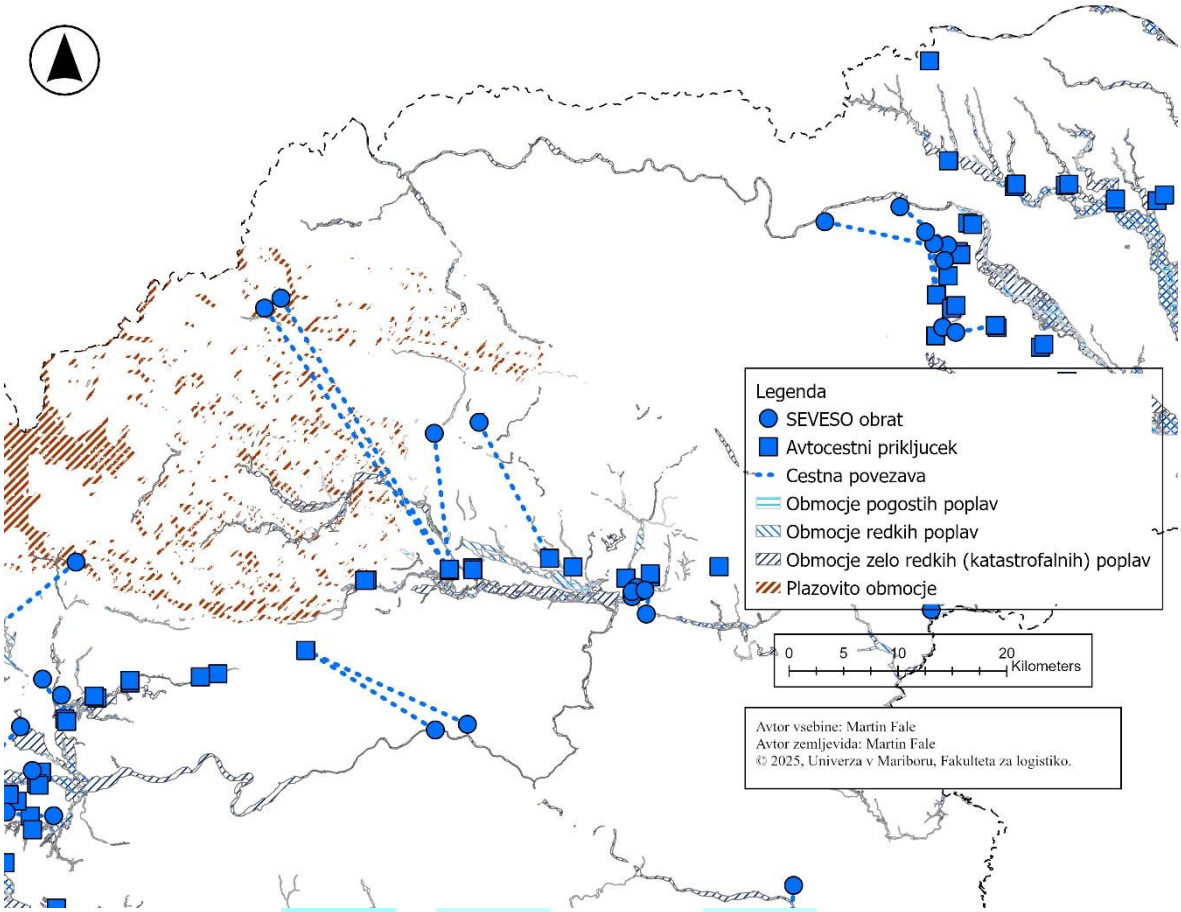


Analiza najkrajših poti med izbranim SEVESO obratom in najbližjim avtocestnim priključkom je prikazala, da je najkrajših poti, ki prečkajo plazovita območja, pet, najkrajših poti, ki prečkajo območja pogostih poplav devet, najkrajših poti, ki prečkajo območja redkih poplav 27 in najkrajših poti, ki prečkajo območja zelo redkih (katastrofalnih) poplav 26. Izmed SEVESO obratov bi izpostavili obrata Lecana, d. o. o in TKK d. o. o., za kateri najkrajša pot za tovorno vozilo poteka prek vseh štirih tipov ogroženih območij. Podrobni rezultati so podani v Preglednici 1. Vizualni prikaz dela rezultatov analize dostopnosti je podan na Sliki 3.

***Preglednica 1**: Podrobni rezultati analize dostopnosti do najbližjega avtocestnega priključka*

Najkrajša pot med SEVESO obratom in najbližjim avtocestnim priključkom, ki prečka:	SEVESO obrat
plazovita območja	Lecana, d. o. o., Acroni, d. o. o., TAB d. d., TAB d. d. (Topla), TKK d. o. o.
območja pogostih poplav	Lecana, d. o. o., Petrol d. d., Ljubljana, lokacija Sermin, Petrol d. d., Ljubljana, lokacija Fram, Fenolit d. d., Skladišče eksploziva Škale, Weiler Abrasives d. o. o. - Slovenske Konjice, TKK d. o. o., Zavod Republike Slovenije za blagovne rezerve, Fibran, d. o. o.
območja redkih poplav	Lecana, d. o. o., Lek d. d., GTG plin d. o. o., Luka Koper, d. d., Melamin d. d., PAM d. o. o., Petrol Energetika d. o. o., Petrol d. d., Ljubljana, lokacija Sermin, Butan plin, d. d., lokacija Ljubljana, Cinkarna Celje, d. d., Fenolit d. d., Kansai Helios d. o. o., Intereuropa d. d., Interina d. o. o., lokacija Ljubljana, Istrabenz Plini d. o. o., lokacija Koper, Istrabenz Plini d. o. o., lokacija Celje, Skladišče eksploziva Škale, Sapio Plini d. o. o., Steklarna Rogaška d. o. o., Weiler Abrasives d. o. o., TAB d. d., TAB d. d. (Topla), TEB d. o. o., TEŠ d. o. o., TKK d. o. o., Zavod Republike Slovenije za blagovne rezerve, Krka, d. d.
območja zelo redkih (katastrofalnih) poplav	Lecana, d. o. o., Lek d. d., Luka Koper, d. d., Melamin d. d., PAM d. o. o., Petrol d. d., Ljubljana, lokacija Ljubljana, Petrol d. d., Ljubljana, lokacija Lendava, Atotech Slovenija d. d., Butan plin, d. d., lokacija Ljubljana, Eko - Nafta d. o. o., Fenolit d. d., Kansai Helios d. o. o., lokacija Kidričevo, Kansai Helios d. o. o., lokacija Medvode, Interina d. o. o., lokacija Ljubljana, Istrabenz Plini d. o. o., lokacija Koper, Skladišče eksploziva Škale, Steklarna Rogaška d. o. o., Weiler Abrasives d. o. o., TAB d. d., TAB d. d. (Topla), TEB d. o. o., TEŠ d. o. o., TKK d. o. o., Zavod Republike Slovenije za blagovne rezerve, Fibran, d. o. o., Krka, d. d.

***Slika 3**: Del rezultata analize dostopnosti do najbližjega avtocestnega priključka v programskem orodju ArcGIS Pro*



4 Diskusija

Slovenija je zaradi svojih geografskih značilnosti postavljena pred velik izziv – vzpostavitev in ohranjanje odporne transportne infrastrukture. Ekstremni vremenski dogodki razkrivajo slabosti sistema, ki jih je treba odpraviti, da bo transportni sistem odporen proti motnjam. Dogodki v italijanski pokrajini Emilia-Romagna in na Japonskem lahko služijo kot učni primeri za izboljšanje odpornosti slovenskega transportnega sistema. Motnje neizogibno povzročijo zmanjšanje zmogljivosti transportnega sistema. Cilj načrtovanja je oblikovati tak sistem, pri katerem bo obseg izgub, prikazan z modrim in rdečkastim območjem na Sliki 1, čim manjši. To bi pomenilo, da je transportni sistem odporen, saj se po motnji hitro stabilizira, povrne ključne funkcije in ponovno zagotovi nemoteno izvajanje transportnih storitev. Rezultati analize tako jasno nakazujejo na ključni pomen odpornosti transportnega sistema za nemoteno delovanje SEVESO obratov v Sloveniji. Otežen dostop in morebitne prekinitve v oskrbi bi morali upravljavci vključiti v analize tveganja ter pripraviti alternativne scenarije oskrbe za primere zmanjšane zmogljivosti transportnega sistema.

Onemogočena prevoznost najkrajših poti pomeni, da se poveča obremenjenost vzporednih cest. V primeru naravnih nesreč so te cestne povezave obremenjene tudi z interventnimi vozili, kar le še povečuje obremenjenost vzporednih cest, kar podaljšuje čas vožnje na teh odsekih. Pomembno je, da ne zanemarimo pomena dostopnosti do obratov, saj lahko naravne nesreče resno vplivajo na prevoznost transportne infrastrukture in posledično na dostop do posameznih obratov. Obrati, ki so na območjih z gosto razvejano transportno

infrastrukturo, imajo prednost v primerih, ko ena od transportnih poti ni več prevozna zaradi nesreče, saj obstajajo alternativne poti. Po drugi strani pa, če je obrat dostopen samo z eno cesto, naravne nesreče, kot so zemeljski plazovi, lahko povzročijo nedostopnost obrata, kar oteži odziv na morebitno nesrečo in omeji možnost hitrega ukrepanja intervencijskih enot. Zanemarjanje pomena odpornosti transportne infrastrukture ima lahko več posledic – ne le potrebe po obnovitvi obstoječih/izgradnji novih transportnih povezav po vremenski ujmi, ampak tudi v škodi, ki jo povzroči nezmožnost uporabljati obstoječo transportno infrastrukturo. Ponavljajoči se vremenski ekstremi nam sporočajo, da je treba vpeljati nove tehnike in tehnologije za vzpostavitev odpornosti transportne infrastrukture. Ena izmed možnosti, ki se ponuja, je modrozelena infrastruktura – naravni sistemi, ki posnemajo delovanje narave – že uporabna na mikrolokacijah v transportnem sistemu (Odpornost mest proti podnebnim spremembam: Deževni vrtovi, 2025).

5 Viri in literatura

- Arrighi, C., & Domeneghetti, A. (2023). Brief communication: On the environmental impacts of 2023 flood in Emilia-Romagna (Italy). Natural Hazards and Earth System Sciences Discussions, 2023, 1-10.
- Chen, Z., Song, K., Shen, Z., Xiao, D., & Xu, X. (2023, August). A Review of Resilient Transportation Systems in the Last Five Years. In 2023 7th International Conference on Transportation Information and Safety (ICTIS) (pp. 521-529). IEEE.
- gis.arso.gov.si/atlasokolja/profile.aspx?id=Atlas_Okolja_AXL@Arso, 15. 10. 2024
- Orense, R. P. Ground damage caused by Typhoon “Hagibis” in Central and Eastern Japan. NZGS Symposium, 21st NZGS Symposium. Japonska.
- Rosi, R., Borghetti, F., Longo, M., Somaschini, C., Fiduccia, A., & Tartaglia, M. (2023, November). Railway Infrastructure Resilience Analysis in Case of Flooding: Case Study in Italy. In 2023 7th International Conference on System Reliability and Safety (ICSRS) (pp. 213-220). IEEE.
- www.delo.si/novice/okolje/zaradi-mocnega-dezevja-zaprte-stevilne-cestne-in-zelezniske-povezave 4. 8. 2023
- www.evode.gov.si/index.php?id=122, 15. 10. 2024
- www.evode.gov.si/index.php?id=119, 15. 10. 2024
- www.gov.si/podrocja/okolje-in-prostor/okolje/onesnazenje-okolja/register-obratov-seveso-obrati-manjsega-in-vecjega-tveganja-za-okolje/, 15. 10. 2024
- Uredba o preprečevanju večjih nesreč in zmanjševanju njihovih posledic, Uradni list RS, št. 22/16, 44/22 – ZVO-2 in 50/23
- White, R. K., Edwards, W. C., Farrar, A., & Plodinec, M. J. (2015). A practical approach to building resilience in America’s communities. American Behavioral Scientist, 59(2), 200-219.
- Zhou, Y., Wang, J., & Yang, H. (2019). Resilience of transportation systems: concepts and comprehensive review. IEEE Transactions on Intelligent Transportation Systems, 20(12), 4262-4276.
- 365.rtvslo.si/arhiv/ugriznimo-znanost/175135642, 29. 5. 2025

assist. Martin Fale, red. Prof. Dr. Borut Jereb, assistant. Mirjana Lazarević, ed. Prof. Dr. Matevž Obrecht, Assoc. Prof. Dr. Maja Rosi, Assistant. Bojana Slomšek Šlamberger

University of Maribor Faculty of Logistics

RESILIENCE OF TRANSPORT INFRASTRUCTURE TO NATURAL DISASTERS IN SLOVENIA: THE CASE OF SOVESO PLANTS

From a business perspective, the resilience of transport infrastructure is crucial for the smooth operation of people, goods and energy. This also applies to SEVESO plants, which are classified as posing a risk to the environment due to the storage of a certain amount of hazardous substances. In the study, we were interested in whether floods and avalanches threaten access to SEVESO plants. The research included the use of the geographic information system ArcGIS Pro. Flood warning map layers and the area layer of landslide areas were used to prepare flood and avalanche risk maps. We analysed the accessibility in the immediate vicinity of the SEVESO plant and the accessibility of the SEVESO plant to the nearest motorway connection. The results show that access in the immediate vicinity to 31 SEVESO plants is at risk of flooding, and up to 6 plants are at risk of avalanches. Particularly prominent are the plants Lecana, d.o.o., TAB d.d. and TAB d.d. (Topla). The analysis of the accessibility of the SEVESO plant to the nearest motorway junction showed that 5 of the shortest routes cross landslide areas, 9 routes pass through areas of frequent floods, 27 routes cross areas of rare floods and 26 routes pass through areas of very rare (catastrophic) floods. Of all SEVESO plants, Lecana, d.o.o. and TKK, d.o.o. stand out, as the shortest access route to both plants is through all four types of endangered areas.

1 Introduction

1.1 Disorders

The floods that hit Slovenia in August 2023 caused enormous damage to infrastructure. Road and rail transport was affected, highlighting the impassability of the motorway at Šempeter in the Savinja Valley, which, in addition to the fact that parallel roads were also impassable, meant that road transport on the Ljubljana-Maribor route was interrupted (delo.si, 2023). Events at the micro level, such as the flooding of the underpass at Tivoli Park in Ljubljana during heavy rains, can have a significant impact on the change in transport flows in the immediate vicinity of the event, while events at the macro level paralyze the operation of the entire transport system. It should be remembered that during emergencies, road networks play a key role in carrying out evacuation and distributing aid (Zhou et al., 2019). The impassability of transport links also means an increased load on parallel roads, which reduces the flow and significantly increases travel time in the case of longer detours and congestion on parallel roads.

1.2 SEVESO plants

From the perspective of business operations, transport is crucial for smooth operation, involving the flow of people, goods and energy. This also applies to SEVESO plants, which

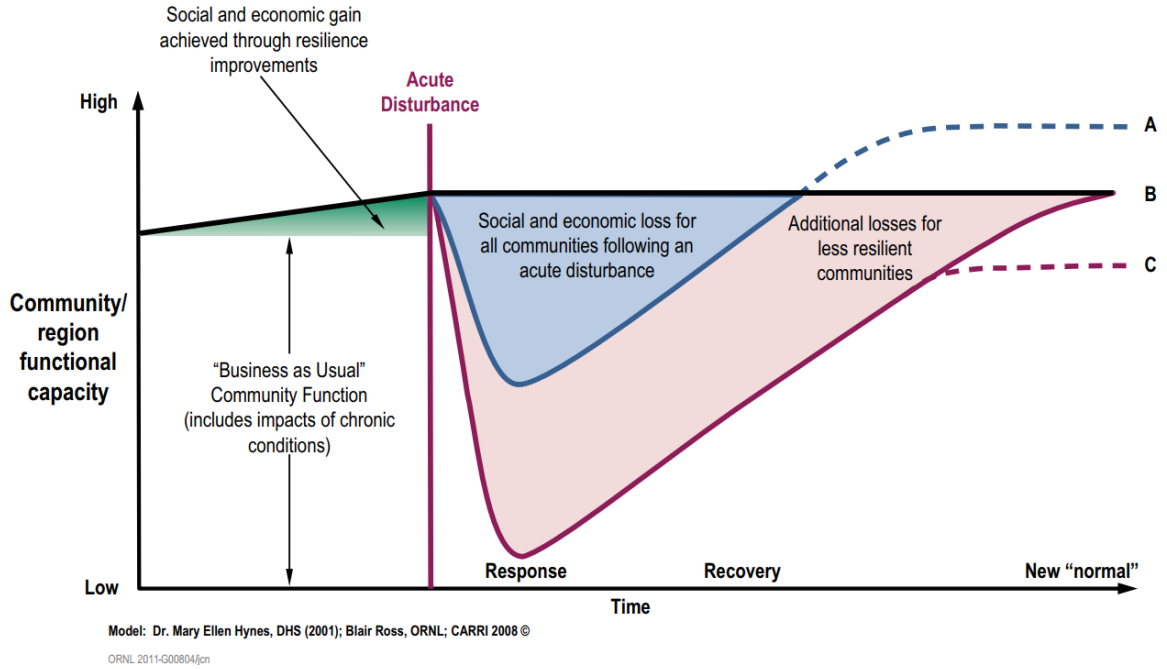
are classified as posing a risk to the environment due to the storage of a certain amount of hazardous substances ("Regulation on the prevention of major accidents and the reduction of their consequences", 2016). As of 15/10/2024, there are 60 SEVESO plants in Slovenia. Most SEVESO plants are wholesale and retail storage and distribution plants (except liquefied petroleum gas) (15 plants), chemical plants (14 plants) and plants for the production, bottling and distribution of liquefied petroleum gas (12 plants). Depending on the amount of hazardous substances, they are classified either as installations with a higher risk for the environment or as installations with a lower risk to the environment. Of the 60 SEVESO plants in Slovenia, 29 are classified as SEVESO plants with a higher environmental risk and 31 as SEVESO plants with a lower environmental risk (Ministry of the Environment, Climate and Energy, 2023). From the very beginning, plants are faced with a choice: either to store larger quantities of hazardous substances in the plant, which reduces the need for supply, or to reduce the quantities of hazardous substances to a level that still ensures the smooth operation of the plant, thereby increasing the need for supply. Supplies to SEVESO plants are carried out by road. Although some plants also have the possibility of access by rail, road transport is the dominant type of transport for supplying SEVESO plants. The resilience of transport infrastructure is therefore crucial.

1.3 Resistance

Increasingly frequent weather extremes require us to adapt. Strengthening the key systems of society, to which transport certainly belongs, must become a guide in the planning of modern society. Resilience means the ability of transport systems to withstand and recover quickly from disruptions such as natural disasters, while maintaining critical services for users. Well-designed systems can absorb minor disturbances, while reducing the extent and duration of deviations from normal operation in the case of larger ones. Their key feature is flexibility, based on thoughtful planning, management and maintenance with resilience in mind. Climate change, with its consequences such as sea level rise, floods, and storms, threatens transportation systems, so there is an increasing focus on their resilience to extreme weather events and long-term climate impacts (Chen et al., 2023). The criteria for assessing the resilience of transport systems are divided into topology, attribute and performance, with the former being based on the grid structure, the latter on individual aspects of resilience, and the third allowing for a comprehensive assessment of the system (Zhou et al., 2019).

Figure 1 shows how acute disturbances (e.g. earthquakes, chemical spills, terrorist attacks, hurricane winds, etc.) cause a marked decline in community functionality. For less resilient communities, the consequences are exacerbated, while more resilient communities adapt more quickly, regain key functions and form a new state of normality. A similar dynamic applies to transport systems: a pronounced disturbance, perceived as a strong impulse, immediately reduces their ability to perform services. The extent of the decline depends on their resilience – more resilient systems suffer smaller losses, while non-resilient or ostensibly resilient systems are exposed to their vulnerability (White et al. 2015).

***Figure 1**: Community Resilience Model*



Rosi et al. (2023) studied the resilience of the Italian rail network. First, they identified vulnerable rail links. The rail network – including different types of lines, stations and main lines – was compared with flood maps to identify any overlaps. On the basis of statistical data, weights were attributed to these connections: the number of passengers in passenger trains and the amount of freight carried in freight trains. With the help of a heat map, they highlighted key points in the network that are most at risk from flooding, according to the added weights. The methodology included the work procedures that are carried out in geographic information systems. The province of Emilia-Romagna, which was hit by severe flooding in 2023, was also identified as a particularly risky area. Two consecutive weather events with intense rainfall, between May 1 and 4 and May 16 and 18, saw massive amounts of rain. Between 16 and 18 May, as much as 200 mm of rainfall was recorded – a record recorded for the area (Arrighi & Domeneghetti, 2023).

Resilient transport infrastructure can mitigate the negative effects of extreme weather events. Japan's culture of adapting to natural disasters can be a role model for others, but even the most resilient systems may not hold their own. In 2013, the Japanese island of Honshu was hit by Typhoon Hagibis. More than 1,000 mm of precipitation fell in some places in 72 hours. The infrastructure did not hold up – rail transport was severely affected, the road network was damaged. Analysis of the disaster showed that despite the enormous financial resources that Japan is allocating to building a resilient society, the existing infrastructure has not been and will not be able to withstand increasingly violent extreme events in the future (Orense, 2022). Research (Rosi et al., 2023) allows us to identify the risks that we need to minimize in order to establish a resilient social system. In the research, we limited ourselves to a micro-problem: Resilience of the transport infrastructure of SEVESO plants, focusing on flood and landslide risk.

2 Methodology

In the research, we focused on publicly available data. When presenting the environment, we supported the articles on the information portals with the conducted research. A search for related research was conducted in the IEEE Xplore, Web of Science, and ScienceDirect scientific databases, using the keywords "transport" and "resilence". The analysis included the use of the geographic information system ArcGIS Pro, version 3.4.0. For the preparation of flood and avalanche risk maps, we used layers: flood warning map, which includes the regional layer of the very rare (catastrophic) flood area (published on: 15/11/2023, D96/TM), the regional layer of the rare flood area (published on: 12/11/2020, D96/TM) and the regional layer of the frequent flood area (published on: 12/11/2020, D96/TM). In addition, we also used the regional layer of landslide areas – areas of snow avalanche occurrence – from NUV1 (date of publication: 3.4.2019 D48/GK). We assumed that the layers of floodplains and landslides obtained from publicly available sources are accurate (Ministry of Natural Resources and Spatial Planning, 2022a; Ministry of Natural Resources and Spatial Planning, 2022b).

We analysed the accessibility in the immediate vicinity of the SEVESO plant and the accessibility of the SEVESO plant to the nearest motorway connection. If, according to the flood warning map or the landslide area, the flood or landslide area has crossed the transport links in the immediate vicinity of the plant area, whether by road or rail, we have assumed that access to the plant is at risk for this plant. With the help of satellite images, we created a zoning layer showing the areas of the SEVESO plants. In doing so, we took advantage of the visual characteristics of each area (visible fence of the plant, visible installations of the plant, grass mowing, natural features). We assumed that using the collected data and satellite imagery, we would be able to create an accurate regional layer of SEVESO plants.

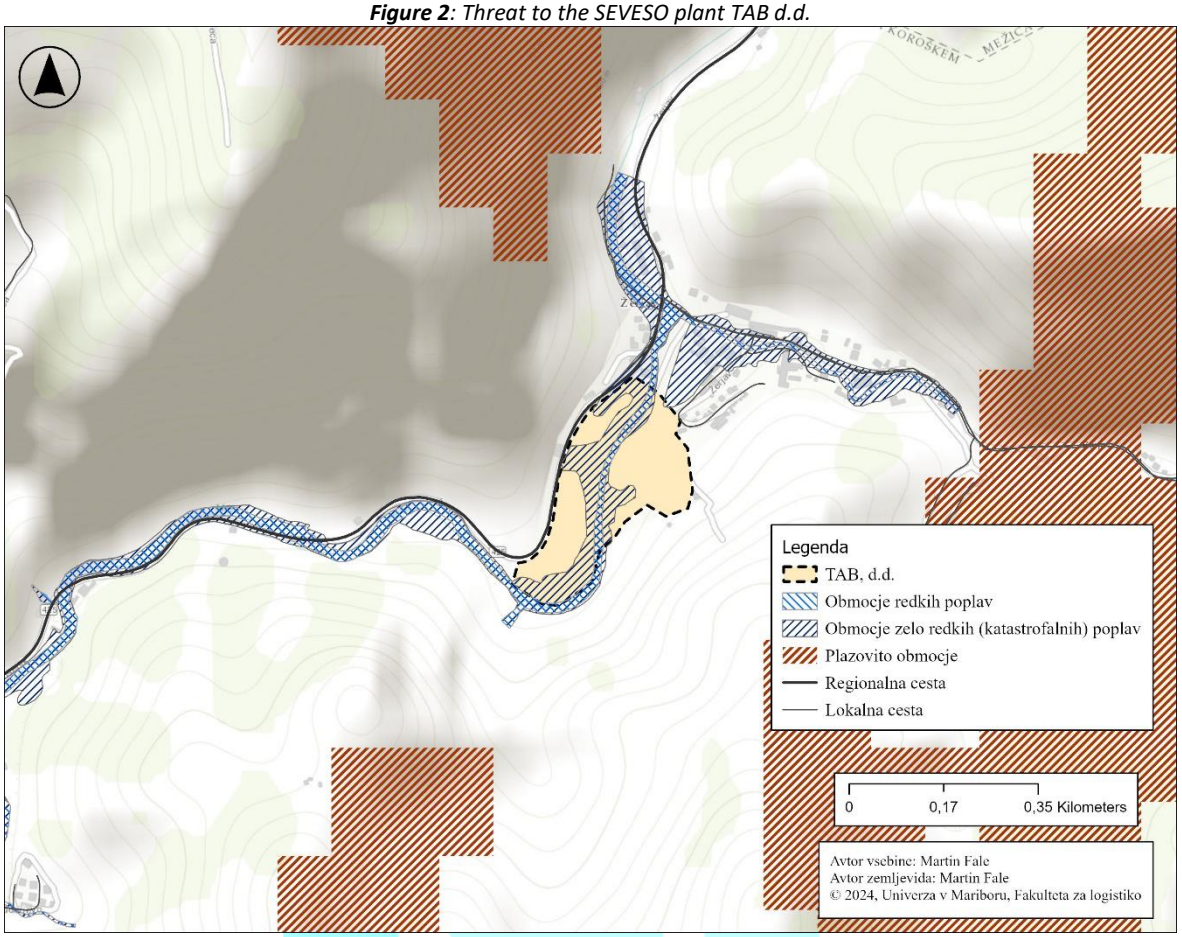
In the analysis of accessibility to the nearest motorway junction, we assumed that a truck would drive along the shortest route from the SEVESO plant to the nearest motorway junction. The OD Cost-Matrix type of network analysis was used. We used ArcGIS Online as the data source for the network analysis. Origins represents the point layer of SEVESO plants, and Destinations represents the point layer of highway connections. From the website of the Environmental Atlas (2025), we obtained a pre-prepared point layer of SEVESO plants. We have determined the motorway connections on the basis of Google Maps. We created a point layer with 170 highway connectors. The result of the OD Cost-Matrix network analysis showed us the nearest motorway connection for each SEVESO plant. Using the Clip tool, we then determined routes, Lines that cross landslide areas, frequent flood areas, rare flood areas, and very rare (catastrophic) flood areas. In the context of this analysis, the term shortest route is understood as the road connection between the SEVESO plant and the nearest motorway connection.

3 Results

Taking into account the immediate surroundings of the plant area, access to 31 SEVESO plants is at risk of flooding and access to six SEVESO plants is at risk of avalanches. Access to the plants of Lecana, d.o.o., TAB d.d. and TAB d.d. (Topla) is threatened by both floods and landslides. Figure 2 shows as an example the immediate vicinity of the plant with a higher environmental risk TAB d.d., a plant for the processing of non-ferrous metals. The area of the plant is already in the area of rare and very rare (catastrophic) floods. Access to

the plant area is at risk as road connections run through the Rare Flood Zone and the Very Rare (Catastrophic) Flood Zone, and the road connection from the east also runs through the landslide area.

***Figure 2**: Threat to the SEVESO plant TAB d.d.*

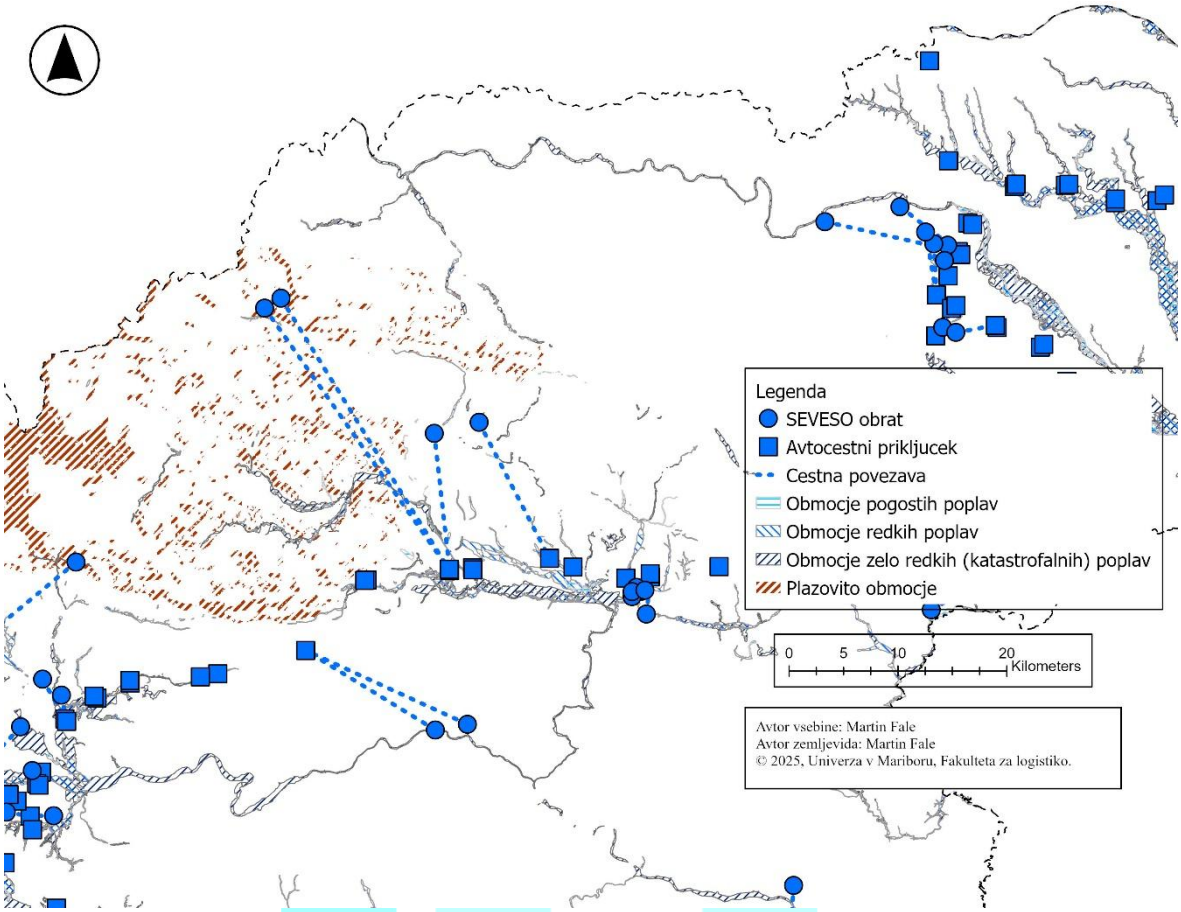


The analysis of the shortest routes between the selected SEVESO plant and the nearest motorway junction showed that there are five shortest routes crossing landslide areas, nine shortest routes crossing areas of frequent flooding, 27 shortest routes crossing areas of rare floods, and 26 shortest routes crossing areas of very rare (catastrophic) floods. Of the SEVESO plants, we would like to point out the plants Lecana, d.o.o. and TKK d.o.o., for which the shortest route for a truck runs through all four types of endangered areas. Detailed results are given in Table 1. A visual representation of part of the results of the accessibility analysis is given in Figure 3.

***Table 1**: Detailed results of the analysis of accessibility to the nearest motorway junction*

The shortest route between the SEVESO plant and the nearest motorway junction crossing:	SEVESO plant
Landslide areas	Lecana, d. o. o., Acroni, d. o. o., TAB d. d., TAB d. d. (Topla), TKK d. o. o.
Areas of frequent flooding	Lecana, d.o.o., Petrol d.d., Ljubljana, location Sermin, Petrol d.d., Ljubljana, location Fram, Fenolit d.d., Explosives warehouse Škale, Weiler Abrasives d.o.o. - Slovenske Konjice, TKK d.o.o., Institute of the Republic of Slovenia for Commodity Reserves, Fibran, d.o.o.
Rare Flood Zones	Lecana, d.o.o., Lek d.d., GTG plin d.o.o., Luka Koper, d.d., Melamin d.d., PAM d.o.o., Petrol Energetika d.o.o., Petrol d.d., Ljubljana, location Sermin, Butan plin, d.d., location Ljubljana, Cinkarna Celje, d.d., Fenolit d.d., Kansai Helios d.o.o., Intereuropa d.d., Interina d.o.o., location Ljubljana, Istrabenz Plini d.o.o., Koper location, Istrabenz Plini d.o.o., Celje location, Škale explosives warehouse, Sapio Plini d.o.o., Steklarna Rogaška d.o.o., Weiler Abrasives d.o.o., TAB d.d., TAB d.d. (Topla), TEB d.o.o., TEŠ d.o.o., TKK d.o.o., Institute of the Republic of Slovenia for Commodity Reserves, Krka, d. d.
Areas of very rare (catastrophic) floods	Lecana, d.o.o., Lek d.d., Luka Koper, d.d., Melamin d.d., PAM d.o.o., Petrol d.d., Ljubljana, location Ljubljana, Petrol d.d., Ljubljana, location Lendava, Atotech Slovenia d.d., Butan plin, d.d., location Ljubljana, Eko - Nafta d.o.o., Fenolit d.d., Kansai Helios d.o.o., location Kidričevo, Kansai Helios d.o.o., location Medvode, Interina d.o.o., location Ljubljana, Istrabenz Plini d.o.o., location Koper, Explosives warehouse Škale, Steklarna Rogaška d.o.o., Weiler Abrasives d.o.o., TAB d.d., TAB d.d. (Topla), TEB d.o.o., TEŠ d.o.o., TKK d.o.o., Institute of the Republic of Slovenia for Commodity Reserves, Fibran, d.o.o., Krka, d. d.

***Figure 3**: Part of the result of the accessibility analysis to the nearest highway connector in ArcGIS Pro*



4 Discussion

Due to its geographical characteristics, Slovenia is faced with a major challenge – the establishment and maintenance of a resilient transport infrastructure. Extreme weather events reveal weaknesses in the system that need to be addressed to make the transport system resilient to disruptions. Events in the Italian province of Emilia-Romagna and Japan can serve as teaching examples to improve the resilience of the Slovenian transport system. Disturbances inevitably lead to a decrease in the capacity of the transport system. The aim of the design is to design such a system in which the extent of losses shown by the blue and reddish areas in Figure 1 is kept to a minimum. This would mean that the transport system is resilient, as it quickly stabilises after a disruption, restores key functions and restores the smooth operation of transport services. The results of the analysis thus clearly indicate the key importance of the resilience of the transport system for the smooth operation of SEVESO plants in Slovenia. Difficult access and potential interruptions in supply should be included in risk analyses by operators and alternative supply scenarios should be developed in cases of reduced capacity of the transport system.

The impossibility of transportability of the shortest routes means that the congestion of parallel roads increases. In the event of natural disasters, these road connections are also burdened with emergency vehicles, which only increases the congestion of parallel roads, which increases the driving time on these sections. It is important not to neglect the importance of accessibility to installations, as natural disasters can have a serious impact on

the transportability of transport infrastructure and, consequently, on access to individual installations. Installations located in areas with densely branched transport infrastructure are given priority in cases where one of the transport routes is no longer transportable due to an accident, as there are alternative routes. On the other hand, if the plant is accessible by only one road, natural disasters such as landslides can make the plant inaccessible, which makes it difficult to respond to a potential disaster and limits the ability of intervention units to act quickly. Neglecting the importance of the resilience of transport infrastructure can have several consequences – not only in the need to renew existing/build new transport links after the weather, but also in the damage caused by the inability to use existing transport infrastructure. Recurrent weather extremes tell us that new techniques and technologies need to be introduced to build the resilience of transport infrastructure. One of the options offered is blue-green infrastructure – natural systems that mimic the workings of nature – already usable in micro-locations in the transport system (Urban resilience to climate change: Rain Gardens, 2025).

5 Sources

- Arrighi, C., & Domeneghetti, A. (2023). Brief communication: On the environmental impacts of 2023 flood in Emilia-Romagna (Italy). Natural Hazards and Earth System Sciences Discussions, 2023, 1-10.
- Chen, Z., Song, K., Shen, Z., Xiao, D., & Xu, X. (2023, August). A Review of Resilient Transportation Systems in the Last Five Years. In 2023 7th International Conference on Transportation Information and Safety (ICTIS) (pp. 521-529). IEEE.
- gis.arso.gov.si/atlasokolja/profile.aspx?id=Atlas_Okolja_AXL@Arso, 15. 10. 2024
- Orense, R. P. Ground damage caused by Typhoon "Hagibis" in Central and Eastern Japan. NZGS Symposium, 21st NZGS Symposium. Japonska.
- Rosi, R., Borghetti, F., Longo, M., Somaschini, C., Fiduccia, A., & Tartaglia, M. (2023, November). Railway Infrastructure Resilience Analysis in Case of Flooding: Case Study in Italy. In 2023 7th International Conference on System Reliability and Safety (ICSRS) (pp. 213-220). IEEE.
- www.delo.si/novice/okolje/zaradi-mocnega-dezevja-zaprte-stevilne-cestne-in-zelezniske-povezave 4. 8. 2023
- www.evode.gov.si/index.php?id=122, 15. 10. 2024
- www.evode.gov.si/index.php?id=119, 15. 10. 2024
- www.gov.si/podrocja/okolje-in-prostor/okolje/onesnazenje-okolja/register-obratov-seveso-obrati-manjsega-in-vecjega-tveganja-za-okolje/, 15. 10. 2024
- Regulation on the Prevention of Major Accidents and the Reduction of Their Consequences, Official Gazette of the Republic of Slovenia, Nos. 22/16, 44/22 – ZVO-2 and 50/23
- White, R. K., Edwards, W. C., Farrar, A., & Plodinec, M. J. (2015). A practical approach to building resilience in America's communities. American Behavioral Scientist, 59(2), 200-219.
- Zhou, Y., Wang, J., & Yang, H. (2019). Resilience of transportation systems: concepts and comprehensive review. IEEE Transactions on Intelligent Transportation Systems, 20(12), 4262-4276.
- 365.rtvslo.si/arhiv/ugriznimo-znanost/175135642, 29. 5. 2025

Lončar Kočić Darinka, mag. ing. traff.
Slunjski Piskač Vlatka, dipl. ing. prometa
Strojarska i prometna škola Varaždin

ERASMUS + PROJEKT COMPETENCE+ D/I: RAZVOJ KOMPETENCIJA U JAVNOM PRIJEVOZU ZA VIŠE RAZNOLIKOSTI I UKLJUČIVOSTI

Sažetak

Strojarska i prometna škola partner je u novom Erasmus + KA2 projektu „COMPETENCE+ D/I: Razvoj kompetencija u javnom prijevozu za više raznolikosti i uključivosti (COMP+ D/I)“. Projekt je započeo u siječnju 2024. i trajati će do lipnja 2026. Projekt je nadogradnja projekta Competence+ iz 2020. godine, na kojem su se razvijale inovativne metode podučavanja u području javnog prijevoza putnika. COMP+ D/I koristit će rezultate prethodno završenog projekta za nadogradnju postojećih virtualnih scenarija podučavanja te razvoj programa obuke usmjerenog na raznolikost i uključivost u javnom prijevozu putnika. VR i računalne igre koristiti će se na radionicama za potrebe obuke djelatnika u javnom prijevozu putnika kako bi se lakše nosili sa različitim svakodnevnim situacijama. Razvit će se platforma za e-učenje i virtualne scenarije, u kojima sudionici radionica mogu vježbati svoje nove vještine u sigurnom virtualnom okruženju. COMP+ D/I će kroz postojeće scenarije o svijesti o okolišu, upravljanju stresom i sukobima te moralnoj hrabrosti poticati na više uključivosti u svakodnevnom javnom prijevozu putnika. Tijekom scenarija korisnici će se morati snalaziti u složenim situacijama u okruženju javnog prijevoza i primijeniti svoje znanje sa radionica. Dugoročno gledano, cilj ovog projekta je stvaranje inkluzivnije zajednice za sve, i to poboljšavanjem kompetencija i vještina svih sudionika u javnom prijevozu putnika.

1 Uvod

Erasmus+ je program Europske unije za obrazovanje, osposobljavanje, mlade i sport. Obrazovanje, osposobljavanje, mladi i sport najvažnija su područja za osobni i profesionalni razvoj građana. Visokokvalitetno, uključivo obrazovanje i osposobljavanje te informalno i neformalno učenje na koncu mladima, ali i sudionicima svih dobi, pružaju kvalifikacije i vještine potrebne za konstruktivno sudjelovanje u demokratskom društvu, međukulturno razumijevanje i uspješan prelazak na tržište rada. Program u svim aktivnostima koje obuhvaća nastoji promicati jednake mogućnosti i pristup, uključivost, raznolikost i pravednost. Opći je cilj programa cjeloživotnim učenjem podupirati obrazovni, profesionalni i osobni razvoj ljudi u području obrazovanja, osposobljavanja, mladih i sporta u Europi i šire, što doprinosi održivom rastu, kvaliteti radnih mjesta, socijalnoj koheziji, poticanju inovacija te jačanju europskog identiteta i aktivnoga građanstva.

Važnost navedenog prepoznala je i Strojarska i prometna škola (SIPS) koja provodi projekte

mobilnost od 2014-e godine. SIPS je dosad u sektoru prometa i logistike sudjelovala u „Ključna Aktivnost 1: Mobilnost u svrhu učenja za pojedince“. Navedenim omogućuje svojim učenicima odlazak na praktičnu nastavu u inozemstvo. Cilj razmjene učenika i obavljanja praktične nastave u inozemstvu je poboljšati kvalitetu rada škole i provođenja praktične nastave te stjecanje dodatnih kompetencija učenicima koje su im potrebne za konkurentnost na europskom tržištu rada.

Od siječnja 2024-e godine SIPS kao partner sudjeluje u prvom projektu iz „Ključna Aktivnost 2: Suradnja organizacija i institucija“ pod nazivom COMPETENCE+ D/I: Razvoj kompetencija u javnom prijevozu za više raznolikosti i uključivosti.

Javni prijevoz putnika je sektor od sve većeg značaja za europske gradove i ruralna područja. On pruža bitnu osnovu za ostvarivanje potreba moderne društvene mobilnosti u skladu s održivim i ekološki prihvatljivim razvojem. To također dovodi do rastuće ekonomske važnosti ovog sektora. S rastućom urbanom populacijom i sve većim zahtjevima za održivošću, zaposlenici u javnom prijevozu svakodnevno se suočavaju s nizom izazova, od prihvaćanja novih tehnologija poput sustava autonomnih vozila do upravljanja korisničkom službom i smirivanja sukoba, sve uz pružanje kulturne osviještenosti i zastupanje ideja održivosti. Svime navedenim bavi se projekt **COMPETENCE+ D/I: Razvoj kompetencija u javnom prijevozu za više raznolikosti i uključivos**ti, skraćeno COMP+ D/I. **COMP+ D/I** Erasmus+ je projekt koji traje od siječnja 2024. do svibnja 2026. godine. COMP+ D/I nastavak je projekta **Competence+ iz 2020.: Razvoj programa kombiniranog učenja izvan čistih profesionalnih vještina**.

2 O projektu Competence+: Razvoj programa kombiniranog učenja izvan čistih profesionalnih vještina

COMP+ D/I nastavak je **projekta Competence+ iz 2020.: Razvoj programa kombiniranog učenja izvan čistih profesionalnih vještina**. S Competence+, provela se obuka učenika strukovnog obrazovanja i zaposlenike javnog prijevoza putnika u četiri različita područja:

1. **Svijest o okolišu**, kako bismo senzibilizirali zaposlenike javnog prijevoza putnika za važnost zelenih sustava prijevoza i njihov vlastiti doprinos poticanju održivosti u javnom prijevozu.

2. **Svijest o konfliktima**, kako bismo obučili vještine za prepoznavanje i učinkovito rješavanje situacija koje mogu dovesti do nesporazuma ili sukoba, čime se osnažuju zaposlenici javnog prijevoza putnika i smanjuje njihov nivo stresa.

3. **Moralna hrabrost**, kako bismo opremili zaposlenike i učenike strukovnog obrazovanja u sektoru javnog prijevoza putnika hrabrošću i strategijama koje im omogućuju da interveniraju u slučaju sukoba i kako bi im pokazali da imaju moć i sposobnost pomoći ljudima u nesigurnim situacijama.

4. **Upravljanje stresom**, kako bismo naučili zaposlenike javnog prijevoza putnika kako upravljati svojim stresom i poboljšati svoje opće mentalno zdravlje i dobrobit.

S obzirom na te ciljeve, COMPETENCE+ stvorio je kombinirani program učenja i naprednu platformu za obuku koju polaznici i zaposlenici u javnom prijevozu putnika mogu koristiti za daljnje obrazovanje. Koncept kombiniranog tečaja učenja uključuje i e-učenje i učioničku obuku u obliku radionica. Posebna značajka COMPETENCE+ je da scenariji virtualne

stvarnosti omogućuju učenicima da izravno primijene i testiraju svoje novostečene kompetencije i vještine u sigurnom okruženju.

3 O projektu COMPETENCE+ D/I: Razvoj kompetencija u javnom prijevozu za više raznolikosti i uključivosti

COMP+ D/I (Slika 1) nastavak je projekta Competence+ iz 2020.: Razvoj programa kombiniranog učenja izvan čistih profesionalnih vještina. Na temelju rezultata tog prvog projekta, COMP+ D/I koristi inovativne metode podučavanja, uključujući VR scenarije i računalne igre, kako bi pružio razumljiv program obuke usmjeren na raznolikost i uključivost u javnom prijevozu putnika. Nositelj projekta je poduzeće za cestovni prijevoz putnika Straeto (Island), a partnerstvo se sastoji od još šest organizacija:

- Wisamar Bildungsgesellschaft (Njemačka), neprofitni obrazovni institut,
- DomSpain (Španjolska), centar za obrazovanje i osposobljavanje odraslih i strukovno obrazovanje,
- Virsabi (Danska), konzultantska i softverska kuća,
- StandoutEducation (Cipar), obrazovna organizacija,
- Daugavpils Tehnologiju un turisma tehnikums (Latvija),obrazovna ustanova i
- Strojarska i prometna škola (Hrvatska), obrazovna ustanova.

Slika 1: Logo projekta COMP+ D/I

Glavni cilj COMP+ D/I je razviti inovativni koncept obuke za poboljšanje vještina i radnog okruženja za zaposlenike poduzeća za prijevoz putnika (vozači autobusa)/nastavnike koji obučavaju zaposlenike, s naglaskom na raznolikost i inkluziju. COMP+ D/I će pomoći nastavnicima, osoblju i polaznicima da steknu dublje razumijevanje važnosti življenja raznolikosti i inkluzije u njihovom profesionalnom i svakodnevnom životu. Dugoročan je cilj stvoriti inkluzivniju zajednicu za sve, poboljšavajući vještine, radna okruženja i učinke. Nadalje, projektom se želi dokazati kako se virtualna stvarnost (VR) i računalne igre mogu učinkovito koristiti u profesionalnoj obuci i u nastavnom procesu u strukovnom obrazovanju i osposobljavanju (VET).

COMP+ pristup omogućuje fleksibilno i prilagodljivo poučavanje i učenje ovisno o odgovarajućim okolnostima. Projektom se želi potaknuti učenike/nastavnike da koriste digitalne tehnologije za svoj individualni proces učenja. COMP+ nudi priliku za doživljavanje novih dimenzija učenja i poučavanja, pružajući sveobuhvatan, jednostavan za korištenje, ali zanimljiv i inovativan program učenja koji se lako može integrirati u kontekste

strukovnog obrazovanja i daljnje obuke u javnom prijevozu i šire.

Tijekom provedbe projekta žele se postići sljedeći rezultati:

1. Metodologija za korištenje VR-a i gamifikacije u strukovnom obrazovanju i osposobljavanju

Metodologija za korištenje VR-a i gamifikacije u VET-u je strukturirani pristup razvoju i provedbi programa obuke koji koriste VR i računalne igre općenito, a posebno COMP+ materijale. Kako bi se pristup COMP+ projektu učinio što korisnijim za nastavnike, osigurati će se metodologija za nastavnike u strukovnom obrazovanju i daljnjem obrazovanju o korištenju VR-a i računalnih igara u obrazovnim kontekstima. Metodologija će nastavnicima pružiti zanimljive, interaktivne i učinkovite metode poučavanja koje podržavaju njihov vlastiti i profesionalni razvoj učenika. Dodatno, Metodologija će detaljno objasniti kako se COMP+ materijali mogu koristiti u strukovnom obrazovanju i osposobljavanju. Metodologija će osiguravati prenosivost rezultata projekta i time održivost projekta.

2. Radionica i VR scenarij „Raznolikost i uključenost“

Radionica „Raznolikost i uključenost“ biti će prilagođena učenicima/zaposlenicima/polaznicima obuke u javnom prijevozu putnika. Radionica će biti uživo i online te se može koristiti kao samostalna radionica ili u kombinaciji s drugim COMP+ radionicama o ekološkoj osviještenosti, upravljanju stresom i sukobima, te moralnoj hrabrosti. Radionica „Raznolikost i uključenost“ općenito prati nacrt i koncepte postojećih COMP+ radionica, što uključuje teorijski i praktični dio te VR scenarij koji se može koristiti za obuku. Radionica je koncept kombiniranog učenja i osmišljena je na način da se može provesti u trajanju od dva sata uz dodatno individualno vrijeme za učenje. Kako bi materijali radionice bili što korisniji i sveobuhvatniji u pogledu raznolikosti i uključenosti u različitim kontekstima, omogućuje nastavnicima da odaberu najrelevantnije modularne elemente za svoj kontekst i individualno prilagode opseg svoje radionice. COMP+ VR scenariji nadopunjuju radionice i omogućuju polaznicima da odmah primijene svoje novo stečeno znanje u sigurnom okruženju. COMP+ D/I razvija peti VR scenarij „Raznolikost i uključenost“ kako bi nadopunili postojeći scenariji o ekološkoj osviještenosti, upravljanju stresom i sukobima, te moralnoj hrabrosti. Tijekom scenarija, korisnici će se morati snalaziti u složenim situacijama u okruženju javnog prijevoza putnika i primijeniti svoje znanje stečeno na radionicama.

4 COMP+ računalna igra

Tijekom projekta razviti će se računalna igra temeljena na pet COMP+ radionica koja se može koristiti kao dio radionice ili kao dio učenja kod kuće. Dodavanje računalne igre pomoći će smanjiti „tehnički prag“ za nastavnike i učenike, imajući na umu da je VR još uvijek prilično nova tehnologija i nije široko korištena, posebno u obrazovanju. COMP+ računalnu igru mogu koristiti sudionici radionica, ali i svi drugi zainteresirani. Igra će biti dizajnirana kako bi pomogla korisnicima razviti kompetencije izvan njihovih profesionalnih vještina u kontekstu javnog prijevoza. Igra će se sastojati od nekoliko razina, od kojih će svaka biti usmjerena na različito područje kompetencija.

5 Poboljšana inkluzivnost i pristupačnost postojećih COMP+ materijala

Tijekom projekta će se poboljšati pristupačnost i inkluzivnost COMP+ platforme za učenje i komunikacijskih kanala projekta te proširiti održivost i upotrebljivost svih COMP+ materijala za raznoliku ciljnu skupinu. To uključuje ažuriranje i prilagodbu platforme za učenje i komunikacijskih kanala projekta za bolju pristupačnost i integraciju. Kako je COMP+ D/I nastavak COMP+, nastavit će se koristiti e-learning platformu https://competencepluselearning.eu za ovaj novi projekt. Uz mogućnost pružanja cjelovitijeg i sveobuhvatnijeg paketa obuke na taj način, cilj je također produžiti vijek materijala koji su izgrađeni u prvom projektu, dajući priliku nastavnicima da imaju pristup različitim metodama, alatima i materijalima na više jezika.

Za COMP+ D/I mogu se identificirati četiri izravne ciljne skupine koje će biti uključene u razvoj i provedbu projekta:

- učenici u zanimanjima javnog prijevoza putnika,
- zaposlenici poduzeća iz javnog prijevoza putnika,
- nastavnici u području strukovnog obrazovanja i osposobljavanja s fokusom na zanimanja u javnom prijevozu putnika,
- edukatori u području daljnje obuke za osoblje s fokusom na zanimanja u javnom prijevozu putnika.

Neizravne ciljne skupine projekta su:

- poduzeća javnog prijevoza putnika u partnerskim zemljama i u Europi,
- kreatori politika u obrazovanju i osposobljavanju u području javnog prijevoza putnika, npr. regionalni ili nacionalni političari ili donosioci odluka na razini poduzeća,
- poduzeća kao i pružatelji strukovnog obrazovanja i daljnje obuke izvan sektora javnog prijevoza putnika, njihovi zaposlenici, polaznici i nastavnici.

Te ciljne skupine bit će obuhvaćene različitim aktivnostima diseminacije, od osobnih razgovora, članaka u specijaliziranim medijima, umrežavanja i aktivnosti udruženja (u sektoru strukovnog obrazovanja i osposobljavanja) na regionalnoj, nacionalnoj i europskoj razini, do ciljanih aktivnosti na društvenim mrežama.

5.1 Provedene aktivnosti

Projekt (Tablica 1) je započet u siječnju 2024-e godine te su provedena tri online sastanaka te jedan transnacionalni partnerski sastanak u Reykjaviku (Slika 2). Do kraja lipnja 2024-e godine izradio se metodološki okvir i nacrt metodologije za korištenje VR-a i gamifikacije u strukovnom obrazovanju i osposobljavanju. Krenulo se sa prijevodom materijala za izradu VR-a i računalnih igara. Provedena je anketa od strane nastavnika iz područja strukovnog obrazovanja o metodologiji za korištenje VR-a i računalnih igara u strukovnom obrazovanju i osposobljavanju. Anketom su nastavnici iz Hrvatske, Latvije, Španjolske i Njemačke potvrdili kako su suglasni sa dosad izrađenom metodologijom.

Tablica 1: Započete i provedene aktivnosti

	Početak	Kraj
Metodologija za korištenje VR-a i gamifikacije u strukovnom obrazovanju i osposobljavanju		
Izrada metodološkog okvira i nacrta poglavlja	01.01.2024	31.05.2024
Evaluacija i povratne informacije od strane nastavnika iz područja strukovnog obrazovanja	01.05.2024	31.05.2024
Transnacionalni partnerski sastanak (Island)	01.06.2024	30.06.2024
Proizvodnja sadržaja	01.06.2024	30.12.2024
Radionica i VR scenarij „Raznolikost i uključenost“		
Konceptualni okvir i struktura radionice, uključujući strategije za poboljšanje D+I postojećih materijala	01.05.2024	30.06.2024
COMP+ računalna igra		
Koncept gamifikacije za COMP+	01.01.2024	29.02.2024
Prilagodba COMP+ i WP3 sadržaja	01.03.2024	28.02.2025
Tehnička izvedba računalne igre	01.06.2024	28.02.2026
Poboljšana inkluzivnost i pristupačnost postojećih COMP+ materijala		
Akcijski plan za prilagodbu i poboljšanu dostupnost platforme za učenje	01.01.2024	31.03.2024
Provedba Akcijskog plana za poboljšanu pristupačnost	01.04.2024	30.11.2025

Transnacionalni partnerski sastanak na Islandu je proveden sa ciljem analize dosadašnjeg rada na projektu i izrade plana za daljnji tijek projekta, ujedno je Strojarska i prometna škola nabavila VR naočala pomoću kojih će učenici u virtualnoj stvarnosti razvijati kompetencije potrebne u javnom prijevozu putnika.



Slika 2: Transnacionalni partnerski sastanak u Reykjaviku, Island

Projekt završava u lipnju 2026, te su ispred projektnog tima još mnogi zadaci i projektne aktivnosti (Tablica 2).

Tablica 2: Projektne aktivnosti u budućnosti

	Početak	Kraj
Metodologija za korištenje VR-a i gamifikacije u strukovnom obrazovanju i osposobljavanju		
Revizija, finalizacija i prijevod	01.01.2025	30.06.2025
Diseminacija i promocija	01.04.2025	30.06.2026
Radionica i VR scenarij „Raznolikost i uključenost“		
Tehnički razvoj novih i poboljšanje postojećih VR scenarija	01.07.2024	31.08.2025
Transnacionalni partnerski sastanak (Španjolska)	01.12.2024	31.12.2024
Prijevodi	01.12.2024	31.08.2025
Glasovne snimke	01.06.2025	31.08.2025
Test i povratne informacije: interno	01.09.2025	30.12.2025
Revizije i finalizacije	01.08.2025	31.05.2026
Diseminacija i promocija	01.09.2025	30.06.2026
COMP+ računalna igra		
Test i povratne informacije: interno	01.05.2025	31.12.2025
Sastanak partnera (Latvija)	01.06.2025	30.07.2025
Revizija i finalizacija	01.07.2025	31.03.2026
Diseminacija i promocija	01.07.2025	30.06.2026
Poboljšana inkluzivnost i pristupačnost postojećih COMP+ materijala		
Implementacija WP 3 sadržaja na platformi za učenje	01.08.2025	30.11.2025
Implementacija WP 5 na platformi za učenje	01.08.2025	30.11.2025
Test i povratne informacije: LTTA (Hrvatska)	01.12.2025	31.12.2025
Sastanak partnera (Hrvatska)	01.12.2025	31.01.2026
Revizija i finalizacija	01.12.2025	30.06.2026
Test i povratne informacije: pilotiranje	01.03.2026	30.04.2026

6 Zaključak

U današnje vrijeme zaposlenici poduzeća za prijevoz putnika, a osobito vozači autobusa, nalaze se u različitim stresnim i nepredviđenim situacijama. Važno je u njihovom redovnom obrazovanju i daljnjem osposobljavanju voditi računa o tome i pripremiti ih na takve situacije. Upravo projekt **COMP+ D/I** pokušava osmisliti zanimljiv i inovativan program

učenja koji se lako može integrirati u kontekste strukovnog obrazovanja i daljnje obuke u javnom prijevozu i to na način da se koristi virtualna stvarnost i računalne igre. Navedeno nije namijenjeno samo već zaposlenima u poduzećima za prijevoz putnika nego i učenicima srednjih škola koji svakodnevno sudjeluju u javnom prijevozu. Cilj ovog načina rade je povećanje motivacije i interesa zaposlenika/učenika te poticanje na određene oblike ponašanja (nediskriminacija, promicanje jednakosti i poštovanja, itd.).

Opće je prihvaćeno kako je učenje lakše kroz igru i kako današnje generacije učenika lakše usvajaju nova znanja i vještine učenjem temeljenom na igri. Upravo korištenje VR-a i računalne igre nam to omogućuje. Igra potiče znatiželju i angažiranost na znatno dubljoj razini od one situacije kada se nastavnik frontalno obraća učenicima. Ali isto tako, korištenje VR-a i računalnih igara u nastavi predstavlja veliki izazov za sve koje su uključeni u nastavni proces. Za takav način rada potrebno je educirati nastavnike za korištenje novih sredstava rada. Kod računalnih igara nastavnici trebaju pažljivo koristiti postojeće te razviti nove pedagoške modele i scenarije učenja koji bi bili prikladni za učenje temeljeno na igrama pri čemu je potrebno uzeti u obzir različita predznanja učenika te različitu brzinu svladavanja gradiva. Upravo navedenim bavi se projekt COMP+ D/I.

7 Literatura

Web stranice:

https://erasmus-plus.ec.europa.eu/hr/programme-guide/part-b/part-b-information-about-the-actions-covered-by-this-guide , 26.06.2024.

https://www.linkedin.com/company/competenceplus-di , 26.06.2024.

https://competenceplusproject.eu , 26.06.2024.

Lončar Kočić Darinka, mag. ing. traff.

Slunjski Piskač Vlatka, dipl. ing. prometa

Strojarska i prometna škola Varaždin

ERASMUS + PROJECT COMPETENCE+ D/I: DEVELOPING COMPETENCES IN PUBLIC TRANSPORT FOR MORE DIVERSITY AND INCLUSION

Summary

The School of Mechanical Engineering and Transport is a partner in the new Erasmus+ KA2 project "COMPETENCE+ D/I: Developing Competences in Public Transport for More Diversity and Inclusion (COMP+ D/I)." The project started in January 2024 and will run until June 2026. It is an upgrade of the 2020 Competence+ project, which focused on developing innovative teaching methods in the field of public passenger transport. COMP+ D/I will use the results of the previously completed project to enhance existing virtual teaching scenarios and develop a training program focused on diversity and inclusion in public passenger transport. Virtual Reality (VR) and computer games will be used in workshops to train public transport employees to better handle various everyday situations. An e-learning platform and virtual scenarios will be developed, enabling workshop participants to practice their new skills in a safe virtual environment. COMP+ D/I will build upon existing scenarios on environmental awareness, stress and conflict management, and moral courage to promote greater inclusion in everyday public transport settings. During the scenarios, users will need to navigate complex situations in a public transport environment and apply the knowledge gained in the workshops. In the long term, the goal of the project is to create a more inclusive community for all by improving the competences and skills of everyone involved in public passenger transport.

1 Introduction

Erasmus+ is the European Union's programme for education, training, youth and sport. Education, training, youth and sport are the most important areas for citizens' personal and professional development. Ultimately, high-quality, inclusive education and training, as well as informal and non-formal learning, provide young people, as well as participants of all ages, with the qualifications and skills needed for constructive participation in a democratic society, intercultural understanding and successful transitions into the labour market. The Programme aims to promote equal opportunities and access, inclusiveness, diversity and equity in all the activities it covers. The general objective of the programme is to support people's educational, professional and personal development in education, training, youth and sport in Europe and beyond through lifelong learning, contributing to sustainable growth, job quality, social cohesion, fostering innovation and strengthening European identity and active citizenship.

The importance of this has been recognized by Mechanical and Transport school (SIPS),

which has been implementing mobility projects since 2014. So far, SIPS has participated in the transport and logistics sector in "Key Action 1: Learning mobility for individuals". With the above, it enables its students to go to practical classes abroad. The aim of the exchange of students and practical classes abroad is to improve the quality of school work and the implementation of practical classes, as well as to acquire additional competencies for students that they need to be competitive in the European labor market.

From January 2024, SIPS as a partner participates in the first project from "Key Activity 2: Cooperation between organizations and institutions" called COMPETENCE+ D/I: Development of competencies in public transport for more diversity and inclusion.

Public passenger transport is a sector of growing importance for European cities and rural areas. It provides an essential basis for meeting the needs of modern social mobility in line with sustainable and environmentally friendly development. This also leads to the growing economic importance of this sector. With a growing urban population and increasing demands for sustainability, public transport employees face a range of challenges on a daily basis, from embracing new technologies such as autonomous vehicle systems to managing customer service and de-escalating conflicts, all while providing cultural awareness and advocating for sustainability ideas. All of the above is addressed by **the project COMPETENCE+ D/I: Development of competences in public transport for more diversity and inclusion, abbreviated COMP+ D/I. COMP+ D/I** Erasmus+ is a project that lasts from January 2024 to May 2026. COMP+ D/I is a follow-up to the **2020 Competence+ project: Developing blended learning programmes beyond pure professional skills**.

2 About the Competence+ project: Development blended learning programmes beyond pure professional skills

COMP+ D/I is a follow-up to **the 2020 Competence+ project: Developing blended learning programmes beyond pure professional skills**. With Competence+, training for vocational education students and public transport employees was carried out in four different areas:

1. **Environmental awareness**, in order to sensitize public passenger transport employees to the importance of green transport systems and their own contribution to fostering sustainability in public transport.
2. **Conflict awareness**, in order to train skills to identify and effectively resolve situations that may lead to misunderstandings or conflicts, thereby empowering public passenger transport employees and reducing their stress levels.
3. **Moral courage**, to equip employees and vocational education students in the public passenger transport sector with the courage and strategies that allow them to intervene in the event of conflict and to show them that they have the power and ability to help people in precarious situations.
4. **Stress management**, to teach public passenger transport employees how to manage their stress and improve their overall mental health and well-being.

With these objectives in mind, COMPETENCE+ has created a blended learning programme and an advanced training platform that can be used by trainees and employees in public passenger transport for further education. The concept of a blended learning course includes

both e-learning and classroom training in the form of workshops. A special feature of COMPETENCE+ is that virtual reality scenarios allow students to directly apply and test their newly acquired competencies and skills in a safe environment.

3 About the COMPETENCE+ D/I project: Developing competences in public transport for more diversity and inclusiveness

COMP+ D/I (Image 1) is a follow-up to the 2020 Competence+ project: Developing blended learning programmes beyond pure professional skills. Building on the results of this first project, COMP+ D/I uses innovative teaching methods, including VR scenarios and computer games, to provide an understandable training programme focused on diversity and inclusion in public passenger transport. The project holder is the road passenger transport company Straeto (Iceland), and the partnership consists of six other organizations:

- Wisamar Bildungsgesellschaft (Germany), a non-profit educational institute,
- DomSpain (Spain), Centre for Adult Education and Training and Vocational Training,
- Virsabi (Denmark), a consulting and software company,
- StandoutEducation (Cyprus), an educational organisation,
- Daugavpils Technologie un turisma tehnikums (Latvia), an educational institution and
- School of Mechanical Engineering and Traffic Engineering (Croatia), educational institution.

Image 1: Logo of the COMP+ D/I project

The main objective of COMP+ D/I is to develop an innovative training concept to improve skills and working environment for employees of passenger transport companies (bus drivers)/teachers who train employees, with a focus on diversity and inclusion. COMP+ D/I will help teachers, staff and students gain a deeper understanding of the importance of living diversity and inclusion in their professional and daily lives. The long-term goal is to create a more inclusive community for all, improving skills, work environments and performance. Furthermore, the project aims to prove how virtual reality (VR) and computer games can be effectively used in professional training and in the teaching process in vocational education and training (VET).

The COMP+ approach allows for flexible and adaptable teaching and learning depending on the appropriate circumstances. The project aims to encourage students/teachers to use

digital technologies for their individual learning process. COMP+ offers the opportunity to experience new dimensions of learning and teaching, providing a comprehensive, easy-to-use, yet engaging and innovative learning programme that can be easily integrated into the contexts of vocational education and further training in public transport and beyond.

During the implementation of the project, the following results are to be achieved:

1. Methodology for the use of VR and gamification in vocational education and training

The methodology for the use of VR and gamification in VET is a structured approach to the development and implementation of training programs that use VR and computer games in general and COMP+ materials in particular. In order to make the approach to the COMP+ project as useful as possible for teachers, a methodology will be provided for teachers in vocational education and further education on the use of VR and computer games in educational contexts. The methodology will provide teachers with engaging, interactive and effective teaching methods that support their own and professional development of students. In addition, the Methodology will explain in detail how COMP+ materials can be used in vocational education and training. The methodology will ensure the transferability of the project results and thus the sustainability of the project.

2. Workshop and VR scenario "Diversity and Inclusion"

The workshop "Diversity and Inclusion" will be tailored to students/employees/trainees in public passenger transport. The workshop will be live and online and can be used as a standalone workshop or in combination with other COMP+ workshops on environmental awareness, stress and conflict management, and moral courage. The "Diversity and Inclusion" workshop generally follows the blueprint and concepts of existing COMP+ workshops, which includes a theoretical and practical part and a VR scenario that can be used for training. The workshop is a blended learning concept and is designed in such a way that it can be conducted in the duration of two hours with additional individual learning time. In order to make the workshop materials as useful and comprehensive as possible in terms of diversity and inclusion in different contexts, it allows teachers to choose the most relevant modular elements for their context and individually adapt the scope of their workshop. COMP+ VR scenarios complement the workshops and allow participants to immediately apply their newly acquired knowledge in a safe environment. COMP+ D/I is developing a fifth VR scenario "Diversity and Inclusion" to complement existing scenarios on environmental awareness, stress and conflict management, and moral courage. During the scenario, users will have to navigate complex situations in the public passenger transport environment and apply their knowledge gained in the workshops.

4 COMP+ computer game

During the project, a computer game based on five COMP+ workshops will be developed that can be used as part of a workshop or as part of learning at home. Adding a computer game will help lower the "technical threshold" for teachers and students, keeping in mind that VR is still a fairly new technology and is not widely used, especially in education. The COMP+ computer game can be used by workshop participants, but also by anyone else interested. The game will be designed to help users develop competencies beyond their professional skills in the context of public transport. The game will consist of several levels, each of which will focus on a different area of competence.

5 Improved inclusiveness and accessibility of existing COMP+ materials

During the project, the accessibility and inclusiveness of the COMP+ learning platform and communication channels of the project will be improved and the sustainability and usability of all COMP+ materials for a diverse target group will be expanded. This includes updating and adapting the project's learning platform and communication channels for better accessibility and integration. As COMP+ D/I is a continuation of COMP+, the e-learning platform will continue to be used https://competencepluselearning.eu for this new project. In addition to being able to provide a more complete and comprehensive training package in this way, the aim is also to extend the life of the materials that were built in the first project, giving teachers the opportunity to have access to different methods, tools and materials in multiple languages.

For COMP+ D/O, four direct target groups can be identified that will be involved in the development and implementation of the project:

- students in public passenger transport professions,
- employees of public passenger transport companies,
- teachers in the field of vocational education and training with a focus on professions in public passenger transport;
- educators in the field of further training for staff with a focus on professions in public passenger transport.

The indirect target groups of the project are:

- public passenger transport companies in partner countries and in Europe;
- policy-makers in public passenger transport education and training, e.g. regional or national politicians or decision-makers at company level;
- companies as well as vocational education and training providers outside the public passenger transport sector, their employees, trainees and teachers.

These target groups will be covered by various dissemination activities, from face-to-face interviews, articles in specialised media, networking and association activities (in the VET sector) at regional, national and European level, to targeted activities on social networks.

5.1 Activities carried out

The project (Table 1) started in January 2024 and three online meetings and one transnational partnership meeting were conducted in Reykjavik (Image 2). By the end of June 2024, a methodological framework and a draft methodology for the use of VR and gamification in vocational education and training have been developed. The translation of materials for the creation of VR and computer games began. A survey was conducted by teachers in the field of vocational education on the methodology for the use of VR and computer games in vocational education and training. With the survey, teachers from Croatia, Latvia, Spain and Germany confirmed that they agree with the methodology

developed so far.

Table 1: Start and implement activities

	Beginning	The end
Methodology for the use of VR and gamification in vocational education and training		
Development of the methodological framework and draft chapters	01.01.2024	31.05.2024
Evaluation and feedback from teachers in the field of vocational education	01.05.2024	31.05.2024
Transnational Partnership Meeting (Iceland)	01.06.2024	30.06.2024
Content Production	01.06.2024	30.12.2024
Workshop and VR scenario "Diversity and Inclusion"		
Conceptual framework and structure of the workshop, including strategies for improving D+I existing materials	01.05.2024	30.06.2024
COMP+ computer game		
The concept of gamification for COMP+	01.01.2024	29.02.2024
Customization of COMP+ and WP3 content	01.03.2024	28.02.2025
Technical performance of a computer game	01.06.2024	28.02.2026
Improved inclusiveness and accessibility of existing COMP+ materials		
Action Plan for Adaptation and Improved Accessibility of the Learning Platform	01.01.2024	31.03.2024
Implementation of the Action Plan for Improved Accessibility	01.04.2024	30.11.2025

A transnational partnership meeting in Iceland was conducted with the aim of analyzing the work done so far on the project and developing a plan for the further course of the project, at the same time the School of Mechanical Engineering and Traffic Engineering procured VR glasses with which students will develop the competencies needed in public passenger transport in virtual reality.



Image 2: Transnational Partnership Meeting in Reykjavik, Iceland

The project ends in June 2026, and there are still many tasks and project activities ahead of the project team (Table 2).

Table 2: Project activities in the future

	Beginning	The end
Methodology for the use of VR and gamification in vocational education and training		
Revision, finalization and translation	01.01.2025	30.06.2025
Dissemination and promotion	01.04.2025	30.06.2026
Workshop and VR scenario "Diversity and Inclusion"		
Technical development of new and improvement of existing VR scenarios	01.07.2024	31.08.2025
Transnational Partnership Meeting (Spain)	01.12.2024	31.12.2024
Translations	01.12.2024	31.08.2025
Voice Recordings	01.06.2025	31.08.2025
Test & Feedback: Internally	01.09.2025	30.12.2025
Revisions and finalizations	01.08.2025	31.05.2026
Dissemination and promotion	01.09.2025	30.06.2026
COMP+ computer game		
Test & Feedback: Internally	01.05.2025	31.12.2025
Partner meeting (Latvia)	01.06.2025	30.07.2025
Revision and finalization	01.07.2025	31.03.2026
Dissemination and promotion	01.07.2025	30.06.2026
Improved inclusiveness and accessibility of existing COMP+ materials		
Implementing WP 3 Content on a Learning Platform	01.08.2025	30.11.2025
Implementing WP 5 on a learning platform	01.08.2025	30.11.2025
Test and feedback: LTTA (Croatia)	01.12.2025	31.12.2025
Partner meeting (Croatia)	01.12.2025	31.01.2026
Revision and finalization	01.12.2025	30.06.2026
Test & Feedback: Piloting	01.03.2026	30.04.2026

6 Conclusion

Nowadays, employees of passenger transport companies, and especially bus drivers, find themselves in a variety of stressful and unforeseen situations. It is important to take this into account in their regular education and further training and prepare them for such situations. The **COMP+ D/I project** is trying to design an interesting and innovative learning program

that can be easily integrated into the contexts of vocational education and further training in public transport by using virtual reality and computer games. This is not only intended for those already employed in passenger transport companies, but also for high school students who participate in public transport on a daily basis. The goal of this way of working is to increase the motivation and interest of employees/students and encourage certain forms of behavior (non-discrimination, promotion of equality and respect, etc.).

It is generally accepted that learning is easier through play and that today's generations of students find it easier to acquire new knowledge and skills through game-based learning. It is the use of VR and computer games that allows us to do this. The game stimulates curiosity and engagement on a much deeper level than the situation when the teacher addresses the students head-on. But also, the use of VR and computer games in teaching is a great challenge for everyone involved in the teaching process. For such a way of working, it is necessary to educate teachers to use new means of work. In computer games, teachers should carefully use existing and develop new pedagogical models and learning scenarios that would be suitable for game-based learning, taking into account the different prior knowledge of students and the different speed of mastering the material. This is exactly what the COMP+ D/I project deals with.

7 Literature

Websites:

https://erasmus-plus.ec.europa.eu/hr/programme-guide/part-b/part-b-information-about-the-actions-covered-by-this-guide , 26.06.2024.

https://www.linkedin.com/company/competenceplus-di , 26.06.2024.

https://competenceplusproject.eu , 26.06.2024.

Darja Lužnik
Šolski center Celje, Srednja šola za storitvene dejavnosti in logistiko

LOGISTIKA ODNOSOV: UČINKOVITA KOMUNIKACIJA KOT TEMELJ USPEŠNEGA SODELOVANJA

Celje, avgust 2025

Povzetek

Prispevek obravnava povezovanje svetovalnega dela in logistike kot dveh na videz različnih, a v praksi komplementarnih področij. Izhodišče predstavlja problematika, da se v logističnih procesih pogosto zanemarja človeški dejavnik, kar lahko vodi v slabšo komunikacijo, konflikte, povečano stresno obremenitev zaposlenih in posledično nižjo učinkovitost. Namen prispevka je pokazati, kako lahko integracija svetovalnih storitev v logistične sisteme pripomore k izboljšanju delovnih odnosov, večji odpornosti zaposlenih na spremembe ter višji operativni uspešnosti.

1. Uvod

V sodobnem poslovnem okolju, kjer so spremembe hitre in nepredvidljive, logistika ostaja eden ključnih stebrov gospodarske uspešnosti. Ob tem pa se pogosto pozablja, da logistični procesi niso zgolj zaporedje tehničnih in operativnih nalog, temveč kompleksen sistem, v katerem so človeški dejavniki – odnosi, komunikacija in psihosocialna podpora – enako pomembni kot optimizacija transportnih poti ali uvedba novih informacijskih sistemov.

Svetovalno delo v tem kontekstu prinaša dodano vrednost, saj organizacijam omogoča, da celovito obravnavajo izzive, povezane z delovnimi odnosi, stresom, odpornostjo na spremembe in reševanjem konfliktov. Kot navaja Ule (2015, str. 41), »uspešno svetovalno delo temelji na razumevanju tako organizacijskih kot tudi človeških potreb, pri čemer mora

svetovalec delovati kot povezovalni člen med posamezniki in sistemom.«

Povezovanje svetovalnega dela in logistike se v praksi odraža v višji stopnji zadovoljstva zaposlenih, boljši komunikaciji med oddelki in učinkovitejšem reševanju problemov. Pri tem ne gre le za krizne intervencije, ampak tudi za strateško načrtovane aktivnosti, ki dolgoročno prispevajo k stabilnosti in razvoju organizacije.

Cilj tega prispevka je prikazati, kako lahko integracija svetovalnega dela v logistične sisteme izboljša učinkovitost in psihosocialno dobrobit zaposlenih.

2. Povezava med svetovalnim delom in logistiko

Na prvi pogled se svetovalno delo in logistika morda zdita kot dve povsem ločeni področji. Logistika je pogosto opisana kot tehnična veda, ki se ukvarja z načrtovanjem, izvajanjem in nadzorom tokov blaga, informacij ter storitev (Smiljanić, 2019, str. 86), medtem ko svetovalno delo obravnava predvsem človeški dejavnik – odnose, komunikacijo, čustveno podporo in reševanje konfliktov (Ule, 2015, str. 39). Vendar ob natančnejšem pogledu hitro ugotovimo, da sta ti področji tesno prepleteni in da lahko njuno povezovanje prinese pomembne koristi.

2.1 Skupne točke obeh področij

Osnovna povezava med svetovalnim delom in logistiko je v **upravljanju procesov** – logistika skrbi za materialne in informacijske tokove, svetovalno delo pa za tokove komunikacije in medosebnih odnosov. Oboje mora teči gladko, da organizacija deluje optimalno. Kjer pride do zastojev, so posledice lahko zelo podobne: v logistiki se kažejo kot zamude in napake, v medosebnih odnosih pa kot konflikti, pomanjkanje motivacije in stres.

Kot ugotavlja Kralj (2020, str. 52), "vpeljava svetovalnih pristopov v operativne procese poveča sposobnost organizacije, da se prilagodi spremembam in jih učinkovito obvladuje." To še posebej velja v logistiki, kjer so spremembe (npr. spremembe dobavnih verig, uvedba novih tehnologij, reorganizacije) stalnica.

2.2 Vloga svetovalcev v logističnem okolju

Svetovalci v logistiki lahko delujejo na več ravneh:

- **Preventivno** – s pomočjo delavnic, izobraževanj in timskih srečanj krepijo komunikacijske veščine in odpornost zaposlenih na stres.
- **Reaktivno** – posredujejo v konfliktih, pomagajo pri kriznem komuniciranju in svetujejo vodstvu pri reševanju kadrovskih težav.
- **Strateško** – sodelujejo pri oblikovanju dolgoročnih načrtov, pri čemer opozarjajo na psihosocialne vidike in predlagajo ukrepe za izboljšanje delovne klime.

Primer: V Pošti Slovenije so med prestrukturiranjem logističnih centrov v letih 2021–2022 svetovalci sodelovali z vodstvom in zaposlenimi pri lajšanju procesa sprememb. V *Letnem poročilu 2023* je poudarjeno, da so ob reorganizaciji izvajali ukrepe za krepitev medoddelčne komunikacije in dobrobit zaposlenih, kar je prispevalo k zmanjšanju napetosti in boljšemu sodelovanju (Pošta Slovenije, 2023).

2.3 Sinergija med procesi in ljudmi

Uspešna logistika ni zgolj rezultat dobro načrtovanih poti in optimiziranih skladišč, temveč tudi harmoničnega delovanja timov, ki te procese izvajajo. Če so odnosi znotraj tima slabi ali če komunikacija med oddelki ne deluje, tudi najboljša tehnologija ne bo zagotovila želenih rezultatov.

V DHL Group so v trajnostnem poročilu (2023) posebej poudarili pomembnost neposredne podpore zaposlenim na operativnih ravneh. V svojih logističnih centrih in skladiščih izvajajo programe za krepitev varnosti, zdravja ter psihološkega počutja zaposlenih. Poročilo izpostavlja, da takšne aktivnosti zmanjšujejo stres, povečujejo pripravljenost na sodelovanje med oddelki in dolgoročno prispevajo k nižji fluktuaciji zaposlenih (DHL Group, 2023).

3. Vloga odnosov v logistiki

Logistika je pogosto razumljena kot področje, kjer prevladujejo številke, vozni redi, skladiščne kapacitete in informacijski sistemi. Vendar za temi procesi stojijo ljudje – vozniki, skladiščniki, planerji, vodje izmen, nabavniki – ki s svojim sodelovanjem in medosebnimi odnosi odločilno vplivajo na potek dela. Kadar so odnosi zdravi, komunikacija jasna in zaupanje med sodelavci močno, logistični procesi tečejo nemoteno. Kadar pa pride do napetosti, nerazumevanja ali nezaupanja, se to hitro odrazi v napakah, zamudah in zmanjšani učinkovitosti.

Kot opozarja Ule (2015, str. 57), »medosebni odnosi so temelj vsakega delovnega procesa, še posebej tam, kjer je delo medsebojno odvisno in časovno občutljivo.« V logistiki so ti pogoji stalno prisotni – od sinhronizacije med oddelki do usklajevanja z zunanjimi partnerji.

3.1 Pomen zaupanja in sodelovanja

Zaupanje med sodelavci in med zaposlenimi ter vodstvom je ključni element uspešnega dela v logistiki. V okolju, kjer so naloge pogosto povezane in kjer ena zamuda povzroči verižno reakcijo, morajo člani tima verjeti, da bodo drugi opravili svoje delo kakovostno in pravočasno.

Primer: V podjetju Pošta Slovenije so v Letnem poročilu 2022 predstavili prehod na nov digitalni sistem za sledenje pošiljk, ki je zahteval pomembne organizacijske prilagoditve. Takšne spremembe v logističnih procesih običajno vplivajo na odnose med oddelki in zahtevajo dodatno komunikacijo ter usklajevanje (Pošta Slovenije, 2022).

3.2 Komunikacija kot orodje za preprečevanje napak

V logistiki napake pogosto izvirajo iz pomanjkljive komunikacije. To se lahko zgodi zaradi nejasnih navodil, neustrezno posredovanih informacij ali odsotnosti povratne informacije. Svetovalno delo lahko na tem področju veliko pripomore, saj vključuje tehnike aktivnega poslušanja, jasnega sporočanja in preverjanja razumevanja.

Kot navaja Smiljanić (2019, str. 88), »investicija v izboljšanje komunikacijskih veščin zaposlenih se v logistiki povrne večkratno, saj zmanjšuje stroške napak in povečuje zadovoljstvo strank.«

Primer: Pošta Slovenije je v *Letnem poročilu 2022* predstavila uvedbo digitalnih rešitev in mobilnih aplikacij, ki omogočajo boljšo sledljivost pošiljk in učinkovitejšo komunikacijo v

logističnih procesih. Uvedba tovrstnih tehnologij zmanjšuje možnost napak in prispeva k večji usklajenosti dela med oddelki (Pošta Slovenije, 2022).

3.3 Reševanje konfliktov in ohranjanje motivacije

Konflikti so v logistiki neizogibni – zaradi različnih interesov, obremenitev ali različnih interpretacij nalog. Če so ti konflikti obravnavani konstruktivno, lahko celo pripomorejo k izboljšanju procesov. Če pa se prezrejo, hitro vodijo v zmanjšanje motivacije in povečano fluktuacijo.

Primer: V *Sustainability Report 2023* je DHL Group poudaril pomen vključevanja zaposlenih v procese odločanja in kreiranja delovnega okolja. Po njihovih ugotovitvah takšni pristopi, ki temeljijo na dialogu in sodelovanju, prispevajo k večjemu zadovoljstvu zaposlenih in občutku pravičnosti (DHL Group, 2023).

3.4 Vloga vodij pri gradnji odnosov

Vodje v logistiki imajo dvojno nalogo – skrbeti za operativno učinkovitost in hkrati za dobro počutje zaposlenih. Svetovalci lahko vodjem pomagajo razviti veščine vodenja, ki temeljijo na empatiji, jasni komunikaciji in konstruktivnem reševanju sporov.

Kralj (2020) poudarja, da vodja, ki zna ustvariti pozitivno delovno klimo, ne krepi le produktivnosti, temveč tudi odpornost tima na krizne situacije. To je v logistiki, kjer so motnje in nepredvideni dogodki pogosti, še posebej pomembno.

4. SWOT analiza povezovanja svetovalnega dela in logistike

SWOT analiza je orodje, ki omogoča pregled prednosti, slabosti, priložnosti in nevarnosti določene strategije ali pristopa. V kontekstu povezovanja svetovalnega dela z logistiko nam pomaga razumeti, kje so največje prednosti in kje potencialna tveganja, ki jih je treba obvladati.

Tabela 1: SWOT analiza

Prednosti (Strengths)	Slabosti (Weaknesses)
Izboljšana komunikacija med oddelki in zaposlenimi.	Pomanjkanje znanja svetovalcev o specifičnih logističnih procesih.
Večja motivacija in zadovoljstvo zaposlenih.	Možen odpor vodstva ali zaposlenih do “mehkih” pristopov.
Zmanjšanje bolniških odsotnosti in fluktuacije kadrov.	Potreba po dodatnih finančnih in časovnih virih za izvajanje svetovalnih aktivnosti.
Boljše obvladovanje stresa in konfliktov.	Neenotno sprejemanje svetovalne vloge med zaposlenimi.

Priložnosti (Opportunities)	Nevarnosti (Threats)
Integracija svetovalnih storitev v digitalne logistične platforme.	Gospodarske krize ali rez proračunov, ki zmanjšajo financiranje za svetovalne storitve.
Povečanje konkurenčnosti podjetja zaradi boljše organizacijske kulture.	Zamenjava vodstva, ki spremeni prioritete in zmanjša podporo svetovalnim programom.
Razvoj specializiranih izobraževanj za svetovalce v logistiki.	Tehnološki razvoj, ki bi lahko preusmeril fokus samo na tehnične vidike in zanemaril ljudi.
Možnost mednarodnega sodelovanja in izmenjave dobrih praks.	Povečana fluktuacija kadra, ki otežuje dolgoročno delo na odnosih.

4.1 Prednosti

»Med ključnimi prednostmi se izpostavlja izboljšana komunikacija med oddelki, kar omogoča hitrejše reševanje težav in boljše usklajevanje nalog. Prisotnost svetovalne podpore zmanjšuje stres in konflikte, kar vodi do manj bolniških odsotnosti. Kralj (2020) poudarja, da pozitivna delovna klima pomembno prispeva k večji operativni učinkovitosti.«

4.2 Slabosti

Glavna slabost je lahko **pomanjkanje specifičnega logističnega znanja** med svetovalci, kar lahko vodi do manj učinkovite podpore. Prav tako nekateri zaposleni vidijo svetovalne storitve kot nepotrebno “mehko” komponento, ki jemlje čas operativnim nalogam.

4.3 Priložnosti

Povezovanje svetovalnega dela z logistiko odpira možnosti za **specializirana izobraževanja** in razvoj interdisciplinarnih programov. Digitalizacija logistike omogoča, da so svetovalne storitve (npr. svetovanje na daljavo, digitalne ankete o klimi) še bolj dostopne.

4.4 Nevarnosti

Med nevarnostmi izstopajo **finančne omejitve** in spremembe vodstva, ki lahko zmanjšajo podporo svetovalnim programom. Poleg tega lahko premočan poudarek na tehnoloških rešitvah zasenči pomen človeškega dejavnika, kar dolgoročno vodi do padca motivacije zaposlenih.

5. Praktična priporočila za svetovalce v logistiki

Svetovalno delo v logističnem okolju zahteva posebno kombinacijo znanj in pristopov, saj gre za okolje, kjer se prepletajo visoka operativna dinamika, časovni pritiski in stalne spremembe. Svetovalci, ki želijo učinkovito delovati v tem sektorju, se morajo prilagoditi specifičnim potrebam in ritmu dela.

5.1 Razumevanje logističnih procesov

Svetovalec, ki pozna osnove logističnih tokov, skladiščenja, transporta in IT-sistemov, lažje vzpostavi verodostojnost pri zaposlenih. To ne pomeni, da mora biti strokovnjak za operativne naloge, vendar osnovno razumevanje terminologije, postopkov in ključnih izzivov olajša komunikacijo in sodelovanje. Tudi raziskave poudarjajo, da razumevanje

procesov svetovalcu omogoča učinkovitejšo vlogo sogovornika v organizaciji (DHL Group, 2023).

5.2 Zgodnja vključitev v spremembe

Pri uvajanju novih tehnologij, reorganizaciji ali selitvi logističnih centrov je ključno, da so svetovalci vključeni **že v načrtovalni fazi**. S tem lahko pomagajo prepoznati morebitne psihosocialne izzive, pripravijo preventivne ukrepe in zmanjšajo odpor zaposlenih do sprememb.

Primer: V Pošti Slovenije so svetovalci sodelovali pri načrtovanju sprememb razporedov dela in s tem preprečili, da bi spremembe povzročile povečanje odsotnosti.

5.3 Krepitev komunikacijskih kanalov

V logistiki je komunikacija pogosto hierarhična, kar pomeni, da lahko pomembne informacije "zastanejo" na določeni ravni. Svetovalci lahko pomagajo oblikovati **horizontalne komunikacijske poti** – na primer redne medoddelčne sestanke ali digitalne kanale za hitro izmenjavo informacij.

5.4 Prilagoditev pristopa

Logistični sektor pogosto deluje v izmenah in 24/7 režimu, zato morajo svetovalci prilagoditi razpoložljivost – na primer s ponudbo podpore v različnih terminih ali z uporabo digitalnih orodij. DHL Group (2023) v *Sustainability Report* poudarja, da digitalne platforme in programi podpore zaposlenim povečujejo dostopnost svetovalnih storitev in s tem izboljšujejo dobrobit zaposlenih.

5.5 Merjenje učinkov

Svetovalno delo je včasih težko kvantificirati, a v logistiki so merljivi kazalniki (absentizem, fluktuacija, produktivnost) pomemben del ocene uspešnosti. Zato je smiselno uvajati **redne ankete o zadovoljstvu zaposlenih**, spremljati statistiko konfliktov in beležiti izboljšave.

5.6 Povezovanje z vodji

Vodje so ključni zavezniki svetovalcev. Če vodja razume in podpira svetovalno delo, bo verjetneje tudi spodbujal zaposlene k uporabi teh storitev. Svetovalci lahko organizirajo **coaching** za vodje, da ti pridobijo veščine aktivnega poslušanja, motiviranja in konstruktivnega reševanja sporov.

6. Sklepni razmislek

Povezovanje svetovalnega dela z logistiko predstavlja pristop, ki presega tradicionalno razumevanje obeh področij. Čeprav se logistika pogosto obravnava kot tehnično-operativna dejavnost, so človeški dejavniki – komunikacija, odnosi, zaupanje in psihosocialna stabilnost – ključni za njeno nemoteno delovanje. Svetovalno delo vnaša v logistiko tisto komponento, ki omogoča, da procesi niso le učinkoviti, ampak tudi trajnostni.

Analiza primerov iz slovenskega prostora jasno kaže, da se vključitev svetovalnih storitev obrestuje v obliki manjše fluktuacije, manj bolniških odsotnosti, večje pripravljenosti na spremembe in boljše medoddelčne povezanosti. Ti rezultati potrjujejo ugotovitve Kralja (2020), da organizacije, ki vlagajo v psihosocialno podporo, dolgoročno povečajo tudi svojo konkurenčnost.

SWOT analiza je razkrila, da so prednosti in priložnosti integracije svetovalnega dela v logistiko večje od slabosti in nevarnosti, pri čemer so slednje predvsem povezane s pomanjkanjem specifičnega znanja svetovalcev o logističnih procesih ter morebitnimi finančnimi omejitvami. To pomeni, da je ključ do uspeha v nenehnem usposabljanju svetovalcev, zgodnji vključitvi v strateške odločitve in tesnem sodelovanju z vodji logističnih enot.

Praktična priporočila, predstavljena v tem prispevku, ponujajo jasno pot naprej – od krepitve komunikacijskih kanalov, merjenja učinkov svetovalnega dela, do prilagajanja pristopa delovnim ritmom in tehnološkim spremembam. Vloga svetovalca v logistiki je večplastna: je opazovalec, mediator, strateg in partner, ki skrbi, da človeški kapital ostane zdrav, motiviran in povezan.

S pogledom v prihodnost lahko rečemo, da bo povezovanje svetovalnega dela in logistike postajalo vedno pomembnejše, še posebej ob soočanju z globalnimi izzivi, kot so pomanjkanje kadra, digitalizacija in vse večja potreba po agilnosti organizacij. Organizacije, ki bodo znale združiti tehnično odličnost z močno psihosocialno podporo, bodo tiste, ki bodo dolgoročno izstopale po učinkovitosti, inovativnosti in zadovoljstvu svojih zaposlenih.

7. Literatura in viri

1. DHL Group. (2023). Annual Report 2023 (including sustainability statement). Bonn: DHL. Dostopno na: https://reporting-hub.group.dhl.com/ecomaXL/files/DHL-Group-2023-Annual-Report.pdf
2. European Commission. (2023). Erasmus+ Annual Report 2022. Brussels: European Union. Dostopno na: https://op.europa.eu/en/publication-detail/-/publication/9020d5f5-8f3a-11ee-8aa6-01aa75ed71a1/language-en
3. Kralj, M. (2020). Psihologija v organizacijah: Povezovanje mehkih in trdih veščin. Ljubljana: Založba Vega. COBISS ID: 301394688
4. Pošta Slovenije. (2022). Letno poročilo 2022. Ljubljana: Pošta Slovenije. Dostopno na: https://www.posta.si/o-posti-site/Documents/informacije-o-posti/letna-porocila/Letno-porocilo-2022.pdf
5. Pošta Slovenije. (2023). Letno poročilo 2023. Ljubljana: Pošta Slovenije. Dostopno na: https://www.posta.si/o-posti-site/Documents/informacije-o-posti/letna-porocila/Letno-porocilo-2023.pdf
6. Smiljanić, T. (2019). Logistika in oskrbovalne verige: Teorija in praksa. Koper: Fakulteta za management. COBISS ID: 302229504
7. Ule, N. (2015). Psihologija vsakdanjega življenja. Ljubljana: Znanstvena založba Filozofske fakultete. COBISS ID: 207916544

Darja Lužnik

Celje School Centre, Secondary School for Services and Logistics

RELATIONS LOGISTICS: EFFECTIVE COMMUNICATION AS THE FOUNDATION OF SUCCESSFUL COOPERATION

Celje, avgust 2025

Abstract

This article discusses the integration of consulting and logistics as two seemingly different but, in practice, complementary fields. The starting point is the problem that the human factor is often neglected in logistics processes, which can lead to poor communication, conflicts, increased stress on employees, and consequently lower efficiency. The purpose of this paper is to show how the integration of consulting services into logistics systems can help improve working relationships, increase employee resilience to change, and enhance operational performance.

1. Introduction

In today's business environment, where changes are rapid and unpredictable, logistics remains one of the key pillars of economic performance. However, it is often forgotten that logistics processes are not just a sequence of technical and operational tasks, but a complex system in which human factors – relationships, communication, and psychosocial support – are just as important as optimizing transport routes or introducing new information systems.

Consulting work in this context brings added value, as it enables organizations to comprehensively address challenges related to working relationships, stress, resistance to change, and conflict resolution. As Ule (2015, p. 41) states, "successful counseling is based on an understanding of both organizational and human needs, with the counselor acting as a link between individuals and the system."

In practice, the integration of counseling and logistics is reflected in higher employee

satisfaction, better communication between departments, and more effective problem solving. This is not just a matter of crisis intervention, but also of strategically planned activities that contribute to the long-term stability and development of the organization.

The aim of this article is to show how the integration of counseling into logistics systems can improve the efficiency and psychosocial well-being of employees.

2. The link between counseling and logistics

At first glance, counseling and logistics may seem like two completely separate fields. Logistics is often described as a technical science that deals with the planning, implementation, and control of the flow of goods, information, and services (Smiljanić, 2019, p. 86), while counseling deals primarily with the human factor—relationships, communication, emotional support, and conflict resolution (Ule, 2015, p. 39). However, on closer inspection, we quickly realize that these two areas are closely intertwined and that combining them can bring significant benefits.

2.1 Common points between the two fields

The basic connection between consulting and logistics is in **process management** – logistics takes care of material and information flows, while consulting takes care of communication and interpersonal relationships. Both must run smoothly for an organization to function optimally. Where bottlenecks occur, the consequences can be very similar: in logistics, they manifest as delays and errors, and in interpersonal relationships, as conflicts, lack of motivation, and stress.

As Kralj (2020, p. 52) notes, "the introduction of consulting approaches into operational processes increases an organization's ability to adapt to change and manage it effectively." This is especially true in logistics, where change (e.g., changes in supply chains, the introduction of new technologies, reorganizations) is a constant.

2.2 The role of consultants in the logistics environment

Consultants in logistics can operate on several levels:

- **Preventively** – through workshops, training, and team meetings, they strengthen employees' communication skills and resilience to stress.
- **Reactive** – they mediate in conflicts, assist in crisis communication, and advise management on resolving personnel issues.
- **Strategically** – they participate in the development of long-term plans, drawing attention to psychosocial aspects and proposing measures to improve the working environment.

Example: At Pošta Slovenije, during the restructuring of logistics centers in 2021–2022, consultants worked with management and employees to ease the change process. *The 2023 Annual Report* emphasizes that during the reorganization, measures were implemented to strengthen interdepartmental communication and employee well-being, which contributed to reducing tension and improving cooperation (, 2023).

2.3 Synergy between processes and people

Successful logistics is not only the result of well-planned routes and optimized warehouses,

but also the harmonious work of the teams that carry out these processes. If relationships within the team are poor or if communication between departments does not work, even the best technology will not deliver the desired results.

In its sustainability report (2023), the DHL Group specifically emphasized the importance of direct support for employees at the operational level. In its logistics centers and warehouses, it implements programs to improve the safety, health, and psychological well-being of its employees. The report highlights that such activities reduce stress, increase willingness to cooperate between departments, and contribute to lower employee turnover in the long term (DHL Group, 2023).

3. The role of relationships in logistics

Logistics is often understood as a field dominated by numbers, timetables, storage capacities, and information systems. However, behind these processes are people—drivers, warehouse workers, planners, shift managers, purchasers—whose cooperation and interpersonal relationships have a decisive impact on the workflow. When relationships are healthy, communication is clear, and trust between colleagues is strong, logistics processes run smoothly. However, when tensions, misunderstandings, or mistrust arise, this is quickly reflected in errors, delays, and reduced efficiency.

As Ule (2015, p. 57) points out, "interpersonal relationships are the foundation of every work process, especially where work is interdependent and time-sensitive." In logistics, these conditions are constantly present—from synchronization between departments to coordination with external partners.

3.1 The importance of trust and cooperation

Trust between colleagues and between employees and management is a key element of successful work in logistics. In an environment where tasks are often interlinked and where one delay causes a chain reaction, team members must believe that others will do their work well and on time.

Example: In its 2022 Annual Report, Pošta Slovenije presented the transition to a new digital shipment tracking system, which required significant organizational adjustments. Such changes in logistics processes usually affect interdepartmental relations and require additional communication and coordination (Pošta Slovenije, 2022).

3.2 Communication as a tool for preventing errors

In logistics, errors often stem from poor communication. This can happen due to unclear instructions, inadequately conveyed information, or a lack of feedback. Consulting can be of great help in this area, as it involves techniques of active listening, clear communication, and checking for understanding.

As Smiljanić (2019, p. 88) states, "Investing in improving the communication skills of employees pays off many times over in logistics, as it reduces the cost of errors and increases customer satisfaction."

Example: In its *2022 Annual Report*, Pošta Slovenije presented the introduction of digital solutions and mobile applications that enable better shipment tracking and more efficient communication in logistics processes. The introduction of such technologies reduces the possibility of errors and contributes to greater coordination of work between departments

(Pošta Slovenije, 2022).

3.3 Conflict resolution and maintaining motivation

Conflicts are inevitable in logistics due to different interests, workloads, or different interpretations of tasks. If these conflicts are addressed constructively, they can even help improve processes. However, if they are ignored, they quickly lead to reduced motivation and increased turnover.

Example: In its *Sustainability Report 2023*, the DHL Group emphasized the importance of involving employees in decision-making processes and creating a working environment. According to their findings, such approaches, based on dialogue and cooperation, contribute to greater employee satisfaction and a sense of fairness (DHL Group, 2023).

3.4 The role of managers in building relationships

Managers in logistics have a dual role – to ensure operational efficiency and, at the same time, the well-being of employees. Consultants can help managers develop leadership skills based on empathy, clear communication, and constructive conflict resolution.

Kralj (2020) emphasizes that a manager who knows how to create a positive working environment not only boosts productivity but also the team's resilience to crisis situations. This is particularly important in logistics, where disruptions and unforeseen events are common.

4. SWOT analysis of the integration of consulting and logistics

SWOT analysis is a tool that provides an overview of the strengths, weaknesses, opportunities, and threats of a particular strategy or approach. In the context of integrating consulting with logistics, it helps us understand where the greatest advantages lie and where the potential risks that need to be managed are.

Table 1: SWOT analysis

Strengths	Weaknesses
Improved communication between departments and employees.	Lack of knowledge among consultants about specific logistics processes.
Increased employee motivation and satisfaction.	Possible resistance from management or employees to "soft" approaches.
Reduction in sick leave and staff turnover.	Need for additional financial and time resources to carry out consulting activities.
Better management of stress and conflicts.	Uneven acceptance of the counseling role among employees.

Opportunities	Threats
Integration of advisory services into digital logistics platforms.	Economic crises or budget cuts that reduce funding for advisory services.
Increased competitiveness of the company due to improved organizational culture.	Change in management that alters priorities and reduces support for consulting programs.
Development of specialized training for logistics consultants.	Technological developments that could shift the focus solely to technical aspects and neglect people.
Opportunities for international cooperation and exchange of good practices.	Increased staff turnover, which makes long-term relationship building difficult.

4.1 Advantages

"Among the key advantages is improved communication between departments, which enables faster problem solving and better coordination of tasks. The presence of counseling support reduces stress and conflicts, leading to fewer sick days. Kralj (2020) emphasizes that a positive working climate contributes significantly to greater operational efficiency."

4.2 Disadvantages

The main weakness may be **the lack of specific logistics knowledge** among counselors, which can lead to less effective support. Also, some employees see counseling services as an unnecessary "soft" component that takes time away from operational tasks.

4.3 Opportunities

Linking consulting work with logistics opens up opportunities for **specialized training** and the development of interdisciplinary programs. The digitization of logistics makes consulting services (e.g., remote consulting, digital climate surveys) even more accessible.

4.4 Threats

The main threats are **financial constraints** and management changes, which can reduce support for advisory programs. In addition, an excessive focus on technological solutions can overshadow the importance of the human factor, leading to a decline in employee motivation in the long term.

5. Practical recommendations for logistics consultants

Consulting work in a logistics environment requires a specific combination of skills and approaches, as it is an environment where high operational dynamics, time pressures, and constant change intertwine. Consultants who want to operate effectively in this sector must adapt to the specific needs and pace of work.

5.1 Understanding logistics processes

A consultant who understands the basics of logistics flows, warehousing, transport, and IT systems will find it easier to establish credibility with employees. This does not mean that they have to be experts in operational tasks, but a basic understanding of terminology, procedures, and key challenges facilitates communication and cooperation. Research also

emphasizes that understanding processes enables consultants to play a more effective role as interlocutors within the organization (DHL Group, 2023).

5.2 Early involvement in change

When introducing new technologies, reorganizing, or relocating logistics centers, it is crucial that consultants are involved **as early as the planning stage**. This allows them to help identify potential psychosocial challenges, prepare preventive measures, and reduce employee resistance to change.

Example: At Pošta Slovenije, consultants were involved in planning changes to work schedules, thereby preventing the changes from leading to increased absenteeism.

5.3 Strengthening communication channels

In logistics, communication is often hierarchical, which means that important information can get "stuck" at a certain level. Consultants can help establish **horizontal communication** channels—for example, regular interdepartmental meetings or digital channels for rapid information exchange.

5.4 Adapting the approach

The logistics sector often operates in shifts and 24/7, so consultants need to adapt their availability – for example, by offering support at different times or using digital tools. In its *Sustainability Report*, DHL Group (2023) emphasizes that digital platforms and employee support programs increase the accessibility of counseling services and thus improve employee well-being.

5.5 Measuring effects

Counseling work is sometimes difficult to quantify, but in logistics, measurable indicators (absenteeism, turnover, productivity) are an important part of performance evaluation. It therefore makes sense to introduce **regular employee satisfaction surveys**, monitor conflict statistics, and record improvements.

5.6 Connecting with managers

Managers are key allies of counselors. If a manager understands and supports counseling, they are more likely to encourage employees to use these services. Counselors can organize **coaching** for managers to help them acquire skills in active listening, motivation, and constructive conflict resolution.

6. Final thoughts

Linking counseling work with logistics represents an approach that goes beyond the traditional understanding of both fields. Although logistics is often viewed as a technical and operational activity, human factors—communication, relationships, trust, and psychosocial stability—are key to its smooth functioning. Consulting brings to logistics the component that enables processes to be not only efficient but also sustainable.

An analysis of cases from Slovenia clearly shows that the inclusion of counseling services pays off in the form of lower staff turnover, fewer sick days, greater readiness for change, and better interdepartmental cohesion. These results confirm Kralj's (2020) findings that organizations that invest in psychosocial support also increase their competitiveness in the

long term.

The SWOT analysis revealed that the advantages and opportunities of integrating counseling into logistics outweigh the weaknesses and threats, the latter being mainly related to the lack of specific knowledge of counselors about logistics processes and possible financial constraints. This means that the key to success lies in the continuous training of consultants, their early involvement in strategic decisions, and close cooperation with logistics unit managers.

The practical recommendations presented in this article offer a clear way forward – from strengthening communication channels and measuring the effects of consulting work to adapting the approach to work rhythms and technological changes. The role of a consultant in logistics is multifaceted: they are an observer, mediator, strategist, and partner who ensures that human capital remains healthy, motivated, and connected.

Looking to the future, we can say that the integration of consulting and logistics will become increasingly important, especially when faced with global challenges such as staff shortages, digitalisation and the growing need for organisational agility. Organizations that know how to combine technical excellence with strong psychosocial support will be the ones that stand out in the long term in terms of efficiency, innovation, and employee satisfaction.

7. Literature and sources

1. DHL Group. (2023). Annual Report 2023 (including sustainability statement). Bonn: DHL. Dostopno na: https://reporting-hub.group.dhl.com/ecomaXL/files/DHL-Group-2023-Annual-Report.pdf
2. European Commission. (2023). Erasmus+ Annual Report 2022. Brussels: European Union. Dostopno na: https://op.europa.eu/en/publication-detail/-/publication/9020d5f5-8f3a-11ee-8aa6-01aa75ed71a1/language-en
3. Kralj, M. (2020). Psihologija v organizacijah: Povezovanje mehkih in trdih veščin. Ljubljana: Založba Vega. COBISS ID: 301394688
4. Pošta Slovenije. (2022). Letno poročilo 2022. Ljubljana: Pošta Slovenije. Dostopno na: https://www.posta.si/o-posti-site/Documents/informacije-o-posti/letna-porocila/Letno-porocilo-2022.pdf
5. Pošta Slovenije. (2023). Letno poročilo 2023. Ljubljana: Pošta Slovenije. Dostopno na: https://www.posta.si/o-posti-site/Documents/informacije-o-posti/letna-porocila/Letno-porocilo-2023.pdf
6. Smiljanić, T. (2019). Logistika in oskrbovalne verige: Teorija in praksa. Koper: Fakulteta za management. COBISS ID: 302229504
7. Ule, N. (2015). Psihologija vsakdanjega življenja. Ljubljana: Znanstvena založba Filozofske fakultete. COBISS ID: 207916544

Patricija Majcen, dipl. log. Inž.

Prometna šola Maribor

DIGITALIZACIJA IN TRAJNOST V ŠPEDICIJI: IZZIVI IN PRILOŽNOSTI SODOBNEGA LOGISTIČNEGA SEKTORJA

Povzetek

Digitalizacija izboljšuje logistiko z večjo učinkovitostjo in zadovoljstvom strank. Prilagajanje tem trendom je bistveno za uspeh podjetij. Večja digitalizacija prevoza blaga in logistike bo podjetjem prihranila veliko stroškov ter povečala učinkovitost in trajnost. Uvedba digitalnega e-CMR predstavlja digitalno različico tradicionalnega tovornega lista, ki se uporablja v cestnem tovornem prometu po Konvenciji o tovornem listu (CMR). Implementacija e-CMR omogoča poenostavitev administrativnih postopkov, večjo preglednost, hitrejšo izmenjavo podatkov ter zmanjšanje možnosti napak in goljufij. V članku so analizirane ključne priložnosti, ki jih prinaša digitalizacija tovornih listov, kot so povečana učinkovitost, izboljšana sledljivost in okoljske koristi. Prav tako so obravnavani izzivi, vključno s tehničnimi, pravnimi in organizacijskimi vidiki, ki otežujejo širšo uporabo e-CMR. Posebna pozornost je namenjena mednarodnemu kontekstu, kjer je usklajenost standardov in zakonodaje ključnega pomena za učinkovito uporabo. Članek tudi predstavi trenutno stanje implementacije e-CMR v Sloveniji ter izpostavi predvidene trende in prihodnje smernice razvoja tehnologije digitalnega tovornega lista.

1 Uvod

Cestni tovorni promet je eden ključnih stebrov globalne logistike, kjer natančna in hitra izmenjava podatkov o pošiljkah igra odločilno vlogo za učinkovito delovanje dobavne verige. Tradicionalni papirni tovorni listi (CMR) so dolgo časa predstavljali osnovni dokument za dokazovanje prevoza blaga, vendar njihova uporaba prinaša več izzivov, kot so počasnost, tveganje za izgubo dokumentov, manipulacije in okoljski odtis. Razvoj informacijskih tehnologij in digitalizacija so omogočili uvedbo e-CMR – elektronske različice tovornega lista, ki obljublja preobrazbo celotnega postopka upravljanja s tovornimi dokumenti.

1.1 Osnove e-CMR

1.1.1 Definicija in pravni okvir

Konvencija o pogodbi za mednarodni cestni prevoz blaga (CMR) je bila razvita leta 1956. Ta konvencija standardizira pogodbene pogoje in pogoje odgovornosti prevoznika pri cestnem prevozu blaga z vozili za plačilo, če sta izvorni in namembni kraj v dveh različnih državah in je vsaj ena od držav pogodbenica. H konvenciji je pristopilo 55 držav po vsem svetu, s čimer je uporaba CMR v teh državah obvezna. Leta 1976 je Mednarodna cestna zveza v sodelovanju z Mednarodno trgovinsko zbornico uvedla predlogo tovornega lista CMR, usklajeno z obrazcem Združenih narodov. Ta predloga tovornega lista za cestni

prevoz je bila posodobljena leta 2007 in jo zdaj uporablja večina, če ne vse stranke prevoznih pogodb v državah pogodbenicah CMR. CMR list se uporablja predvsem za namene pogodb o komercialnem prevozu (med podjetji) in ga organi pregona in carinski organi pogosto uporabljajo za preverjanje podatkov o blagu in podatkov o pošiljatelju/prejemniku/prevozniku za carinjenje v čezmejni trgovini ali dodatnih informacij v različnih situacijah. Leta 2008 je bil uveden Dodatni protokol o e-CMR za podporo brezpapirnim različicam lista e-CMR. Čeprav je bilo v naslednjih letih izvedenih več pilotnih testov, ni bilo uradne standardizirane oblike sporočila za elektronski tovorni list. Leta 2017 je projekt Centra Združenih narodov za olajševanje trgovine in elektronsko poslovanje razvil specifikacijo poslovnih zahtev, strukturo ključnih komponent sporočila e-CMR in sporočilo XML. (Unece, 2024).

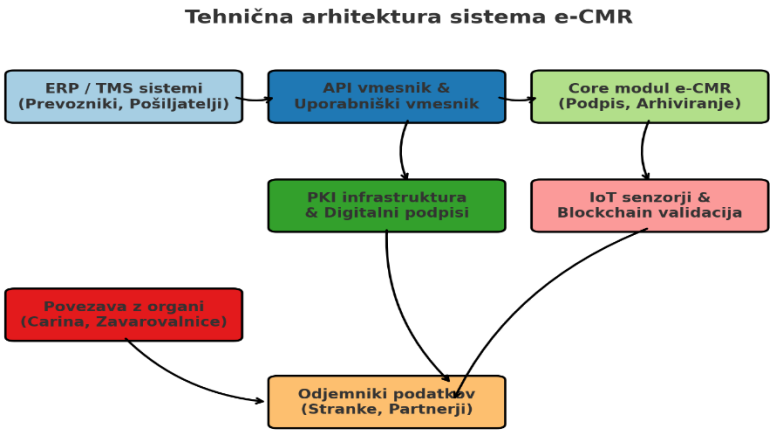
E-CMR je torej elektronsko ustvarjen dokument, ki je pravno skladen in vsebuje enake informacije kot tradicionalni CMR. To pomeni, da ima e-CMR enak pravni status kot tradicionalni papirni CMR in se lahko uporabi kot dokaz v primeru sporov. Ustvarja se, prenaša in shranjuje elektronsko ter nadomešča papirnati CMR (Dasaklis, 2024).

1.1.2 Tehnična zasnova in arhitektura sistema

Sistem e-CMR temelji na digitalnih platformah, ki omogočajo varno in zanesljivo ustvarjanje, izmenjavo ter shranjevanje tovornih listov v elektronski obliki. Osnovni elementi tehnične zasnove, ki jo prikazuje Slika 1 vključujejo (TransFolow):

- Digitalni podpis: Zagotavlja verodostojnost in nemogočnost spreminjanja dokumenta po podpisu.
- Spletne aplikacije in API-ji: Omogočajo integracijo z že obstoječimi transportno-razporeditvenimi sistemi (TMS), ERP in drugimi IT rešitvami v logistiki.
- Shranjevanje podatkov: Podatki se lahko hranijo v centraliziranih oblakih ali decentraliziranih sistemih, odvisno od arhitekture ponudnika storitve.
- Varnostni protokoli: Uporaba šifriranja in drugih varnostnih mehanizmov za zaščito občutljivih informacij.

Slika 1: Tehnična arhitektura sistema e-CMR (Majcen, 2025)



2 Razlika med tradicionalnim in elektronskim tovornim listom

Razlika med tradicionalnim (papirnim) tovornim listom in elektronskim tovornim listom (e-CMR) je precej obsežna in zajema pravno, tehnično, operativno in okoljsko dimenzijo.

2.1 Definicija in oblika

Tradicionalni CMR je fizični, papirni dokument, ki se uporablja v mednarodnem cestnem tovornem prometu v skladu s CMR konvencijo iz leta 1956. Običajno je natisnjen v treh izvirnikih (za pošiljatelja, prevoznika in prejemnika), pri čemer so vsi izvodi ročno podpisani. Dokument se izpolnjuje ročno ali s tiskom iz računalniškega sistema, vendar zahteva fizično dostavo med vsemi udeleženci (United Nations Economic Commission for Europe, 2021).

Elektronski CMR (e-CMR) pa je digitalna različica istega dokumenta, zasnovana na Dodatnem protokolu k CMR iz leta 2008. Namesto papirja je to digitalna datoteka (npr. v XML, JSON ali PDF/A formatu), ki jo je mogoče ustvariti, podpisati in hraniti v elektronski obliki. e-CMR vsebuje enake podatke kot papirni CMR (npr. podatke o pošiljatelju, prevozniku, tovornem blagu in pogojih prevoza), a jih upravlja prek digitalnih platform, kar omogoča takojšen prenos podatkov med deležniki, avtomatizacijo vnosa iz ERP/TMS sistemov ter elektronsko arhiviranje z varnostnimi kopijami. Iz spodnje Preglednice 1 lahko razberemo ključne razlike med papirnim in elektronskim tovornim listom (Planinšek, 2025).

Preglednica 1: Primerjava med tradicionalnim in elektronskim tovornim listom (Majcen, 2025)

Vidik	Tradicionalni CMR	Elektronski CMR (e-CMR)
Oblika	Papirni dokument, 3 izvirniki	Digitalni zapis (XML, JSON, PDF/A)
Podpis	Ročni podpis	Digitalni podpis (PKI)
Pošiljanje	Fizična dostava, pošta	Takojšnja elektronska izmenjava
Dostop	Le na lokaciji dokumenta	Dostop v realnem času
Hramba	Fizični arhiv	Digitalna hramba (v oblak ali lokalno)
Okoljski vpliv	Visoka poraba papirja	Brez porabe papirja

2.2 Pravna veljavnost

Pravna podlaga za elektronski tovorni list e-CMR izhaja iz Konvencije o pogodbi za mednarodni prevoz blaga po cesti (CMR), podpisane leta 1956 v Ženevi. Ta konvencija določa obvezne elemente tovornega lista in pravice ter obveznosti pogodbenih strank pri mednarodnem cestnem prevozu blaga. Leta 2008 je bil sprejet Dodatni protokol k CMR konvenciji, ki je omogočil uporabo elektronskega tovornega lista kot pravno veljavnega dokumenta. Pogoj za pravno veljavnost e-CMR je, da elektronska oblika zagotavlja enako raven zanesljivosti, dokazljivosti in zaščite pred spremembami kot papirna oblika (United Nations Economic Commission for Europe [UNECE], 2021).

Na ravni Evropske unije dodatno veljavnost e-CMR ureja Uredba (EU) 2020/1056 o elektronskih tovornih informacijah (eFTI), ki določa, da morajo države članice EU do 21. avgusta 2026 omogočiti sprejem elektronskih tovornih dokumentov. Uredba določa minimalne zahteve glede interoperabilnosti sistemov, varnosti podatkov in enotnih postopkov, s čimer zagotavlja, da e-CMR uživa enako pravno priznanje kot papirna verzija (European Union, 2020).

Poleg tega UNECE v svojih smernicah poudarja, da mora biti vsak e-CMR opremljen z naprednim elektronskim podpisom, ki temelji na veljavnih digitalnih potrdilih, ter da morajo biti vsi podatki zaščiteni pred nepooblaščenim dostopom in spremembami. Prav tako je predpisano, da se morajo digitalni dokumenti hraniti v skladu z veljavnimi arhivskimi standardi (UNECE, 2021).

2.3 Postopek izpolnjevanja in obdelave

Pri tradicionalnem CMR se podatki o pošiljki, prevozniku in prejemniku vnašajo ročno ali z izpisom iz računalnika, dokument pa se podpisuje fizično in izmenjuje med deležniki po pošti ali osebno (Planinšek, 2025). Pri e-CMR se podatki vnesejo digitalno, pogosto samodejno iz ERP/TMS sistema, dokument se elektronsko podpiše in takojšnje deli prek varnih platform (European Chemical Transport Association [ECTA], 2021). Elektronski zapis omogoča takojšen dostop vsem strankam in samodejno arhiviranje v skladu s pravnimi zahtevami. Razlike med postopkom izpolnjevanja in obdelave so razvidne iz Preglednice 2.

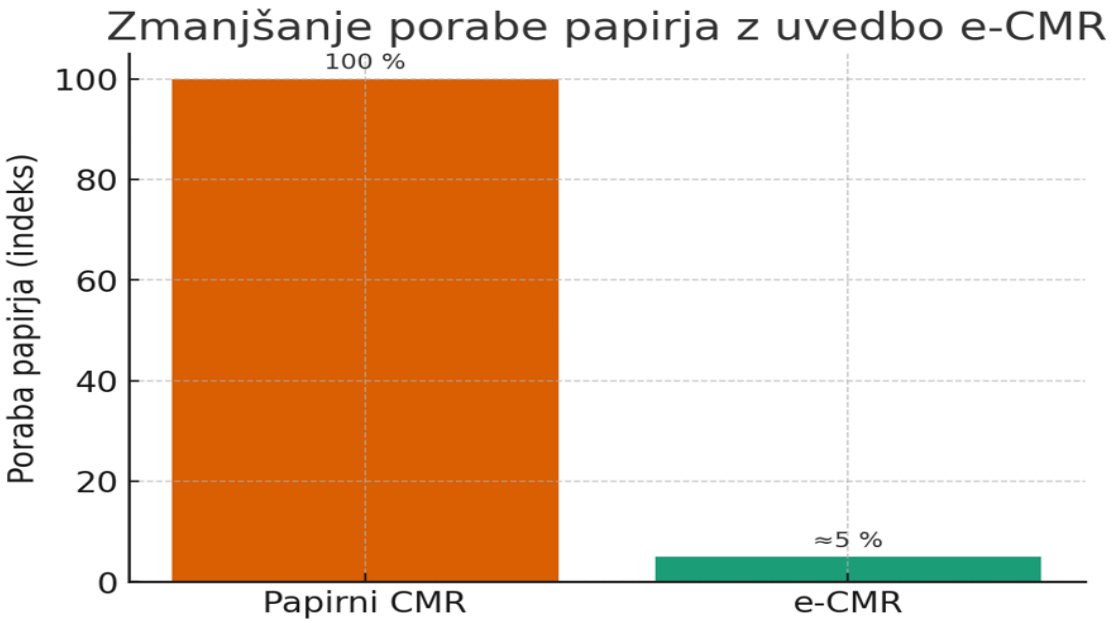
Preglednica 2: Prikaz postopka izpolnjevanja in obdelave (Majcen, 2025)

Korak	Tradicionalni CMR	Elektronski CMR (e-CMR)
Izpolnjevanje	Ročni vnos / tiskanje	Samodejen digitalni vnos iz ERP/TMS
Podpis	Ročni podpis	Digitalni podpis (PKI)
Izmenjava	Po pošti ali osebno	Takojšnja elektronska izmenjava
Dostop	Le fizični izvod	Dostop v realnem času
Hramba	Fizični arhiv	Digitalna hramba z varnostnimi kopijami

2.4 Okoljski vidik

Uvedba e-CMR ima pomemben pozitiven vpliv na okolje, saj odpravlja potrebo po tiskanju in fizični izmenjavi papirnih dokumentov. Vsako leto se v mednarodnem cestnem prometu izdajo milijoni papirnih CMR listov, kar pomeni veliko porabo papirja, črnila in energije za tiskanje ter logistiko dostave dokumentov (Planinšek, 2025). Z digitalizacijo se ta poraba praktično izniči. Grafikon 1 to nazorno prikazuje. S tem se zmanjšuje sečnja dreves, poraba vode in emisije toplogrednih plinov, povezane s proizvodnjo papirja (European Chemical Transport Association [ECTA], 2021). Ker e-CMR omogoča elektronsko posredovanje dokumentov v realnem času, odpravlja tudi potrebo po dodatnih fizičnih prevozih zgolj zaradi dostave dokumentacije, kar zmanjšuje emisije CO_2 iz transporta. Digitalna arhivacija e-CMR je energetsko učinkovitejša kot vzdrževanje fizičnih arhivov, saj ne zahteva prostora, klimatizacije ali fizičnega vzdrževanja dokumentov. Hkrati uporaba e-CMR omogoča boljše sledenje in optimizacijo prevozov, kar lahko vodi do manjših praznih voženj in posledično nižjih emisij. Celoten vpliv na okolje je še večji, če e-CMR povežemo z drugimi digitalnimi rešitvami, kot so e-fakture in e-dobavnice, saj se s tem ustvarja celovita digitalna veriga dokumentov. Na ta način digitalizacija prek e-CMR podpira cilje trajnostne mobilnosti in krožnega gospodarstva, kot jih določa Evropski zeleni dogovor (European Union, 2020).

Grafikon 1: Prikaz razlike porabe papirja



3 Priložnosti e-CMR

3.1 Povečanje učinkovitosti in zmanjšanje administrativnih stroškov

Digitalizacija tovornih listov omogoča hitro ustvarjanje, pošiljanje in preverjanje dokumentov, kar zmanjša čas in stroške administracije (European Commission, 2022). Elektronski prenos podatkov zmanjšuje napake, ki nastajajo pri ročnem vnosu in prenašanju informacij. Po številnih raziskavah, kot je razvidno iz Preglednice 3, lahko podjetja s prehodom na e-CMR zmanjšajo administrativne stroške do 30 %.

Preglednica 3: Učinek e-CMR na učinkovitost in stroške (Majcen, 2025)

Vidik	Pred digitalizacijo (CMR)	Po digitalizaciji (e-CMR)
Čas obdelave dokumenta	15–20 min	5–7 min
Napake pri vnosu podatkov	5–8 %	1–2 %
Stroški na dokument	2,50 €	1,00 €
Letni administrativni stroški	100 %	≈70 %
Dostopnost dokumenta	Le fizično	V realnem času

3.2 Izboljšana sledljivost in transparentnost prevozov

E-CMR omogoča realno časovni vpogled v status prevoza, kar krepi nadzor nad pošiljkami in pomaga pri preprečevanju izgube ali kraje blaga. Digitalni zapisi so tudi lažje dostopni in arhivirani, kar olajša reševanje morebitnih sporov (Kovač & Novak, 2021).

3.3 Izboljšanje varnosti podatkov

Varnost podatkov je ena ključnih prednosti uvedbe elektronskega tovornega lista (e-CMR).Z uporabo digitalnih podpisov, ki temeljijo na infrastrukturi javnih ključev (PKI), je mogoče zagotoviti, da dokument ni bil spremenjen po podpisu in da je mogoče zanesljivo preveriti identiteto podpisnika (United Nations Economic Commission for Europe [UNECE], 2020). V primerjavi s papirnimi dokumenti, ki se lahko fizično poškodujejo, izgubijo ali ponaredijo, elektronski zapisi omogočajo kriptografsko zaščito vsebine ter beleženje revizijske sledi vseh sprememb (European Commission, 2022). Poleg tega e-CMR sistemi uporabljajo varnostne protokole, kot so šifriranje podatkov med prenosom (npr. TLS 1.3) in pri shranjevanju (npr. AES-256), kar preprečuje nepooblaščen dostop in zmanjša tveganje kibernetskih napadov. Napredne platforme omogočajo tudi večnivojsko avtentikacijo uporabnikov in dodeljevanje različnih dostopnih pravic glede na vlogo v procesu (Kovač & Novak, 2021). Uporaba blockchain tehnologije v nekaterih pilotnih projektih dodatno povečuje odpornost sistema na ponarejanje, saj decentralizirana hramba in časovni žigi zagotavljajo, da so podatki nespremenljivi in preverljivi s strani vseh deležnikov (Ponzoa Casado, Gómez Funes, & García García-Doncel, 2021). Takšna arhitektura ne povečuje le varnosti, temveč tudi zaupanje med partnerji v logistični verigi. Skupno lahko rečemo, da e-CMR prispeva k bistveno višji ravni varnosti podatkov v logistiki, saj združuje pravno veljavne elektronske podpise, napredne varnostne protokole, sledljivost sprememb in potencial blockchain tehnologije v enoten zaščitni okvir.

4 Izzivi pri uvedbi e-CMR

4.1 Tehnične ovire

Ena največjih tehničnih ovir pri uvedbi e-CMR je zagotavljanje medsebojne povezljivosti različnih informacijskih sistemov in platform, ki jih uporabljajo prevozniki, pošiljatelji in prejemniki (Smith & Brown, 2023). Različni standardi in formati podatkov otežujejo integracijo, saj lahko vsak deležnik uporablja svoj programski paket ali podatkovno shemo. Pomanjkanje univerzalnih standardov za elektronsko izmenjavo podatkov povzroča potrebo po dragih vmesnikih in prilagoditvah programske opreme. Integracija pogosto zahteva tehnično usposobljene kadre in dodatne investicije v IT infrastrukturo. Pri čezmejnih prevozih se težave povečajo, ker sistemi v različnih državah niso nujno kompatibilni. Zato se kot ključen izziv izpostavlja potreba po harmonizaciji podatkovnih standardov, kot jih poskuša uveljaviti evropska pobuda eFTI. Brez usklajenih tehničnih rešitev se lahko uvedba

e-CMR upočasni in omeji na zaprte partnerske mreže.

4.2 Pravne in regulativne ovire

Čeprav je e-CMR pravno priznan v državah, ki so ratificirale Dodatni protokol k CMR konvenciji, so še vedno številne države, ki tega niso storile, kar otežuje njegovo uporabo v mednarodnem prometu (Kovač & Novak, 2021). Razlike v zakonodaji glede digitalnih podpisov pomenijo, da dokument, veljaven v eni državi, morda ne bo priznan v drugi. Prav tako se med državami razlikujejo zahteve glede varstva osebnih in poslovnih podatkov, kar vpliva na obliko in vsebino e-CMR. EU skuša te razlike zmanjšati z Uredbo (EU) 2020/1056, ki uvaja enotne standarde za elektronske transportne informacije. Vendar se implementacija uredbe med državami razlikuje, kar ustvarja prehodna pravna neskladja. Mednarodne organizacije, kot je UNECE, poudarjajo potrebo po večjem številu ratifikacij protokola in usklajevanju zakonodaj. Dokler ta proces ni zaključen, bo uporaba e-CMR na globalni ravni neenotna.

4.3 Organizacijski in človeški dejavniki

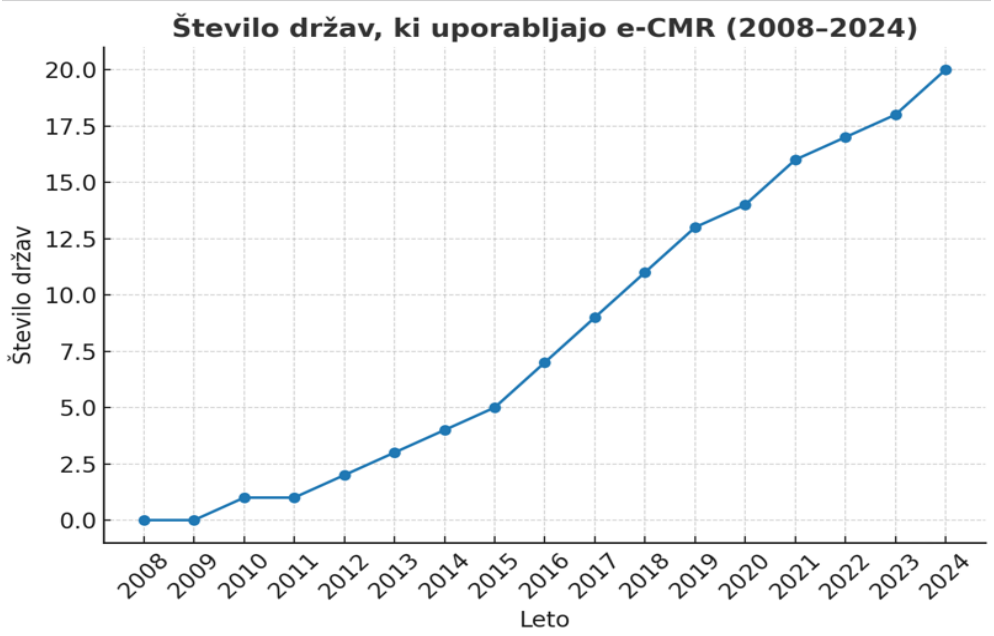
Uvedba e-CMR zahteva spremembe obstoječih poslovnih procesov in usposabljanje zaposlenih, kar za številna podjetja predstavlja organizacijski izziv (European Commission, 2022). Pomanjkanje digitalne pismenosti pri delu zaposlenih lahko upočasni prehod na elektronske dokumente. Nekatera podjetja se zaradi začetnih stroškov, potrebne opreme in licenc odločajo, da bodo raje ostala pri papirni dokumentaciji. Poleg tega sprememba delovnih navad pogosto naleti na odpor pri zaposlenih, ki so navajeni ustaljenih postopkov. Uspešna uvedba e-CMR zahteva tudi aktivno podporo vodstva podjetja, saj brez strateške zavezanosti digitalizacija pogosto ostane na ravni pilotnih projektov. Z ustreznimi programi usposabljanja in motivacije zaposlenih se lahko ti izzivi bistveno omilijo. Organizacijska pripravljenost je zato enako pomembna kot tehnična izvedljivost projekta.

5 Mednarodni vidik e-CMR

5.1 Razširjenost in sprejetost po svetu

Po podatkih UNECE (2024) je Dodatni protokol k CMR konvenciji do začetka leta 2024 ratificiralo več kot 20 držav. Med najaktivnejšimi pri implementaciji e-CMR so članice Evropske unije, Švica, Norveška ter nekatere države Bližnjega vzhoda, kot sta Katar in Združeni arabski emirati. Ta razširjenost prispeva k poenostavitvi čezmejnih prevozov, saj zmanjšuje potrebo po fizični izmenjavi dokumentov in omogoča enotno digitalno obdelavo podatkov. V Evropi poteka tudi povezovanje e-CMR z drugimi pobudami, kot je eFTI, kar dodatno povečuje medsebojno povezljivost. Kljub napredku pa so še vedno regije, kjer protokol ni ratificiran, kar omejuje globalni doseg in popolno interoperabilnost sistema.

Grafikon 2: Prikaz števila držav (UNECE, 2024)



5.2 Standardizacija in usklajevanje

Uspeh e-CMR je v veliki meri odvisen od mednarodne harmonizacije, ki zajema pravno priznanje dokumenta, tehnične standarde in operativne postopke (Kovač & Novak, 2021). UNECE vodi prizadevanja za usklajevanje preko delovnih skupin, ki vključujejo predstavnike držav, logistične industrije in tehnoloških ponudnikov. Standardizacija omogoča, da se e-CMR uporablja na enak način ne glede na državo izvora ali cilja, kar zmanjšuje stroške in povečuje zaupanje v sistem. Poseben poudarek je na razvoju enotnih podatkovnih modelov, ki omogočajo interoperabilnost med različnimi informacijskimi sistemi. Dolgoročno cilj harmonizacije ni le uskladitev znotraj Evrope, temveč tudi vzpostavitev globalnega standarda za digitalne transportne listine.

6 E- CMR v Sloveniji

6.1 Trenutno stanje in implementacija

Slovenija je Dodatni protokol k CMR konvenciji ratificirala leta 2018, s čimer je pravno omogočila uporabo e-CMR v cestnem tovornem prometu (Kovač & Novak, 2021). Po podatkih Ministrstva za infrastrukturo se je od takrat število podjetij, ki uporabljajo e-CMR, postopno povečevalo, predvsem med večjimi logističnimi operaterji. Na trgu deluje več mednarodnih in domačih platform, ki omogočajo elektronsko ustvarjanje, podpisovanje in arhiviranje tovornih listov. V praksi pa uvedba napreduje počasneje pri malih in srednje velikih prevoznikih, kjer so ovire povezane z investicijskimi stroški in pomanjkanjem digitalnih kompetenc. Kljub temu Slovenija sledi evropskim trendom in se vključuje v projekte interoperabilnosti na ravni EU.

Preglednica 4: Prikaz ocenjenega stanja uporabe e-CMR v Sloveniji za leto 2024 (Majcen, 2025)

Segment	Uporaba e-CMR	Uporaba papirnega CMR
Veliki logistični operaterji	70 %	30 %
Srednje velika podjetja	40 %	60 %
Mikro in mala podjetja	15 %	85 %

6.2 Izzivi in priložnosti na lokalnem trgu

Slovenski prevozniki še vedno pretežno uporabljajo papirne dokumente, čeprav raziskave kažejo, da narašča ozaveščenost o prednostih digitalizacije (Novak, 2023). Glavni izzivi vključujejo tehnično integracijo e-CMR rešitev z obstoječimi ERP in TMS sistemi ter pomanjkanje enotnega standarda med ponudniki IT storitev. Na področju priložnosti se izpostavlja možnost optimizacije procesov, zmanjšanja stroškov in večje konkurenčnosti podjetij, ki bodo med prvimi prešla na digitalne rešitve. Državne spodbude in usklajevanje standardov bi lahko pospešili prehod, zlasti med manjšimi podjetji. Povečana uporaba e-CMR bi Sloveniji omogočila boljšo povezljivost z evropskimi in mednarodnimi logističnimi omrežji.

7 Prihodnost e-CMR in digitalizacije v cestnem prometu

7.1 Tehnološki trendi (blockchain, IoT, AI)

Napredne tehnologije, kot so blockchain za neizbrisno sledenje dokumentov, Internet stvari (IoT) za spremljanje statusa pošiljk v realnem času in umetna inteligenca (AI) za optimizacijo logističnih procesov, bodo dodatno izboljšale delovanje e-CMR sistemov (European Commission, 2022). Skupaj bodo te tehnologije ustvarile bolj povezano, varno in učinkovito digitalno logistično okolje.

7.2 Integracija z drugimi digitalnimi orodji v logistiki

E-CMR bo postal del širšega digitalnega ekosistema, ki vključuje elektronske carinske deklaracije, sistemi za upravljanje skladišč, transportne platforme in druge rešitve (Smith & Brown, 2023). Takšna povezava bo omogočila enotno izmenjavo podatkov med različnimi deležniki v verigi oskrbe brez ponavljajočega se vnosa informacij.

7.3 Potenciali za nadaljnjo avtomatizacijo in optimizacijo

Digitalizacija dokumentacije omogoča avtomatizirano obdelavo, zmanjšuje potrebo po človeški intervenciji in odpravlja ozka grla v upravljanju transportnih podatkov (Kovač & Novak, 2021). V prihodnosti bo možno integrirati tudi napredne prediktivne modele, ki bodo preprečevali zamude in zmanjšali stroške prevoza. S tem se bo logistični proces premaknil proti popolni digitalni samo-opravljivosti.

8 Zaključek

Digitalizacija tovornih listov s pomočjo e-CMR predstavlja pomemben korak k modernizaciji in izboljšanju učinkovitosti cestnega tovornega prometa. Kljub številnim priložnostim še vedno obstajajo izzivi, zlasti na področju standardizacije, varnosti in

sprejemanja novih tehnologij. Slovenija je na dobri poti k digitalni transformaciji, vendar je potrebna nadaljnja uskladitev in osveščanje deležnikov. V Sloveniji se uporaba e-CMR že povečuje med večjimi logističnimi operaterji, a med malimi in srednje velikimi podjetji je prehod počasnejši, predvsem zaradi stroškov in pomanjkanja digitalne infrastrukture. Država bi lahko proces pospešila z uvedbo spodbud, sofinanciranja opreme in programov usposabljanja zaposlenih v transportnem sektorju. Poseben poudarek bi moral biti tudi na interoperabilnosti sistemov, saj se slovenski prevozniki pogosto soočajo z mednarodnimi partnerji, ki uporabljajo različne digitalne rešitve. Uspeh bo v veliki meri odvisen od tesnega sodelovanja med državo, logističnimi podjetji in ponudniki IT rešitev. Slovenija lahko s proaktivnim pristopom in sodelovanjem v evropskih projektih postane zgled učinkovite digitalne preobrazbe v regiji. Dolgoročno bi to lahko pripomoglo k povečanju konkurenčnosti slovenskih prevoznikov na mednarodnem trgu in zmanjšanju administrativnih bremen.

VIRI IN LITERATURA

Dasaklis. T. (2024). Exploring the challenges in the implementation of the Freight Electronic Information Regulation (eFTI): empirična perspektiva iz Grčije. https://www.mdpi.com/2305-6290/8/1/30

European Chemical Transport Association. (2021). Best Practice Guideline: Digital Documents – e-CMR and e-ECD. European Chemical Transport Association. https://www.ecta.com/wp-content/uploads/2021/03/ECTA-BEST-PRACTICE-GUIDELINE-DIGITAL-DOCUMENTS-eCMR-AND-eECD.pdf

European Commission. (2022). Digitalisation in freight transport: Towards paperless logistics. European Union. https://transport.ec.europa.eu/digitalisation_en

European Union. (2020). Regulation (EU) 2020/1056 of the European Parliament and of the Council on electronic freight transport information. Official Journal of the European Union. http://data.europa.eu/eli/reg/2020/1056/oj

European Union. (2020). Regulation (EU) 2020/1056 on electronic freight transport information. http://data.europa.eu/eli/reg/2020/1056/oj

Kovač, M., & Novak, P. (2021). Digitalna transformacija v cestnem tovornem prometu: Primer uporabe e-CMR za izboljšanje sledljivosti. Logistični vestnik, 35(4), 45–53. Ljubljana: Slovensko logistično društvo.

Ministrstvo za infrastrukturo Republike Slovenije. (2024). Poročilo o stanju digitalizacije v cestnem tovornem prometu. Ljubljana: MZI.

Novak, T. (2023). Analiza stanja digitalizacije v slovenski logistiki. Revija za promet in logistiko, 29(2), 34–41.

Planinšek, N. (2025). Digitalizacija tovornih listin: primer e-CMR. Diplomsko delo, Univerza v Ljubljani.

Ponzoa Casado, J. M., Gómez Funes, A., & García García-Doncel, J. (2021). Digital Transformation: Advantages and Opportunities of e-CMR. Digital Economy and Innovation Journal, 1(1), 85–93. https://doi.org/10.55234/edeij-1-1-004

Smith, J., & Brown, L. (2023). Cost reduction and efficiency gains from electronic consignment notes (e-CMR). Journal of Transport Economics, 45(2), 115–132.

https://doi.org/10.1016/j.jte.2023.ecmr

TransFollow. (2025). eCMR. https://www.transfollow.org/support/drive/ecmr/

UNECE. (2021). Additional Protocol to the CMR Convention concerning the Electronic Consignment Note (e-CMR). https://unece.org

Unece. (2024). Practitioner's Guide to e-CMR. https://unece.org/trade/documents/2023/10/executive-guide-e-cmr

United Nations Economic Commission for Europe. (2020). e-CMR – The electronic consignment note. UNECE. https://unece.org/transport/documents/2020/02/e-cmr-electronic-consignment-note

United Nations Economic Commission for Europe. (2021). Additional Protocol to the CMR Convention concerning the Electronic Consignment Note (e-CMR). https://unece.org/transport/documents/2021/05/standards/additional-protocol-cmr-convention-concerning-electronic-consignment-note

United Nations Economic Commission for Europe. (2024). Status of the Additional Protocol to the CMR Convention concerning the Electronic Consignment Note (e-CMR). UNECE. https://unece.org/transport/documents/2024/04/status-additional-protocol-cmr-convention-concerning-electronic-consignment-note

Patricija Majcen, B.sc.. Log. Eng.

Prometna šola Maribor

DIGITALIZATION AND SUSTAINABILITY IN FREIGHT FORWARDING: CHALLENGES AND OPPORTUNITIES OF THE MODERN LOGISTICS SECTOR

Summary

Digitalization improves logistics with greater efficiency and customer satisfaction. Adapting to these trends is essential for the success of businesses. Greater digitalisation of freight transport and logistics will save companies a lot of costs and increase efficiency and sustainability. The introduction of the digital e-CMR represents a digital version of the traditional consignment note used in road freight transport under the Convention Consignment Note (CMR). The implementation of e-CMR enables simplification of administrative procedures, greater transparency, faster data exchange and reduction of the possibility of errors and fraud. This article analyses the key opportunities brought about by the digitalisation of consignment notes, such as increased efficiency, improved traceability and environmental benefits. It also addresses challenges, including technical, legal and organisational aspects that make it difficult to use e-CMR more widely. Particular attention is paid to the international context, where harmonisation of standards and legislation is crucial for effective application. The article also presents the current state of e-CMR implementation in Slovenia and highlights the anticipated trends and future trends in the development of digital consignment note technology.

1 Introduction

Road freight transport is one of the key pillars of global logistics, where the accurate and fast exchange of shipment data plays a critical role in the efficient operation of the supply chain. Traditional paper consignment notes (CMRs) have long been the basic document for proving the transportation of goods, but their use comes with several challenges, such as slowness, risk of document loss, manipulation, and environmental footprint. The development of information technologies and digitalization have enabled the introduction of e-CMR – an electronic version of the consignment notes, which promises to transform the entire process of managing freight documents.

1.1 Basics of e-CMR

1.1.1 Definition and legal framework

The Convention on the Contract for the International Carriage of Goods by Road (CMR) was developed in 1956. This Convention shall standardise the contractual conditions and the conditions of liability of the carrier in the carriage of goods by road by means of vehicles for remuneration, provided that the place of origin and destination are in two different States and at least one of the States Parties is a Contracting Party. 55 countries around the world

have acceded to the convention, making the use of CMR mandatory in these countries. In 1976, the International Road Federation, in cooperation with the International Chamber of Commerce, introduced the CMR consignment note template, harmonized with the United Nations form. This consignment note template for road transport was updated in 2007 and is now used by most, if not all, parties to transport contracts in the States Parties to the CMR. The CMR is mainly used for the purposes of commercial (business-to-business) transport contracts and is often used by law enforcement and customs authorities to verify goods and consignor/consignee/carrier information for customs clearance in cross-border trade, or additional information in various situations. In 2008, the Additional Protocol on e-CMR was introduced to support paperless versions of the e-CMR sheet. Although several pilot tests were carried out in the following years, there was no official standardised message format for the electronic consignment note. In 2017, a project of the United Nations Trade Facilitation and E-Commerce Centre developed a business requirements specification, a structure of key components of an e-CMR message, and an XML message. (Unece, 2024).

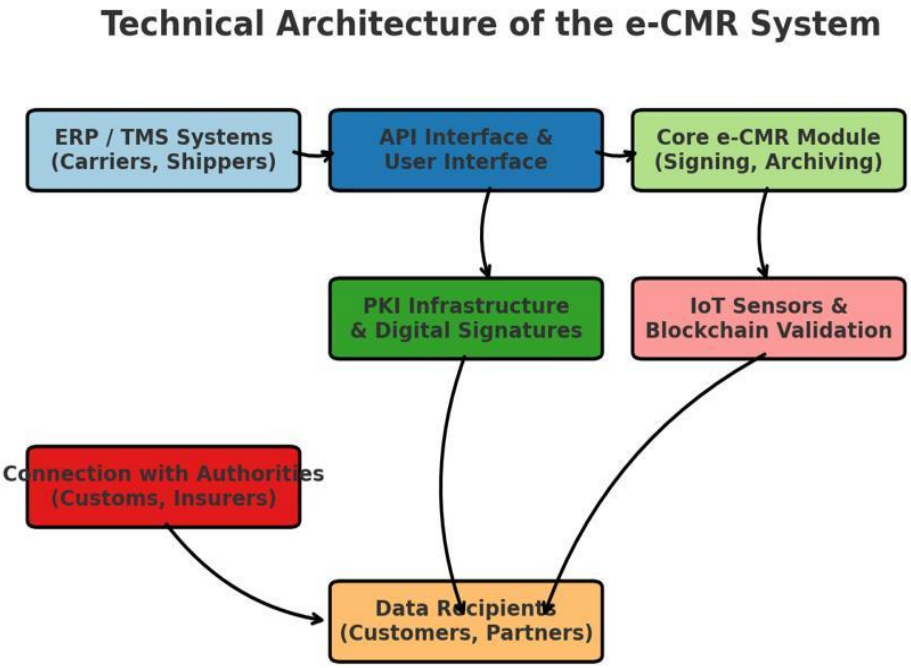
An e-CMR is therefore an electronically generated document that is legally compliant and contains the same information as a traditional CMR. This means that the e-CMR has the same legal status as a traditional paper CMR and can be used as evidence in case of disputes. It is created, transmitted, and stored electronically and replaces paper CMR (Dasaklis, 2024).

1.1.2. Technical design and architecture of the system

The e-CMR system is based on digital platforms that enable the safe and reliable creation, exchange and storage of consignment notes in electronic form. The basic elements of the technical design shown in Figure 1 include (TransFolow):

- Digital signature: Provides authenticity and the impossibility of changing the document after signing.
- Web applications and APIs: They enable integration with already existing transport and distribution systems (TMS), ERP and other IT solutions in logistics.
- Data storage: Data can be stored in centralized clouds or decentralized systems, depending on the architecture of the service provider.
- Security protocols: The use of encryption and other security mechanisms to protect sensitive information.

Figure 1: Technical architecture of the e-CMR system (Majcen, 2025)



2 Difference between traditional and electronic consignment note

The difference between a traditional (paper) consignment note and an electronic consignment note (e-CMR) is quite extensive, covering legal, technical, operational and environmental dimensions.

2.1 Definition and format

A traditional CMR is a physical, paper document used in international road freight transport in accordance with the CMR Convention of 1956. It is usually printed in three originals (for the sender, carrier and consignee), all copies being hand-signed. The document is completed by hand or by printing from a computer system but requires physical delivery between all participants (United Nations Economic Commission for Europe, 2021).

An electronic CMR (e-CMR) is a digital version of the same document, based on the 2008 CMR Additional Protocol. Instead of paper, it is a digital file (e.g. in XML, JSON or PDF/A format) that can be created, signed and stored electronically. e-CMR contains the same data as paper CMR (e.g. data on sender, carrier, freight goods and transport conditions), but manages it through digital platforms, which enables immediate data transfer between stakeholders, automation of entry from ERP/TMS systems and electronic archiving with backup copies. From Table 1 below, we can see the key differences between paper and electronic consignment notes (Planinšek, 2025).

Table 1: Comparison between traditional and electronic consignment note (Majcen, 2025)

Aspect	Traditional CMR	Electronic CMR (e-CMR)
Form	Paper document, 3 originals	Digital record (XML, JSON, PDF/A)
Signature	Handwritten signature	Digital signature (PKI)
Sending	Physical delivery, post	Instant electronic exchange
Access	Only at the document location	Real-time access
Storage	Physical archive	Digital storage (cloud or local)
Environmental impact	High paper consumption	No paper consumption

2.2 Legal validity

The legal basis for the e-CMR electronic consignment note is the Convention on the Contract for the International Carriage of Goods by Road (CMR), signed in Geneva in 1956. This Convention lays down the mandatory elements of the consignment note and the rights and obligations of the Contracting Parties in the international carriage of goods by road. In 2008, the Additional Protocol to the CMR Convention was adopted, which enabled the use of the electronic consignment note as a legally valid document. A prerequisite for the legal validity of an e-CMR is that the electronic form provides the same level of reliability, verifiability and protection against change as the paper form (United Nations Economic Commission for Europe [UNECE], 2021).

At the European Union level, the additional validity of e-CMR is regulated by Regulation (EU) 2020/1056 on Electronic Freight Information (eFTI), which stipulates that EU Member States must allow the acceptance of electronic freight documents by 21 August 2026. The Regulation lays down minimum requirements for interoperability of systems, data security and uniform procedures, ensuring that e-CMR enjoys the same legal recognition as the paper version (European Union, 2020).

In addition, UNECE stresses in its guidelines that each e-CMR must be provided with an advanced electronic signature based on valid digital certificates, and that all data must be protected from unauthorized access and alteration. It also stipulates that digital documents must be kept in accordance with applicable archival standards (UNECE, 2021).

2.3 Filling and processing process

In traditional CMR, data on the shipment, carrier and recipient are entered manually or by printing out from a computer, and the document is signed physically and exchanged between stakeholders by mail or in person (Planinšek, 2025). In e-CMR, data is entered digitally, often automatically from the ERP/TMS system, the document is electronically signed and immediately shared via secure platforms (European Chemical Transport Association [ECTA], 2021). The electronic record allows immediate access to all customers and automatic archiving in accordance with legal requirements. The differences between the filling and processing process can be seen in Table 2.

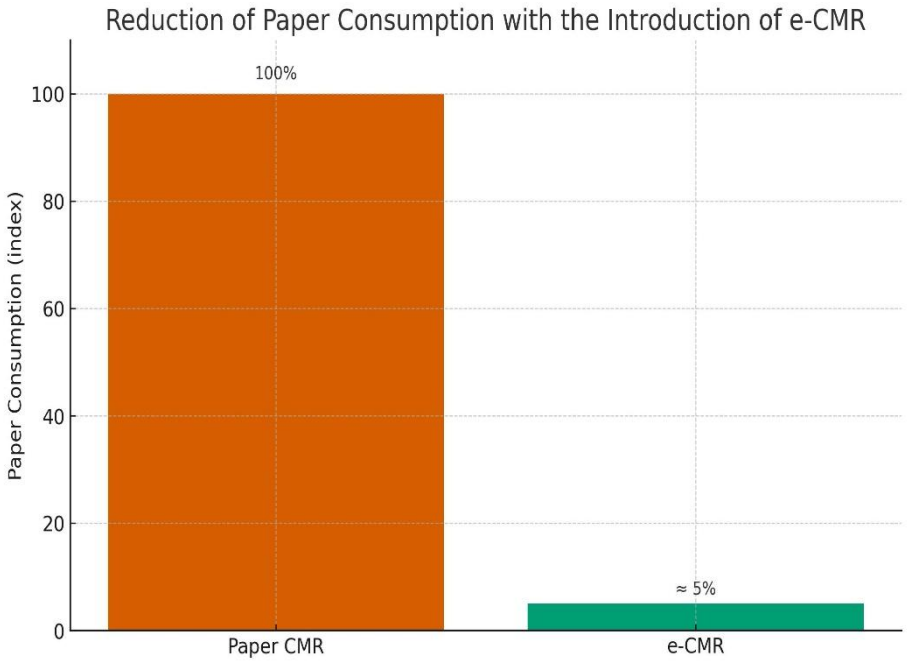
Table 2: Demonstration of the filling and processing process (Majcen, 2025)

Aspect	Traditional CMR	Electronic CMR (e-CMR)
Form	Paper document, 3 originals	Digital record (XML, JSON, PDF/A)
Signature	Handwritten signature	Digital signature (PKI)
Sending	Physical delivery, post	Instant electronic exchange
Access	Only at the document's location	Real-time access
Storage	Physical archive	Digital storage (cloud or local)
Environmental impact	High paper consumption	No paper consumption

2.4 Environmental aspect

The introduction of e-CMR has a significant positive impact on the environment, as it eliminates the need to print and physically exchange paper documents. Every year, millions of papers CMR sheets are issued in international road traffic, which means a large consumption of paper, ink and energy for printing and the logistics of document delivery (Planinšek, 2025). With digitalisation, this consumption is virtually eliminated. Figure 1 illustrates this. This reduces tree felling, water consumption, and greenhouse gas emissions associated with paper production (European Chemical Transport Association [ECTA], 2021). Since e-CMR enables the electronic transmission of documents in real time, it also eliminates the need for additional physical transports just for the delivery of documentation, which reduces CO_2 emissions from transport. e-CMR digital archiving is more energy-efficient than maintaining physical archives because it does not require space, air conditioning or physical maintenance of documents. At the same time, the use of e-CMR allows for better tracking and optimisation of transports, which can lead to fewer empty runs and consequently lower emissions. The overall environmental impact is even greater if we connect e-CMR with other digital solutions, such as e-invoices and e-delivery notes, as this creates a comprehensive digital chain of documents. In this way, digitalisation through e-CMR supports the objectives of sustainable mobility and the circular economy as set out in the European Green Deal (European Union, 2020).

Chart 1: Showing the difference in paper usage



3 Opportunities of e-CMR

3.1 Increase efficiency and reduce administrative costs

The digitization of consignment notes allows documents to be quickly created, sent and verified, which reduces time and administrative costs (European Commission, 2022). Electronic data transmission reduces errors that occur when manually entering and transmitting information. According to a number of studies, as can be seen in Table 3, companies can reduce administrative costs by up to 30% by switching to e-CMR.

Table 3: Effect of e-CMR on efficiency and costs (Majcen, 2025)

Aspect	Before Digitalization (CMR)	After Digitalization (e-CMR)
Document processing time	15–20 min	5–7 min
Data entry errors	5–8 %	1–2 %
Cost per document	EUR 2.50	EUR 1.00
Annual administrative costs	100 %	~ 70 %
Document accessibility	Physical only	Real-time

3.2 Improved traceability and transparency of transports

E-CMR provides real-time insight into the status of transport, which strengthens the control of shipments and helps prevent loss or theft of goods. Digital records are also more easily accessible and archived, which makes it easier to resolve potential disputes (Kovač & Novak, 2021).

3.3 Improve data security

Data security is one of the key benefits of the introduction of the electronic consignment note (e-CMR). The use of digital signatures based on Public Key Infrastructure (PKI) can ensure that the document has not been altered after signature and that the identity of the signatory can be reliably verified (United Nations Economic Commission for Europe [UNECE], 2020). Compared to paper documents, which can be physically damaged, lost or falsified, electronic records allow for cryptographic protection of content and recording of an audit trail of any changes (European Commission, 2022). In addition, e-CMR systems use security protocols such as data encryption in transit (e.g., TLS 1.3) and at rest (e.g., AES-256), which prevents unauthorized access and reduces the risk of cyberattacks. Advanced platforms also enable multi-level user authentication and the assignment of different access rights depending on their role in the process (Kovač & Novak, 2021). The use of blockchain technology in some pilot projects further increases the system's resilience to counterfeiting, as decentralized storage and timestamps ensure that the data is immutable and verifiable by all stakeholders (Ponzoa Casado, Gómez Funes, & García García-Doncel, 2021). Such an architecture not only increases security but also trust between partners in the logistics chain. Collectively, we can say that e-CMR contributes to a significantly higher level of data security in logistics, as it combines legally valid electronic signatures, advanced security protocols, traceability of changes and the potential of blockchain technology into a single protection framework.

4 Challenges in the implementation of e-CMR

4.1 Technical barriers

One of the biggest technical barriers to the introduction of e-CMR is ensuring the interconnectivity of different information systems and platforms used by carriers, shippers and consignees (Smith & Brown, 2023). Different data standards and formats make integration difficult, as each stakeholder can use their own software package or data schema. The lack of universal standards for electronic data interchange leads to the need for expensive interfaces and software adaptations. Integration often requires technically trained personnel and additional investments in IT infrastructure. In the case of cross-border transport, the problems are exacerbated by the fact that the systems in different countries are not necessarily compatible. Therefore, the need to harmonise data standards, as sought by the European eFTI initiative, is highlighted as a key challenge. Without harmonised technical solutions, the deployment of e-CMR may be slowed down and limited to closed partner networks.

4.2 and regulatory barriers

Although e-CMR is legally recognized in countries that have ratified the Additional Protocol to the CMR Convention, there are still many countries that have not done so, which makes

it difficult to use it in international traffic (Kovač & Novak, 2021). Differences in legislation regarding digital signatures mean that a document valid in one country may not be recognised in another. Also, the requirements for the protection of personal and business data differ between countries, which affects the form and content of the e-CMR. The EU aims to reduce these differences through Regulation (EU) 2020/1056, which introduces uniform standards for electronic transport information. However, the implementation of the regulation varies between countries, which creates temporary legal inconsistencies. International organisations such as UNECE emphasise the need for more ratifications of the protocol and harmonisation of legislation. Until this process is completed, the use of e-CMR on a global level will be patchy.

4.3 Organizational and human factors

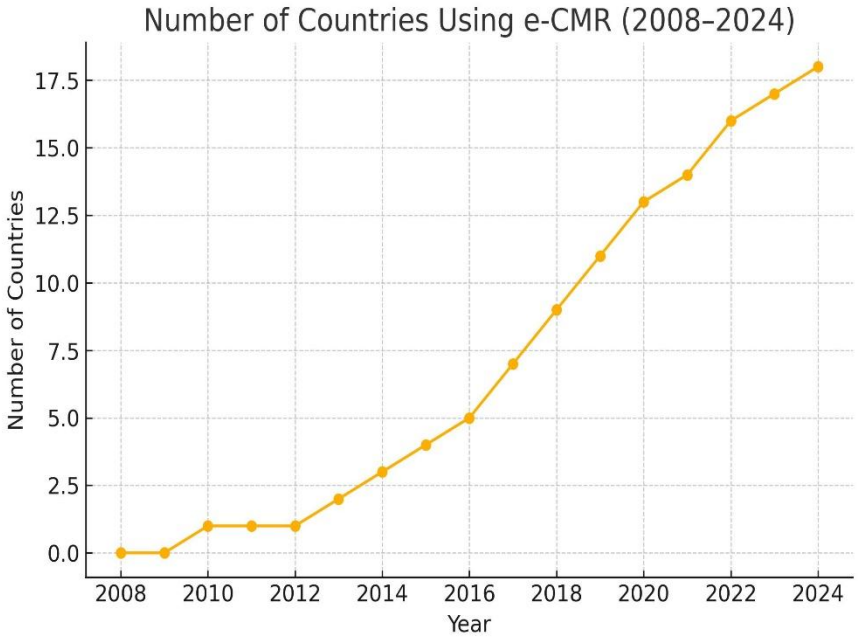
The introduction of e-CMR requires changes to existing business processes and employee training, which is an organizational challenge for many companies (European Commission, 2022). A lack of digital literacy in the work of employees may slow down the transition to electronic documents. Some companies decide to stick with paper documentation because of the initial cost, equipment and licenses needed. In addition, changing work habits often encounters resistance from employees who are accustomed to established procedures. The successful implementation of e-CMR also requires the active support of the company's management, because without a strategic commitment, digitalization often remains at the level of pilot projects. With appropriate training and employee motivation programs, these challenges can be significantly mitigated. Organisational readiness is therefore just as important as the technical feasibility of the project.

2 The international aspect of e-CMR

5.1 Worldwide prevalence and adoption

According to UNECE (2024), the Additional Protocol to the CMR Convention has been ratified by more than 20 countries by early 2024, as shown in Chart 2. Among the most active in the implementation of e-CMR are the members of the European Union, Switzerland, Norway and some countries of the Middle East, such as Qatar and the United Arab Emirates. This prevalence contributes to the simplification of cross-border transport operations by reducing the need for the physical exchange of documents and allowing for uniform digital data processing. The integration of e-CMR with other initiatives, such as eFTI, is also underway in Europe, further increasing interconnectivity. However, despite progress, there are still regions where the protocol has not been ratified, limiting the global reach and full interoperability of the system.

Chart 2: Country count (UNECE, 2024)



5.2 Standardisation and harmonisation

The success of e-CMR depends largely on international harmonization, which includes legal recognition of the document, technical standards and operational procedures (Kovač & Novak, 2021). UNECE is leading coordination efforts through working groups that include representatives of countries, the logistics industry and technology providers. Standardization allows e-CMR to be used in the same way regardless of the country of origin or destination, which reduces costs and increases trust in the system. Emphasis is placed on the development of uniform data models that enable interoperability between different information systems. In the long term, the aim of harmonisation is not only harmonisation within Europe, but also the establishment of a global standard for digital transport documents.

3 E- CMR in Slovenia

6.1 Status and implementation

Slovenia ratified the Additional Protocol to the CMR Convention in 2018, thus legally enabling the use of e-CMR in road freight transport (Kovač & Novak, 2021). According to the Ministry of Infrastructure, since then, the number of companies using e-CMR has gradually increased, especially among major logistics operators. There are several international and domestic platforms on the market that enable electronic creation, signing and archiving of consignment notes. In practice, however, the roll-out is progressing more slowly for small and medium-sized carriers, where barriers are related to investment costs and a lack of digital competences. Nevertheless, Slovenia follows European trends and is involved in interoperability projects at the EU level.

Table 4: Overview of the estimated state of e-CMR use in Slovenia for 2024 (Majcen, 2025)

Segment	Use of e-CMR	Use of Paper CMR
Large logistics operators	70 %	30 %
Medium-sized companies	40 %	60 %
Micro and small companies	15 %	85 %

6.2 Challenges and opportunities in the local market

Slovenian carriers still predominantly use paper documents, although research shows that awareness of the benefits of digitalization is growing (Novak, 2023). The main challenges include the technical integration of e-CMR solutions with existing ERP and TMS systems and the lack of a uniform standard among IT service providers. In the area of opportunities, the possibility of optimizing processes, reducing costs and increasing the competitiveness of companies that will be among the first to switch to digital solutions is highlighted. Government incentives and harmonization of standards could speed up the transition, especially among smaller companies. The increased use of e-CMR would enable Slovenia to have better connectivity with European and international logistics networks.

4 The future of e-CMR and digitalisation in road transport

7.1 Technology trends (blockchain, IoT, AI)

Advanced technologies such as blockchain for indelible document tracking, Internet of Things (IoT) for real-time shipment status monitoring, and artificial intelligence (AI) to optimize logistics processes will further improve the performance of e-CMR systems (European Commission, 2022). Together, these technologies will create a more connected, secure and efficient digital logistics environment.

7.2 Integration with other digital tools in logistics

E-CMR will become part of a broader digital ecosystem that includes electronic customs declarations, warehouse management systems, transport platforms, and other solutions (Smith & Brown, 2023). Such a link will allow for a uniform exchange of data between different stakeholders in the supply chain without repetitive input of information.

7.3 Potentials for further automation and optimization

Digitization of documentation enables automated processing, reduces the need for human intervention and eliminates bottlenecks in transport data management (Kovač & Novak, 2021). In the future, it will also be possible to integrate advanced predictive models that will prevent delays and reduce transport costs. This will move the logistics process towards complete digital self-efficacy.

5 Conclusion

The digitalisation of consignment notes with the help of e-CMR represents an important step towards modernising and improving the efficiency of road freight transport. Despite the many opportunities, challenges remain, especially in the areas of standardisation, security and the adoption of new technologies. Slovenia is on the right path to digital transformation, but further coordination and awareness of stakeholders is needed. In Slovenia, the use of e-CMR is already increasing among larger logistics operators, but the transition is slower among small and medium-sized enterprises, mainly due to costs and lack of digital infrastructure. The state could speed up the process by introducing incentives, co-financing of equipment and training programs for employees in the transport sector. Special emphasis should also be placed on the interoperability of systems, as Slovenian carriers often face international partners who use various digital solutions. Success will largely depend on close cooperation between the state, logistics companies and IT solution providers. With a proactive approach and participation in European projects, Slovenia can become an example of effective digital transformation in the region. In the long term, this could help to increase the competitiveness of Slovenian carriers on the international market and reduce administrative burdens.

Sources

Dasaklis. T. (2024). Exploring the challenges in the implementation of the Freight Electronic Information Regulation (eFTI): empirična perspektiva iz Grčije. https://www.mdpi.com/2305-6290/8/1/30

European Chemical Transport Association. (2021). Best Practice Guideline: Digital Documents – e-CMR and e-ECD. European Chemical Transport Association. https://www.ecta.com/wp-content/uploads/2021/03/ECTA-BEST-PRACTICE-GUIDELINE-DIGITAL-DOCUMENTS-eCMR-AND-eECD.pdf

European Commission. (2022). Digitalisation in freight transport: Towards paperless logistics. European Union. https://transport.ec.europa.eu/digitalisation_en

European Union. (2020). Regulation (EU) 2020/1056 of the European Parliament and of the Council on electronic freight transport information. Official Journal of the European Union. http://data.europa.eu/eli/reg/2020/1056/oj

European Union. (2020). Regulation (EU) 2020/1056 on electronic freight transport information. http://data.europa.eu/eli/reg/2020/1056/oj

Kovač, M., & Novak, P. (2021). Digitalna transformacija v cestnem tovornem prometu: Primer uporabe e-CMR za izboljšanje sledljivosti. Logistični vestnik, 35(4), 45–53. Ljubljana: Slovensko logistično društvo.

Ministrstvo za infrastrukturo Republike Slovenije. (2024). Poročilo o stanju digitalizacije v cestnem tovornem prometu. Ljubljana: MZI.

Novak, T. (2023). Analiza stanja digitalizacije v slovenski logistiki. Revija za promet in logistiko, 29(2), 34–41.

Planinšek, N. (2025). Digitalizacija tovornih listin: primer e-CMR. Diplomsko delo, Univerza v Ljubljani.

Ponzoa Casado, J. M., Gómez Funes, A., & García García-Doncel, J. (2021). Digital

Transformation: Advantages and Opportunities of e-CMR. Digital Economy and Innovation Journal, 1(1), 85–93. https://doi.org/10.55234/edeij-1-1-004

Smith, J., & Brown, L. (2023). Cost reduction and efficiency gains from electronic consignment notes (e-CMR). Journal of Transport Economics, 45(2), 115–132. https://doi.org/10.1016/j.jte.2023.ecmr

TransFollow. (2025). eCMR. https://www.transfollow.org/support/drive/ecmr/

UNECE. (2021). Additional Protocol to the CMR Convention concerning the Electronic Consignment Note (e-CMR). https://unece.org

Unece. (2024). Practitioner's Guide to e-CMR. https://unece.org/trade/documents/2023/10/executive-guide-e-cmr

United Nations Economic Commission for Europe. (2020). e-CMR – The electronic consignment note. UNECE. https://unece.org/transport/documents/2020/02/e-cmr-electronic-consignment-note

United Nations Economic Commission for Europe. (2021). Additional Protocol to the CMR Convention concerning the Electronic Consignment Note (e-CMR). https://unece.org/transport/documents/2021/05/standards/additional-protocol-cmr-convention-concerning-electronic-consignment-note

United Nations Economic Commission for Europe. (2024). Status of the Additional Protocol to the CMR Convention concerning the Electronic Consignment Note (e-CMR). UNECE. https://unece.org/transport/documents/2024/04/status-additional-protocol-cmr-convention-concerning-electronic-consignment-note

J.U. SREDNJA ŠKOLA ZA SAOBRAĆAJ I KOMUNIKACIJE SARAJEVO

Mr.sci.Emilija Martinčević, dipl. ing. saob. i komunikacija

Solak Sabhudin, dipl. ing. saob. i komunikacija

MODELIRANJE CITY LOGISTIKE ZA PODRUČJE GRADA SARAJEVA

Sažetak

Ovaj rad bavi se istraživanjem potencijala i mogućnosti primjene teretnih bicikala u urbanim sredinama, s posebnim fokusom na Kanton Sarajevo. Teretni bicikli predstavljaju održivu alternativu motornim vozilima, jer doprinose smanjenju emisije štetnih plinova, buke i prometnih gužvi, a istovremeno nude ekonomično i praktično rješenje za dostavu različitih vrsta tereta. U radu su predstavljeni modeli teretnih bicikala, njihove tehničke karakteristike, nosivost i cijene, kao i glavne pogodnosti njihove upotrebe – ekološki učinci, povećanje sigurnosti u saobraćaju, rasterećenje gradskih ulica, uštede za privredu te logistička učinkovitost.

Poseban naglasak stavljen je na preporuke za nadležna tijela u Kantonu Sarajevo u vezi s razvojem biciklističke infrastrukture, uvođenjem električnih teretnih bicikala u dostavne sisteme, poticanjem pilot-projekata i osnivanjem urbanih logističkih centara. Predložen je i model mogućeg korištenja teretnih bicikala u Sarajevu, uključujući identifikaciju potencijalnih korisnika, tipove robe pogodne za dostavu te mogućnosti povezivanja s postojećim sistemom Nextbike.

Analizom je utvrđeno da bi primjena teretnih bicikala mogla značajno unaprijediti urbanu mobilnost, smanjiti negativne ekološke utjecaje i donijeti ekonomske koristi poslovnim subjektima i građanima. Rezultati ukazuju da Sarajevo ima realan potencijal da postane jedan od gradova u regiji koji će razviti održiv i moderan sistem dostave zasnovan na električnim teretnim biciklima.

Ključne riječi: *teretni bicikli, električni bicikli, urbana mobilnost, logistika, održivi transport, Kanton Sarajevo*

UVOD

Urbana mobilnost jedno je od ključnih pitanja s kojima se suočavaju savremeni gradovi. Povećanje broja stanovnika, razvoj online trgovine i stalno rastući zahtjevi za brzim i efikasnim dostavama doveli su do velikog pritiska na postojeće prometne sisteme. Istovremeno, promet predstavlja jedan od najvećih izvora zagađenja zraka, buke i emisije ugljičnog dioksida, što negativno utiče na kvalitet života stanovnika. Zbog toga je neophodno razvijati alternativna, održiva rješenja koja mogu odgovoriti na izazove današnjeg društva.

Jedno od takvih rješenja su teretni bicikli, vozila koja su posebno konstruisana za prijevoz tereta različite težine i dimenzija. Njihova primjena u praksi pokazuje da su efikasna alternativa motornim vozilima, posebno u gradskim sredinama gdje su gužve, ograničeni prostori za parkiranje i stroge regulative u vezi s emisijama postale svakodnevica. Teretni bicikli nisu novost – koriste se više od stotinu godina – ali zahvaljujući inovacijama u dizajnu, upotrebi laganih materijala i razvoju električnih pogona, danas imaju daleko veći potencijal nego ikada ranije.

Ovaj rad bavi se istraživanjem pogodnosti korištenja teretnih bicikala, analizom njihovih ekoloških, ekonomskih i logističkih prednosti, kao i mogućnostima njihove implementacije u Kantonu Sarajevo. Poseban naglasak stavljen je na preporuke za nadležna tijela u cilju izgradnje biciklističke infrastrukture i razvoja pilot-projekata koji bi Sarajevo mogli svrstati u red gradova s modernim i održivim rješenjima za urbani transport.

Model Teretnih bicikala

Teretni bicikli posebno su osmišljeni kako bi se njima prevozio teret, bilo da je riječ o nečemu teškom, laganom, velikom ili malom. Teretni bicikli dolaze u mnogo oblika, u rasponu od klasičnog bicikla s košarom (tzv. Short-John), preko teretnih modela na tri kotača, do posebno izrađenih modela na četiri kotača s pomoćnim električnim pogonom za posebne komercijalne svrhe. Iako su teretni bicikli u uporabi više od stotinu godina, zahvaljujući nedavnim inovacijama u dizajnu i napajanju, suvremeni su modeli mnogo učinkovitiji i pristupačniji.

Nosivost i cijene teretnih bicikla također su mnogo bolji: laganiji bicikli stoje 1.000 do 2.000 eura i nosivosti su 80 kg, dok teži bicikli stoje od 2.000 do 12.000 eura i mogu prevoziti i do 350 kg. Takvi se bicikli potencijalno mogu uhvatiti ukoštac s ekološkim, logističkim, prometnim i društvenim problemima s kojima se suočavaju brojni europski gradovi. Istodobno omogućavaju novo poimanje mobilnosti, prijevoza i kvalitete života.



Slika 1. Teretno biciklo u lancu Intermodalnosti

Glavne pogodnosti korištenja teretnih bicikala

Sredstvo za borbu protiv ispuštanja ugljičnog dioksida, zagađenja, nepotrebnog trošenja energije te za bolje iskorištavanje zemljišta. Buka i zagađenje koji dolaze od komercijalnog pro - meta izrazit su problem u gradskim središtima. Naime, gradovi proizvode 40% sve emisije ugljič - nog dioksida vezane za prijevoz te 70% svih drugih zagađivača povezanih s prijevozom. Jedan jedini teretni bicikl kojim bi se zamijenilo vozilo na di - zel-gorivo godišnje može uštedjeti 5 tona ugljičnog dioksida, što znači da su teretni bicikli učinkovit alat za postizanje europskog cilja gradske logistike s nultom stopom CO 2 do 2030. Osim što su teretni bicikli ekološko rješenje, za njihovu je izradu potre - bno samo 5% materijala i energije koji se utroše na izradu automobila. Zemljište je također ograničen resurs u urbanim područjima i gradovima poput Berlina u kojem, prema statistikama iz 2013., 28 km otpada na parkirališta. Kad bi se samo 2% tog prostora pretvorilo u parkirališta za bicikle, moglo bi se parkirati više od 300.000 bicikla.

Smanjenje opterećenosti saobraćaja

Prenapučeni gradovi nova su norma, a neprestani porast online trgovine neće biti održiv bez značajnih promjena. Urbanizacija je sve brža, gradovi su prenapučeni, a logističke procedure sve su teže održive. Stoga europsko gospodarstvo svake godine izgubi 1% BDP-a zbog prometnih zastoja. Dok zone s ograničenim prometom postaju sve učestalije (deseci europskih gradova onemogućili su promet motornim vozilima po centru), online trgovina svake godine raste za 10%. Teretni bicikli učinkovito su rješenje za ovu vrstu urbanog prijevoza tereta do odredišta (tzv. „posljednji kilometar“ ili last mile). Ovi se bicikli mogu uhvatiti ukoštac s ekološkim, logističkim i prometnim problemima s kojima se bore brojni europski gradovi. Istodobno omogućuju novo viđenje mobilnosti, prijevoza i kvalitete života građana.

Povećanje mobilnosti obitelji

Najlakši, najpametniji i najzabavniji jednovolumen koji možete zamisliti. Vlasnici automobila suočeni su sa sve većim porezima, kaznama za emisije štetnih plinova i zabranama prometovanja. Teretni bicikli nude sigurniji i praktičniji način prijevoza za obitelji i djecu. Djecu se može voditi u školu i ići po njih sigurno i jednostavno, a da se pritom rijeke auta ne natječu na cestama i tako ne ugrožavaju djecu. S obzirom na mogućnost prijevoza i do četvero djece istodobno, i to u četverostruko manje prostora nego što ga zauzima automobil, teretni bicikli neizmjerno su korisni i učinkoviti. Zauzimaju tek djelić prostora potrebnog za parkiranje automobila pa su stoga jeftinije i sigurnije rješenje od automobila.

Sigurnije ulice

Teretni bicikli mogu smanjiti broj automobila na ulica ma i tako sačuvati i poboljšati živote. Kao što smo vidjeli diljem Europe, broj smrtnih slučajeva uzrokovanih prometom manji je što je na cestama više bicikla. Nije stoga slučajnost što Nizozemska, zemlja s najvećim brojem biciklista, ujedno ima i najmanji broj biciklista koji podlegnu ozljedama uslijed sudara (1.1 stradali na 100 miliona km prevaljenih biciklom). Istraživanje koje je nedavno proveo Institut za globalno zdravlje iz Barcelone predviđa da bi poboljšanje biciklističke infrastrukture moglo dovesti do smanjenja od 10.000 preuranjenih smrti u europskim gradovima. Preurede li se ulice tako da se četvrtina građana vozi na biciklističkim stazama, smanjit će se prometne nesreće, ali i štetan učinak zagađivača i sjedilačkog načina života.[110]

Intermodalnost

Uz mogućnost prelaska s bicikla na vlak, vaše putovanje teretnim biciklom doista nema granica. Biciklisti koji se voze teretnim biciklima često mogu iskoristiti prednosti koje pruža povezanost biciklističkih staza i vlakova. Gradovi diljem Europe omogućavaju intermodalnost zahvaljujući sigurnim parkiralištima za teretne bicikle u neposrednoj blizini prijevoznih centara (kolodvori i sl.). Malmo, Maastricht, Cambridge i Utrecht neki su od gradova koji su napravili parkirališta za teretne bicikle na željezničkim kolodvorima. Intermodalnost teretnih bicikla, tj. mogućnost njihova korištenja na ulici, na biciklističkoj stazi i jednostavan prelazak na kolodvore, čini ih praktičnijim i bržim od automobila.

Ušteda

Unosno i povoljno prometno sredstvo kojim možete prije voziti poslovne pošiljke. Teretni bicikli ekonomična su zamjena za klasični vozni park. Stoje tek djelić cijene koju biste platili za novi automobil, gotovo i nema troška goriva, a troškovi osiguranja, održavanja i popravka su niski pa teretni bicikli mogao tvrtkama mogu donijeti značajne uštede u voznom parku. Među ostalim su prednostima i manje prostora potrebnog za parkiranje, manje radnika na bolovanju te manje vremena provedenog u probijanju kroz zakrčene ulice i prometne gužve. Uzmimo za primjer slučaj mesara iz Greenwicha koji je 95% dostava na udaljenostima manjima od 5 km mogao obaviti teretnim biciklom i tako uštedjeti 830£ godišnje samo na gorivu. Veći dio težine vozila otpada na samo vozilo, a samo je djelić težina tereta pa je teretni bicikl u tom smislu vrlo učinkovit jer ima 4 do 6 puta veću korisnu nosivost po kilogramu u usporedbi s kombijem.

Logistička učinkovitost

Za logističke tvrtke čija vozila moraju biti učinkovita i dolaziti na vrijeme, teretni bicikli najbolje su rješenje za sve veći problem dolaska do krajnjeg odredišta. U Cyclelogisticsu smatraju da bi se sve vrste prijevoza tereta, bilo da je riječ o vrećici s namirnicama ili o hladnjaku, mogle obavljati biciklom pod uvjetom da je riječ o udaljenostima od 7 km i manje i da je težina tereta manja od 200 kg po m3. Teretni bicikli mogli bi zamijeniti pola logističkih i četvrt komercijalnih dostava u europskim gradovima. U centru Londona logistika prijevoza do krajnjeg odredišta odlikuje se kratkim udaljenostima u vozilima koja se duže parkiraju no što voze. Teretnim se biciklima može manevrirati kroz prometne, pješačke i biciklističke zone pa se dostave izvršavaju brže nego motornim vozilima, bez obzira na to što motorna vozila mogu postići veće brzine.111

Povoljnija infrastruktura

Promicanje teretnih bicikla i biciklističkih traka najbolje je ulaganje u gradsku infrastrukturu. Gradovi mogu ojačati proračun promicanjem teretnih bicikla i ulaganjem u biciklističku infrastrukturu. Kontinuirana izgradnja biciklističke infrastrukture donosi veći povrat te omjer koristi i troškova nego veliki cestovni projekti i projekti javnog prijevoza, a istodobno stoji tek djelić njihove cijene. Ulaganja u mrežu biciklističkih staza u Londonu donijela su povrat u omjeru 4:1, a u Helsinkiju je povrat čak dvostruk te iznosi 8 eura na svaki utrošeni euro! Dok vožnja automobilom postaje sve skuplja, a vožnja biciklom sve jeftinija, gradovi mogu prednjačiti u iznalaženju rješenja zahvaljujući ulaganjima u bicikliranje.



Slika 2. DHL dostavno teretno biciklo

Preporuke za nadležna tijela na svim razinama u Kantonu Sarajevo za uvođenje električnih bicikala u svrhu dostave robe

Politike, strategije i planovi trebaju uzeti u obzir i dostavu biciklima

Koncept logistike biciklima treba biti uključen u strateške dokumente poput Planova za održivu urbanu mobilnost (SUMP) i Planova za održivu urbanu logistiku (SULP), prostornih planova i strategija, kao dio šireg cilja za njegovanje prijelaza na održivi saobraćaj. Saobraćajne studije i simulacije saobraćaja trebaju uzeti u obzir i potencijal razvoja logistike biciklima.

Biciklistička infrastruktura, kao što su biciklističke staze i parkirališta za bicikle, treba biti proširena i poboljšana

Nova i bolja infrastruktura omogućava brže i sigurnije kretanje biciklista, a time i učinkovitiju dostavu biciklima. Istovremeno omogućava prijelaz s automobila na bicikle i za ostale potrebe putovanja, a ne samo dostavu.

Lokalne vlasti trebaju osigurati nabavku e-bicikala i provoditi usluge isporuke biciklima

Lokalna upravna tijela mogu poslužiti kao primjer lokalnim preduzećima i susjednim tijelima uvođenjeme-bicikla u vlastiti vozni park, i/ili putem naručivanja od operatera koji koriste e- bicikle za dostavu roba i pružanje usluga.

Potrebno je provesti ograničenje brzine do 30 km/h u urbanim područjima kako bi bicikliranje bilo sa aspekta sigurnosti što bezbjednije

Ograničenje brzine na 30km/h ima široki raspon prednosti u smislu sigurnosti, podržavanja prijelaza na održivu urbanu mobilnost i čak poboljšanja javnog zdravlja kroz njegovanje aktivnog putovanja. Ograničenje znači i davanje prednosti dostavi pomoću bicikala.

Pilot programe poslovnih aktivnosti biciklima treba podržati kroz fiskalne i financijske poticaje

Nacionalna fiskalna politika, investicijski program i šeme financijskih poticaja trebaju uzeti u obzir prednosti koje se ostvaruju prijelazom na održivi teretni i putnički saobraćaj. Dostava biciklima je dobra vrijednost.

Potrebno je informiranje javnosti i promocija, kako bi se ukazalo na prednosti e-bicikala

Kako bi se osiguralo javno odobravanje i isticale razne prednosti koje nastaju prijelazom na dostavu biciklima, potrebne su kampanje i događaji s ciljem informiranja građana.

Potrebno je podržati osnivanje gradskih logističkih centara

Sistemi dostave biciklom za "zadnji kilometar" biti će najučinkovitiji kada se predaja pošiljki od teretnih sistema za veće udaljenosti, kao što su cestovna teretna vozila i željeznica, može odvijati blizu gradskog središta. Grad može imati u posjedu neiskorištene zgrade koje može ponuditi za distribucijski centar, besplatno ili za povlaštenu naknadu, kako bi se preduzeća potaknula da dio voznog parka zamijene e-biciklima.

Potrebne su regulatorne mjere kojima se njeguje prijelaz na održivi saobraćaj

Dokazane mjere uključuju naplatu cestarine i naknade za zagušenja u saobraćaju, zone niskih emisija, ograničenje parkiranja, ograničenje vremena dostave, kao i zone bez saobraćaja, u cijelosti ili djelomično.

Potrebno je provodtii zakone

Sprječavanje vozača konvencionalnih motornih vozila u stvaraju opasnosti i prepreka za ostale sudionike u saobraćaju i njihovo sankcionisanje korisno je za sve oblike održivog saobraćaja

Modeliranje teretnih bicikala za primjenu na podrucju grada Sarajeva

Kao prvi korak pri osnivanju preduzeća sa dostavnim uslugama potrebno je steći potencijalne korisnike te usluge. Kako bi preduzeće imalo uspješan početak potrebno je identificirati korisnike koji imaju potrebu za takvom vrstom usluge i čija roba se može lako prevoziti putem električnih bicikala. Sljedeći primjeri su potencijalni korisnici usluga i vrste robe koja se prevozi za njih:

- Apoteke - dostava lijekova za slabe i nemoćne;
- Cvjećarnice - cvijeće i buketi su idealni za dostavu pomoću električnih bicikala, ali su također potrebni posebni okviri kako bi održavali robu u uspravnom položaju tijekom vožnje;
- Servisna preduzeća - kompjuterska oprema, kućanski aparati itd.;
- Izdavaci novina i časopisa - izdavači novina imaju potrebu za svakodnevnom dostavom dnevnih novina i mjesečnom dostavom časopisa, kako bi došli ispred tržišta mogu imati ponudu pretplate i dostave;
- Preduzeća sa poslovnim aktivnostima na više lokacija - često veća preduzeća, privatna ili državna, nalaze se na više lokaciju u gradu. Uslugom dostave električnim biciklima, svaka lokacija bi se mogla obezbjediti pravovremenom i brzom
- opskrbom robe i svih ostalih pošiljaka koje su potrebne;
- Kopirnice- broj kopirnica je najčešće vrlo velik u svim većim gradovima, te kako bi poboljšali svoju uslugu, mogu ponuditi usluge dostave svojim korisnicima. Za takav posao najbolje rješenje za brzu i efikasnu dostavu je električni bicikl;

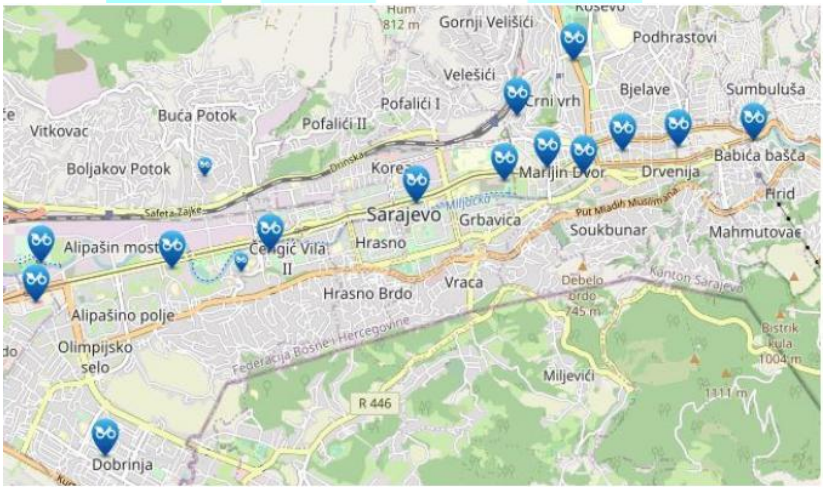
- Lanac dostave brze hrane - dostava hrane do krajenjg korisnika (potrebna je sigurna dostava ivremenski ograničena zbog mogućnosti serviranja ohlađene hrane); itd.

Razvoj urbanih konsolidacijskih i distribucijskih centara može biti ključni čimbenik u razvitku sistema dostave biciklima "zadnjeg kilometra". Ovakvi centri, koji se nalaze blizu središta grada, omogućavaju privremeno skladištenje roba za dostavu unutar grada. Gradske vlasti mogu imati u posjedu neiskorištene prostore koje mogu ponuditi za distribucijske centre, besplatno ili uz povlašteni zakup, kako bi se dostavna preduzeća potaknulo da zamjene dio svojeg voznog parka e-biciklima. Takav aranžman može također poslužiti za regeneraciju neiskorištenih ili napuštenih dijelova grada.

Kao polazište mogla bi se iskoristiti mreža stajališta sistema Nextbike za instaliranje infrastrukture potrebne za električna bicikla koja bi se koristila u svrhu dostave robe. Istovremeno iskustva vezana za rezervaciju, rentiranje i korištenje bicikala mogu biti korisno polazište u kasnijem razvoju.Nextbike je sistem gradskih bicikala koji u Kantonu Sarajevo postoji već četiri godine. Aplikacija za registraciju moguća je putem mobilne aplikacije, web stranice www.nextbike.ba, terminala ili lično na prodajnim mjestima Nextbike partnera. Kako bi postao registrovan korisnik, aplikant mora imati najmanje 18 godina u trenutku prihvatanja aplikacije.Na osnovu prijema svih relevantnih podataka, pružatelj usluga odlučuje da li će ili ne prihvatiti poslovnu relaciju sa aplikantom.

Kao dio procesa aplikacije, pružatelj usluge je ovlašten koristiti servis WorldPay kako bi

i nprovjerio kreditnu sposobnost aplikanta. Nakon registracije, aplikant će primiti PIN koji se koristi za prijavu na mobilnu aplikaciju ili web stranicu, kao i za vršenje najmova i povrata na terminalima.



Slika 3. Lokacije sistema Nextbike u Kantonu Sarajevo

Dostava električnim biciklima vršila bi se do ulaza u stambeni objekat željene adrese. Za pošiljke većih gabarita dostava bi bila moguća do prve fizičke prepreke koja onemogućava prilaz dostavnog vozila stambenom objektu. Ukoliko se radi o stambenoj zgradi, dostavljač nije dužan nositi robu do sprata na kojem se nalazi kupac već do ulaza u zgradu. Dostava bi se vršila putem prijevozničkih kompanija koje obavljaju usluge transporta.

Dostavna služba najčešće bi dostavljala u roku 24 sata od preuzimanja pošiljke u skladištu. U slučaju vanrednih situacija (poteškoće u saobraćaju, vremenskih neprilika, povećan broj pošiljaka, itd.) vrijeme dostave bilo bi duže od navedenog. Proizvodi će biti zapakovani tako

da se uobičajenom manipulacijom u transportu ne mogu oštetiti.

Kupac je dužan prilikom preuzimanja proizvoda provjeriti eventualna oštećenja i odmah ih reklamirati dostavnom radniku koji je robu dostavio, odnosno odbiti preuzeti pošiljku na kojoj su vidljiva vanjska oštećenja. Kupac je obavezan prilikom preuzimanja robe potpisati otpremnicu te je dostavna služba uzima kao potvrdu o preuzimanju.

ZAKLJUČAK

Na temelju provedenih analiza može se zaključiti da teretni bicikli nude brojne prednosti u odnosu na klasična motorna vozila. Oni ne samo da smanjuju emisije štetnih plinova i doprinose očuvanju okoliša, već predstavljaju i ekonomično rješenje jer su troškovi održavanja, goriva i osiguranja višestruko manji. Također, zauzimaju manje prostora, čime doprinose rasterećenju gradskih ulica i smanjenju prometnih gužvi. U društvenom smislu, teretni bicikli doprinose sigurnijem i zdravijem životu, jer povećavaju broj biciklista na ulicama, smanjuju rizik od nesreća i potiču aktivan način života.

Kanton Sarajevo, kao i mnogi drugi evropski gradovi, suočava se s izazovima sve gušćeg saobraćaja i loše kvalitete zraka. Upravo zbog toga uvođenje električnih teretnih bicikala može biti strateški korak prema održivoj urbanoj mobilnosti. Da bi se to ostvarilo, neophodno je da nadležna tijela osiguraju pravni i infrastrukturni okvir, podrže pilot-programe i potaknu poslovne subjekte na primjenu ovakvog vida transporta. Time bi se stvorili uslovi za razvoj intermodalnih sistema dostave, smanjenje emisija CO_2 i veći kvalitet života građana.

Na kraju, teretni bicikli nisu samo tehničko rješenje za transport, već i simbol šire društvene promjene ka održivosti. Njihova primjena povezuje ekologiju, ekonomiju i društvenu odgovornost u jedinstvenu cjelinu. Ako Sarajevo iskoristi ovu priliku i krene putem ulaganja u biciklističku infrastrukturu i promociju teretnih bicikala, može postati primjer grada koji gradi svoju budućnost na održivim, zdravim i ekonomičnim temeljima.

LITERATURA

[1] Kiba-Janiak Maja, 2015, Key success factors for city logistics from the perspective of variousgroups of stakeholders (9. Međunarodna konferencija o gradskoj logistici)

[2] Krekešić Igor, 2016, Organizacija distribucije paketnih pošiljaka u urbanim područjima - DIPLOMSKI RAD, Fakultet prometnih znanosti, ZagrebPriručnik iz prostornog planiranja, Projekat upravne odgovornosti Tadić Snežana, 2014, Modeliranje performansi integrisanih city logističkih sistema - DOKTORSKA DISERTACIJA, Saobraćajni fakultet, Beograd

[3] Taniguchi, E., Thompson, R.G., Yamada T., 2001, Recent advances in modelling city logistics, International Conference on City logistics, Okinawa, Japan

[4] http://sumpnetwork.eu/fileadmin/user upload/downloads/innovation briefs/PROSPERITY Inno vation Brief City logistics solutions HR.pdf (Pristup: 10.09.2020)

[5] http://sumpnetwork.eu/fileadmin/user upload/downloads/innovation briefs/PROSPERITY Inno vation Brief City logistics solutions HR.pdf (Pristup: 12.09.2020)

P.I. HIGH SCHOOL FOR TRAFFIC AND COMMUNICATIONS

SARAJEVO

Mr.sci.Emilija Martinčević, traffic engineer and communcations

Solak Sabahudin, traffic engineer and communcations

MODELING URBAN LOGISTICS FOR THE CITY OF SARAJEVO

Abstract

This paper explores the potential and possibilities of using cargo bicycles in urban environments, with a particular focus on the Sarajevo Canton. Cargo bicycles represent a sustainable alternative to motor vehicles, as they contribute to reducing harmful gas emissions, noise, and traffic congestion, while simultaneously providing an economical and practical solution for transporting various types of goods. The study presents different models of cargo bicycles, their technical specifications, load capacities, and prices, as well as the main benefits of their use—environmental impacts, increased traffic safety, alleviation of urban street congestion, economic savings for businesses, and logistical efficiency.

Special emphasis is placed on recommendations for the relevant authorities in Sarajevo Canton regarding the development of cycling infrastructure, the introduction of electric cargo bicycles into delivery systems, the promotion of pilot projects, and the establishment of urban logistics centers. A model for the potential use of cargo bicycles in Sarajevo is also proposed, including the identification of potential users, types of goods suitable for delivery, and possibilities for integration with the existing Nextbike system.

The analysis indicates that the implementation of cargo bicycles could significantly improve urban mobility, reduce negative environmental impacts, and provide economic benefits to both businesses and citizens. The results suggest that Sarajevo has a realistic potential to become one of the regional cities to develop a sustainable and modern delivery system based on electric cargo bicycles.

Keywords: *cargo bicycles, electric bicycles, urban mobility, logistics, sustainable transport, Sarajevo Canton*

Introduction

Urban mobility is one of the key challenges faced by modern cities. The increasing population, the growth of online commerce, and the ever-rising demand for fast and efficient deliveries have put significant pressure on existing transportation systems. At the same time, traffic is one of the major sources of air pollution, noise, and carbon dioxide emissions, which negatively affects the quality of life of urban residents. Therefore, it is essential to develop alternative, sustainable solutions that can address the challenges of contemporary society.

One such solution is cargo bicycles, vehicles specifically designed for transporting goods of various weights and sizes. Their practical application demonstrates that they are an efficient alternative to motor vehicles, particularly in urban environments where congestion, limited parking space, and strict emission regulations have become the norm. Cargo bicycles are not a novelty—they have been in use for more than a century—but thanks to innovations in design, the use of lightweight materials, and the development of electric drives, they now have far greater potential than ever before.

This study examines the benefits of using cargo bicycles, analyzing their environmental, economic, and logistical advantages, as well as the possibilities for their implementation in the Sarajevo Canton. Particular emphasis is placed on recommendations for the relevant authorities aimed at building cycling infrastructure and developing pilot projects that could position Sarajevo among the cities with modern and sustainable urban transport solutions.

CARGO BICYCLE MODELS

Cargo bicycles are specifically designed for transporting goods, whether heavy, light, large, or small. They come in a variety of forms, ranging from the classic bicycle with a cargo box (so-called Short-John), to three-wheeled cargo models, and even specially constructed four-wheeled models with electric assist for particular commercial purposes. Although cargo bicycles have been in use for over a century, recent innovations in design and propulsion have made modern models significantly more efficient and accessible.

The load capacity and prices of cargo bicycles have also improved considerably: lighter models cost between €1,000 and €2,000 and can carry up to 80 kg, while heavier models range from €2,000 to €12,000 and can transport up to 350 kg. Such bicycles have the potential to address ecological, logistical, traffic, and social challenges faced by many European cities. At the same time, they offer a new perspective on mobility, transportation, and quality of life.



Figure 1. Cargo Bicycle in the Intermodality Chain

Main benefits of using cargo bicycles

A means to combat carbon dioxide emissions, pollution, unnecessary energy consumption, and to achieve better land use. Noise and pollution from commercial traffic represent a significant problem in urban centers. Cities, in fact, produce 40% of all transport-related carbon dioxide emissions and 70% of all other transport-related pollutants. A single cargo bicycle replacing a diesel-powered vehicle can save 5 tons of carbon dioxide annually, demonstrating that cargo bicycles are an effective tool for achieving the European goal of zero-CO_2 urban logistics by 2030.

In addition to being an ecological solution, the production of cargo bicycles requires only 5% of the materials and energy needed to manufacture a car. Land is also a limited resource in urban areas; for instance, in Berlin, according to 2013 statistics, 28 km^2 is devoted to parking lots. If just 2% of this space were converted into bicycle parking, more than 300,000 bicycles could be accommodated.

Reducing Traffic Congestion

Overcrowded cities have become the new norm, and the continuous growth of online commerce will not be sustainable without significant changes. Urbanization is accelerating, cities are congested, and logistical processes are increasingly difficult to maintain. As a result, the European economy loses approximately 1% of GDP annually due to traffic congestion. While low-emission or restricted traffic zones are becoming more common (dozens of European cities have banned motorized vehicles from city centers), online commerce continues to grow by 10% each year.

Cargo bicycles provide an effective solution for this type of urban freight transport to its destination (the so-called “last mile”). These bicycles can address ecological, logistical, and traffic challenges faced by many European cities. At the same time, they enable a new perspective on mobility, transportation, and citizens’ quality of life.

Increasing Family Mobility

The easiest, smartest, and most enjoyable family vehicle one can imagine. Car owners face increasing taxes, fines for harmful emissions, and traffic restrictions. Cargo bicycles offer a safer and more practical means of transportation for families and children. Children can be safely and conveniently transported to school without competing with streams of cars on the road, thereby reducing risks. With the capacity to carry up to four children simultaneously—occupying four times less space than a car—cargo bicycles are extremely useful and efficient. They require only a fraction of the parking space needed for a car, making them a more affordable and safer alternative.

Safer Streets

Cargo bicycles can reduce the number of cars on the streets, thereby preserving and improving lives. As observed across Europe, traffic-related fatalities decrease when there are more bicycles on the roads. It is therefore no coincidence that the Netherlands, a country with the highest number of cyclists, also has the lowest rate of cyclist fatalities due to collisions (1.1 deaths per 100 million kilometers cycled). A recent study conducted by the Barcelona Institute for Global Health predicts that improving cycling infrastructure could prevent up to 10,000 premature deaths in European cities. If streets are redesigned so that a

quarter of citizens use bicycle lanes, traffic accidents would decrease, along with the harmful effects of pollution and sedentary lifestyles.

Intermodality

With the possibility of transferring from a bicycle to a train, your journey with a cargo bicycle truly knows no bounds. Cyclists using cargo bicycles can often take advantage of the connectivity between bike lanes and rail networks. Cities across Europe facilitate intermodality by providing secure parking for cargo bicycles in close proximity to transport hubs, such as train stations. Malmö, Maastricht, Cambridge, and Utrecht are among the cities that have established cargo bicycle parking facilities at railway stations. The intermodality of cargo bicycles—the ability to use them on streets, bike lanes, and easily transfer to train stations—makes them more practical and faster than cars.

Savings

A profitable and cost-effective means of transport for delivering business shipments. Cargo bicycles are an economical alternative to a conventional vehicle fleet. They cost only a fraction of what a new car would, require almost no fuel, and have low insurance, maintenance, and repair expenses, allowing companies to achieve significant savings in fleet management. Additional advantages include reduced parking space requirements, fewer employee absences, and less time spent navigating congested streets and traffic jams.

For example, a butcher in Greenwich was able to complete 95% of deliveries under 5 km using a cargo bicycle, saving £830 annually on fuel alone. Most of the vehicle's weight is attributed to the bicycle itself, with only a small portion representing the cargo. In this sense, cargo bicycles are highly efficient, offering 4 to 6 times greater useful load capacity per kilogram compared to a van.

Logistical Efficiency

For logistics companies whose vehicles must operate efficiently and arrive on time, cargo bicycles offer the best solution for the increasing challenge of last-mile delivery. According to Cyclelogistics, all types of freight transport—whether a grocery bag or a refrigerator—could be carried out by bicycle, provided the distance is 7 km or less and the cargo weight does not exceed 200 kg per cubic meter. Cargo bicycles could potentially replace half of urban logistics deliveries and a quarter of commercial deliveries in European cities.

In central London, last-mile logistics is characterized by short distances in vehicles that spend more time parked than in motion. Cargo bicycles can maneuver through traffic, pedestrian, and cycling zones, allowing deliveries to be completed faster than motor vehicles, even though motor vehicles can achieve higher speeds.

More Affordable Infrastructure

Promoting cargo bicycles and bicycle lanes is one of the best investments in urban infrastructure. Cities can strengthen their budgets by supporting cargo bicycles and investing in cycling infrastructure. Continuous development of cycling infrastructure yields a higher return and a better cost-benefit ratio than large road or public transport projects, while costing only a fraction of their price. Investments in London's cycling network have produced a 4:1 return, while in Helsinki the return is even double, amounting to €8 for every euro spent. As car travel becomes increasingly expensive and cycling increasingly affordable, cities can take the lead in finding sustainable solutions through investment in

cycling.



Figure 2. DHL Delivery Cargo Bicycle

Recommendations for authorities at all levels in the sarajevo canton for the implementation of electric bicycles for goods delivery

Policies, strategies, and plans should also take bicycle deliveries into account

The concept of bicycle logistics should be incorporated into strategic documents such as Sustainable Urban Mobility Plans (SUMP), Sustainable Urban Logistics Plans (SULP), spatial plans, and strategies, as part of a broader goal to promote the transition to sustainable transport. Traffic studies and simulations should also consider the potential for bicycle logistics development.

Cycling infrastructure, such as bike lanes and bicycle parking, should be expanded and improved.

New and enhanced infrastructure enables faster and safer movement for cyclists, thereby supporting more efficient bicycle deliveries. At the same time, it facilitates the transition from cars to bicycles for other travel needs, not just deliveries.

Local authorities should ensure the procurement of e-bikes and implement bicycle delivery services

Local administrations can serve as examples for local businesses and neighboring institutions by introducing e-bikes into their own fleets and/or by contracting operators that use e-bikes for goods delivery and service provision.

Speed limits of up to 30 km/h in urban areas should be implemented to maximize safety for cyclists

A 30 km/h limit offers wide-ranging benefits in terms of safety, supporting the shift to sustainable urban mobility, and even improving public health through the promotion of active travel. It also prioritizes bicycle-based deliveries.

Pilot programs for business activities using bicycles should be supported through fiscal and financial incentives

National fiscal policies, investment programs, and financial incentive schemes should consider the benefits achieved through the transition to sustainable freight and passenger transport. Bicycle deliveries provide significant value.

Public awareness and promotion are necessary to highlight the advantages of e-bikes

Campaigns and events should inform citizens to ensure public support and emphasize the various benefits of transitioning to bicycle-based deliveries.

The establishment of urban logistics centers should be supported

Bicycle delivery systems for the "last mile" are most effective when parcel handovers from long-distance freight systems, such as road trucks and rail, can occur near city centers. Cities may provide unused buildings for distribution centers, either free of charge or at a preferential rate, to encourage businesses to replace part of their fleet with e-bikes.

Regulatory measures should be implemented to foster the transition to sustainable transport

Proven measures include tolls and congestion charges, low-emission zones, parking restrictions, delivery time limitations, and traffic-free zones, either fully or partially.

Laws should be enforced

Preventing conventional motor vehicle drivers from creating hazards and obstacles for other road users, and sanctioning violations, is beneficial for all forms of sustainable transport.

Modeling Cargo Bicycles for Implementation in the City of Sarajevo

As a first step in establishing a delivery service company, it is necessary to identify potential users of the service. For the company to have a successful start, it is important to identify customers who require this type of service and whose goods can be easily transported using electric bicycles. The following are examples of potential service users and the types of goods transported for them:

- Pharmacies – delivery of medicines to the elderly and infirm
- Florists – flowers and bouquets are ideal for delivery via electric bicycles, though special frames are needed to keep the goods upright during transit;
- Service companies – computer equipment, household appliances, etc.
- Newspaper and magazine publishers – daily and monthly publication deliveries, offering subscription-based delivery services to stay ahead in the market.
- Businesses with multiple locations – larger private or public companies often operate from several locations within the city. Bicycle delivery services can ensure timely and rapid supply of goods and shipments to each location;
- Copy centers – numerous in larger cities, these businesses can improve service by offering deliveries to customers; electric bicycles are the most efficient solution for fast and effective delivery;
- Food delivery chains – delivery of food to end customers, requiring safe and timely delivery to preserve food quality.

The development of urban consolidation and distribution centers can be a key factor in implementing "last-mile" bicycle delivery systems. Such centers, located near city centers, allow temporary storage of goods for urban delivery. City authorities may provide unused

spaces for distribution centers, either free of charge or at a reduced rental fee, to encourage delivery companies to replace part of their fleet with e-bikes. This arrangement can also help revitalize unused or abandoned areas of the city.

The existing Nextbike network could serve as a starting point for installing infrastructure for electric bicycles intended for goods delivery. Experience gained from bike reservation, rental, and usage can provide a useful foundation for further development. Nextbike has been operating in the Sarajevo Canton for four years. Registration can be completed via the mobile app, website, terminal, or in person at Nextbike partner locations. Applicants must be at least 18 years old. Based on the information provided, the service provider decides whether to accept the business relationship.

As part of the application process, the provider may use the WorldPay service to check the applicant's creditworthiness. Upon registration, the applicant receives a PIN for accessing the mobile app or website, and for rentals and returns at terminals.

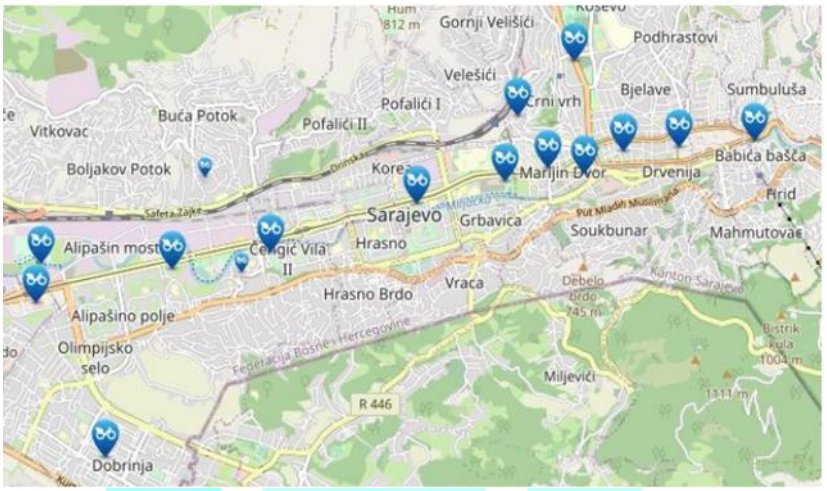


Figure 3. Nextbike System Locations in the Sarajevo Canton

Deliveries via electric bicycles would be made to the entrance of the residential building at the specified address. For larger shipments, delivery would extend only to the first physical barrier that prevents vehicle access. In apartment buildings, the courier is not required to carry goods to the customer's floor, only to the building entrance. Delivery would be carried out by transportation companies providing courier services.

The delivery service would typically deliver within 24 hours from collection at the warehouse. In exceptional cases (traffic difficulties, weather conditions, high shipment volume, etc.), delivery may take longer. Products will be packaged to prevent damage during regular handling in transport.

Customers are required to check for any visible damage upon receipt and immediately report it to the delivery worker, or refuse shipment with visible external damage. Customers must sign a delivery note, which serves as confirmation of receipt by the delivery service.

CONCLUSION

Based on the analysis, it can be concluded that cargo bicycles offer numerous advantages compared to conventional motor vehicles. They not only reduce harmful emissions and contribute to environmental preservation but also provide an economical solution due to

significantly lower maintenance, fuel, and insurance costs. They occupy less space, helping to relieve urban streets and reduce traffic congestion. Socially, cargo bicycles contribute to a safer and healthier lifestyle by increasing the number of cyclists, reducing accident risks, and promoting active living.

The Sarajevo Canton, like many other European cities, faces challenges related to dense traffic and poor air quality. Therefore, the introduction of electric cargo bicycles could be a strategic step toward sustainable urban mobility. To achieve this, authorities must provide a legal and infrastructural framework, support pilot programs, and encourage businesses to adopt this mode of transport. This would create conditions for developing intermodal delivery systems, reducing CO_2 emissions, and improving citizens' quality of life.

Ultimately, cargo bicycles are not only a technical solution for transport but also a symbol of broader societal change toward sustainability. Their use integrates ecology, economy, and social responsibility into a unified whole. If Sarajevo seizes this opportunity and invests in cycling infrastructure and the promotion of cargo bicycles, it can become a model city building its future on sustainable, healthy, and economical foundations..

REFERENCES

[1] Kiba-Janiak Maja, 2015, Key success factors for city logistics from the perspective of variousgroups of stakeholders (9. Međunarodna konferencija o gradskoj logistici)

[2] Krekešić Igor, 2016, Organizacija distribucije paketnih pošiljaka u urbanim područjima - DIPLOMSKI RAD, Fakultet prometnih znanosti, ZagrebPriručnik iz prostornog planiranja, Projekat upravne odgovornosti Tadić Snežana, 2014, Modeliranje performansi integrisanih city logističkih sistema - DOKTORSKA DISERTACIJA, Saobraćajni fakultet, Beograd

[3] Taniguchi, E., Thompson, R.G., Yamada T., 2001, Recent advances in modelling city logistics, International Conference on City logistics, Okinawa, Japan

[4] http://sumpnetwork.eu/fileadmin/user upload/downloads/innovation briefs/PROSPERITY Inno vation Brief City logistics solutions HR.pdf (Pristup: 10.09.2020)

http://sumpnetwork.eu/fileadmin/user upload/downloads/innovation briefs/PROSPERITY Inno vation Brief Citv logistics solutions HR.pdf (Pristup: 12.09.2020)

Prometna šola Maribor, Srednja prometna šola

Preradovičeva ulica 33

2000 Maribor

Izidor Mandl, univ. dipl. inž. prom.

TRAJNOSTNA MOBILNOST NA PROMETNI ŠOLI MARIBOR

Povzetek:

Prometna šola Maribor s svojo strateško lego in infrastrukturo spodbuja trajnostno mobilnost med dijaki in zaposlenimi.

Prednosti šole so:

bližina železniške postaje, ki omogoča enostaven dostop do javnega prevoza; dve glavni liniji mestnega potniškega prometa, ki potekata neposredno mimo šole, kar dodatno prispeva k učinkoviti mobilnosti dijakov; šola spodbuja souporabo vozil (car sharing) kot trajnostno obliko mobilnosti; na voljo je polnilna postaja za električna vozila, kar spodbuja uporabo okolju prijaznejših prevoznih sredstev; za kolesarje je na voljo pokrita kolesarnica ter sistem izposoje koles, ki omogoča trajnostno alternativo motoriziranemu prevozu. S to celovito infrastrukturo Prometna šola Maribor aktivno prispeva k zmanjšanju emisij in spodbuja trajnostne oblike mobilnosti. Hkrati (p)ostaja pomembno večmodalno vozlišče.

Ključne besede: Trajnostna mobilnost, javni prevoz, souporaba vozil, električna vozila, kolesarjenje, večmodalno vozlišče.

Abstract:

Prometna šola Maribor (Traffic school Maribor), with its strategic location and infrastructure, promotes sustainable mobility among students and staff. Its advantages include proximity to the railway station, two main city bus lines passing directly by the school, car sharing initiatives, a charging station for electric vehicles, and a covered bicycle storage area with a bike rental system. Through this comprehensive infrastructure, the school reduces emissions, encourages sustainable forms of mobility, and remains an important multimodal hub.

Keywords: Sustainable mobility, public transport, car sharing, electric vehicles, cycling, multimodal hub.

1. Uvod

Trajnostna mobilnost predstavlja eno ključnih usmeritev sodobne prometne politike, ki se odziva na okoljske izzive, prostorsko omejenost urbanih središč ter potrebo po učinkovitem in dostopnem prevozu za vse prebivalce. V izobraževalnem okolju ima ta koncept še poseben pomen, saj oblikuje potovalne navade mladih in vpliva na njihovo dolgoročno vedenje kot uporabnikov prometnega sistema.

Prometna šola Maribor, Srednja prometna šola (*v nadaljevanju Prometna šola Maribor*) kot izobraževalna ustanova s poudarkom na prometu in logistiki nosi posebno odgovornost pri spodbujanju trajnostnih oblik mobilnosti. S svojo strateško lego, sodobno infrastrukturo in aktivnim pristopom k ozaveščanju dijakov ter zaposlenih, šola ne le izobražuje o trajnostnem prometu, temveč ga tudi dejansko udejanja v svojem vsakdanjem delovanju.

Prispevek obravnava konkretne ukrepe, prostorske danosti in tehnične rešitve, ki omogočajo trajnostno mobilnost na Prometni šoli Maribor. Poleg tega osvetljuje širši vpliv teh ukrepov na okolje, vedenje dijakov ter vlogo šole kot večmodalnega (tudi v izobraževalnem smislu) vozlišča v lokalnem prometnem sistemu.

2. Zgodovina Prometne šole Maribor

Začetki prometnega izobraževanja v Mariboru segajo v leto 1958, ko je bila ustanovljena Železniška prometna šola Zemun – Oddelek ljubljanske direkcije s sedežem v Mariboru (železniška postaja Maribor.



Slika 20: Zgradba železniškega dijaškega doma iz leta 1958 (Kopitarjeva ulica 2, Maribor)

Vir:https://prometna.net/srednja-sola/wp-content/uploads/sites/3/2018/01/Prometni_informator_jan_2018_web.pdf (22. 6. 2025)

Leta 1961 je nastala Železniška prometna šola Maribor, 1967 pa Železniško prometno-transportna šola Maribor. Leta 1974 je bila vključena v ŽG – Železniški šolski center Ljubljana.



Slika 21:Stari zgradbi iz leta 1966 (Preradovičeva ulica 33, Maribor)

Vir: https://prometna.net/srednja-sola/wp-content/uploads/sites/3/2018/01/Prometni_informator_jan_2018_web.pdf (22. 6. 2025)

Z reorganizacijo 1988 je postala Železniška srednja šola Maribor, leta 1992 SŽ – Železniška srednja šola Maribor, 1995 Srednja prometna šola Maribor, 1999 javni zavod Srednja prometna šola Maribor. Leta 2001 je spremenila naziv v Prometna šola Maribor z dvema organizacijskima enotama – Srednjo prometno šolo z dijaškim (študentskim) domom in Višjo prometno šolo (danes Višja prometna šola L.I.V.E.)



Slika 22: Prometna šola Maribor (2025)

Vir: Osebni arhiv – May Mahorič

3. Geografska lega in dostopnost

Prometna šola Maribor se nahaja na izjemno ugodni lokaciji z vidika dostopnosti in prometne povezanosti. Mimo šole vodi glavna (nedokončana) obvoznica iz smeri Koroška proti Ljubljani. V bližini potekata dve glavni liniji G3 in G4 s pripadajočimi postajališči v neposredni bližini šole, železniška proga s postajališčem Maribor (Sokolska).



Slika 23: Železniško in avtobusna postajališča

Vir: Lasten

Njena neposredna bližina železniške postaje Maribor (Sokolska) omogoča dijakom in zaposlenim enostaven dostop z vlakom, kar predstavlja eno najbolj trajnostnih oblik javnega prevoza. Redne železniške povezave z okoliškimi kraji omogočajo, da se dijaki iz širše regije lahko vsakodnevno vozijo v šolo brez uporabe osebnega avtomobila.



Slika 24: železniška postaja Maribor Sokolska

Vir: Osebni arhiv – Alex Ajdnik



Slika 25: železniška postaja Maribor Sokolska

Vir: Osebni arhiv – May Mahorič

Poleg železniške infrastrukture je šola umeščena ob dveh glavnih linijah mestnega potniškega prometa, ki potekata neposredno mimo šolskega kompleksa. To omogoča hitro in učinkovito povezavo z različnimi deli mesta, kar dodatno spodbuja uporabo javnega prevoza med dijaki in zaposlenimi.



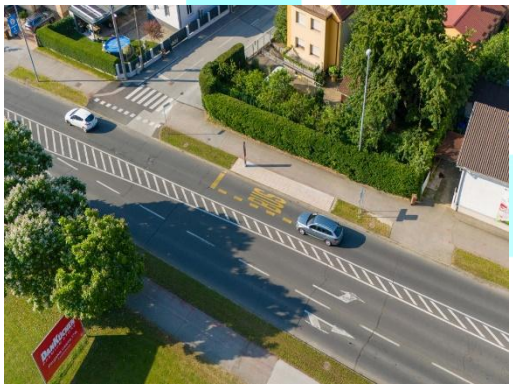
Slika 26: avtobusna postaja glavne linije G3 bližini šole



Slika 27: postajališče G3 v neposredni

Vir: Osebni arhiv – May Mahorič

Takšna večmodalna dostopnost predstavlja pomembno prednost, saj omogoča kombiniranje različnih oblik prevoza – vlak, avtobus, kolo – in s tem prispeva k zmanjšanju prometnih obremenitev ter emisij v urbanem okolju. Prometna šola Maribor tako že s svojo lokacijo aktivno podpira cilje trajnostne mobilnosti in predstavlja zgled dobre prostorske umestitve izobraževalne ustanove.



Slika 28: avtobusna postaja glavne linije G4



Slika 29: avtobusna postaja glavne linije G3

Vir: Osebni arhiv - May Mahorič

4. Infrastruktura za trajnostno mobilnost

Na Prometni šoli Maribor se zavedamo, da zgolj dobra prometna povezanost ni dovolj za uresničevanje ciljev trajnostne mobilnosti. Ključno je tudi zagotavljanje ustrezne infrastrukture, ki omogoča in spodbuja uporabo okolju prijaznejših oblik prevoza. V ta namen je šola v zadnjih letih razvila več ukrepov, ki dijakom in zaposlenim omogočajo prehod iz klasičnih, motoriziranih oblik prevoza na bolj trajnostne alternative.

4.1. Polnilna postaja za električna vozila

Na šolskem parkirišču je nameščena polnilna postaja za električna vozila, ki je dostopna tako zaposlenim kot obiskovalcem. S tem šola spodbuja prehod na električna vozila, ki predstavljajo pomemben korak k razogljičenju prometa. Polnilna postaja je del širše strategije šole, ki vključuje podporo zelenim tehnologijam in trajnostnim rešitvam v prometu.



Slika 30: Rezervirana parkirišča samo za električna vozila

Vir: Lasten

4.2. Souporaba električnih vozil (car sharing) – Avant2Go

Šola spodbuja uporabo električnih vozil med dijaki, študenti in zaposlenimi, zlasti tistimi, ki prihajajo iz bolj oddaljenih krajev, kjer javni prevoz ni optimalno razvit.



Slika 31: Tri (3) rezervirana parkirna mesta za souporabo vozil Avant2Go

Vir: Osebni arhiv – May Mahorič

S tem se zmanjšuje število »okolju manj prijaznih« vozil na cestah, kar prispeva k manjši prometni obremenitvi in nižjim emisijam. Souporaba vozil je organizirana s storitvijo Avant2Go[7]. To prakso šola aktivno podpira tako z ozaveščanjem in logistično podporo tj.

[7] https://avant2go.si/about

zagotavljanjem stalnih rezerviranih parkirnih prostorov na šolskem parkirišču.

5. Kolesarska infrastruktura

Za dijake in zaposlene, ki se v šolo vozijo s kolesom, je na voljo pokrita kolesarnica, ki zagotavlja varno in zaščiteno shranjevanje koles. Poleg tega šola sodeluje v lokalnem sistemu izposoje koles *mbajk*[8], kar omogoča dijakom, da se po mestu gibljejo hitro, učinkovito in okolju prijazno.

Kolesarska infrastruktura je dopolnjena z ustreznimi varnostnimi ukrepi, kot so nadzorni sistemi in osvetlitev, kar dodatno spodbuja uporabo koles kot vsakodnevnega prevoznega sredstva.



Slika 32: Postaja za izposojo koles mbajk



Slika 33: kolesa mbajk

Vir: Osebni arhiv – May Mahorič

Z omenjeno infrastrukturo Prometna šola Maribor ne le omogoča trajnostno mobilnost, temveč jo tudi aktivno spodbuja. S tem postavlja zgled drugim izobraževalnim ustanovam in dokazuje, da je mogoče trajnostne rešitve uspešno vključiti v vsakdanje delovanje šole.



Slika 34: pokrita kolesarnica s stojali ob šoli

Vir: Osebni arhiv - May Mahorič

6. Vpliv na okolje in vedenje dijakov

Uvajanje trajnostne mobilnosti na Prometni šoli Maribor ima neposreden in merljiv vpliv na okolje ter na potovalne navade dijakov. Z razpoložljivo infrastrukturo in dostopnostjo trajnostnih oblik prevoza se zmanjšuje potreba po uporabi osebnih avtomobilov, kar vodi v

[8]https://www.mbajk.si/sl/home

nižje emisije toplogrednih plinov in manjšo prometno obremenitev v okolici šole.

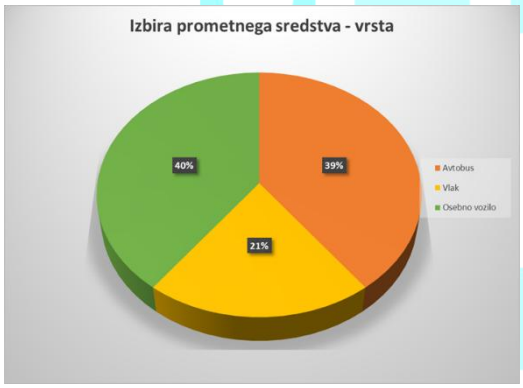
6.1. Okoljski učinki

Zmanjšanje emisij je eden najpomembnejših okoljskih učinkov, ki izhaja iz večje uporabe javnega prevoza, kolesarjenja in souporabe vozil. Dijaki, ki se v šolo vozijo z vlakom ali avtobusom, prispevajo k bistveno manjšemu ogljičnemu odtisu v primerjavi z individualnim motoriziranim prevozom. Poleg tega uporaba električnih vozil, ki jih omogoča šolska polnilna postaja, dodatno zmanjšuje lokalno onesnaženost zraka.

6.2. Spremembe v vedenju dijakov

Opazne so tudi spremembe v vedenjskih vzorcih dijakov. V zadnjih letih se povečuje delež dijakov, ki se v šolo vozijo z javnim prevozom ali kolesom. Šola aktivno spodbuja tovrstne oblike mobilnosti z izobraževalnimi vsebinami, projekti in kampanjami, ki poudarjajo prednosti trajnostnega prevoza.

Ena od takih je tudi Dan kolesarjenja. Gre za projektni teden, pri katerem na Dan kolesarjenja izvajamo anketo med dijaki prvih in drugih letnikov glede njihovega prihoda v šolo. Podatke analiziramo in objavimo na socialnih omrežjih. Vsebine in rezultate kasneje uporabimo tudi pri pouku v okviru projektnega tedna pri strokovnih in splošno-izobraževalnih predmetih.



Grafikon 1: Izbira prometnega sredstva



Grafikon 2: Št. uporabljenih prometnih sredstev

Vir: Lasten

Dijaki se tudi zaradi tega projektnega tedna odločajo za okolju prijaznejše oblike prevoza in razvijajo večjo okoljsko zavest, odgovornost in pomen trajnostne mobilnosti.

6.3. Vloga šole pri ozaveščanju

Prometna šola Maribor ne deluje zgolj kot ponudnik infrastrukture, temveč tudi kot izobraževalni in ozaveščevalni center. V okviru pouka, projektnih dni in sodelovanja z lokalnimi skupnostmi se dijakom predstavljajo koncepti trajnostne mobilnosti, energetske učinkovitosti in okoljske odgovornosti. S tem šola krepi kompetence dijakov na področju trajnostnega razvoja in jih pripravlja na vlogo aktivnih udeležencev v prometnem sistemu prihodnosti.

Z letošnjim letom se je v 3. letniku programa Logistični tehnik pričelo z izvajanjem pouka

pri predmetu Trajnostna mobilnost. Srednja prometna šola pa ne ostaja samo pri tem, da del svojega programa v sekundarnem izobraževanju »deli« med dijake.

V okviru *projekta Trajnostna mobilno* sodelujemo tudi na primarni ravni izobraževanja z OŠ Martin Konšak ter s prijateljsko šolo na sekundarni ravni, Srednjo šolo za gostinstvo in turizem Maribor. Na našo srečo je prehod v terciarno izobraževanju blizu, saj nas v isto stavbo z Višjo prometno šolo L.I.V.E. povezuje Dijaški dom. V prihodnje si prizadevamo, da bomo še poglobili sodelovanje tudi s Fakulteto za gradbeništvo, prometno inženirstvo in arhitekturo Maribor (FGPA, Univerza v Mariboru).

7. Prometna šola kot večmodalno vozlišče

Koncept večmodalnosti v prometu se nanaša na povezovanje različnih oblik prevoza v enoten, učinkovit in uporabniku prijazen sistem. Večmodalna vozlišča omogočajo preprosto prestopanje med različnimi prevoznimi sredstvi, kar povečuje fleksibilnost, zmanjšuje čas potovanja in spodbuja uporabo trajnostnih oblik mobilnosti.

Prometna šola Maribor s svojo prostorsko umestitvijo in prometno infrastrukturo izpolnjuje vse pogoje za delovanje kot lokalno večmodalno vozlišče. V neposredni bližini šole se nahajajo:

- železniška postaja z regionalnimi in medkrajevnimi povezavami,
- postajališča mestnega potniškega prometa,
- urejena kolesarska infrastruktura (storitev mbajk in pokrita kolesarnica),
- parkirišča s polnilno postajo za električna vozila.



Slika 35: Glavni prometnici ob šoli

Vir: Osebni arhiv - May Mahorič

Ta kombinacija omogoča dijakom, zaposlenim in obiskovalcem, da med različnimi oblikami prevoza prehajajo brez večjih časovnih ali logističnih ovir. Na primer, dijak lahko zjutraj prispe z vlakom, se do šole pripelje s kolesom iz sistema izposoje, in se popoldne vrne domov z avtobusom – vse to brez uporabe osebnega avtomobila.



Slika 36: Prometna šola Maribor

Vir: : Osebni arhiv - May Mahorič

Poleg fizične infrastrukture šola spodbuja večmodalnost tudi z izobraževalnimi vsebinami, ki dijake seznanjajo z načrtovanjem poti, uporabo digitalnih orodij za usklajevanje prevozov ter z razumevanjem širšega pomena trajnostne mobilnosti. S tem Prometna šola Maribor ne le omogoča večmodalno trajnostno mobilnost, temveč jo tudi aktivno vključuje v izobraževalni proces.

Letos smo v okviru prenovljenega programa logistični tehnik v 3. letniku začeli z izvajanjem predmeta Trajnostna mobilnost.

Večmodalnost izobraževanja se kaže tudi v sodelovanju šole v projektu *Trajnostna mobilnost*. Naša šola je vozlišče, ki povezuje tako primarne vzgojno izobraževalne, kot sekundarne in terciarne izobraževalne zavode oz. institucije. V okviru nosilcev projekta tvorno sodelujemo z OŠ Martin Konšak in Srednjo šolo za gostinstvo in turizem Maribor.

V prihodnosti se načrtuje še večja integracija šole v lokalni prometni sistem, vključno s popularizacijo uporabe digitalnih rešitev za usklajevanje prevozov, sodelovanjem z mestnimi oblastmi in vključevanjem v evropske projekte, ki podpirajo razvoj pametnih in trajnostnih prometnih vozlišč.

8. Izzivi in prihodnje usmeritve

Kljub številnim pozitivnim premikom na področju trajnostne mobilnosti se Prometna šola Maribor sooča z različnimi izzivi, ki vplivajo na hitrost in obseg uvajanja trajnostnih rešitev.

Ti izzivi so tako tehnične kot organizacijske narave, vključujejo pa tudi vedenjske vzorce uporabnikov, ki se spreminjajo postopoma.

8.1. Tehnični in prostorski izzivi

Eden izmed ključnih izzivov je prostorska omejenost, ki vpliva na možnosti širitve obstoječe infrastrukture. Parkirne površine, kolesarnice in polnilne postaje zahtevajo ustrezno načrtovanje in usklajevanje z lokalnimi prostorskimi akti. Poleg tega je vzdrževanje teh sistemov – zlasti električnih polnilnic in kolesarskih postaj – povezano z dodatnimi stroški in potrebo po tehnični podpori.

8.2. Organizacijski izzivi

Uvajanje trajnostne mobilnosti zahteva usklajeno delovanje različnih deležnikov – šole, lokalne skupnosti, javnih prevoznikov in dijakov. Včasih prihaja do neusklajenosti urnikov javnega prevoza z začetkom pouka, kar zmanjšuje uporabnost teh storitev. Poleg tega je za uspešno izvajanje potrebna stalna komunikacija in promocija, kar zahteva dodatne kadrovske vire.

8.3. Vedenjski izzivi

Sprememba potovalnih navad je dolgotrajen proces. Nekateri dijaki in zaposleni še vedno dajejo prednost uporabi osebnega avtomobila zaradi udobja, navade ali pomanjkanja informacij o alternativah. Zato je ključno, da šola nadaljuje z ozaveščanjem, izobraževanjem in vključevanjem dijakov v projekte, ki poudarjajo prednosti trajnostne mobilnosti.

8.4. Prihodnje usmeritve

Prometna šola Maribor načrtuje več ukrepov za nadgradnjo obstoječega sistema:

- **Digitalizacija mobilnosti:** uvedba oz. promocija obstoječih aplikacij za usklajevanje prevozov, obveščanje o voznih redih in spodbujanje souporabe vozil.
- **Sodelovanje z lokalno skupnostjo:** skupni projekti z mestno občino Maribor za izboljšanje prometne dostopnosti in varnosti.
- **Vključevanje v evropske projekte:** prijava na razpise EU za financiranje trajnostne mobilnosti v izobraževalnih ustanovah.
- **Razširitev izobraževalnih vsebin:** vključitev trajnostne mobilnosti v učne načrte in projektno delo dijakov.

S temi usmeritvami želi šola utrditi svojo vlogo kot vodilna izobraževalna ustanova na področju trajnostne mobilnosti ter prispevati k širšemu prehodu v okolju prijaznejši prometni sistem.

9. Zaključek

Prometna šola Maribor s svojo strateško lego, premišljeno infrastrukturo in aktivnim pristopom k ozaveščanju predstavlja zgleden primer izobraževalne ustanove, ki uspešno uresničuje načela trajnostne mobilnosti. S povezovanjem različnih oblik prevoza, spodbujanjem souporabe vozil, uporabo električnih vozil ter razvojem kolesarske infrastrukture šola ne le zmanjšuje svoj okoljski odtis, temveč tudi oblikuje potovalne navade prihodnjih generacij.

Večmodalna dostopnost in vključevanje trajnostne mobilnosti v izobraževalni proces prispevata k širšemu razumevanju prometnih izzivov in rešitev, ki so usmerjene v prihodnost. Kljub obstoječim izzivom šola ostaja zavezana nadaljnjemu razvoju, sodelovanju z lokalno skupnostjo in vključevanju v širše projekte, ki podpirajo trajnostni promet.

Prispevek potrjuje, da je mogoče s premišljenimi ukrepi in sodelovanjem vseh deležnikov doseči pomembne premike v smeri okolju prijaznejšega, učinkovitejšega in bolj dostopnega prometnega sistema. Prometna šola Maribor tako ne le izobražuje o mobilnosti, temveč jo tudi aktivno soustvarja.

10. Reference

[1] *Strategija razvoja prometa v Republiki Sloveniji do leta 2030*. Ministrstvo za infrastrukturo, Vlada Republike Slovenije, 2020. https://www.gov.si/assets/ministrstva/MzI/Dokumenti/Strategija-razvoja-prometa-v-Republiki-Sloveniji-do-leta-2030.pdf

[2] Strategija za trajnostno mobilnost in izobraževanje za trajnostni razvoj otrok in mladostnikov v vzgoji in izobraževanju do leta 2027. Zavod RŠ za šolstvo, 2023.

Strategija-za-trajnostno-mobilnost-in-izobrazevanje-za-trajnostni-razvoj-otrok-in-mladostnikov-v-vzgoji-in-izobrazevanju-do-leta-2027.pdf

[3] *Lokalni energetsko podnebni koncept Mestne občine Maribor*. Mestna občina Maribor, 2022. https://maribor.si/mestna-obcina/strateski-dokumenti/lokalni-energetsko-podnebni-koncept-mestne-obcine-maribor/

[4] *Skupna prometna politika EU – pregled*. Evropski parlament, 2023. https://www.europarl.europa.eu/factsheets/sl/sheet/123/skupna-prometna-politika-pregled

[5] *Cilji trajnostnega razvoja*. Uradni list Republike Slovenije, 2021. https://www.uradni-list.si/e-bilten/novica/cilji-trajnostnega-razvoja/cilji-trajnostnega-razvoja/cilji-trajnostnega-razvoja/cilji-trajnostnega-razvoja

[6] *Smernice za integracijo prometnega in prostorskega načrtovanja*. Ministrstvo za naravne vire in prostor, Vlada Republike Slovenije, 2022. https://www.gov.si/assets/ministrstva/MNVP/Dokumenti/urejanje_prostora/Smernice_za_integracijo_prometnega_in_prostorskega_nacrtovanja.pdf

[7] Spletna stran Višje šole L.I.V.E.: https://prometna.net/visja-sola/

[8] Spletna stran storitve Avant2Go: https://avant2go.si/about

[9] *Spletna stran storitve mbajk:* https://www.mbajk.si/sl/home

[10] Spletna stran šole – Projekt trajnostna mobilnost: https://prometna.net/srednja-sola/wp-content/uploads/sites/3/2025/05/Akcijski_nacrt_dela_za_2024_25.pdf

Prometna šola Maribor, Srednja prometna šola

Preradovičeva ulica 33

2000 Maribor

Izidor Mandl, univ. dipl. inž. prom.

SUSTAINABLE MOBILITY AT THE MARIBOR SCHOOL OF TRANSPORT AND TRAFFIC

Abstract:

Prometna šola Maribor (Traffic school Maribor), with its strategic location and infrastructure, promotes sustainable mobility among students and staff. Its advantages include proximity to the railway station, two main city bus lines passing directly by the school, car sharing initiatives, a charging station for electric vehicles, and a covered bicycle storage area with a bike rental system. Through this comprehensive infrastructure, the school reduces emissions, encourages sustainable forms of mobility, and remains an important multimodal hub.

Keywords: *Sustainable mobility, public transport, car sharing, electric vehicles, cycling, multimodal hub.*

1. INTRODUCTION

Sustainable mobility is one of the key directions of modern transport policy, which responds to environmental challenges, the spatial limitations of urban centres and the need for efficient and accessible transport for all residents. In the educational environment, this concept is of particular importance, as it shapes the travel habits of young people and influences their long-term behaviour as users of the transport system.

As an educational institution with an emphasis on transport and logistics, the Maribor Secondary School of Transport *and Transport (hereinafter referred to as the Maribor* School of Transport) has a special responsibility in promoting sustainable forms of mobility. With its strategic location, modern infrastructure and active approach to raising awareness among students and employees, the school not only educates about sustainable transport, but also actually implements it in its daily operations.

The paper discusses concrete measures, spatial conditions and technical solutions that enable sustainable mobility at the Maribor School of Transportation. It also highlights the wider impact of these measures on the environment, pupils' behavior and the role of the school as a multimodal (also in educational terms) hub in the local transport system.

2. HISTORY OF THE PROMETNA ŠOLA MARIBOR

The beginnings of transport education in Maribor date back to 1958, when the Railway Transport School Zemun – Department of the Ljubljana Directorate was established with its headquarters in Maribor (Maribor Railway Station).



Figure 37: Building of the railway student dormitory from 1958 (Kopitarjeva ulica 2, Maribor)

In 1961, the Maribor Railway Transport School was established, and in 1967 the Maribor Railway Transport and Transport School. In 1974 it was included in the ŽG – Railway School Centre Ljubljana.



Figure 38: Old buildings from 1966 (Preradovičeva ulica 33, Maribor)

With the reorganization in 1988 it became the Railway Secondary School Maribor, in 1992 SŽ – Railway Secondary School Maribor, in 1995 the Secondary Transport School Maribor, in 1999 the Public Institute Secondary Transport School Maribor. In 2001, it changed its name to the Traffic School Maribor with two organizational units – the Secondary School of Traffic Engineering with a student dormitory and the Higher School of Traffic Engineering (today the Higher School of Traffic Engineering L.I.V.E.)



Figure 39: Traffic School Maribor (2025)

Source: Personal archive – May Mahorič

3. GEOGRAPHICAL LOCATION AND ACCESSIBILITY

Prometna šola Maribor is in an extremely favorable location in terms of accessibility and traffic connections. The main (unfinished) bypass from the direction of Carinthia towards Ljubljana leads past the school. Nearby there are two main lines G3 and G4 with associated stops in the immediate vicinity of the school, the railway line with the Maribor (Sokolska).



Figure 40: Train and bus stops

Source: Own

Its immediate vicinity of the Maribor (Sokolska) railway station provides students and staff with easy access by train, which is one of the most sustainable forms of public transport. Regular rail connections with the surrounding towns allow students from the wider region to commute to school every day without using a private car.



Figure 41: Maribor Sokolska Railway Station

Source: Personal archive – Alex Ajdnik



Figure 42: Maribor Sokolska Railway Station

Source: Personal archive – May Mahorič

In addition to the railway infrastructure, the school is located along two main lines of urban passenger transport, which run directly past the school complex. This allows for a quick and efficient connection to different parts of the city, which further encourages the use of public transport between students and staff.



Figure 43: Bus stop of the main line G3



Figure 44: Bus stop G3 in the immediate vicinity of the school

Source: Personal archive – May Mahorič

Such multimodal accessibility is an important advantage, as it allows different modes of transport to be combined – train, bus, bicycle – and thus contributes to the reduction of traffic congestion and emissions in the urban environment. With its location, the Maribor School of Transport and Traffic actively supports the goals of sustainable mobility and is an example of a good spatial location of an educational institution.





Figure 45: Bus station of the main line G4 Figure 46: Bus station of the main line G3

Source: Personal archive - May Mahorič

4. INFRASTRUCTURE FOR SUSTAINABLE MOBILITY

At the Maribor School of Transport and Traffic Engineering, we are aware that good transport connections alone are not enough to achieve sustainable mobility goals. It is also crucial to provide adequate infrastructure that enables and encourages the use of more environmentally friendly forms of transport. To this end, the school has developed several measures in recent years that enable students and staff to switch from classic, motorized forms of transport to more sustainable alternatives.

4.1. Electric Vehicle Charging Station

An electric vehicle charging station is installed in the school parking lot, which is accessible to both employees and visitors. By doing so, the school promotes the transition to electric vehicles, which represent an important step towards decarbonizing transport. The charging station is part of the school's wider strategy, which includes support for green technologies and sustainable transport solutions.



Figure 47: Reserved parking lots for electric vehicles only

Source: Own

4.2. Electric vehicle sharing (car sharing) – Avant2Go

The school encourages the use of electric vehicles among pupils, students and staff, especially those coming from more remote places where public transport is not optimally developed.



Figure 48: Three (3) reserved parking spaces for Avant2Go car sharing

Source: Personal archive – May Mahorič

This reduces the number of "less environmentally friendly" vehicles on the roads, contributing to lower traffic congestion and emissions. Car sharing is organized with the Avant2Go service. The school actively supports this practice through awareness raising and logistical support, i.e. providing permanent reserved parking spaces in the school parking lot.

5. CYCLING INFRASTRUCTURE

For students and staff who cycle to school, there is a covered bike storage area to ensure safe and secure bicycle storage. In addition, the school participates in the local *mbajk bicycle rental system*, which allows students to move around the city quickly, efficiently and environmentally friendly.

The cycling infrastructure is complemented by appropriate safety measures, such as control systems and lighting, which further encourages the use of bicycles as a daily means of transport.



Figure 49: mbajk bicycle rental station



Figure 50: mbajk bikes

Source: Personal archive – May Mahorič

With this infrastructure, the Maribor School of Transport not only enables sustainable mobility, but also actively promotes it. In doing so, it sets an example for other educational institutions and proves that sustainable solutions can be successfully integrated into the day-to-day operation of a school.



Figure 51: Covered bicycle room withstands next to the school

Source: Personal archive - May Mahorič

6. IMPACT ON THE ENVIRONMENT AND STUDENT BEHAVIOUR

The introduction of sustainable mobility at the Maribor School of Transport and Traffic has a direct and measurable impact on the environment and on the travel habits of students. With the available infrastructure and the availability of sustainable forms of transport, the need to use private cars is reduced, leading to lower greenhouse gas emissions and less traffic in the vicinity of the school.

6.1. Environmental effects

Emission reductions are one of the most important environmental impacts resulting from increased use of public transport, cycling and car-sharing. Students who travel to school by train or bus contribute to a significantly smaller carbon footprint compared to individual motorized transport. In addition, the use of electric vehicles enabled by the school's charging station further reduces local air pollution.

6.2. Changes in student behavior

Changes in the behavioral patterns of pupils are also noticeable. In recent years, the proportion of pupils who commute to school by public transport or bicycle has been increasing. The school actively promotes this type of mobility through educational content, projects and campaigns that highlight the benefits of sustainable transport.

One of these is Cycling Day. It is a project week, in which on Cycling Day we conduct a survey among first- and second-year students about their arrival at school. We analyze the data and publish it on social networks. The content and results are later used in classes within the project week in professional and general education subjects.

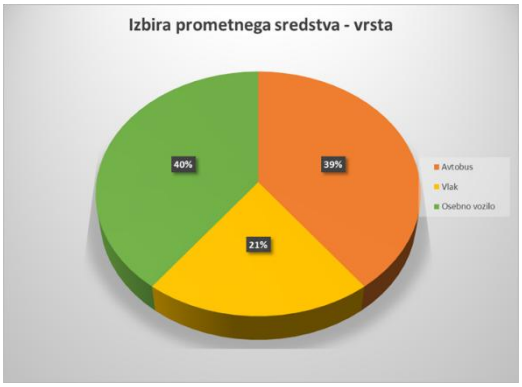




Chart 3: Choice of means of transport Chart 4: Number of means of transport used

Source: Own

Thanks to this project week, students also opt for more environmentally friendly forms of transport and develop greater environmental awareness, responsibility and the importance of sustainable mobility.

6.3. The role of schools in raising awareness

The Maribor School of Transport and Traffic operates not only as an infrastructure provider, but also as an educational and awareness-raising center. Within the framework of classes, project days and cooperation with local communities, students are introduced to the concepts of sustainable mobility, energy efficiency and environmental responsibility. In this way, the school strengthens students' competencies in the field of sustainable development and prepares them for the role of active participants in the transport system of the future.

This year, in the 3rd year of the Logistics Technician program, classes in the subject Sustainable Mobility began. And the high school doesn't just "share" part of its secondary education program among students. As part *of the Sustainable Mobile project*, we also cooperate at the primary level of education with the Martin Konšak Elementary School and with a friendly school at the secondary level, the Secondary School for Hospitality and Tourism Maribor. Fortunately for us, the transition to tertiary education is close, as the Student Dormitory connects us to the same building with the L.I.V.E. Higher School of Transportation. In the future, we are striving to further deepen our cooperation with the Faculty of Civil Engineering, Transport Engineering and Architecture Maribor.

7. PROMETNA ŠOLA MARIBOR AS A MULTIMODAL HUB

The concept of multimodality in transport refers to the integration of different modes of transport into a single, efficient and user-friendly system. Multimodal hubs make it easy to switch between different modes of transport, increasing flexibility, reducing travel time and promoting the use of sustainable forms of mobility.

With its spatial location and transport infrastructure, the Maribor School of Transport meets all the conditions for operating as a local multimodal hub. In the immediate vicinity of the

school there are:

- a railway station with regional and intercity connections,
- urban passenger transport stops,
- arranged cycling infrastructure (mbajk service and covered cycling area),
- car parks with charging stations for electric vehicles.



Figure 52: Main roads next to the school

Source: Personal archive - May Mahorič

This combination allows students, staff and visitors to switch between different modes of transport without major time or logistical barriers. For example, a student can arrive by train in the morning, ride a bicycle from the rental system to school, and return home by bus in the afternoon – all without using a private car.



Figure 537: Prometna šola Maribor

Source: Personal archive - May Mahorič

In addition to the physical infrastructure, the school also promotes multimodality through educational content that introduces students to route planning, the use of digital tools for transport coordination and the understanding of the wider meaning of sustainable mobility. In this way, the Maribor School of Transport not only enables multimodal sustainable mobility, but also actively includes it in the educational process.

This year, as part of the renewed Logistics Technician program in the 3rd year, we started implementing the subject Sustainable Mobility.

The multimodality of education is also reflected in the school's participation in the *Sustainable Mobility project*. Our school is a hub that connects both primary educational, secondary and tertiary educational institutions or institutions. Within the framework of the project holders, we are actively cooperating with the Martin Konšak Elementary School and the Secondary School for Hospitality and Tourism Maribor.

In the future, it is planned to integrate the school even more into the local transport system, including popularizing the use of digital solutions for transport coordination, cooperation with city authorities and involvement in European projects that support the development of smart and sustainable transport hubs.

8. CHALLENGES AND FUTURE DIRECTIONS

Despite numerous positive developments in the field of sustainable mobility, the Maribor School of Transport and Traffic is facing various challenges that affect the speed and scope of the introduction of sustainable solutions. These challenges are both technical and organizational in nature, and also involve user behavioral patterns that change gradually.

8.1. Technical and spatial challenges

One of the key challenges is spatial limitations, which affect the possibilities of expanding existing infrastructure. Parking areas, bicycle spaces and charging stations require appropriate planning and coordination with local spatial acts. In addition, the maintenance of these systems – in particular electric charging stations and cycle stations – is associated with additional costs and the need for technical support.

8.2. Organizational challenges

The introduction of sustainable mobility requires coordinated action by various stakeholders – schools, local communities, public transport operators and students. Sometimes there is a mismatch between public transport schedules and the start of classes, which reduces the usefulness of these services. In addition, for successful implementation, constant communication and promotion are required, which requires additional human resources.

8.3. Behavioral challenges

Changing your travel habits is a lengthy process. Some students and staff still prefer to use a private car because of convenience, habit, or lack of information about alternatives. Therefore, it is crucial that the school continues to raise awareness, educate and involve students in projects that highlight the benefits of sustainable mobility.

8.4. Future directions

The Maribor School of Transport and Traffic is planning several measures to upgrade the existing system:

- **Digitalization of mobility:** introduction or promotion of existing applications for transport coordination, timetable information and promotion of vehicle sharing.
- **Cooperation with the local community:** joint projects with the Municipality of Maribor to improve transport accessibility and safety.
- **Getting involved in European projects:** applying for EU calls for funding sustainable mobility in educational institutions.
- **Extension of educational content:** integration of sustainable mobility into curricula and project work of students.

With these guidelines, the school aims to consolidate its role as a leading educational institution in the field of sustainable mobility and contribute to a wider transition to a greener transport system.

9. CONCLUSION

With its strategic location, well-thought-out infrastructure and active approach to awareness-raising, the Maribor School of Transport and Traffic Sciences is an exemplary example of an educational institution that successfully implements the principles of sustainable mobility. By integrating different forms of transport, promoting car-sharing, the use of electric vehicles and developing cycling infrastructure, the school not only reduces its environmental footprint, but also shapes the travel habits of future generations.

Multimodal accessibility and the integration of sustainable mobility into the education process contribute to a broader understanding of transport challenges and future-oriented

solutions. Despite the challenges present, the school remains committed to further development, cooperation with the local community and involvement in wider projects that support sustainable transport.

The paper confirms that with deliberate action and the cooperation of all stakeholders, important moves can be achieved towards a greener, more efficient and more accessible transport system. The Maribor School of Transport and Traffic Sciences thus not only educates about mobility, but also actively co-creates it.

10. REFERENCE

[11] *Strategija razvoja prometa v Republiki Sloveniji do leta 2030*. Ministrstvo za infrastrukturo, Vlada Republike Slovenije, 2020. https://www.gov.si/assets/ministrstva/MzI/Dokumenti/Strategija-razvoja-prometa-v-Republiki-Sloveniji-do-leta-2030.pdf

[12] Strategija za trajnostno mobilnost in izobraževanje za trajnostni razvoj otrok in mladostnikov v vzgoji in izobraževanju do leta 2027. Zavod RŠ za šolstvo, 2023.

Strategija-za-trajnostno-mobilnost-in-izobrazevanje-za-trajnostni-razvoj-otrok-in-mladostnikov-v-vzgoji-in-izobrazevanju-do-leta-2027.pdf

[13] *Lokalni energetsko podnebni koncept Mestne občine Maribor*. Mestna občina Maribor, 2022. https://maribor.si/mestna-obcina/strateski-dokumenti/lokalni-energetsko-podnebni-koncept-mestne-obcine-maribor/

[14] *Skupna prometna politika EU – pregled*. Evropski parlament, 2023. https://www.europarl.europa.eu/factsheets/sl/sheet/123/skupna-prometna-politika-pregled

[15] *Cilji trajnostnega razvoja*. Uradni list Republike Slovenije, 2021. https://www.uradni-list.si/e-bilten/novica/cilji-trajnostnega-razvoja/cilji-trajnostnega-razvoja/cilji-trajnostnega-razvoja/cilji-trajnostnega-razvoja

[16] *Smernice za integracijo prometnega in prostorskega načrtovanja*. Ministrstvo za naravne vire in prostor, Vlada Republike Slovenije, 2022. https://www.gov.si/assets/ministrstva/MNVP/Dokumenti/urejanje_prostora/Smernice_za_integracijo_prometnega_in_prostorskega_nacrtovanja.pdf

[17] Spletna stran Višje šole L.I.V.E.: https://prometna.net/visja-sola/

[18] Spletna stran storitve Avant2Go: https://avant2go.si/about

[19] *Spletna stran storitve mbajk:* https://www.mbajk.si/sl/home

[20] Spletna stran šole – Projekt trajnostna mobilnost: https://prometna.net/srednja-sola/wp-content/uploads/sites/3/2025/05/Akcijski_nacrt_dela_za_2024_25.pdf

Mateja Mazgan Senegačnik, mag. varstvoslovja

VAROVANJE Z DRONI

Maribor, april 2025

Povzetek:

Droni so se v zelo kratkem času ekstremno hitro razširili med fizične in poslovne uporabnike. Postali so tako del zabave kot tudi poklica. Predvsem koristno so se izkazali na področju zasebnega varovanja. Z njimi se lahko varuje tako objekte, prireditve kot tudi ljudi. Gre za samostojni sistem varovanja kot tudi za pomoč varnostnemu osebju, kateremu skrajša redne linije obhodov, saj le to nadomesti z droni. Droni na področju varovanja tako lahko nadomestijo marsikaterega varnostnika. Ob tem se srečujemo tudi z nekaj izzivi, kjer največji problem predstavlja njihova uporaba v javnem prostoru.

Ključne besede: varovanje, droni, varnost

Abstract

Drones have rapidly expanded among both private and commercial users in a very short period of time. They have become part of entertainment as well as a professional tool. They have proven particularly useful in the field of private security, where they are employed to monitor facilities, events, and individuals. Drones can function as an independent security system or serve as support to security personnel by reducing the need for regular patrols. In some cases, they can even replace human security guards. However, their use also presents certain challenges, particularly regarding their operation in public spaces.

Keywords: security, drones, private security

1. UVOD

V zadnjih letih smo priča izjemnemu tehnološkemu razvoju, ki spreminja skoraj vse vidike našega vsakdanjega življenja. Ena izmed najbolj prepoznavnih in hkrati vsestransko uporabnih sodobnih tehnologij so brezpilotna letala, bolj znana kot droni. Ti letalniki, ki so bili sprva namenjeni predvsem vojaškim in raziskovalnim namenom, danes najdejo svoje mesto v različnih panogah – od filmske industrije in kmetijstva do dostave paketov ter, vse pogosteje, v varnostnem sektorju.

Uporaba dronov za namene varovanja je postala pomemben in učinkovit način nadzora nad ljudmi, objekti in dogodki. Zaradi svoje mobilnosti, dostopnosti in napredne tehnologije (na primer termalne kamere, GPS sledenje in zaznavanje gibanja) predstavljajo droni pomembno orodje pri zagotavljanju varnosti, bodisi kot pomoč varnostnim službam bodisi kot samostojni nadzorni sistemi. Z njihovo pomočjo lahko spremljamo večje površine, hitro zaznamo morebitne nevarnosti in ukrepamo brez neposrednega tveganja za človeka.

Toda kot pri vsaki tehnologiji tudi pri uporabi dronov za varnostne namene ne smemo zanemariti izzivov in nevarnosti. Eden ključnih pomislekov je vprašanje zasebnosti in varovanja osebnih podatkov, saj lahko droni snemajo in zbirajo podatke brez vedenja posameznika. Poleg tega se pojavljajo tudi etični in pravni izzivi, povezani z njihovo uporabo v javnem prostoru.

Cilj te naloge je predstaviti in analizirati, kako se droni uporabljajo na področju varovanja, kakšne prednosti in slabosti prinašajo ter kako je njihova uporaba urejena z zakonodajo v Sloveniji in drugod. S pomočjo primerov iz prakse bomo skušali odgovoriti na vprašanje, ali so droni res prihodnost varovanja ali zgolj modna muha sodobne tehnologije.

2 KAJ SO DRONI

Droni, uradno imenovani brezpilotna zračna plovila, so letalniki, ki za delovanje ne potrebujejo pilota na krovu. Upravljajo se lahko na daljavo s pomočjo daljinskih upravljalnikov ali pametnih naprav, ali pa delujejo povsem samostojno, na podlagi vnaprej določenih poti in programiranih algoritmov. Njihova uporaba je v zadnjih letih izjemno narasla in se razširila z vojaškega področja tudi na civilno, gospodarsko, znanstveno ter zasebno rabo.

Zaradi tehnične dovršenosti in vedno večje dostopnosti postajajo droni ključni pripomoček na številnih področjih – od snemanja in fotografiranja, nadzora prometa, kmetijstva, dostave paketov, pa vse do iskanja pogrešanih oseb in seveda varovanja. Njihova funkcionalnost je odvisna predvsem od opreme, ki jo nosijo – kot so visokoločljive kamere, toplotni senzorji, infrardeče kamere, GPS sprejemniki, komunikacijski moduli in celo umetna inteligenca, ki omogoča delno avtonomno odločanje.

2.1 Definicija in osnovne značilnosti

Droni so različno veliki in različno zmogljivi, njihova skupna lastnost pa je, da omogočajo vpogled iz zraka brez fizične prisotnosti človeka. Operaterji lahko preko posebnih aplikacij na tablicah ali telefonih v živo spremljajo, kaj vidi dronova kamera, in tako natančno nadzorujejo dogajanje na terenu. Poleg enostavnejših modelov za rekreativno uporabo obstajajo tudi zelo zmogljivi profesionalni droni, namenjeni kompleksnim nalogam, kjer je potrebna visoka natančnost in zanesljivost – na primer v primeru varovanja velikih območij ali dogodkov z množico ljudi.

2.2 Vrste dronov

Droni se razlikujejo po številnih kriterijih: velikosti, številu rotorjev, zmogljivosti baterije, vrsti uporabe in načinu letenja. Najpogostejša oblika drona je kvadrokopter, ki ima štiri rotorje in nudi visoko stabilnost pri letenju, zato je zelo razširjen med rekreativnimi in komercialnimi uporabniki. Za bolj zahtevne naloge se uporabljajo heksakopterji (šest rotorjev) ali oktrokopterji (osem rotorjev), ki zmorejo nositi večjo težo, kot so profesionalne kamere, dodatni senzorji ali druge naprave.

Posebno kategorijo predstavljajo profesionalni in vojaški droni, ki dosegajo večjo višino, letijo dalj časa ter imajo bolj napredne funkcije, kot so termalno slikanje, zaznavanje gibanja ali delovanje v nočnih razmerah. Takšni droni se pogosto uporabljajo za nadzor meja, varovanje kritične infrastrukture, policijsko spremljanje množičnih dogodkov ali celo za nadzor naravnih nesreč.

2.3 Sodobne funkcije

Sodobni droni vključujejo številne napredne tehnologije, ki povečujejo njihovo varnost, natančnost in uporabnost. Med pomembnejšimi funkcijami so:

- Sledenje objektom – dron lahko samodejno sledi določeni osebi ali vozilu brez potrebe po stalnem upravljanju.
- Avtomatsko izogibanje oviram – z uporabo senzorjev dron zazna ovire (drevesa, zgradbe) in se jim izogne, kar zmanjša tveganje za nesreče
- .Geofenciranje – omogoča omejitev območja letenja, kar preprečuje nenamerno vstopanje v prepovedane cone, kot so bližina letališč ali vojaških objektov.
- Funkcija "Return to Home" – v primeru izgube signala, prazne baterije ali izrednih razmer se dron samodejno vrne na začetno lokacijo.
- Prenos slike v živo – uporabniku omogoča, da v realnem času spremlja posnetke z drona, kar je ključno pri varovanju in nadzoru.

Ti elementi omogočajo, da droni učinkovito delujejo tudi v kompleksnih razmerah, kot so urbana okolja, naravne nesreče ali množični dogodki. Zaradi njihove fleksibilnosti in tehnične dovršenosti so postali nepogrešljiv del sodobnih varnostnih sistemov, kar bo podrobneje predstavljeno v naslednjem poglavju.



Slika 54: dron (Vir: https://www.merkur.si/televizorji-in-avdio/foto/droni/)

3. ZGODOVINA RAZVOJA DRONOV

3.1 VOJAŠKI ZAČETKI

Zamisel o brezpilotnem zračnem plovilu sega več kot stoletje nazaj. Prve zametke razvoja dronov najdemo že v času prve svetovne vojne, ko so inženirji v ZDA eksperimentirali z radijsko vodenimi letali, kot je bil npr. "Kettering Bug" – preprosta leteča bomba, ki je predstavljala predhodnika sodobnih UAV-jev. Čeprav projekt takrat ni dosegel večjega uspeha, je nakazal potencial brezpilotne tehnologije.

V drugi svetovni vojni je razvoj napredoval. Zavezniške in osi sile so uporabljale primitivne drone za izvidniške namene in testiranje zračnih napadov. Nemški projekt V-1, znan tudi kot “leteča bomba”, je bil eden prvih primerov uporabe brezpilotnega orožja v vojni. Vzporedno so Američani razvijali drone za urjenje protiletalske obrambe in za preizkušanje radarjev.

Največji preskok se je zgodil v obdobju hladne vojne, ko sta ZDA in Sovjetska zveza množično vlagali v razvoj brezpilotnih sistemov za obveščevalno in nadzorstveno dejavnost. ZDA so uporabljale UAV-je, kot je bil slavni Ryan Model 147, za zbiranje podatkov nad Kitajsko, Kubo in Severno Korejo. Ti droni so bili sprva enosmerni – po končanem poletu so se uničili ali izgubili – a so omogočili pridobivanje pomembnih taktičnih informacij brez ogrožanja človeških življenj.

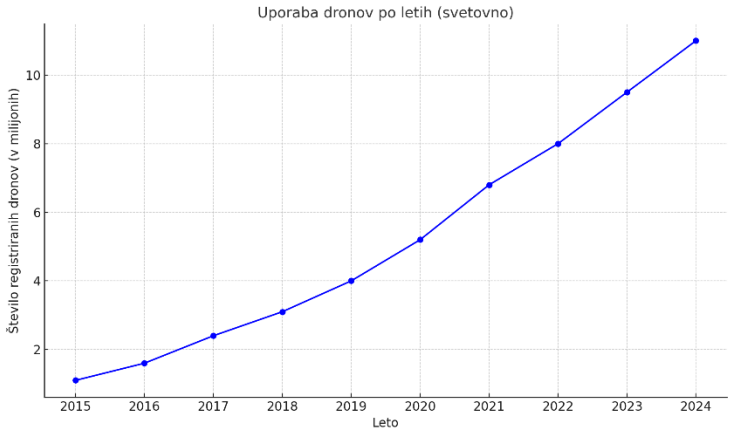
Vojaška uporaba je bila več desetletij glavno gonilo razvoja, saj so UAV-ji ponujali možnost izvajanja nevarnih nalog brez neposrednega tveganja za posadko.

3.2 Prehod v civilno rabo

Z razvojem mikroelektronike, kompaktnih kamer, satelitske navigacije (GPS) in lažjih baterij so se droni v drugi polovici 20. stoletja začeli seliti tudi iz vojaškega v civilni sektor. Pomemben mejnik je predstavljalo desetletje 1990-ih, ko so droni postali dostopnejši raziskovalcem, znanstvenikom in akademikom. Začeli so se uporabljati za kartiranje terena, geodetske meritve, opazovanje narave in vremenske analize.

Z naraščajočo miniaturizacijo tehnologije in padanjem cen so se droni postopoma razširili tudi v komercialne panoge. Mediji in filmska industrija so jih začeli uporabljati za snemanje iz zraka, kar je močno znižalo stroške produkcije. Kmetijstvo jih je vključilo za spremljanje rasti pridelkov in učinkovitejše zalivanje. V gradbeništvu so omogočili nadzor gradbišč in infrastrukture z višine.

Pomemben korak je bila tudi regulacija civilne uporabe dronov, ki je omogočila njihovo širšo uporabo na trgu. Z razmahom spletne trgovine in dostavnih storitev so podjetja, kot je Amazon, pričela raziskovati možnosti dostave z droni, medtem ko so varnostne agencije in podjetja začela razvijati drone za spremljanje množic, nadzor premoženja in iskanje pogrešanih oseb.



Slika 55: Graf registriranih dronov po vsem svetu (Vir: https://www.statista.com/accounts/pa?recommendation=discovery)

3.3 Vloga dronov danes

Danes so droni postali nepogrešljiv del številnih panog. Njihova vloga presega zgolj tehnične naloge – postajajo del širših informacijskih, logističnih in varnostnih sistemov. Uporabljajo jih reševalne službe pri iskanju pogrešanih oseb, gasilci pri nadzoru gozdnih požarov, policija pri spremljanju množičnih prireditev in protestov, varnostne službe za zaščito objektov, vojska pa še naprej za obveščevalne in bojne naloge.

Njihov razvoj gre v smer večje avtonomije, kjer umetna inteligenca in strojno učenje omogočata samostojno odločanje drona na terenu. Prav tako postajajo ključni pri integraciji z drugimi tehnologijami, kot so pametni nadzorni sistemi, senzorji gibanja, oblačna hrambe podatkov in celo sistemi za prepoznavanje obrazov.

Ob tem se pojavljajo tudi nova vprašanja glede zasebnosti, pravne odgovornosti in etične uporabe, kar pomeni, da bo prihodnji razvoj dronov moral biti uravnotežen med tehničnim napredkom in družbenimi normami.

Z razvojem tehnologije bodo droni v prihodnosti igrali še pomembnejšo vlogo pri zagotavljanju varnosti in nadzoru, kar bomo podrobneje raziskali v naslednjem poglavju.

4 UPORABA DRONOV V VARNOSTNE NAMENE

V zadnjem desetletju so droni postali pomembno orodje na področju varnosti in nadzora, saj združujejo mobilnost, tehnološko naprednost in stroškovno učinkovitost. V primerjavi s tradicionalnimi metodami varovanja – kot so nadzorne kamere, patrulje ali helikopterji – ponujajo številne prednosti: hiter odziv, dostopnost do težko dosegljivih območij ter možnost pridobivanja podatkov v realnem času.

S pomočjo visokoločljivih kamer, termalnih senzorjev, nočnega vida, GPS sledenja in umetne inteligence omogočajo natančno spremljanje in analizo dogajanja iz zraka. Droni se lahko hitro premikajo med različnimi točkami, zato so idealni za dinamične in nepredvidljive situacije, kjer je potreben takojšen odziv.

4.1 DRONI V PODPORO POLICIJI IN REŠEVALNIM SLUŽBAM

Varnostni organi in reševalne službe vse pogosteje uporabljajo drone za:

- nadzor množičnih dogodkov, kot so koncerti, športne prireditve, protesti ali javna

zbiranja, kjer je potrebno spremljati množice in morebitna tveganja,

- iskanje pogrešanih oseb v naravi, gorah ali ruševinah po naravnih nesrečah
- nadzor nad prometom in prepoznavo prometnih zastojev ali nesreč,
- usmerjanje reševalnih ekip na težko dostopnih terenih,
- opazovanje požarov in iskanje toplotnih žarišč pri gašenju (termalni droni),
- spremljanje kriminalnih aktivnosti brez ogrožanja osebja (npr. sledenje osumljencem iz varne razdalje).

Uporaba dronov pri nesrečah, kot so poplave, potresi ali plazovi, omogoča hitrejšo oceno stanja ter ciljno usmerjeno pomoč, kar lahko bistveno poveča učinkovitost reševanja in zmanjša tveganje za reševalce.

4.2 VAROVANJE OBJEKTOV IN ZASEBNIH POSESTI

Varnostna podjetja uporabljajo drone za nadzor industrijskih obratov, gradbišč, skladišč, letališč, elektrarn, naftovodov in drugih ključnih objektov. Droni lahko avtomatizirano patruljirajo po vnaprej določeni poti in ob zaznavi gibanja sprožijo alarm ali obvestilo operaterju. Na ta način se lahko takoj preveri dogajanje, še preden pride do morebitne škode.

Tudi lastniki večjih zasebnih zemljišč ali ranljivih objektov (kot so vile, turistični kompleksi ali vinarije) čedalje pogosteje vlagajo v drone kot del celostnega varnostnega sistema. Ti sistemi pogosto vključujejo tudi povezavo z drugimi varnostnimi ukrepi, kot so senzorji gibanja, osvetlitev ali zvočna opozorila.

4.3 UPORABA DRONOV V NARAVNEM IN OKOLJSKEM VARSTVU

Poleg urbanega in industrijskega varovanja so droni nepogrešljivi tudi na področju okoljskega nadzora:

- nadzor gozdnih požarov in zaznavanje požarnih žarišč z uporabo termalnih kamer
- preprečevanje krivolova in varovanje divjih živali v naravnih parkih,
- spremljanje onesnaževanja rek in jezer, pregledovanje vodotokov in nasipov,
- nadzor nad črno gradnjo ali posegi v zaščitena območja.

Takšne operacije so pogosto izvajane v sodelovanju z okoljskimi inšpektorati, gasilci ter nevladnimi organizacijami, ki se ukvarjajo z naravovarstvom.

4.4 PREDNOSTI UPORABE DRONOV V VARNOSTI

Glavne prednosti dronov v varnostnih aplikacijah vključujejo:

- hitrost odziva – droni lahko v nekaj minutah pridejo na kraj dogodka,
- zmanjšano tveganje za osebje, saj omogočajo oddaljeno spremljanje nevarnih območij,
- celovit pregled terena – z višine je mogoče hitro zaznati dogajanje, ki bi ga s tal spregledali,
- stroškovna učinkovitost – v primerjavi s helikopterji ali velikimi patruljami so droni

veliko cenejši,

- natančnost in prilagodljivost – droni lahko letijo zelo nizko ali zelo visoko, nad različnimi vrstami terena, in so primerni za vse vremenske razmere (odvisno od modela).

4.5 PRIMERI IZ PRAKSE

V Sloveniji so droni že večkrat pripomogli k hitremu reševanju življenj in varovanju ljudi

- Gorska reševalna služba uporablja drone za iskanje pogrešanih planincev v gorah, zlasti ponoči ali v slabem vremenu,
- Policija uporablja drone za nadzor državne meje in za pomoč pri iskanju osumljencev,
- Gasilske enote uporabljajo termalne drone za nadzor požarišč in določanje, kje so najbolj ogrožena območja,
- Civilna zaščita jih vključuje v protokole ob naravnih nesrečah, kot so poplave ali žled.

Tudi drugod po svetu je uporaba dronov vse bolj razširjena. V ZDA policija redno uporablja drone za nadzor nad mestnimi območji in odzivanje na streljanja, medtem ko je na Japonskem dron del vsakega večjega reševalnega vozila. V Avstraliji uporabljajo drone za nadzor nad morskimi psi na obalah, na Nizozemskem pa za preverjanje stanja nasipov in kanalov.

5 PREDNOSTI IN SLABOSTI UPORABE DRONOV PRI VAROVANJU

Droni predstavljajo enega izmed najhitreje razvijajočih se tehnoloških dosežkov sodobnega časa. Njihova uporaba v varnostne namene narašča iz leta v leto, saj omogočajo boljši nadzor, večjo odzivnost in učinkovitejše ukrepanje v številnih situacijah. Kljub temu pa uporaba te tehnologije odpira tudi številna vprašanja, tako s tehničnega kot s pravno-etičnega vidika. V tem poglavju bomo podrobneje predstavili najpomembnejše prednosti in slabosti, ki jih prinaša vključevanje dronov v sisteme varovanja.

5.1Prednosti

5.1.1 Hitrost odziva in dostopnost

Droni se lahko v nekaj sekundah dvignejo v zrak in dosežejo cilj, kar jih naredi idealne za hitro ukrepanje v kriznih situacijah, kot so naravne nesreče, požari, prometne nesreče ali grožnje v urbanih središčih. V primerjavi s klasičnimi varnostnimi patruljami ali helikopterji so droni izjemno fleksibilni in lahko dostopajo do območij, ki so za ljudi težko ali celo nemogoče dosegljiva.

5.1.2 Povečana varnost osebja

Uporaba dronov zmanjšuje potrebo po neposredni izpostavljenosti varnostnega osebja nevarnim situacijam. Namesto fizične prisotnosti lahko osebje dogajanje spremlja na varni razdalji s pomočjo prenosa slike v živo. To se je izkazalo za zelo koristno tudi pri nadzoru množičnih prireditev ali med iskalnimi akcijami v nevarnih okoljih.

5.1.3 Natančnost in kakovost podatkov

Sodobni droni so opremljeni z visokoločljivimi kamerami, termalnimi senzorji, lidarji in drugimi naprednimi tehnologijami, ki omogočajo natančen in zanesljiv pregled območja.

Nekateri modeli omogočajo tudi nočno snemanje in zaznavanje toplote, kar je še posebej pomembno pri iskanju pogrešanih oseb ali pri zaznavanju vdorov v varovana območja.

5.1.4 Nižji stroški operacij

Čeprav je začetna investicija v profesionalno dronsko opremo lahko visoka, se dolgoročno uporaba dronov izkaže kot stroškovno učinkovita rešitev. Droni potrebujejo manj vzdrževanja, manj osebja in porabijo manj energije kot klasična letala ali helikopterji.

5.1.5 Avtonomno delovanje in programabilnost

Večina naprednejših dronov omogoča programiranje poti letenja, avtomatsko vračanje ob izgubi signala ali prazni bateriji, sledenje osebam ali objektom in zaznavanje ovir. S tem se zmanjša možnost napak zaradi človeškega faktorja, poveča se učinkovitost in omogoča neprekinjen nadzor določenega območja.

5.1.6 Vsestranskost uporabe

Droni se uporabljajo za nadzor dogodkov, nadzor prometa, zaščito objektov, iskanje in reševanje, zaznavanje naravnih nevarnosti, varovanje mej in celo za nadzor industrijskih območij. Njihova prilagodljivost omogoča, da se jih z različnimi senzorji in napravami prilagodi skoraj vsakemu varnostnemu izzivu.

5.2 Slabosti

5.2.1 Omejena avtonomija (čas letenja)

Ena izmed glavnih omejitev dronov je njihova omejena kapaciteta baterije. Večina manjših in srednje velikih dronov lahko leti med 20 in 45 minut, kar predstavlja težavo pri daljših operacijah. To zahteva dodatne baterije, polnilne postaje ali celo menjavo dronov med nalogo.

5.2.2 Občutljivost na vremenske razmere

Vreme ima velik vpliv na delovanje dronov. Močan veter, dež, megla ali sneg lahko zmanjšajo stabilnost letenja ali celo onemogočijo vzlet. Tudi temperature vplivajo na delovanje baterij, kar še dodatno omejuje njihovo uporabo v ekstremnih razmerah.

5.2.3 Pravne in etične dileme

Uporaba dronov za snemanje ali nadzor hitro odpira vprašanja zasebnosti in varstva osebnih podatkov. V mnogih državah (tudi v Sloveniji) je uporaba dronov nad določenimi območji, kot so zasebna zemljišča, šole, bolnišnice in letališča, omejena ali celo prepovedana brez posebnega dovoljenja. Neupoštevanje zakonodaje lahko privede do pravnih posledic za operaterja ali organizacijo.

5.2.4 Motnje signala in tehnične napake

Droni delujejo na brezžičnih signalih (radijskih in GPS), ki so lahko moteni zaradi elektromagnetnih motenj, visokih zgradb, daljnovodov ali v primeru kibernetskih napadov. V nekaterih primerih lahko pride do izgube signala, izgube nadzora ali celo padca drona.

5.2.5 Potrebno znanje in usposobljenost

Za upravljanje naprednih dronov je potrebno tehnično znanje, pridobitev dovoljenja (v Sloveniji tudi A1/A3 certifikat pri CAA) in praktično usposabljanje. Nepravilno upravljanje lahko vodi do nesreč ali poškodb ljudi in premoženja.

5.2.6 Visoki začetni stroški

Čeprav so operativni stroški nižji, je nakup profesionalnega drona z vso pripadajočo opremo (kamere, senzorji, programska oprema) lahko visoka investicija. Poleg tega je potrebno zagotoviti še ustrezno vzdrževanje, zavarovanje ter usposobljen kader.

ZAKLJUČEK

Tehnološki napredek je v zadnjih desetletjih močno vplival na številna področja življenja, še posebej pa na področje varnosti. Droni, kot ena izmed najnaprednejših in najbolj dinamično razvijajočih se tehnologij, postajajo vse bolj pomemben del sodobnih varnostnih sistemov. Njihova uporaba je že danes nepogrešljiva pri nadzoru večjih območij, zaščiti kritične infrastrukture, upravljanju množičnih dogodkov, iskalno-reševalnih akcijah ter pri hitrem odzivu na naravne in druge nesreče.

V nalogi sem predstavil temeljne značilnosti dronov, njihov zgodovinski razvoj ter podrobno analiziral njihovo vlogo in učinkovitost na področju varovanja. Posebno pozornost sem namenil tudi sestavi drona ter tehničnim in operativnim vidikom njihove uporabe. Ob tem sem izpostavil številne prednosti, kot so hitro ukrepanje, znižanje tveganja za ljudi, natančno spremljanje terena in stroškovna učinkovitost. Hkrati pa sem opozoril tudi na omejitve, kot so omejen čas letenja, občutljivost na vremenske razmere, pravni izzivi in potreba po ustreznem znanju operaterjev.

Iz vseh zbranih informacij lahko sklepam, da droni v varnostnem sektorju niso le trenutni trend, temveč dolgoročna rešitev, ki se bo z nadaljnjim razvojem umetne inteligence, senzorike in zakonodaje še bolj uveljavila. Njihova prihodnost leži v pametni integraciji z obstoječimi varnostnimi sistemi, razvoju etičnih in pravnih standardov ter trajnostnem načrtovanju njihove uporabe v javno korist.

Čeprav tehnologija sama po sebi ni popolna, pa njena premišljena in odgovorna uporaba omogoča izboljšanje kakovosti življenja, večjo varnost ljudi in boljšo pripravljenost na izzive sodobnega časa. Droni torej niso le orodje prihodnosti – postajajo ključni del današnjega varnostnega vsakdana.

VIRI IN LITERATURA:

Europian Union Aviation Safety Agency (https://www.easa.europa.eu/domains/civil-drones-rpas), 21.4.2025

Statista – Drone Industry Statistics (https://www.statista.com/topics/4395/drones/), 21.4.2025

DJI – Vodilni proizvajalec dronov (https://www.dji.com/), 20.4.2025

Drone Industry Insights (https://droneii.com/), 18.4.2025

Slovenian Civil Aviation Agency (CAA – SLO)(https://www.caa.si/droni.html) , 21.4.2025

Slovenska Agencija za civilno letalstvo (CAA Slovenia) – pravila in dovoljenja za drone v Sloveniji (https://www.caa.si/letalske-dejavnosti/brezpilotni-zracni-sistemi-droni/), 17.4.2025

Zasebno varnostno podjetje Aktiva (https://aktiva.si/blog/varovanje-z-droni/), 21.4.2025

Secondary School of Traffic Maribor, Slovenia

Mateja Mazgan Senegačnik, mag. varstvoslovja

DRONES IN SECURITY

Maribor, april 2025

Abstract

Drones have rapidly expanded among both private and commercial users in a very short period of time. They have become part of entertainment as well as a professional tool. They have proven particularly useful in the field of private security, where they are employed to monitor facilities, events, and individuals. Drones can function as an independent security system or serve as support to security personnel by reducing the need for regular patrols. In some cases, they can even replace human security guards. However, their use also presents certain challenges, particularly regarding their operation in public spaces.

Keywords: security, drones, private security

1 Introduction

In recent years, we have witnessed remarkable technological advancements that are transforming nearly every aspect of our daily lives. One of the most recognizable and versatile modern technologies is unmanned aerial vehicles, better known as drones. Originally developed primarily for military and research purposes, drones are now finding their place in various industries – from the film industry and agriculture to package delivery and, increasingly, the security sector. The use of drones for security purposes has become an important and effective method of monitoring people, facilities, and events. Thanks to their mobility, accessibility, and advanced technology (such as thermal cameras, GPS tracking, and motion detection), drones represent a significant tool for ensuring safety, either as a support to security services or as independent surveillance systems. With their help, it is possible to monitor large areas, quickly detect potential threats, and respond without exposing personnel to danger. How ever, as with any technology, the use of drones for security purposes brings challenges and risks. A key concern is the issue of privacy and the

protection of personal data, as drones can record and collect information without the knowledge of individuals. Furthermore, ethical and legal issues arise regarding their use in public spaces. The aim of this paper is to present and analyse how drones are utilized in the field of security, what advantages and disadvantages they bring, and how their use is regulated by legislation in Slovenia and other countries. Using practical examples, we will try to answer whether drones truly represent the future of security or are merely a passing trend in modern technology.

2 What are drones

Drones, officially known as unmanned aerial vehicles (UAVs), are aircraft that operate without a pilot on board. They can be controlled remotely using handheld controllers or smart devices, or they can operate fully autonomously based on pre-programmed routes and algorithms. In recent years, the use of drones has grown significantly, expanding from military applications into civilian, commercial, scientific, and private sectors.

Due to their technical sophistication and increasing accessibility, drones are becoming essential tools across various fields from aerial photography, traffic monitoring to agriculture, package delivery, search and rescue missions, and of course, security. Their functionality largely depends on the equipment they carry, such as high-resolution cameras, thermal sensors, infrared cameras, GPS receivers, communication modules, and even artificial intelligence that enables partial autonomous decision making.

2.1 Definition and Basic Characteristics

Drones vary in size and capabilities, but their common feature is that they provide an aerial perspective without the need for a human presence. Operators can use special applications on tablets or smartphones to monitor in real time what the drone's camera sees, allowing precise supervision of activities on the ground. In addition to simpler models intended for recreational use, there are highly sophisticated professional drones designed for complex tasks that require high precision and reliability, for example, securing large areas or monitoring events with large crowds.

2.2 Types of Drones

Drones differ according to various criteria, such as size, number of rotors, battery capacity, intended use, and flight characteristics. The most common type of drone is the quadcopter, which has four rotors and offers high flight stability, making it very popular among recreational and commercial users. For more demanding tasks, hexacopters (six rotors) or octocopters (eight rotors) are used, as they can carry heavier loads, such as professional cameras, additional sensors, or other equipment. A special category consists of professional and military drones, which can fly at higher altitudes, stay airborne longer, and are equipped with advanced features such as thermal imaging, motion detection, and nighttime operation. These drones are frequently used for border surveillance, the protection of critical infrastructure, police monitoring of mass events, and even disaster management.

2.3 Modern Features

Modern drones incorporate a wide range of advanced technologies that enhance their safety, precision, and usability. Key features include:

- Object tracking – the drone can automatically follow a designated person or vehicle without the need for constant manual control.
- Automatic obstacle avoidance – using sensors, the drone detects obstacles (such as trees or buildings) and avoids them, reducing the risk of accidents.
- Geofencing – limits the drone's flight area to prevent it from accidentally entering restricted zones, such as near airports or military installations.
- Return to Home function – in case of signal loss, low battery, or emergency situations, the drone automatically returns to its starting location.
- Live video transmission – enables users to monitor real-time footage from the drone, which is crucial for security and surveillance operations.



Photo 56: drone (Source: https://www.merkur.si/televizorji-in-avdio/foto/droni/)

3 History

The concept of unmanned aerial vehicles dates back over a century. The first ideas for drone development appeared during World War I, when engineers in the United States experimented with radio-controlled aircraft, such as the "Kettering Bug", a simple flying bomb that served as a precursor to modern UAVs. Although the project was not particularly successful at the time, it demonstrated the potential of unmanned technology.

During World War II, development advanced further. Both Allied and Axis forces used primitive drones for reconnaissance and to test aerial attacks. The German V-1 project, also known as the “flying bomb,” was one of the first examples of unmanned weaponry in warfare. Meanwhile, the Americans developed drones for anti-aircraft training and radar testing.

The greatest leap occurred during the Cold War, when the United States and the Soviet Union invested heavily in the development of unmanned systems for intelligence gathering and surveillance. The U.S. used UAVs like the famous Ryan Model 147 to collect data over China, Cuba, and North Korea. These drones were initially designed for one-way missions, destroyed or lost after completing their flights, but they enabled the acquisition of critical tactical information without endangering human lives.

For decades, military use remained the main driver of drone development, as UAVs offered the ability to perform dangerous missions without directly risking crew members.

3.1 Military beginnings

The first initiatives for drone development appeared during World War I, when the United States worked on radio-controlled aircraft for military purposes. Although these early projects were not highly successful, they laid important foundations for the further advancement of unmanned technology. During World War II, both Allied and Axis forces used drones for reconnaissance and targeting purposes, confirming the utility of unmanned systems in military operations. The Cold War brought the most significant progress, as the United States and the Soviet Union invested heavily in the development of unmanned aircraft for intelligence and military applications.

3.2 Transition to civilian use

With the development of microelectronics, compact cameras, GPS and lighter batteries, drones began to transition from military to civilian sectors in the second half of the 20th century. A significant milestone occurred during the 90s, when drones became more accessible to researchers, scientists, and academics. They started to be used for terrain mapping, land surveying, wildlife observation, and weather analysis.

As technology continued to miniaturize and prices dropped, drones gradually spread into commercial industries. Media and the film industry adopted drones for aerial filming, significantly reducing production costs. Agriculture utilized them for crop monitoring and more efficient irrigation. In construction, drones allowed for the monitoring of sites and infrastructure from above.

Another important step was the regulation of civilian drone use, which enabled broader market adoption. With the expansion of e-commerce and delivery services, companies like Amazon began exploring drone delivery possibilities, while security agencies and companies developed drones for crowd monitoring, as set protection and search and rescue operations.

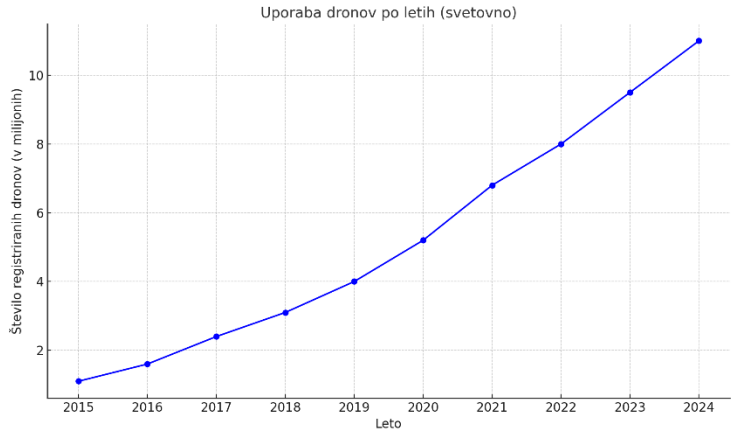


Photo 57: Graph of registered drones worldwide (Source: https://www.statista.com/accounts/pa?recommendation=discovery)

3.3 The role of drones today

Today, drones have become an indispensable part of numerous industries. Their role goes beyond purely technical tasks. They are becoming integrated into broader information, logistics, and security systems. Rescue services use them to locate missing persons,

firefighters to monitor forest fires, police to oversee mass gatherings and protests, security services to protect facilities, and the military continues to employ them for intelligence and combat operations.

Drone development is moving toward greater autonomy, with artificial intelligence and machine learning enabling drones to make independent decisions in the field. They are also becoming crucial components of integrated systems, including smart surveillance networks, motion sensors, cloud data storage, and even facial recognition technologies.

However, new issues are emerging regarding privacy, legal liability, and ethical use, meaning that future drone development must strike a balance between technological progress and societal norms.

As technology continues to evolve, drones are expected to play an even more significant role in ensuring safety and monitoring, which will be explored further in the following chapter.

4 Use of drones for security purposes

In the past decade, drones have become important tools in the fields of security and surveillance, combining mobility, technological advancement, and cost efficiency. Compared to traditional security methods such as surveillance cameras, patrols, or helicopters they offer numerous advantages: rapid response, access to hard-to-reach areas, and the ability to collect real-time data.

Equipped with high-resolution cameras, thermal sensors, night vision, GPS tracking, and artificial intelligence, drones enable precise monitoring and analysis of activities from the air. They can quickly move between different locations, making them ideal for dynamic and unpredictable situations that require immediate action.

4.1 Drones supporting police and rescue services

Security authorities and rescue services are increasingly using drones for:

- monitoring mass events such as concerts, sports events, protests, or public gatherings, where crowd management and risk detection are critical,
- searching for missing persons in nature, mountains, or ruins following natural disasters,
- monitoring traffic and identifying traffic jams or accidents,
- directing rescue teams in hard-to-reach terrains,
- observing fires and detecting heat sources during firefighting (thermal drones),
- monitoring criminal activities without endangering personnel (e.g., tracking suspects from a safe distance).

The use of drones during incidents such as floods, earthquakes, or landslides allows for faster situation assessment and targeted assistance, which can significantly enhance rescue effectiveness and reduce risks to rescue teams.

4.2 Drones in private security

Security companies use drones to monitor industrial facilities, construction sites, warehouses, airports, power plants, pipelines, and other critical infrastructure. Drones can patrol along pre-programmed routes and trigger an alarm or notify an operator upon detecting movement. This allows for immediate verification of events before any potential damage occurs.

Owners of larger private estates or vulnerable properties (such as villas, tourist complexes, or wineries) are increasingly investing in drones as part of comprehensive security systems. These systems are often integrated with other security measures, such as motion sensors, lighting, or audio alerts.

4.3 Use in environmental protection

In addition to urban and industrial security, drones are also indispensable in environmental monitoring:

- monitoring forest fires and detecting fire hotspots using thermal cameras,
- preventing poaching and protecting wildlife in national parks,
- monitoring river and lake pollution, inspecting waterways and embankments,
- overseeing illegal construction or unauthorized activities in protected areas.

Such operations are often carried out in cooperation with environmental inspectorates, firefighting services, and non-governmental organizations focused on environmental conservation.

4.4 ADVANTAGES OF USING DRONES IN SECURITY

The main advantages of drones in security applications include:

- rapid response – drones can reach the incident location within minutes,
- reduced risk to personnel, as they allow remote monitoring of hazardous areas,
- comprehensive terrain overview – from an aerial perspective, it is easier to detect activities that might be missed from the ground,
- cost-effectiveness – compared to helicopters or large patrols, drones are significantly cheaper,
- precision and flexibility – drones can fly at very low or very high altitudes over various types of terrain and are suitable for all weather conditions (depending on the model).

4.5 PRACTICAL EXAMPLES

In Slovenia, drones have already contributed multiple times to saving lives and protecting people:

- The Mountain Rescue Service uses drones to search for missing hikers in the mountains, especially at night or in bad weather conditions,

- The Police use drones to monitor the national border and assist in the search for suspects,
- Firefighting units use thermal drones to monitor fire sites and identify the most threatened areas,
- The Civil Protection Service incorporates drones into emergency protocols for natural disasters such as floods or ice storms.

Elsewhere in the world, the use of drones is also expanding. In the United States, police regularly use drones to monitor urban areas and respond to shootings, while in Japan, drones are a standard part of major rescue vehicles. In Australia, drones are deployed for shark surveillance along beaches, and in the Netherlands, they are used to inspect dikes and canals.

5 Advantages and disadvantages of using drones in security

Drones represent one of the fastest-growing technological advancements of modern times. Their use for security purposes is increasing year by year, as they enable better surveillance, faster response, and more effective action in various situations. However, the use of this technology also raises numerous issues, both from a technical and a legal and ethical perspective.

This chapter will provide a detailed overview of the main advantages and disadvantages associated with integrating drones into security systems.

5.1 Advantages

5.1.1 Speed of Response and Accessibility

Drones can take off and reach a target within seconds, making them ideal for rapid intervention in crisis situations such as natural disasters, fires, traffic accidents, or threats in urban centres. Compared to traditional security patrols or helicopters, drones are extremely flexible and can access areas that are difficult or even impossible for humans to reach.

5.1.2 Increased Personnel Safety

The use of drones reduces the need for security personnel to be directly exposed to dangerous situations. Instead, personnel can monitor events from a safe distance through live video transmission.

5.1.3 Accuracy and Data Quality

Modern drones are equipped with high-resolution cameras, thermal sensors, LiDARs, and other advanced technologies that enable precise and reliable area surveillance.

5.1.4 Lower Operational Costs

Although the initial investment in professional drone equipment can be high, over the long term, drone use proves to be a cost-effective solution.

5.1.5 Autonomous Operation and Programmability

Most advanced drones allow for flight path programming, automatic return upon signal loss or low battery, object or person tracking, and obstacle detection.

5.1.6 Versatility of Use

Drones are used for event monitoring, traffic surveillance, asset protection, search and

rescue missions, natural hazard detection, border security, and more.

5.2 Disadvantages

5.2.1 Limited Autonomy (Flight Time)

One of the main limitations of drones is their restricted battery capacity. Most small and medium-sized drones can fly for between 20 and 45 minutes, which poses challenges for longer operations.

5.2.2 Sensitivity to Weather Conditions

Weather significantly affects drone operation. Strong winds, rain, fog, or snow can reduce flight stability or even prevent drones from taking off.

5.2.3 Legal and Ethical Dilemmas

The use of drones for surveillance or recording quickly raises concerns regarding privacy and the protection of personal data.

5.2.4 Signal Interference and Technical Failures

Drones operate on wireless signals (radio and GPS), which can be disrupted by electromagnetic interference, tall buildings, power lines, or even cyberattacks.

5.2.5 Required Knowledge and Training

Operating advanced drones requires technical knowledge, the acquisition of licenses, and practical training.

5.2.6 High Initial Costs

Although operational costs are lower, purchasing a professional drone with all necessary equipment re-presents a significant investment.

6 Conclusion

Technological progress in recent decades has significantly influenced many areas of life, especially in the field of security. Drones, as one of the most advanced and rapidly evolving technologies, are becoming an increasingly important part of modern security systems. Their use is already indispensable today in the monitoring of large areas, the protection of critical infrastructure, the management of mass events, search and rescue operations, and rapid responses to natural and other emergencies.

In this paper, I presented the fundamental characteristics of drones, their historical development, and analysed in detail their role and effectiveness in the field of security. Special attention was given to the construction of drones and the technical and operational aspects of their use. I also highlighted numerous advantages, such as rapid intervention, reduced risk to people, precise terrain monitoring, and cost-effectiveness. At the same time, I pointed out several limitations, such as limited flight time, sensitivity to weather conditions, legal challenges, and the need for operator expertise.

Based on all the gathered information, I conclude that drones in the security sector are not just a passing trend but a long-term solution that will become even more prominent with the further development of artificial intelligence, sensor technology, and legislation. Their future lies in the smart integration with existing security systems, the development of ethical and legal standards, and the sustainable planning of their use for the public good.

Although the technology itself is not perfect, its thoughtful and responsible use enables improvements in quality of life, greater personal safety, and better preparedness for the challenges of modern times. Drones are not merely tools of the future – they are becoming an essential part of today's security landscape.

7 REFERENCES

Europian Union Aviation Safety Agency (https://www.easa.europa.eu/domains/civil-drones-rpas), 21.4.2025

Statista – Drone Industry Statistics (https://www.statista.com/topics/4395/drones/), 21.4.2025

DJI – Vodilni proizvajalec dronov (https://www.dji.com/), 20.4.2025

Drone Industry Insights (https://droneii.com/), 18.4.2025

Slovenian Civil Aviation Agency (CAA – SLO)(https://www.caa.si/droni.html) , 21.4.2025

Slovenska Agencija za civilno letalstvo (CAA Slovenia) – pravila in dovoljenja za drone v Sloveniji (https://www.caa.si/letalske-dejavnosti/brezpilotni-zracni-sistemi-droni/), 17.4.2025

Zasebno varnostno podjetje Aktiva (https://aktiva.si/blog/varovanje-z-droni/), 21.4.2025

Avtor: Nevenka Ozebek, profesorica razrednega pouka

Ime organizacije: OŠ Lava, Celje

ANALIZA USPEŠNOSTI UKREPOV ZA IZBOLJŠANJE VARNOSTI OTROK STARIH OD 6 DO 11 LET

Povzetek

Pasavček je eden izmed najbolj prepoznavnih in dolgoročno uspešnih projektov na področju prometne vzgoje v Sloveniji. Že več kot 20 let ga na nacionalni ravni koordinira Agencija RS za varnost prometa, pri čemer projekt dosledno opozarja na izjemno pomembnost pravilne uporabe otroških varnostnih sedežev. Skozi ta projekt se krepi zavest in razvijajo navade o varnosti najmlajših potnikov v vozilih na mestu, kjer nevarnost nastaja in hkrati na mestu, kjer je prisotno zavedanje vseh deležnikov. Učinki projekta vplivajo na vedenje staršev in drugih skrbnikov pri zagotavljanju varnosti otrok med vožnjo, kar deloma trenutno in predvsem dolgoročno prispeva k zmanjševanju posledic prometnih nesreč.

Ciljna skupina udeležencev raziskovanja vključuje predvsem otroke, stare od 6 do 11 let, ki se izobražujejo v vrtcih in osnovnih šolah. Otroke od 1.do 5. razreda OŠ, ki so udeleženi v prometu kot potniki v vozilih in so njihove navade v razvoju in oblikovanju, hkrati pa je njihova varnost ključnega pomena zaradi nepredvidljivosti in pomanjkanja izkušenj otrok.

Aktivnosti projekta Pasavček, ki ga vodim na OŠ Lava sledijo ciljem, da udeleženi starši in otroci osvetlijo in ozavestijo elemente varnosti ter s tem zagotovimo varnejša izhodišča za udeležbo v prometu. Rezultati projekta merljivo opišejo dejansko stanje pred, med in po aktivnostih na šoli in končno statistično primerjavo podatkov na državnem nivoju.

Dejansko opazujemo vpliv programa na prometno varnost otrok, kjer otroci s poznavanjem varnostnih elementov v komplementarni in obrnjeni vlogi z voznikom, izboljšajo navade in pravilnost uporabe varnostnih sedežev, pasov in ostalih elementov varnosti ter nevarnosti oseb v prometu.

1 Uvod

Šolski učni program je z enotnimi cilji povezan skozi projekt Pasavček, kjer z opazovanjem pripetosti otrok v otroške varnostne sedeže (OVS) šole pomembno prispevajo v del raziskave za oceno učinkov projekta. Opazovanja so bila izvedena na vhodu v šolo, kjer so otroci prihajali v spremstvu staršev, s poudarkom na preverjanju pravilne uporabe

varnostnih pasov in sedežev pri dostavah otrok v šolo z osebnimi vozili.

Zakonodaja v Sloveniji zahteva pripenjanje otrok v avtomobilu skladno z **Zakonom o pravilih cestnega prometa (ZPrCP)**, kjer naštejem nekaj ključnih pravil glede otroških sedežev in pripenjanja:

- Otroci do 12. leta in do 135 cm morajo biti vedno pripeti in uporabljati otroški sedež.
- Otroci nad 135 cm lahko uporabljajo le varnostni pas vozila, kar dopušča tudi sedenje spredaj.
- Sedež na sprednjem sedežu: Če je otrok v lupinici obrnjeni nazaj, mora biti izklopljen zračni meh.

Primerjava zakonodaje in ukrepanja pri nas in sosedih je zbrana z uporabo ChatGPT40, ki najde podatke za denarne kazni za ne pripenjanje otrok v vozilu[1]:

- Sloveniji: od 120 € naprej in možna kazenska točka za voznika.
- Avstrija: Približno 35 €.
- Italija: Od 33 – 80 €.
- Madžarska: 50 in tudi preko 1000 €.
- Hrvaška: 135 €.
- Bosna in Hercegovina: 200 - 500 €.
- Srbija: 40 €
- Severna Makedonija: 45 €

Varnostni pas je nujen pogoj za ustrezno zaščito z varnostnim mehom. Ne pripet voznik ali potnik lahko v primeru trka tvega hujše poškodbe. Varnostni pasovi so eden najpomembnejših varnostnih sistemov v vozilih, saj zmanjšujejo tveganje za smrtne žrtve in resne poškodbe v primeru prometne nesreče. Delujejo tako, da zadržijo potnika na sedežu in preprečijo udarec ob notranje dele vozila ali izmet iz vozila. Varnostni pasovi so pomembni, saj zmanjšujejo smrtnost, preprečujejo hude poškodbe. Pri trkih zadržijo telo na sedežu in zmanjšujejo silo udarca. Brez varnostnega pasu so zračne blazine manj učinkovite ali celo nevarne, saj ne morejo pravilno zaščititi potnika. V osebnem avtomobilu morajo biti pripeti vsi potniki, tako na prednjem in zadnjih sedežih. Poznamo različne vrste varnostnih pasov2:

- Dvotočkovni pas – Uporablja se predvsem v letalih in nekaterih starejših vozilih in srednjem sedežu zadnje klopi osebnih vozil in se zapenja se čez boke.
- Tritočkovni pas – Najpogostejši tip, ki se zapenja dvotočkovno čez trup in dvotočkovno čez boke ter zagotavlja optimalno zaščito.

---

[1] https://chatgpt.com/c/67e42edf-c8c4-800a-9745-3c9699f5bace

[2] Kerkez, V.: Uporaba varnostnega pasu v RS, B/B, Diplomsko delo Višješolskega strokovnega študija, Kranj 2011.

- Večtočkovni pas (štiri- ali pettočkovni) – Uporablja se pri dirkalnih avtomobilih in otroških varnostnih sedežih.

Voznik je odgovoren za uporabo varnostnih elementov v vozilu, saj ne pripeti potniki tudi na zadnjih sedežih ogrožajo poleg sebe še voznika in sopotnike v vozilu.

1.1 Aktivnosti projekta Pasavček

Ves čas projekta smo se z otroki veliko pogovarjali o prometu v različnih situacijah in vlogah, o pravilnem obnašanju v prometu kot pešec, kot sopotnik v avtu, nato o prometni varnosti in varni vožnji, vlogi prometnih sredstev v prometu, prometnih znakih, obnašanju v različnih prevoznih sredstvih in o vedenju na poti, uporabi varnostnih pasov, uporabi otroških varnostnih sedežev in drugih pripomočkih za večjo vidnost v prometu, povezanosti prometa z onesnaženostjo okolja.

Aktivnosti projekta Pasavček sledijo naslednjim ciljem:

- Seznanjanje otrok in staršev s pomenom uporabe varnostnega pasu in OVS.
- Navajanje staršev in otrok na doslednost pri uporabi varnostnega pasu in OVS.
- Povečanje uporabe varnostnih pasov med vožnjo.
- Seznanjanje otrok in staršev s pravilnim vedenjem in ravnanjem otrok v prometu.
- Prispevati k čim večji prometni ozaveščenosti staršev in posledično tudi ostalih potnikov.
- Privzgojiti pravila v cestnem prometu s pomočjo učencem zanimivih dejavnosti.

V sklopu programa Pasavček smo izvedli različne dejavnosti, s katerimi smo otroke ozaveščali o pomenu varne vožnje in uporabe varnostnega pasu.

1.1.1 Usvojena znanja in veščine učencev

Preko interaktivnih iger, ustvarjalnih delavnic in poučnih vsebin, smo spodbujali odgovorno ravnanje v prometu ter razvijali varnostne navade. Naš cilj je bil, da otroci na zabaven in poučen način usvojijo ključna pravila varne vožnje in jih prenesejo tudi v vsakdanje življenje. Otroci so spoznali naslednje veščine in znanja:

- Promet v različnih situacijah.
- Pravilno obnašanje v prometu kot pešec in kot sopotnik v avtu:
- Prometna varnost in varna vožnja.
- Vloga prometnih sredstev v prometu.
- Prometni znaki.
- Obnašanje v različnih prevoznih sredstvih in o vedenju na poti.
- Uporaba varnostnih pasov.
- Uporaba otroških varnostnih sedežev in drugih pripomočkih za večjo vidnost v prometu.
- Povezanost prometa z onesnaženostjo okolja.

- Privzgojiti pravila v cestnem prometu s pomočjo učencem zanimivih dejavnosti.

1.1.2 Načrtovane in izvedene aktivnosti

Skozi projekt Pasavček smo izvedli različne aktivnosti, ki so otroke spodbujale k varnemu in odgovornemu ravnanju v prometu. Te aktivnosti so bile[1]:

- Izdelava prometnih znakih, slika **1**.
- Promet v različnih situacijah, slika **2**.
- Pravilno obnašanje v prometu kot pešec in kot sopotnik v avtu.
- Prometna varnost in varna vožnja.
- Vloga prometnih sredstev v prometu.
- Obnašanje v različnih prevoznih sredstvih in o vedenju na poti.
- Uporaba varnostnih pasov.
- Uporaba otroških varnostnih sedežev in drugih pripomočkih za večjo vidnost v prometu.
- Povezanost prometa z onesnaženostjo okolja.
- Ozaveščanje odraslih o varnosti v cestnem prometu.
- Urejanje prometnega kotička v razredu.
- Branje in poslušanje zgodb s prometnimi vsebinami.
- Pripovedovanje otrok o načinu prihoda v šolo in beleženje rednosti uporabe varnostnih pasov in otroških varnostnih sedežev med vožnjo.
- Pasovi (tabela beleženja na kartončke).
- Opazovanje pripetosti in uporabe OVS.

Ustvarjanje in igranje družabnih iger s prometno vsebino, slika **3**.

Slika 59: Prometni znaki v kotičku



Slika 58: Likovno ustvarjanje - prevozna sredstva



[1] Ozebek, N.: Končno poročilo Pasavček za šolsko leto 2023/24

Slika 60: Družabna igra-V prometu ne jezi se



2. Opis postopka raziskovanja

V okviru raziskovanja smo sistematično beležili, ali so otroci bili med vožnjo v avtomobilu pravilno pripeti z varnostnim pasom ali ustreznim zadrževalnim sistemom. Opazovanje je potekalo ob prihodu otrok v šolo. Zbrani podatki nam bodo omogočili analizo navad pripetosti ter prepoznavanje morebitnih pomanjkljivosti pri uporabi varnostnih ukrepov. Na podlagi ugotovitev bomo oblikovali predloge za izboljšanje ozaveščenosti staršev in otrok o pomenu varne vožnje. Raziskava je potekala v dveh fazah, z uporabo metode opazovanja, da smo pridobili celovite podatke o učinkovitosti projekta Pasavček. Z metodo opazovanja pripetosti otrok v otroške varnostne sedeže (OVS) je pomemben del raziskave za oceno učinkov projekta Pasavček. Opazovanja so bila izvedena pri vhodu v šolo, kjer so otroci prihajali v spremstvu staršev, s poudarkom na preverjanju pravilne uporabe varnostnih pasov in sedežev.

2.1 Opis in rezultati raziskovanja

Raziskava je bila izvedena v dveh terminih, in sicer novembra 2024 in marca 2025, kar omogoča opazovanje sprememb skozi šolsko leto. Raziskava je zajela 115 otrok v novembru 2024 in 114 otrok v marcu 2025, izbranih iz različnih razredov naše osnovne šole Lava, ki sodelujejo v projektu Pasavček, v jutranjem času od 7.00 do 7.45 ure.

Med opazovanjem so bile zabeležene različne napake, kot so nepravilno pripet varnostni pas, neustrezna velikost OVS glede na težo ali višino otroka, ohlapni ali zviti varnostni pasovi, neustrezno pritrjen OVS. Prav tako je bilo zabeleženo, koliko otrok je bilo pravilno pripetih v ustrezne otroške varnostne sedeže.

Vzorec opazovanih otrok je zajemal otroke, stare od 6 do 11 let, ki so prihajali v šolo v spremljavi staršev. Pričakovalo se je, da so otroci uporabljali različne vrste otroških varnostnih sedežev in varnostnih pasov, kar je omogočilo pridobitev raznolikih podatkov. Po dveh krogih opazovanja so bili rezultati analizirani in primerjani.

Preglednica 1: Opazovalna preglednica pri beleženju pripetosti otrok v avtomobilih

Datum	Čas	Kraj	Opažanja				Število opazovanih otrok	Ustrezni h %
			Ne pripet	Ohlapen pas	Neustrez. velikost OVS	Ustrezno pripet otrok v OVS		
15.11.2024	7.00-7.45	Parkirišče pred šolo	11	12	5	37	65	57 %
16.11.2024	6.30.-7.45	Parkirišče pred šolo	9	13	5	23	50	46 %
13.3.2025	7.00-7.45	Parkirišče pred šolo	1	8	3	46	59	78 %
14.3.2025	6.30.-7.45	Parkirišče pred šolo	2	1	2	50	55	91 %

Preglednica **1** potrjuje pričakovanja, da je bilo po izvedenih aktivnostih marca več ustrezno pripetih otrok kot na začetku leta, v mesecu novembru. V novembru je bilo več napak, kot so nepravilno napeti-zategnjeni ali prepognjeni varnostni pasovi, nepravilno nameščeni OVS ali neustrezna velikost sedeža. Na izboljšanje stanja v marcu so vplivale dodatne ozaveščevalne aktivnosti za otroke, kot je zbiranje štampiljk za pravilno pripetost. Opazovanje pripetosti pred in po izvedbi preventivnih aktivnosti v okviru projekta Pasavček je bila ključnega pomena za oceno uspešnosti programa in ugotavljanje vpliva na varnost otrok v prometu.[1]

[1]https://www.avp-rs.si/preventiva/prometna-vzgoja/programi/pasavcek/#odrasliinuporabavarnostnegapasu

Skupno je doseženih 91%, kar je sicer znatno izboljšanje izhodiščnega stanja, a še vedno pod najboljšimi rezultati statističnih meritev v RS, s katerim razpolaga AVP in je:

Preglednica 2: Podatki AVP o pripetosti otrok v Sloveniji[1]

Leto	Delež pripetosti otrok
2005	61,2 %
2006	70,6 %
2009	80,2 %
2010	91,7 %
2016	93,3 %
2017	94,8 %
2018	94,3 %
2022	88,6 %

2.1.1 Ugotovitve, izzivi in predlogi za izboljšave

Zbrani podatki so pokazali naslednje ugotovitve, da je bilo 91 % otrok pravilno pripetih med vožnjo, najslabši rezultat ne pripetih otrok je bil 54 % ne pripetih otrok in razlika pred in po akciji je bila 34 % izboljšanje ustrezno pripetih otrok, kar v praksi pomeni iz 57% pripetosti na 91 %**.** Dejavniki, ki vplivajo na ne pripetost so hitenje staršev, kratka razdalja vožnje in neprijetnost za otroka.

Ugotovili smo, da se večina staršev zaveda pomena varne vožnje, vendar zaradi vsakodnevnih obveznosti včasih zanemarijo pravilno pripenjanje otrok. Starši in otroci so se pritoževali nad neudobnostjo varnostnih pasov, kar vodi do manj dosledne uporabe.

Starše in otroke bomo se naprej ozaveščali preko medijev, plakatov in delavnic. Otrokom bomo nudili izobraževalne vsebine za otroke, kjer bodo skozi igro in zgled razumeli pomen varne vožnje. Pri starših bomo spodbujali zgledno vedenje, saj otroci prevzemajo navade svojih skrbnikov. Krepilo bomo sodelovanje med izobraževalnimi ustanovami, starši in lokalnimi skupnostmi. Nekateri starši si bili mnenja, da otroci pri krajših vožnjah niso ogroženi, zato ne uporabljajo otroških sedežev ali varnostnih pasov.

3. Zaključek

Varnostni pasovi so za otroke ključni pri zagotavljanju zaščite v vozilu, saj zmanjšujejo tveganje za hude poškodbe in smrtne izide v primeru nesreče. Otroci so zaradi svoje manjše telesne mase in drugačne anatomije bolj ranljivi, zato morajo uporabljati ustrezne otroške varnostne sedeže ali jahače, ki zagotavljajo pravilno namestitev pasu. Starši in skrbniki imajo ključno vlogo pri varnosti otrok v vozilih, saj dosledna uporaba varnostnih pasov in otroških sedežev lahko prepreči hude posledice nesreč. Ne glede na razdaljo vožnje ali

[1] www.avp-rs.si.

hitrost, je varnostni pas nujen za zaščito vsakega otroka v vozilu.

Projekt Pasavček je pomemben prispevek k povečani varnosti otrok v prometu. Pridobljeni podatki so nam omogočili vpogled v navade pripenjanja otrok, hkrati pa smo zaznali številne priložnosti za izboljšave. Verjamemo, da bomo s pravilnim pristopom in nadaljnjimi izobraževalnimi aktivnostmi mogoče še dodatno izboljšali varnost naših najmlajših udeležencev v prometu.

Projekt Pasavček ni le uspešno prispeval k ozaveščanju otrok, staršev in učiteljev o pomenu varne vožnje in uporabe varnostnega pasu, ampak je skozi načrtovane aktivnosti otrokom na igriv in poučen način dal pomembna znanja o prometni varnosti ter razvil odgovorne navade kot potniki v vozilih. Otroci so bili vedoželjni, navdušeni nad izvajanjem raznih aktivnosti in dejavnosti, radi so sodelovali, iskali informacije, prinašali gradiva. Dobra motivacija je bilo tudi beleženje pripetosti z varnostnim pasom v tabelo in na kartončke. Prav tako so radi barvali pobarvanko in reševali učne liste.

Z beleženjem pripetosti smo dobili vpogled v resnično stanje uporabe varnostnih sistemov in prepoznali možnosti za izboljšave in dokazano povečali uporabo varnostnih pasov za dobro tretjino na 91%. Verjamemo, da bodo pridobljene izkušnje prispevale k večji varnosti v prometu in oblikovanju trajnih, pozitivnih vzorcev vedenja pri otrocih in njihovih družinah. Le s skupnimi napori lahko zagotovimo varnejšo prihodnost najmlajšim udeležencem v prometu – kajti "Red je vedno pas pripet!"

4. Viri

OpenAI. (2021). *ChatGPT* (različica 3.5) [Programska oprema]. Pridobljeno s spletne strani https://chatgpt.com/c/67e42edf-c8c4-800a-9745-3c9699f5bace.

Kerkez, V.: Uporaba varnostnega pasu v RS, B/B, Diplomsko delo Višješolskega strokovnega študija, Kranj 2011.

Ozebek, N.: Končno poročilo Pasavček za šolsko leto 2023/24

https://www.avp-rs.si/preventiva/prometna-vzgoja/programi/pasavcek/#odrasliinuporabavarnostnegapasu, 7.3. 2025.

www.avp-rs.si, 7. 3. 2025

Author: Nevenka Ozebek, Primary School Teacher
Organization: OŠ Lava, Celje

ANALYSIS OF THE EFFECTIVENESS OF MEASURES TO IMPROVE THE SAFETY OF CHILDREN AGED 6 TO 11 YEARS

Summary

Pasavček is one of the most recognizable and long-standing successful projects in traffic education in Slovenia. For over 20 years, it has been coordinated on the national level by the Slovenian Traffic Safety Agency, constantly emphasizing the great importance of correctly using child safety seats. Through this project, awareness is strengthened and habits related to the safety of the youngest passengers in vehicles are developed at the place where danger arises and where awareness is present among all participants. The effects of the project influence the behavior of parents and other caregivers in ensuring the safety of children while driving, which contributes partially in the short term and mainly in the long term to reducing the consequences of traffic accidents.

The target group of the research includes primarily children aged 6 to 11 years who attend kindergartens and primary schools. These are children from grades 1 to 5, who are passengers in vehicles and are still developing habits, while their safety is essential due to their unpredictability and lack of experience.

The activities of the Pasavček project, which I lead at OŠ Lava, aim to help parents and children understand and become aware of safety elements, thereby ensuring safer conditions for participation in traffic. The results of the project describe the actual situation before, during, and after the activities at school, and finally provide a statistical comparison of the data at the national level.

We observe the impact of the program on the traffic safety of children, where children, by understanding safety elements in a complementary and mirrored role with the driver, improve habits and the proper use of safety seats, belts, and other safety and risk factors for people in traffic.

1 Introduction

The school curriculum is aligned with the objectives of the Pasavček project, where by observing whether children are buckled in child safety seats (CSS), schools contribute significantly to research assessing the project's effectiveness. The observations were conducted at the school entrance, where children arrived accompanied by their parents, with a focus on checking the correct use of seat belts and seats during drop-off in personal vehicles.

Slovenian road traffic law requires children to be buckled up in the car in accordance with the **Road Traffic Rules Act (ZPrCP)**, which includes the following key rules about child seats and seat belts:

Children up to 12 years of age and up to 135 cm in height must always be buckled and use a child seat.

Children over 135 cm in height can use only the vehicle seat belt, which also allows them to sit in the front seat.

Front seat: If a child in a rear-facing infant carrier is placed in the front seat, the airbag must be deactivated.

A comparison of laws and actions in Slovenia and neighboring countries was gathered using ChatGPT40, which found data about fines for not buckling children in vehicles[14]:

Slovenia: from €120 and a possible penalty point for the driver.

Austria: approximately €35.

Italy: from €33 to €80.

Hungary: €50 and even over €1000.

Croatia: €135.

Bosnia and Herzegovina: €200 - €500.

Serbia: €40.

North Macedonia: €45.

The seat belt is a crucial condition for the proper function of the airbag. An unbuckled driver or passenger can suffer more severe injuries in case of a crash. Seat belts are one of the most important safety systems in vehicles because they reduce the risk of fatal injuries and serious harm in accidents. They keep passengers in their seats and prevent impact with the vehicle's interior or ejection. Seat belts are important because they lower mortality and prevent serious injuries. They hold the body in place during collisions and reduce the force of impact. Without seat belts, airbags are less effective or even dangerous, as they cannot properly protect the passenger. In a car, all passengers must be buckled up, both in the front and back seats. We know different types of seat belts[15]:

[14] https://chatgpt.com/c/67e42edf-c8c4-800a-9745-3c9699f5bace

[15] Kerkez, V.: Uporaba varnostnega pasu v RS, B/B, Diplomsko delo Višješolskega strokovnega študija, Kranj 2011.

Two-point belt – Mainly used in airplanes, some older vehicles, and the middle seat of the back row. It fastens across the hips.

Three-point belt – The most common type, fastens across the torso and hips and provides optimal protection.

Multi-point belt (four- or five-point) – Used in race cars and child safety seats.

The driver is responsible for the use of safety elements in the vehicle, since unbuckled passengers, even in the back seats, endanger not only themselves but also the driver and other passengers.

1.1 Activities of the Pasavček project

Throughout the project, we had many discussions with the children about traffic in various situations and roles, proper behavior in traffic as pedestrians and as passengers in cars, traffic safety and safe driving, the role of transport vehicles in traffic, traffic signs, behavior in different modes of transport and on the way to school, the use of seat belts, child safety seats, and other tools for increased visibility in traffic, and the connection between traffic and environmental pollution.

The activities of the Pasavček project follow the following goals:

- Familiarizing children and parents with the importance of using seat belts and CSS.
- Encouraging consistency in using seat belts and CSS among parents and children.
- Increasing the use of seat belts while driving.
- Teaching children and parents proper behavior and actions of children in traffic.
- Contributing to greater traffic awareness among parents and consequently other passengers.
- Instilling traffic rules through interesting activities for students.

As part of the Pasavček program, we carried out various activities to raise children's awareness about the importance of safe driving and the use of seat belts.

1.1.1 Acquired Knowledge and Skills of Students

Through interactive games, creative workshops, and educational content, we promoted responsible traffic behavior and developed safety habits. Our goal was for children to learn key safe driving rules in a fun and educational way and apply them in everyday life. Children learned the following skills and knowledge:

- Traffic in various situations.
- Proper behavior in traffic as pedestrians and as passengers in cars.
- Traffic safety and safe driving.
- The role of vehicles in traffic.
- Traffic signs.
- Behavior in different modes of transport and on the way to school.
- Use of seat belts.

- Use of child safety seats and other tools for increased visibility in traffic.
- Connection between traffic and environmental pollution.
- Instilling traffic rules through engaging activities for students.

i. Planned and Executed Activities

Throughout the Pasavček project, we carried out various activities that encouraged children to act safely and responsibly in traffic. These activities included[16]:

- Creating traffic signs (Figure **1**).
- Traffic in different situations (Figure **2**).
- Proper behavior in traffic as a pedestrian and as a passenger in a car.
- Traffic safety and safe driving.
- The role of transport vehicles in traffic.
- Behavior in different vehicles and on the road.
- Use of seat belts.
- Use of child safety seats and other visibility tools.
- Traffic and environmental pollution awareness.
- Raising adult awareness about road safety.
- Organizing a traffic corner in the classroom.
- Reading and listening to traffic-related stories.
- Children describing how they come to school and recording the frequency of using seat belts and child seats.
- Belts (tracking cards).
- Observing if children are buckled and using CSS.
- Creating and playing board games with traffic content (Figure **3**).

[16] Ozebek, N.: Končno poročilo Pasavček za šolsko leto 2023/24

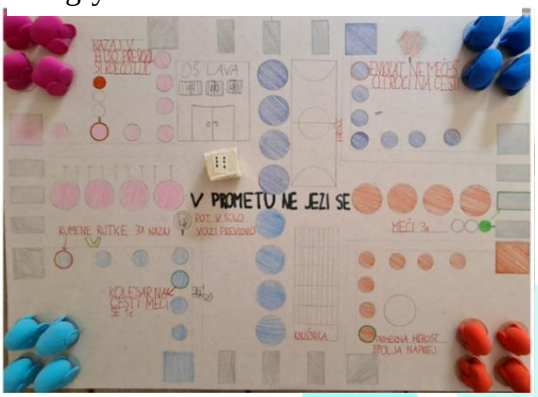
Figure 62: Traffic signs in the corner



Figure 61: Artistic creation – means of transport



Figure 63: Board game – Don't Get Angry in Traffic



2. Description of the Research Process

As part of the research, we systematically recorded whether children were properly buckled with a seat belt or appropriate restraint system while driving. Observations were made as children arrived at school. The collected data allows us to analyze fastening habits and identify potential shortcomings in safety measure usage. Based on the findings, we will propose improvements to raise awareness among parents and children about the importance of safe driving. The research was conducted in two phases, using the observation method to gather comprehensive data on the effectiveness of the Pasavček project. Observations focused on checking the proper use of seat belts and child seats as children were dropped off at school by their parents.

2.1 Description and Results of the Research

The study was carried out in two time periods, November 2024 and March 2025, allowing us to observe changes over the school year. In November 2024, we observed 115 children, and in March 2025, 114 children from various grades at OŠ Lava who participate in the Pasavček project, during the morning from 7:00 to 7:45.

During observations, various mistakes were recorded, such as improperly fastened seat belts, unsuitable CSS sizes according to the child's height or weight, loose or twisted seat belts, and incorrectly installed CSS. We also recorded how many children were properly buckled in appropriate safety seats.

Observed sample included children aged from 6 to 11, arriving with their parents. We expected children to use different types of CSS and seat belts, enabling a diverse data set. After both observation rounds, the results were analyzed and compared.

Table 3: Opazovalna preglednica pri beleženju pripetosti otrok v avtomobilih

Date	Time	Place	Observations				Number of observated childr en	Properly Secured %
			Not buckled	Loose belt	Incorrect size	Properly buckled		
15.11.2024	7.00-7.45	Drop-off parking lot	11	12	5	37	65	57 %
16.11.2024	6.30.-7.45	Drop-off parking lot	9	13	5	23	50	46 %
13.3.2025	7.00-7.45	Drop-off parking lot	1	8	3	46	59	78 %
14.3.2025	6.30.-7.45	Drop-off parking lot	2	1	2	50	55	91 %

Table **1** confirms expectations that, after the activities conducted in March, more children were properly buckled compared to the beginning of the school year in November. In November, there were more errors, such as improperly tightened or twisted seat belts, incorrectly installed child safety seats, or seats of inappropriate size. The improvement observed in March was influenced by additional awareness-raising activities for children, such as collecting stamps for proper buckling. Observing seat belt use before and after the preventive activities within the Pasavček project was crucial for evaluating the program's

effectiveness and understanding its impact on children's traffic safety.[17]

A total of 91% proper usage was achieved, a significant improvement from the initial condition, though still below the best national statistics from the Slovenian Traffic Safety Agency (AVP):

Table 4: Podatki AVP o pripetosti otrok v Sloveniji[18]

Leto	Delež pripetosti otrok
2005	61,2 %
2006	70,6 %
2009	80,2 %
2010	91,7 %
2016	93,3 %
2017	94,8 %
2018	94,3 %
2022	88,6 %

2.2.1 Findings, Challenges, and Suggestions for Improvements

The data showed that 91% of children were properly buckled during driving. The lowest recorded result was 54% unbuckled children, and the improvement after the campaign was 34%, rising from 57% to 91%. Factors influencing non-use include parents being in a hurry, short travel distances, and discomfort for the child.

We found that most parents are aware of the importance of safe driving, but sometimes neglect correct fastening due to daily obligations. Some children and parents complained about the discomfort of seat belts, leading to inconsistent use.

We will continue raising awareness among parents and children via media, posters, and workshops. We will offer educational content that helps children understand the importance of safe driving through play and example. We will encourage parents to set a positive example, as children imitate their caregivers. We aim to strengthen collaboration between educational institutions, parents, and local communities. Some parents believed that short drives don’t pose danger, thus avoiding CSS or seat belts.

3. Conclusion

Seat belts are essential for protecting children in vehicles, as they reduce the risk of serious injuries and fatalities in the event of an accident. Due to their lower body weight and different anatomy, children are more vulnerable, which is why they must use appropriate child safety seats or boosters that ensure correct belt positioning. Parents and caregivers play a key role in ensuring children's safety in vehicles, as consistent use of seat belts and child

[17] https://www.avp-rs.si/preventiva/prometna-vzgoja/programi/pasavcek/#odrasliinuporabavarnostnegapasu

[18] www.avp-rs.si.

seats can prevent severe consequences in accidents. Regardless of the travel distance or speed, a seat belt is crucial for protecting every child in the vehicle.

The Pasavček project is an important contribution to improving the safety of children in traffic. The data we gathered provided insight into children's seat belt habits, while also revealing numerous opportunities for improvement. We believe that with the right approach and continued educational activities, it will be possible to further enhance the safety of our youngest road users.

The Pasavček project not only successfully contributed to raising awareness among children, parents, and teachers about the importance of safe driving and seat belt use, but also provided children with important knowledge about traffic safety in a playful and educational way through planned activities, and helped develop responsible habits as vehicle passengers. The children were curious, enthusiastic about participating in various activities, eager to collaborate, searched for information, and brought in materials. A strong motivator was also tracking seat belt use on a chart and individual cards. They also enjoyed coloring and solving worksheets.

By tracking seat belt use, we gained insight into the actual state of safety system usage, identified opportunities for improvement, and successfully increased seat belt use by a full third, reaching 91%. We believe that the experience gained will contribute to greater traffic safety and the development of lasting, positive behavioral patterns in children and their families. Only through joint efforts can we ensure a safer future for our youngest road users – because "**Always buckle up!**"

4. Sources

OpenAI. (2021). *ChatGPT* (različica 3.5) [Programska oprema]. Pridobljeno s spletne strani https://chatgpt.com/c/67e42edf-c8c4-800a-9745-3c9699f5bace.

Kerkez, V.: Uporaba varnostnega pasu v RS, B/B, Diplomsko delo Višješolskega strokovnega študija, Kranj 2011.

Ozebek, N.: Končno poročilo Pasavček za šolsko leto 2023/24.

https://www.avp-rs.si/preventiva/prometna-vzgoja/programi/pasavcek/#odrasliinuporabavarnostnegapasu, 7.3. 2025.

www.avp-rs.si, 7. 3. 2025.

SIC Ljubljana
Strokovni izobraževalni center Ljubljana

Ptujska ulica 6

1000 Ljubljana

Rajko PALČAR

diplomirani inženir tehnologije prometa

Ljubljana, 29.7.2025

VARNOST V PREDORIH NA CESTNEM OMREŽJU

POVZETEK

Cestni predori predstavljajo eno najzahtevnejših infrastrukturnih rešitev v prometnem inženirstvu. Njihov glavni namen je zagotavljanje prometne povezljivosti na območjih z zahtevnimi geografskimi in topografskimi pogoji, zlasti v gorskih regijah in urbanih območjih z visoko gostoto poselitve. Zaradi svoje zaprtosti in omejenih možnosti za evakuacijo predstavljajo predori tudi specifična tveganja za prometno varnost, med katerimi so najpomembnejši požari, prometne nesreče in motnje v prezračevanju.

Varnost v predorih pa lahko zagotovijo samo ljudje, kot so: načrtovalci predorov in njegovih sistemov, lastniki in tisti, ki skrbijo za obratovanje, ter njegovi uporabniki. Le-ti se poslužujejo raznih predpisov in navodil za načrtovanje in opremljanje predorov, ter tako zagotovijo ustrezno raven varnosti v predoru. Na žalost pa imajo načrtovalci in lastniki le malo vpliva na tisto, kar je verjetno največja grožnja varnosti v predoru, to je obnašanje njegovih uporabnikov.

Namen prispevka je poudariti tista področja, kjer se s sistemskimi rešitvami lahko bistveno prispeva k izboljšanju stanja na področju zagotavljanja prometne varnosti v predorih in v primerih če že pride do izrednih dogodkov zmanjšanje negativnih posledic. Osredotočam se predvsem na preventivne ukrepe v zvezi z načini prezračevanja v predorih.

KLJUČNE BESEDE: predori, varnost v predorih, prezračevanje predorov.

1 Uvod

Za zagotovitev varnostnih ukrepov moramo sprva razmišljati o možnih vzrokih za nastanek nesreče. Tako največjo nevarnost za predor predstavljajo prometne nesreče, požar in razlitje nevarnega tovora.

Varnost v predorih pa lahko zagotovijo samo ljudje, kot so: načrtovalci predorov in njegovih sistemov, lastniki in tisti, ki skrbijo za obratovanje, ter njegovi uporabniki. Le-ti se poslužujejo raznih predpisov in navodil za načrtovanje in opremljanje predorov, ter tako zagotovijo ustrezno raven varnosti v predoru. Na žalost pa imajo načrtovalci in lastniki le malo vpliva na tisto, kar je verjetno največja grožnja varnosti v predoru, to je obnašanje njegovih uporabnikov.

Ker je požar po naravi zelo nepredvidljiv in je za njegovo nastanek možnih nešteto vzrokov, je potrebno v predoru razmišljati o tem, kako preprečiti njegov nastanek oz. omejiti njegovo širjenje po predoru in pri tem upoštevati varno evakuacijo ljudi.

Med protipožarne sisteme za zagotavljanje požarne varnosti v predoru, štejemo tako preventivne kot aktivne ukrepe.

Preventivni ukrepi so vsi gradbeni, tehnološki, tehnični in organizacijski ukrepi, ki se upoštevajo že pri načrtovanju predora ter zmanjšujejo možnost nastanka požara in preprečujejo njegovo širjene in ti so:

- primeren odtočni sistem in prečni profil, s katerim se zmanjša površina, ki jo ima polita tekočina na voljo za gorenje,
- evakuacijske poti, ki vodijo na varno,
- primerno urejeno prezračevanje za odvod dima in toplote v primeru požara,
- oprema, ki prenese visoke temperature oz. požarno odporni materiali,
- izbira primernega materiala za vozno površino
- krizni management (za primere nesreče ustrezni alarmni in reševalni načrt).

Aktivni ukrepi pa so vsi tehnični in tehnološki ukrepi, ki so namenjeni za gašenje požara in njegovo odkrivanje kot so:

- avtomatski in ročni javljalniki požara,
- telefonski sistemi za klic v sili,
- ročni gasilni aparati in hidrantno omrežje,
- zasilna razsvetljava,
- video nadzorni sistemi (dim, temperatura, nesreča),
- stabilni sistemi za odkrivanje in gašenje požara kot so sprinkler, vodna megla in vodna zavesa.

Najbolj učinkoviti ukrepi so seveda vzdrževanje opreme, pripravljeni postopki za ukrepanje v sili ter redno usposabljanje in vaje, s katerimi se zagotavlja, da so vsi udeleženci seznanjeni s svojimi vlogami, nalogami in odgovornostmi v primeru nesreče ter s sistemi, ki zaznajo

požar že ob njegovem nastanku, saj je najbolj pomembnih prvi nekaj minut od izbruha požara.

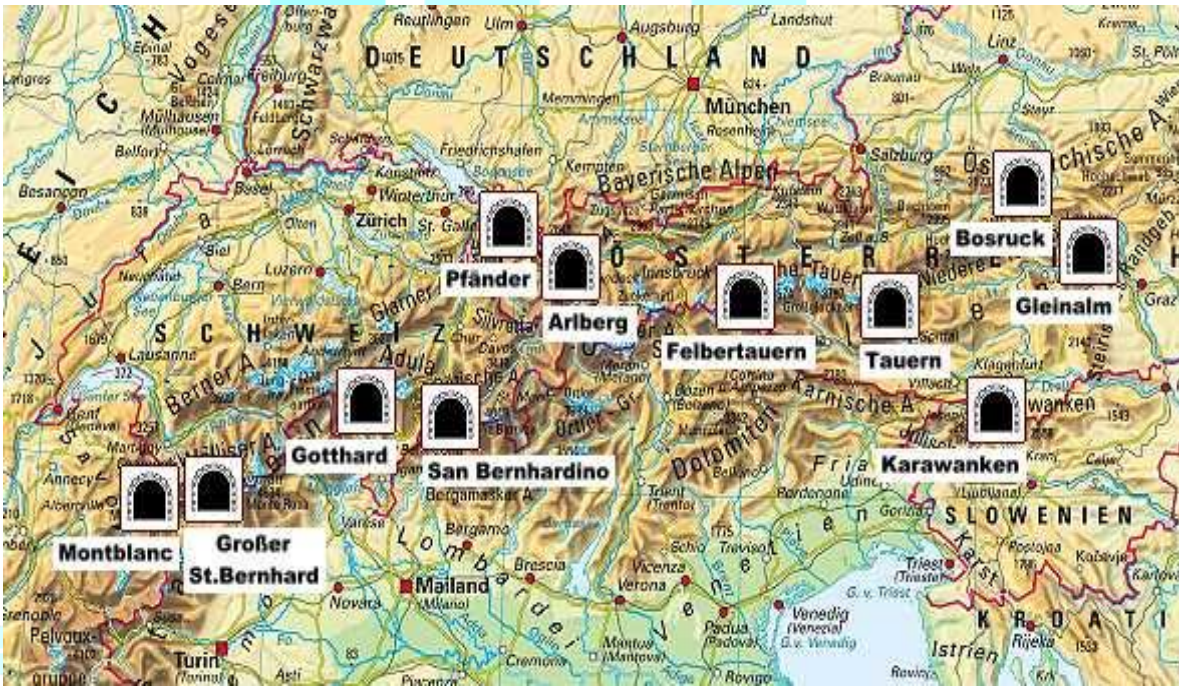
Za novo grajene in obnovljene cestne predore, se mora vgrajena strukturna in tehnična varnost ravnati po pravilih nacionalnih in internacionalnih priporočil, smernic ali standardov. Varnost pa je lahko učinkovita le z dobro medsebojno povezavo z reševalnimi službami in pravilnim obnašanjem uporabnikov ceste. V tej povezavi ima nadzor prometa in kontroliranje s strani policije ali ostalih primernih služb preventivni učinek. Kakorkoli, redni in temeljit nadzor s strani operaterjev predora in policije ne more popolno eliminirati nastanek nesreč in požara v predoru.

Največjo nevarnost v predoru predstavljajo požari, ki pa so na srečo redki, ampak ko izbruhnejo lahko privedejo do katastrofalnih posledic, kot se je to že pokazalo v preteklosti. Zaradi tega, so se v nekaterih državah odločili izdelati projekte, študije in smernice, ki bi zagotovile večjo varnost v predoru in s tem posredno tudi požarno varnost.

Požar v predoru ne ogroža samo udeležencev predora, ampak tudi povzroči škodo na konstrukciji predora in njegovi opremljenosti, kar ima lahko dolgotrajne posledice.

Tako je glavni namen zagotavljanja varnosti, preprečiti nesreče v predoru in določiti primerna merila za uporabnike predora, da se lahko sami rešijo ali so rešeni s strani reševalnih ekip.

V nadaljevanju so s strani institucij, organizacij in ustanov, ki se ukvarjajo s tematiko varnosti v predorih podani sistemi in varnostni ukrepi, ki pripomorejo k izboljšanju varnosti v cestnih predorih.



Slika 1: Predori, ki predstavljajo pomembno prometno povezavo v Alpskem svetu Evrope.

Vir: internet

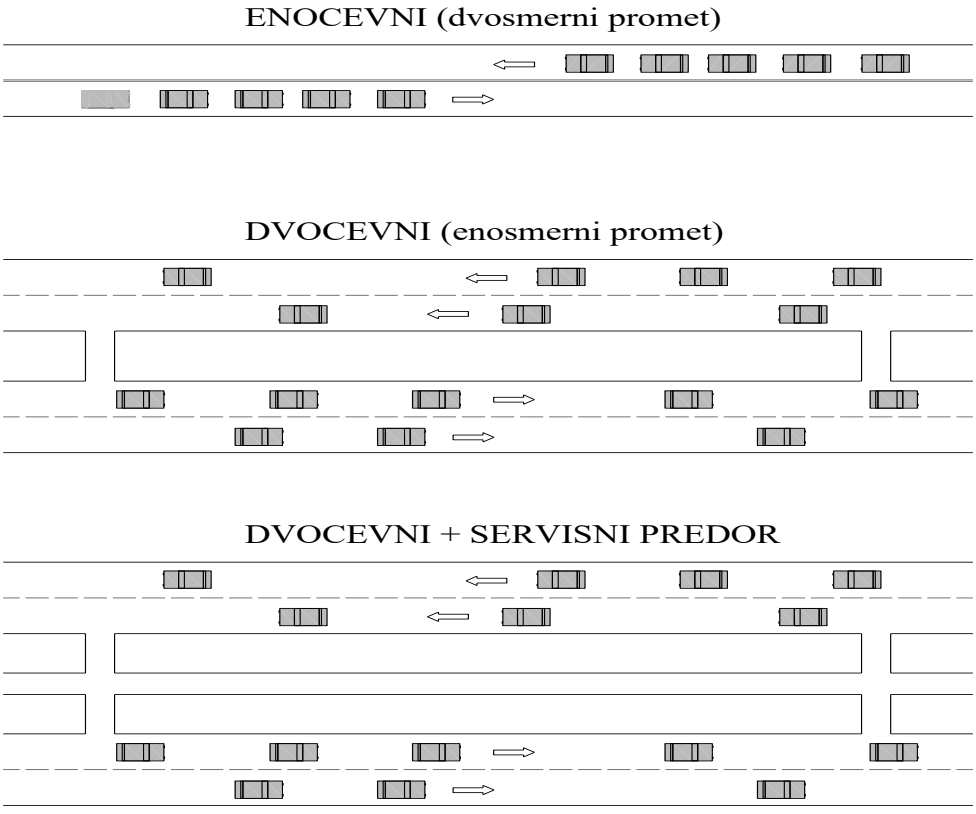
2. Sistem predora

2.1 Primerjava enocevnega predora z dvocevnim iz vidika varnosti

Praviloma so enosmerni dvocevni predori varnejši, saj ni nasprotnega prometa. V dvocevnih predorih se še navadno uredijo prečini povezovalni predori, ki se uporabljajo za evakuacijo in reševanje. V daljših predorih naj bodo ti prečni povezovalni predori ne samo prehodni ampak tudi prevozni. Vendar imajo dvocevni predori to slabost, da omogočajo večji pretok vozil in s tem tudi večje hitrosti v predoru, kar ima lahko za posledico več nesreč. Pri tem pa nastaneta v primeru nesreče dve koloni vozil, ki ujameta dvakratno število vozil v primerjavi z nesrečo v dvosmernem predoru (enocevni predor).

Vendar se v vedno večji meri gradijo dvocevni (enosmerni) predori, ki so bodisi novo grajeni ali dodani k obstoječemu enocevnemu predoru.

Po evropskih priporočilih bi se naj enocevni predori gradili le tam, kjer je želimo umiriti promet v predoru.



Slika 2: Sistem različnih vrst predora

Vir.internet

2.2 Ureditev vozišča

Širina prometnih pasov naj bo takšna kot določa kategorija ceste, katera je speljana skozi predor.

2.3 Odstavni pas

Zaradi velikih stroškov, ki se povečajo pri izgradnji predora, je ta sprejemljiv le pod določenimi ekonomskimi in prometnimi pogoji. Navadno se ti uredijo v predorih s povečano prometno obremenitvijo.

2.4 Odstavne niše

Odstavne niše se predvidijo tam, kjer ni odstavnega pasu in so pomemben varnostni ukrep. Morajo meriti v dolžino vsaj 40 m in v širino 3 m. Njihov namen je, zagotoviti varnost udeležencem prometa ob njihovi okvari vozila. V predoru z dvosmernim prometom se lahko uredijo tako, da omogočajo obračanje vozil. Priporočljiva medsebojna oddaljenost med odstavnimi nišami je po RABT največ 600 m ter minimalne zahteve s strani EU podajajo največjo razdaljo 1000 m. Dobro bi bilo, če bi bile urejene s potrebnimi gasilniki in sistemom, za klic v sili.

2.5. Možnost obračanja vozil

Obračališča za vozila se uredijo iz varnostih razlogov, tako da v primeru neposredne nevarnosti se lahko vozila obrnejo v nasprotno smer in zapustijo predor čim hitreje. To pa ne bi bilo dobro izvesti v predorih z enosmernim prometom, saj bi tako obstajala velika možnost čelnih trčenj.

2.6 Hodniki za pešce z ureditvijo pločnika

V predoru je potrebno zagotoviti varnost gibanja udeležencev, uslužbencev ali vzdrževalcev. To lahko zagotovimo tudi s pomočjo pločnika, ki je urejen na obeh straneh konca cestišča (slika 3).



Slika 3: Primer izvedbe pločnika v predoru Mont Blanc

Vir:internet

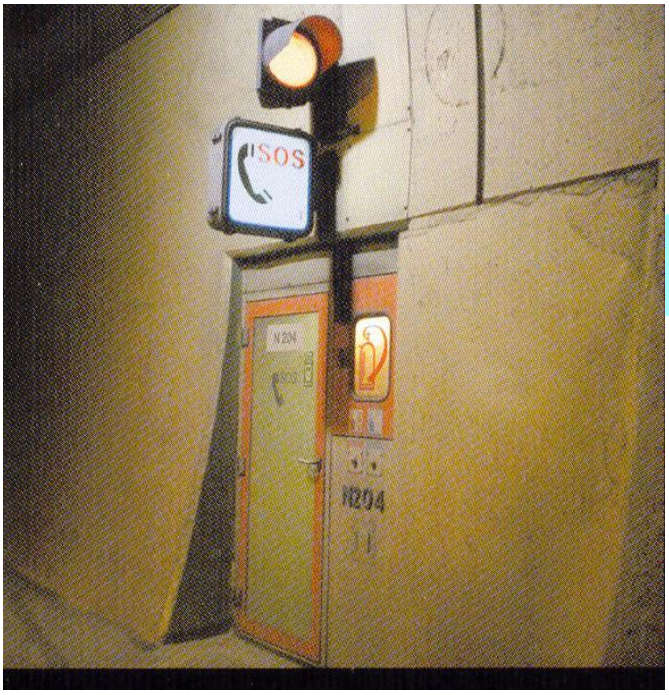
Zaradi preprečitve nesreč, naj bodo robniki dvignjeni za najmanj 7 cm (po RVS 9.821 za 15 cm) ter pločnik širok najmanj 1 m. Zagotoviti moramo prostor v višino, ki meri 2,25 m zaradi normalnega gibanja oseb. Višino dviga pločnika je potrebno upoštevati pri tem, da v primeru nevarnosti ali nesreče lahko udeleženci ceste ali poškodovani izstopijo iz vozila na sovoznikovi strani, tako da ne ogrožajo sebe in mimoidočega prometa.

Za zagotovitev večje varnosti se še lahko na pločniku namestijo cestni smerniki, mačja

očesa, svetlobne diode oz. lahko se uredi varnostna ograja, ki mora biti visoka 1,2 m, kar omogoča varno gibanje ljudi in preprečuje trk vozil s konstrukcijo predora.

2.7 Niše za klic v sili

Udeleženci predora lahko v primeru nevarnosti posredujejo nevarnost in s tem njihovo lokacijo operaterjem predora. V nišah za klic v sili (slika 4) je nameščen telefon za klic v sili ter potrebni gasilniki in ročni javljalnik požara. Pri odprtju vrat se mora v komandnem prostoru sprožiti signal in če je predvidena opozorilna luč se mora le-ta vklopiti in tako opozori prihajajoč promet na nevarnost,s čemu se mora prilagoditi signalizacija v predoru. Kako so te niše opremljene in med seboj oddaljene je odvisno po katerih smernicah se zgledujemo.V splošnem velja, da so opremljene s tipko za ročno javljanje požara in dvema gasilnikoma ter naj ne bi bile med seboj oddaljene več kot 150 m in dodatno nameščene še na začetku in koncu evakuacijskih poti ter na vsaki odstavni niši.



Slika 4: Niša za klic v sili

Vir:internet

Niše so zaprte z vrati, ki so požarno odporne in protihrupne. Zaradi večje obratovalnosti, bi bilo dobro,da je sistem klica povezan z lastnimi požarno odpornimi kabli z komandnim prostorom, saj tako zagotovimo hiter in varen prenos podatkov.

2.8. Protipožarna niša

Urejene imamo tudi protipožarne niše, kjer se nahaja oprema za gašenje požara. Ta vsebuje hidrant, povezan na hidrantno omrežje s cevjo in ročnikom ter ročne gasilnike in po možnosti še priključek za vodo za gasilce.



Slika 5: Protipožarna niša.

Vir:internet

2.9 Razsvetljava v predoru

V predoru moramo zagotoviti ″dobro″ vidljivost po celotni njegovi dolžini, kar pomeni, da je dobro vidna opremljenost predora ter da ima voznik zmožnost zelo hitrega prepoznavanja potencialne nevarnosti. Dobra osvetljenost pripomore k temu, da uporabniki predora ne občutijo klastrofobije in da ne predstavlja zastrašujočega temnega objekta. Pri vstopu v predor mora biti osvetljenost predora močnejša (predor Karavanke 100x), saj se oko ne more takoj prilagoditi svetlobi. Pri tem uporabimo za merjenje zunanje osvetljenosti fotometre, ki avtomatsko prilagajajo posamezne stopnje osvetlitve.

Za razsvetljavo se v večini primerov uporabljajo stropne svetilke, kar nam predstavlja točkovno osvetlitev.

Za predorsko razsvetljavo je ugodna namestitev krmilnega procesorja, kjer je osnova časovni program in se upoštevajo tudi izjemna stanja.

Stene znotraj predora in cestna površina morajo znotraj predora imeti visoko odbojno jakost razpršene svetlobe. To nam omogoča možnost prihranka na energiji, zmanjša nam število potrebnih svetilk in zagotavlja visoko osvetljenosti tudi v zasenčenih delih.

Pri tem pa ne smemo pozabiti na redno čiščenje, vzdrževanje in zamenjavo uporabljenih svetil.

2.10 Odvodnjavanje

Sistem primerno urejenega odvodnjavanja je zelo pomemben pri preprečevanju in kontroliranju požara v predoru z ali brez instaliranega avtomatskega sistema gašenja. Odvodnjavnje zagotavlja varen promet in zmanjšuje možnost vžiga snovi, odstranjuje tekoče in gorljive snovi po nesreči ali med požarom, ter varno shranjuje in odstranjuje nevarne tekočine brez možnosti samovžiga. Minimalni kriterij odvodnjavanja v predoru je:

- cestišče mora biti zaključeno in ne nagnjeno na samo eno stran, tako da odpadna voda ne poteka čez prometne pasove
- odvodni kanali izvedeni na obeh straneh cestišča
- izvedena prečna rešetka za lovljenje deževnice ali ostalih razlitij znotraj predora
- rešetke oz. luknje za odtekanje vode ali zbiralne posode morajo biti urejene tako, da

imajo možnost čiščenja[19]

Zaradi nevarnosti razlitja bencina ali olja, kateri lahko zaradi svoje količine povzročijo eksplozivno atmosfero v zbiralniku in veliko varnostno tveganje, so zbiralniki opremljeni s prezračevanjem in senzorji, ki odkrivajo nastajanje ogljikovega vodika ter bodo zagotovili z avtomatskim zaščitnim ukrepom nastajanje eksplozivne atmosfere.

Izračun pričakovanih dotokov vsebuje podrobno raziskavo lastnost in obsežnosti:

- podzemne vode in odvodnjavanja v predoru,
- deževnice,
- odpadne vode od čiščenja zidov predora,
- vode pridobljene z gašenjem in izpiranje nevarnih razlitij.

2.11 Prezračevanje v predoru

Sistem prezračevanja se predvidi že pri samem projektiranju predora. Zagotavljati mora dotok svežega zraka v vseh predelih predora, s tem pa uravnavati koncentracijo izpušnih plinov in posredno vidljivost v predoru.

Prezračevanje v predoru se mora ločiti na normalno delovanje in na delovanje v primeru požara. Slednje je obravnavano nekoliko kasneje.

Na splošno ločimo prezračevalni sistem na vzdolžno, polprečno, prečno in kombinirano prezračevanje. Slednje lahko opazimo v predoru Karavanke, kjer je kombinacija vzdolžnega (na sredini predora) in prečnega (od sredine levo in desno) prezračevanja.

Vzdolžno prezračevanje

Pri vzdolžnem prezračevanju ločimo :

Naravno prezračevanje

To prezračevanje ne potrebuje opremljenosti s prezračevalnim sistemom. Prezračevanje so zagotovi na podlagi različnih meteoroloških potencialov tlaka med portaloma in s pomočjo vozil, ki povzročijo izmenjavo zraka v predoru.

Mehansko prezračevanje

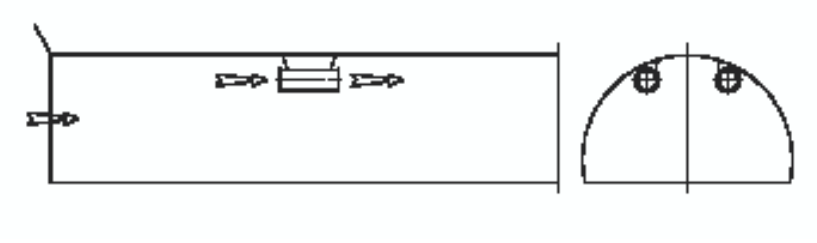
Vzdolžno prezračevanje se ustvari s ustvarjanjem zračnih tokov vzdolž predora skozi prekrivanjem batnega učinka vozil, meteoroloških potencialov med portaloma, tlaka zraka in delovanja ventilatorjev. V normalnem delovanju služi za razredčitev izpušnih plinov in se lahko uporablja v primeru požara za odvajanje dima.

Mehansko prezračevanje se lahko uredi na dva načina:

- vzdolžno prezračevanje z aksialnimi ventilatorji

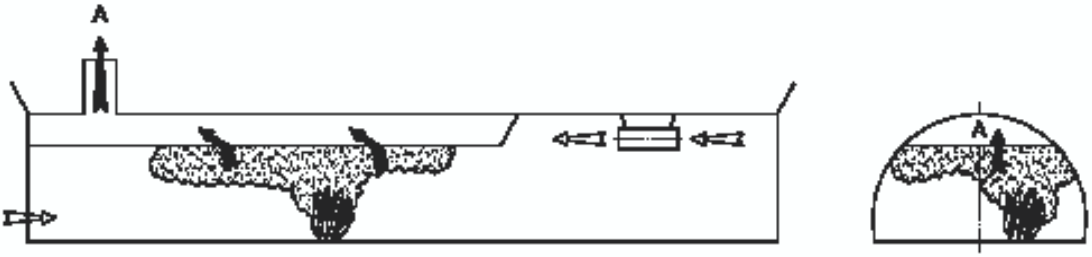
Ti ustvarjajo vzdolžni pretok zraka skozi predor (slika 6).Ta sistem je primeren za kratke predore s dvosmernim prometom in za predore poljubne dolžine s dvosmernim prometom., kjer pa je zraven še potrebno urediti za primere požara odsesovanje zraka v predoru (slika 7). Dolgi enosmerni predori pa so v primeru normalnega delovanja razdeljeni preko postaj

za izmenjavo zraka.



Slika 6: Vzdolžno prezračevanje s aksialnimi ventilatorji

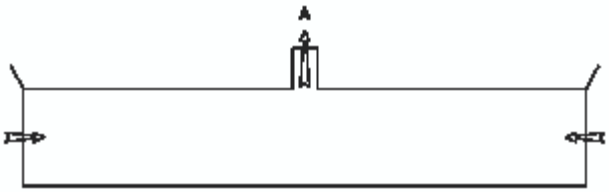
Vir:internet



Slika 7: Vzdolžno prezračevanje in odsesavanje zraka v primeru požara

Vir:internet

Pri tem sistemu vzdolžnega prezračevanja se ustvarita s pomočjo odsesovanja zraka v sredini predora dva zračna tokova od portala do odsesovalnega mesta (slika 8). Pretežno so primerni za predore z dvosmernim prometom, še posebno tam, kjer je potrebno odsesavanje emisij v predoru. Od določene dolžine predora se morajo upoštevati dodatne zahteve za odsesovanje dima v primeru požara Ker pa promet v obeh smereh ni nikoli izenačen, vpliva to na pretok zraka v predoru, za kar se mora pravilno dimenzionirati odsesovalni učinek, če se ne namestijo dodatni aksialni ventilatorji, ki izenačijo vzdolžno prezračevanje.



Slika 8 : Vzdolžno prezračevanje skozi središčno odsesovanje

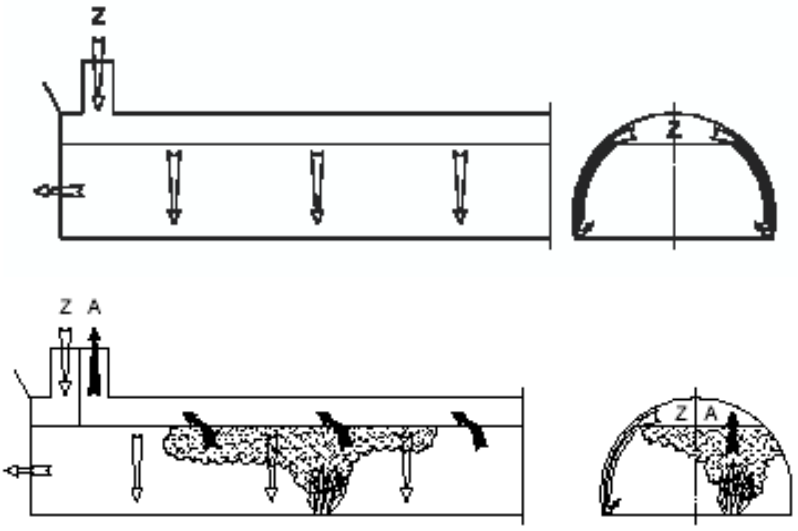
Vir:internet

Polprečno prezračevanje

Pri tem prezračevanju se dovaja zrak (Z) preko ločenega kanala nameščenega vzdolž predora (slika 9). Kanal se lahko namesti odzgoraj, odspodaj ali ob straneh predorskega prostora.

Odprtine za dovod zraka so nameščene v bližini vozišča v medsebojni oddaljenosti ≤ 20 m. Hitrost vstopnega zraka lahko znaša ob normalnih pogojih do 10 m/s, medtem, ko v primeru požara ne sme preseči 3 m/s. Odpadni zrak se navadno odvaja izven predora skozi portale.

V dolgih predorih lahko v enem prezračevalnem sektorju razdeljeno polprečno prezračevanje predstavlja ekonomsko alternativo k vzdolžnem prezračevanju, ampak samo v kombinaciji z dimnim kanalom (A) .

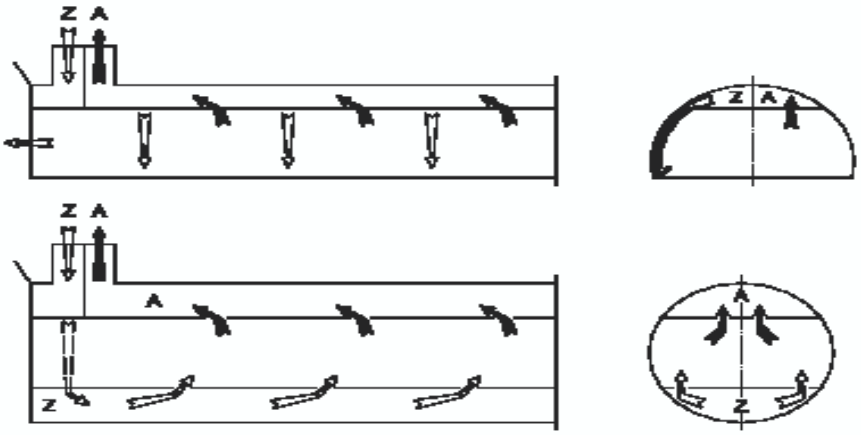


Slika 9: Polprečno prezračevanje

Vir:internet

Prečno prezračevanje

Pri prečnem prezračevanju (slika 10) se dovodni zrak (Z) dovaja preko ločenega razdeljenega kanala, ki pripada prometnemu prostoru. Zaradi možnosti požara se dovodni zrak dovaja od spodaj in odpadni zrak se odsesava preko stropa iz prometnega prostora. Odsesovalne odprtine se morajo urediti po merilih, ki zagotavljajo različne zahteve v normalnih in izjemnih (požar) pogojih. Dandanes se še prečno prezračevanje uporablja samo za dolge predore, kjer izgradi polkrožni predorski profil, in kjer zaradi imisijskih razlogov zrak v predore ne odvaja preko portalov.



Slika 10: Prečno prezračevanje

Vir:internet

Kombinacija prezračevalnega sistema

Posebni robni pogoji lahko pripomorejo, da se namestijo različni prezračevalni sistemi. Kombinacija različnega prezračevalnega sistema pripelje do optimalnih rešitev. Pri vsakem izbori prezračevalnega sistema je prvotna naloga, najbolje izkoristiti naravno vzdolžno prezračevanje, ki ga ustvari promet.

3. Zaključek

Varnost v cestnih predorih je večplastna in zahteva celosten pristop, ki združuje tehnološke rešitve, upravljanje tveganj, zakonodajne okvirje in človeški dejavnik. Napredne tehnične rešitve, kot so vzdolžni in prečni sistemi prezračevanja, avtomatsko zaznavanje incidentov, videonadzor, senzorika dima in toplote ter sodobni sistemi za usmerjanje prometa, predstavljajo ključni temelj za preprečevanje in obvladovanje izrednih dogodkov. Vendar sama tehnologija ne zadostuje – izkušnje kažejo, da se učinkovitost sistemov bistveno poveča šele z ustrezno organizacijo intervencij, usposobljenostjo gasilskih in reševalnih enot ter z doslednim usposabljanjem uporabnikov predorov.

Pravna in regulativna ureditev na evropski in nacionalni ravni določa minimalne standarde (Direktiva 2004/54/ES, nacionalni pravilniki), vendar pa praksa kaže, da je nujno presegati zgolj zakonske zahteve ter uvajati najboljše razpoložljive tehnologije (BAT – Best Available Technologies). Prihodnost varnosti v cestnih predorih bo zaznamovana z digitalizacijo in avtomatizacijo: uporaba umetne inteligence za napovedovanje tveganj, digitalni dvojčki za simulacijo scenarijev požarov in evakuacij ter integracija s sistemi pametne mobilnosti bodo omogočili še hitrejše in bolj natančne odzive.

Nenazadnje pa se vedno znova izkaže, da je človeški dejavnik odločilen: varnostna kultura, upoštevanje cestnoprometnih pravil vožnje, pravilno ravnanje uporabnikov ob nesreči in zaupanje v navodila reševalnih služb lahko bistveno zmanjšajo posledice nesreč. Zato morajo prihodnje strategije poudarjati tudi izobraževanje in ozaveščanje voznikov, saj je varnost v predorih v enaki meri odvisna od tehnike kot tudi od ljudi.

4.Viri in literatura:

- PIARC (2020). *Road Tunnels: Operational Safety*. World Road Association.
- Evropska komisija (2004). Direktiva 2004/54/ES o minimalnih varnostnih zahtevah za predore v TEN-T.
- Uprava RS za zaščito in reševanje (2021). *Vaje in protokoli v cestnih predorih*.
- DARS d.d. (2022). *Letno poročilo o varnosti v predorih*. Ljubljana.
- Baber, C. (2018). *Human Factors in Tunnel Safety*. Springer.
- National Fire Protection Association (NFPA 502: 2020). *Standard for Road Tunnels, Bridges, and Other Limited Access Highways*.

SIC Ljubljana
Strokovni izobraževalni center Ljubljana

Ptujska ulica 6

1000 Ljubljana

Rajko PALČAR

graduate traffic technology engineer

Ljubljana, 29 July 2025

SAFETY IN TUNNELS ON THE ROAD NETWORK

ABSTRACT

Road tunnels are among the most demanding infrastructural solutions in traffic engineering. Their primary purpose is to ensure traffic connectivity in areas with demanding geographic and topographic conditions, especially in mountainous regions and densely populated urban areas. Because they are enclosed and evacuation possibilities are limited, tunnels also present specific road safety risks, the most important of which are fires, traffic accidents and ventilation failures.

Safety in tunnels can be ensured only by people, namely tunnel and systems designers, owners and operators, and the users. They rely on a variety of regulations and guidelines for the design and equipment of tunnels, in order to provide an adequate safety level in the tunnel. Unfortunately, designers and owners have little influence on what is probably the greatest threat to tunnel safety, the behavior of its users.

The aim of this paper is to highlight those areas where systemic solutions can significantly improve the state of road tunnel safety and, if an incident does occur, reduce the negative consequences. I focus mainly on preventive measures related to tunnel ventilation modes.

KEYWORDS: tunnels, tunnel safety, tunnel ventilation.

1 Introduction

To provide safety measures we must first consider possible causes of an accident. The greatest hazards for a tunnel are traffic accidents, fire and spills of dangerous goods.

Safety in tunnels can be ensured only by people, namely tunnel and systems designers, owners and operators, and the users. They rely on various regulations and guidelines for the design and equipment of tunnels, in order to provide an adequate level of safety in the tunnel. Unfortunately, designers and owners have little influence on what is probably the greatest

threat to tunnel safety, the behavior of its users.

Because fire is highly unpredictable and there are countless possible causes for its outbreak, it is necessary in a tunnel to think about how to prevent its ignition or limit its spread, while ensuring the safe evacuation of people.

Fire protection systems for ensuring fire safety in a tunnel include preventive and active measures.

Preventive measures

- a suitable drainage system and cross section, which reduce the area available for burning of spilled liquids,
- evacuation routes that lead to a safe place,
- properly arranged ventilation for smoke and heat extraction in the event of a fire,
- equipment that can withstand high temperatures, that is fire resistant materials,
- selection of appropriate pavement material,
- crisis management, appropriate alarm and rescue plans for accident scenarios.

Active measures

- automatic and manual fire detectors,
- emergency telephone systems,
- portable fire extinguishers and the hydrant network,
- emergency lighting,
- video surveillance systems, smoke, temperature, incident,
- fixed fire detection and suppression systems, such as sprinklers, water mist and water curtains.

Most effective measures and organization

The most effective measures are the maintenance of equipment, prepared emergency procedures and regular training and drills. These ensure that all participants are familiar with their roles, tasks and responsibilities in the event of an incident, and with systems that detect fires at their very start, since the first minutes after ignition are the most important.

For newly built and rehabilitated road tunnels, the installed structural and technical safety must follow national and international recommendations, guidelines or standards. Safety is effective only with good coordination with emergency services and proper behavior of road users. Traffic monitoring and enforcement by the police or other appropriate services has a preventive effect. However, regular and thorough supervision by tunnel operators and the police cannot completely eliminate the occurrence of accidents and fires in tunnels.

The greatest danger in a tunnel is fire, thankfully rare, but when it breaks out it can lead to catastrophic consequences, as the past has shown. For this reason, some countries have undertaken projects, studies and guidelines to provide greater tunnel safety and, indirectly,

fire safety.

A tunnel fire does not endanger only the users, it also causes damage to the tunnel structure and its equipment, which can have long lasting consequences.

The main purpose of safety is to prevent accidents in the tunnel and to set appropriate criteria for tunnel users, so that they can rescue themselves or be rescued by emergency teams.

Below, institutions and organizations that deal with tunnel safety present systems and safety measures that help improve safety in road tunnels.

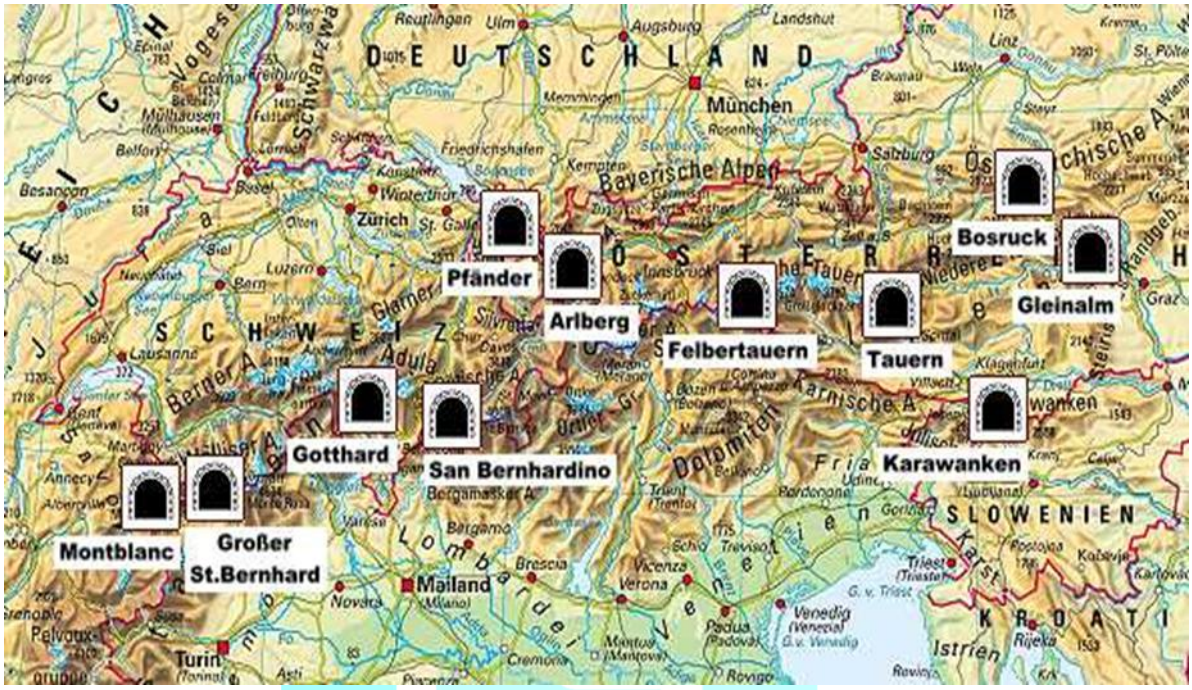


Figure 1: Tunnels that represent important transport links in the Alpine region of Europe.SOURCE: website

2. Tunnel system

2.1 Comparison of single tube and twin tube tunnels from the safety point of view

As a rule, one way twin tube tunnels are safer, since there is no opposing traffic. In twin tube tunnels, cross passages are usually provided and used for evacuation and rescue. In longer tunnels, these cross passages should be not only walkable, but drivable as well. However, twin tube tunnels allow a higher traffic flow and therefore higher speeds, which can lead to more accidents. In addition, in the event of an accident, two vehicle queues form, trapping twice as many vehicles as in an accident in a two way tunnel, that is a single tube.

Nevertheless, twin tube, one way, tunnels are being built increasingly, either as new construction or as a second tube added to an existing single tube tunnel.

According to European recommendations, single tube tunnels should be built only where calming traffic in the tunnel is desired.

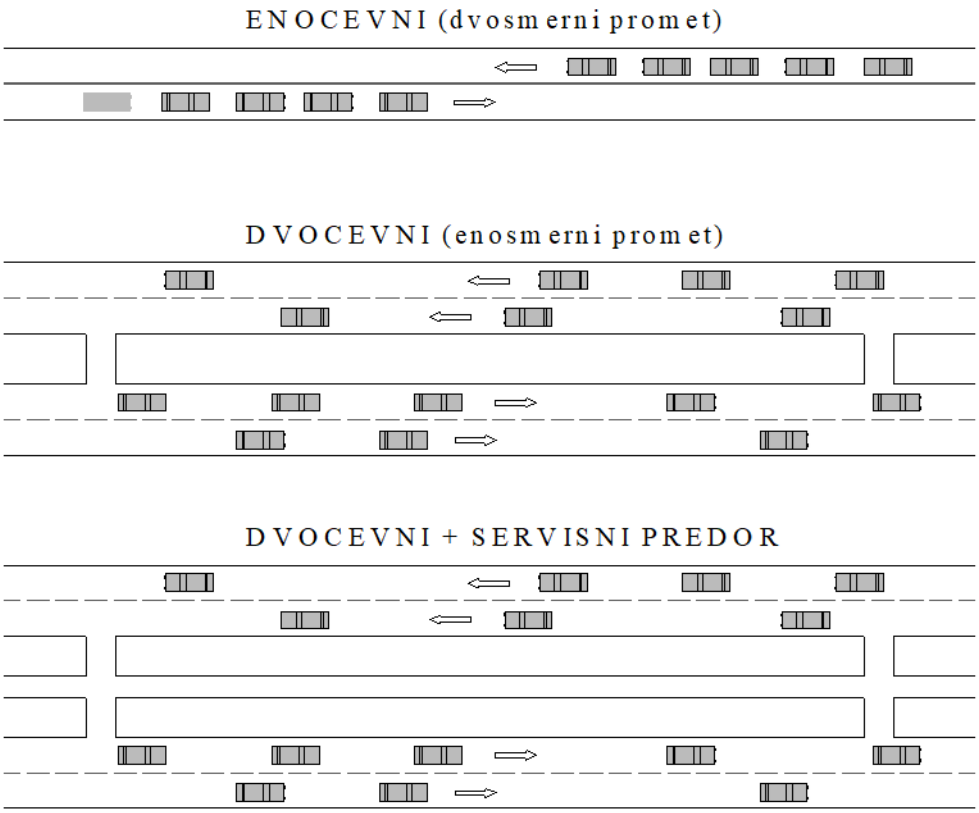


Figure 2: System of different tunnel types.

SOURCE: website

2.2 Roadway arrangement

The width of the traffic lanes should be in accordance with the road category that passes through the tunnel.

2.3 Hard shoulder

Due to high costs that increase with tunnel construction, the hard shoulder is acceptable only under certain economic and traffic conditions. It is usually provided in tunnels with increased traffic load.

2.4 Lay by bays

Lay by bays are planned where there is no hard shoulder and are an important safety measure. They should be at least 40 m long and 3 m wide. Their purpose is to provide safety to road users in case of a vehicle breakdown. In a two way tunnel they can be arranged to allow vehicles to turn around. The recommended distance between lay bys is at most 600 m according to RABT, and the minimum EU requirement sets a maximum spacing of 1000 m. It is advisable to equip them with extinguishers and an emergency call system.

2.5 Possibility of turning vehicles

Turning areas are arranged for safety reasons, so that in case of immediate danger vehicles can turn around and leave the tunnel as quickly as possible. This is not advisable in one way tunnels, since it would create a high risk of head on collisions.

2.6 Pedestrian corridors with a sidewalk

In a tunnel it is necessary to ensure safe movement of users, staff and maintenance workers. This can be provided by a sidewalk installed on both sides at the edge of the carriageway, see Figure 3.



Figure 3: Example of sidewalk arrangement in the Mont Blanc tunnel.

SOURCE: website

To prevent accidents, kerbs should be raised by at least 7 cm, under RVS 9.821 by 15 cm, and the sidewalk should be at least 1 m wide. A clear height of 2.25 m must be provided for normal movement of people. The height of the raised sidewalk must be considered so that, in case of danger or an accident, road users or injured persons can exit the vehicle on the passenger side without endangering themselves or passing traffic.

For greater safety, delineators, cat's eyes or light emitting diodes can be installed on the sidewalk, or a safety barrier can be provided, 1.2 m high, which allows safe movement and prevents vehicle impacts with the tunnel structure.

2.7 Emergency call niches

In case of danger users can report the hazard and their location to the tunnel operators. Emergency call niches, see Figure 4, contain an emergency telephone, extinguishers and a manual fire alarm. When the door is opened a signal must be triggered in the control room and, if a warning light is provided, it must switch on and warn approaching traffic of the hazard, the tunnel signaling must then be adapted. The equipment and spacing of these niches depends on the guidelines followed. In general, they are equipped with a manual fire alarm button and two extinguishers, and the distance between them should not exceed 150 m, with additional installations at the start and end of evacuation routes and at each lay by.

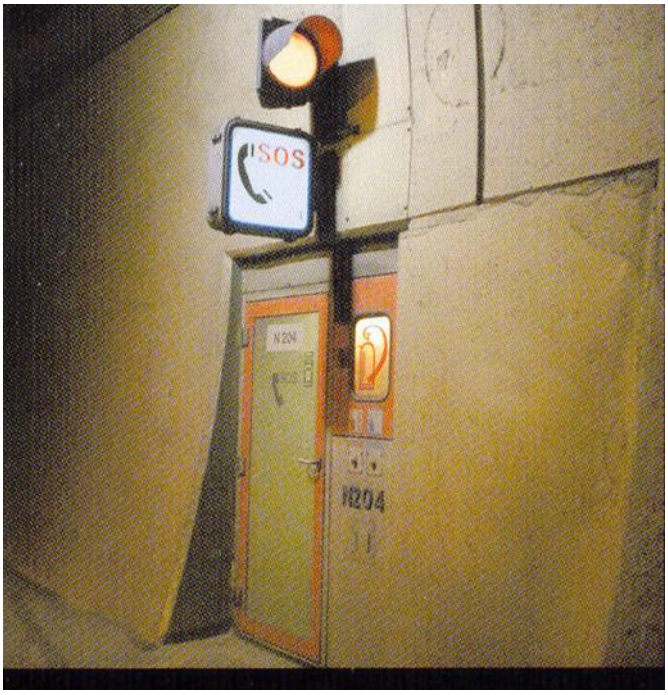


Figure 4: Emergency call niche.

SOURCE: website

The niches are closed with doors that are fire resistant and sound proof. For greater reliability it is advisable that the call system is connected to the control room with its own fire resistant cables, this ensures fast and safe data transmission.

2.8 Fire fighting niche

Fire fighting niches contain fire extinguishing equipment. This includes a hydrant connected to the hydrant network with a hose and nozzle, portable fire extinguishers and, if possible, an additional water connection for firefighters.



Figure 5: Fire fighting niche.

SOURCE: website

2.9 Tunnel lighting

Good visibility must be ensured along the entire length of the tunnel. This means that the tunnel equipment is clearly visible and that the driver can very quickly recognize potential danger. Good lighting helps users avoid claustrophobia and prevents the tunnel from being perceived as a frightening dark object. At the portal, the tunnel must be more strongly lit, for example Karavanke tunnel 100 times, since the human eye cannot adjust to the light

immediately. Photometers are used to measure outdoor illumination and automatically adjust the lighting levels.

In most cases, ceiling mounted luminaires are used, which provide point lighting.

For tunnel lighting, a control processor is favorable. The base is a time program and exceptional states are also taken into account.

The walls and pavement inside the tunnel must have high diffuse reflectance. This enables energy savings, reduces the number of luminaires needed and provides high illumination even in shaded areas.

Regular cleaning, maintenance and replacement of luminaires must not be overlooked.

2.10 Drainage

A properly arranged drainage system is very important for preventing and controlling fires in tunnels, whether or not an automatic extinguishing system is installed. Drainage ensures safe traffic, reduces the possibility of ignition, removes liquid and flammable substances after an accident or during a fire, and safely stores and removes hazardous liquids without the possibility of self ignition. The minimum drainage criteria in a tunnel are:

Minimum drainage criteria

- the carriageway must be cambered, not sloped to only one side, so that runoff does not flow across the traffic lanes,
- drainage channels must be installed on both sides of the carriageway,
- a transverse grate must be installed to capture rainwater or other spillages inside the tunnel,
- grates or holes for water runoff or collection tanks must be arranged so that they can be cleaned.

Additional drainage considerations

Because of the risk of spilled petrol or oil, which, due to their quantity, can cause an explosive atmosphere in the collector and a large safety risk, the collectors are equipped with ventilation and sensors that detect the formation of hydrocarbons, they will trigger automatic protective actions to prevent the creation of an explosive atmosphere.

The calculation of expected inflows includes a detailed investigation of the properties and magnitude of:

Inflows to consider

- groundwater and drainage in the tunnel,
- rainwater,
- wastewater from washing tunnel walls,
- water used for firefighting and for flushing hazardous spills.

2.11 Tunnel ventilation

The ventilation system is designed already at the tunnel design stage. It must ensure a supply

of fresh air in all parts of the tunnel, regulating the concentration of exhaust gases and, indirectly, visibility.

Tunnel ventilation must be divided into normal operation and operation in the event of a fire. The latter is discussed later.

In general we distinguish longitudinal, semi transverse, transverse and combined ventilation. The Karavanke tunnel is an example of a combination, longitudinal in the middle section of the tunnel and transverse from the middle to both portals.

Longitudinal ventilation

Within longitudinal ventilation we distinguish:

Natural ventilation

This ventilation does not require mechanical equipment. Ventilation is provided by meteorological pressure difference between portals and by the piston effect of vehicles, which creates air exchange in the tunnel.

Mechanical ventilation

Longitudinal ventilation is created by generating air flows along the tunnel that overlap the piston effect of vehicles, the meteorological pressure difference between portals and the action of fans. In normal operation it dilutes exhaust gases and it can be used in a fire to extract smoke.

Mechanical ventilation can be arranged in two ways:

Longitudinal ventilation with axial fans

They create a longitudinal airflow through the tunnel,see Figure 6. This system is suitable for short two way tunnels and for tunnels of any length with one way traffic, where additional smoke extraction must be provided for fire scenarios, see Figure 7. Long one way tunnels are, in normal operation, divided into air exchange stations.

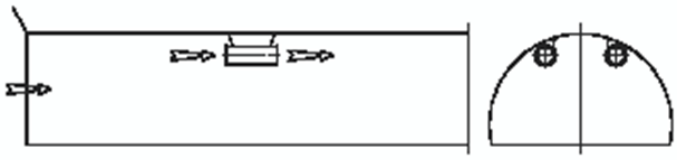


Figure 6: Longitudinal ventilation with axial fan.

SOURCE: website

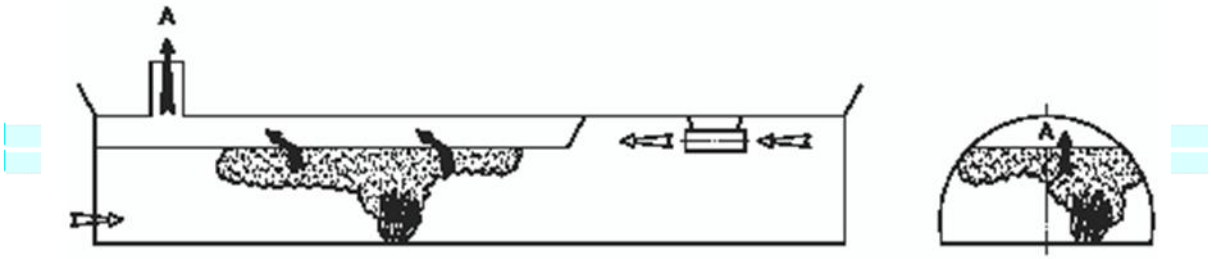


Figure 7: Longitudinal ventilation and air extraction in case of fire.

SOURCE: website

Central extraction within longitudinal ventilation

With this system, by extracting air in the middle of the tunnel, two air streams are created from the portals to the extraction point, see Figure 8. It is suitable mainly for two way tunnels, especially where emission extraction is necessary. From a certain tunnel length, additional requirements for smoke extraction in the event of a fire must be considered. Because the traffic flows in both directions are never equal, this affects the longitudinal airflow in the tunnel, therefore the extraction capacity mus be correctly sized, unless additional axial fans are installed to equalize longitudinal ventilation.

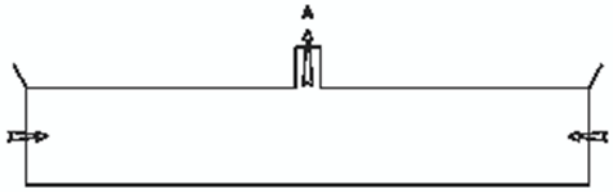


Figure 8: Longitudinal ventilation through central extraction

SOURCE: website

Semi transverse ventilation

In this system, supply air, marked Z, is delivered through a separate duct installed along the tunnel, see Figure 9. The duct can be located at the top, at the bottom, or along the sides of the tunnel space.

Supply openings are placed near the roadway at intervals of 20 m or less. Under normal conditions the inlet air speed can be up to 10 m per second, while in case of fire it must not exceed 3 m per second. In many tunnels exhaust air is discharged through the portals. In long tunnels, within a ventilation sector, divided semi transverse ventilation can be an economic alternative to longitudinal ventilation, but only in combination with a smoke duct, marked A.

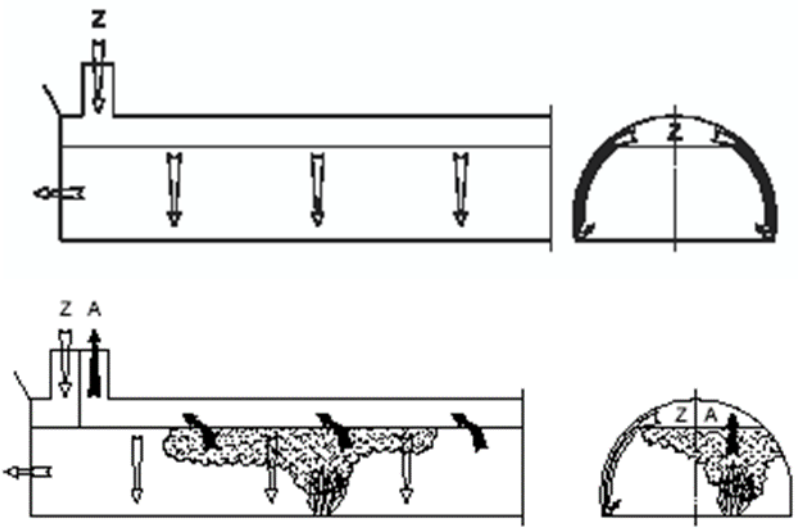


Figure 9: Transverse ventilation

SOURCE: website

Transverse ventilation

In transverse ventilation, see Figure 10, supply air, marked Z, is delivered through a separate distribution duct belonging to the traffic space. Due to the possibility of fire, supply air is introduced from below and exhaust air is extracted through the ceiling from the traffic space. The extraction openings must be arranged according to criteria that meet different requirements in normal and exceptional, fire, conditions. Nowadays, transverse ventilation is used only for long tunnels, with a semicircular profile, and where, for immission reasons, tunnel air cannot be discharged through the portals.

Combination of ventilation systems

Special boundary conditions may lead to the installation of different ventilation systems. Combining ventilation systems can provide optimal solutions. In every case the first task is to exploit natural longitudinal ventilation produced by traffic as much as possible.

3 Conclusion

Safety in road tunnels is multi layered and requires a holistic approach that combines technological solutions, risk management, the legal framework and the human factor. Advanced technical solutions, such as longitudinal and transverse ventilation systems, automatic incident detection, video surveillance, smoke and heat sensors and modern traffic guidance systems, provide the key foundation for preventing and managing incidents. However, technology alone is not enough, experience shows that the effectiveness of systems increases significantly only with appropriate organization of interventions, the competence of fire and rescue units, and consistent training of tunnel users.

The legal and regulatory framework at European and national level sets minimum standards, Directive 2004/54/EC and national regulations, however practice shows that it is necessary to go beyond legal requirements and to implement the best available technologies, BAT. The future of road tunnel safety will be marked by digitalization and automation, the use of artificial intelligence for risk prediction, digital twins for simulating fire and evacuation scenarios, and integration with smart mobility systems will enable faster and more precise responses.

Finally, the human factor is decisive. Safety culture, compliance with traffic rules, correct behavior of users in an accident and trust in the instructions of rescue services can significantly reduce the consequences of incidents. Future strategies must therefore also emphasize the education and awareness of drivers, since safety in tunnels depends as much on technology as it does on people.

4 Sources and references

PIARC, 2020, Road Tunnels, Operational Safety, World Road Association.

European Commission, 2004, Directive 2004/54/EC on minimum safety requirements for tunnels in the TEN T.

Administration of the Republic of Slovenia for Civil Protection and Disaster Relief, 2021, Exercises and protocols in road tunnels.

DARS d.d., 2022, Annual report on tunnel safety, Ljubljana.

Baber, C., 2018, Human Factors in Tunnel Safety, Springer.

National Fire Protection Association, NFPA 502, 2020, Standard for Road Tunnels, Bridges, and Other Limited Access Highways.

АВТОСООБРАКАЕН УЧИЛИШЕН ЦЕНТАР
“Боро Петрушевски” – на град Скопје

XV Мегународен симпозиум

ИНТЕРДИСЦИПИЛАНРНОСТ НА ЛОГИСТИКАТА И СООБРАКАЈОТ

25-27 септември 2025

-“ВЛИЈАНИЕТО НА ЕДУКАЦИЈА НА МАТУРАНТИТЕ ЗА БЕЗБЕДНОСТА ВО СООБРАКАЈОТ”-

Изработиле :

Зоки Стојмиров дипл.сооб.инж.

Анета Пашоска дипл.проф.

Скопје, 2025

Вовед

Сообраќајот претставува една од најдинамичните и најризичните сфери на секојдневното живеење. Современото општество е соочено со голем број предизвици во однос на безбедноста во сообраќајот, а еден од најзначајните фактори се младите луѓе, особено матурантите. Тие се на возраст кога ја стекнуваат својата прва возачка дозвола, активно учествуваат во сообраќајот и често се изложени на различни

искушенија и ризици. Во овој контекст, едукацијата претставува клучен елемент во градењето на свеста и културата за безбедно учество во сообраќајот.

Сообраќајните незгоди остануваат значаен проблем во Република Северна Македонија. Податоците покажуваат дека во последните години има голем број загинати и повредени, често меѓу младите, вклучувајќи ги и матурантите. Едукацијата за безбедност во сообраќајот може да игра клучна улога во превенирањето на ризикот кој го носи оваа група, со оглед на нивното склоност кон ризично однесување и недостаток на возачко искуство.

Целта на оваа тема е да се анализира:

1. Каква е состојбата на сообраќајната безбедност во Македонија, особено кај матуранти / млади возачи,
2. Кои едукативни активности се одржуваат и какови резултати се постигнуваат,
3. Како едукацијата може да се унапреди со цел зголемување на безбедноста.

Ризици кај младите возачи

Фактор на ризик	Објаснување
Недостаток на искуство	Младите немаат доволно практично искуство за справување со критични ситуации.
Склони кон ризици	Адолесцентите често се докажуваат преку брзо возење или непочитување на правила.
Алкохол и дрога	Зголемена изложеност на несреќи поради консумација на алкохол и психоактивни супстанци.
Користење мобилен телефон	Вниманието е одвлечено од патот, што ја зголемува можноста за несреќи.

Форми на едукација

Едукацијата за сообраќајна безбедност може да се реализира на повеќе начини. Најзначајните форми се следни:

1. Формална едукација – преку наставни програми и организирани предавања.
2. Неформална едукација – преку семинари, работилници и симулации.
3. Медиумска едукација – преку медиуми и социјални мрежи.
4. Пример од возрасните – следење на позитивни модели на возрасните учесници во сообраќајот.

Теоретско објаснување

Едукацијата може да влијае на безбедноста преку неколку механизми:

1. **Зголемување на знаењето** — учениците да научат правилата, сообраќајните знаци, ризиците и начини да се избегнат несреќи.
2. **Промена на ставови** — развивање на вредности како одговорност, почитување на правилата, разбирање на последиците.
3. **Развивање на вештини** — симулации, практична обука (пример, возење велосипед, пешачење, како да се премине улица, практична користење на сообраќајни средства).
4. **Промена на однесување** — користење на појас, велосипедска кацига, избегнување на употреба на мобилен, почитување на брзинските лимити и др.
5. **Социјални и системски фактори** — влијание на врсници, родители, законодавство, инфраструктура, контрола (полиција, казни), услови на патиштата.

Предности на едукацијата за матурантите

- **Рана интервенција** — пред да почнат активно да возат, да бидат возачи, пешаци, облици на мобилност.
- **Психосоцијални придобивки** — развивање на одговорност, емпатија, разбирање на последиците.
- **Култура на безбедност** — ако во училиштата и општеството се нагласува значењето на безбедното однесување.
- **Кумулативен ефект** — повторување и продлабочување на знаењето поврзано со практичното искуство (на пример практична симулација, возење, учење преку искуство).

Ограничувања и предизвици

- Често **знаењето** се зголемува, но **однесувањето** не секогаш се менува или не доволно.
- Ефектите можат да бидат краткотрајни, без долгорочни следења.
- Разлики по пол, возраст, социјално-економски статус.
- Праг на влијание: едукацијата мора да биде соодветно дизајнирана (релевантни материјали, методи, контекст, практични вежби).
- Потреба од поддршка со инфраструктура, законодавство, контрола.
- Ограниченост на ресурси (време, учебни средства, одобрение) и непостоење на унифициран пристап.

Дали е ефикасно?

Општо, истражувањата покажуваат дека едукацијата има значителен позитивен ефект на **знаење, ставови, намери** и делумно на **однесување** (особено на заштита – кациги, користење на појас, внимателност). Но, не сите интервенции доведуваат до намалување на несреќи и штети, особено ако не се поддржани со други мерки (закон, контрола, инфраструктура).

Табела 3: Предлог индикатори за мерење во сопствено истражување

Индикатор	Како да се мери / инструмент	Време на мерење
Знаење за сообраќајни правила / сообраќајни знаци	Анкети пред и после едукацијата	пред едукација, веднаш после, и 6-12 месеци подоцна
Ставови / намери	Скали (Likert) – колку се согласни со изјави како „возењето под дејство е неприфатливо“	пред/после + follow up
Практично однесување	Самопријавено (анкети), или директно набљудување (на пример, процент на користење на појас, кацига, почитување на знаци)	пред/после, и стабилен follow up
Ризини на невнимание / прекршување	Анкети, можеби казни / податоци од полиција	пред/после
Инциденти / несреќи	Податоци од училишта, болници, полиција	период од неколку години

Практични препораки за едукација на матуранти

- Интегрирај едукација за сообраќајна безбедност во програмата на средно училиште, не само како еднократна активност.
- Вклучи практични елементи: симулации, практична обука, возење/употреба на велосипед, пешачење, сообраќајни обуки.
- Peer-led програми: учениците учат од врсници, што може да биде мотивирачки.
- Користење на современи методи: видео-сведочења, виртуелна реалност, онлајн ресурси, gamification.
- Повторување и мониторинг: едукацијата треба да се наносува неколкупати, и да се прави follow-up за да се гледа дали однесувањето се менува долгорочно.
- Вклучување на законодавство / контрола / инфраструктура: едно е да се едуцира, но ако нема контрола (на пример казни за прекршување), добар пат, велосипедска инфраструктура, патни знаци и сл., ефектот може да биде ограничен.

- Персонализација: материјали кои одговараат на локалниот контекст (патишта, сообраќајни услови, ментални модели на учениците), пол, возраст, искуство.

Податоци за С. Македонија

Во последните **пет години**, 707 лица загинале, и над 38.136 повредени во сообраќајни несреќи.

Во 2024 година се регистрирани **8.457** сообраќајни незгоди; **142** лица загинале.

Стапка на загинати лица: ~ **68 на еден милион жители** во 2024.

Во 2021 година: **73% намалување** на бројот на жртви во септември, во споредба со септември 2020 (од 15 жртви на 4 жртви).

Во 2020 година: **125 жртви** на сообраќајни незгоди, **5774 повредени** лица.

Извидени прекршувања: пречекорување на брзина, управување под дејство на алкохол, возење без возачка дозвола, непрописно користење на појас, мобилен телефон при возење.

Табела 1: Вкупна статистика на сообраќајни незгоди / жртви / повредени

Година / Период	Број на незгоди	Број на жртви	Број на повредени	Коментари
Последни 5 години	—	**707**	**38.136**	Сите незгоди, сите возрасни групи.
2024	**8.457**	**142**	—	Загинати: 142.
2020	—	**125**	**5.774**	Повредени и жртви за цела година.

Табела 2: Главни причини за сообраќајни незгоди / прекршувања

Причина	Број на случаи / опис	Значење за едукација и превенција
Брзо возење	Дел од 7.637 незгоди во последни 5 години ги имаат како причина брзото возење.	Едукација за ризиците од брзината, важноста на соодветна брзина, практични обуки и казнени мерки.
Непочитување на првенство (Приоритет)	~4.151 несреќа според изворите.	Се потребни обуки и свест за правилата за првенство, значење на семафори, знаци, сигнали.
Возење под дејство на алкохол	~1.769 случаи.	Кампањи, симулации, практични примери, училници, peer-учење.
Возење без возачка дозвола	Во 2024, идентификувани 19.000 лица кои возеле без дозвола.	Строга контрола, едукација пред да се добие дозволата, проверки.

Едукативни активности и кампањи

Еве неколку примери на активности што се спроведуваат во Македонија:

- Проектот *„Вело училишта – Безбедно и активно до училиште“* во општина Карпош, кој ја зајакнува културата на безбедност и активната мобилност кај ученици и наставници.
- *„Безбедна матурска вечер“* — едукативна работилница за матуранти во Штип, со цел да се подигне свеста за безбедноста и ризиците поврзани со празнувањата, но и возењето.
- Факултативна настава за безбедност на сообраќајот — според една тримесечна акција (2011-2012) во сите средни училишта, учениците покажале дека би ја поддржале таквата настава ако е стручна и релевантна.
- Акции и предавања за пешаци и велосипедисти, едукативно-воспитни работилници за ученици од пониските одделенија (второ, четврто одделение) за „Да ги заштитиме децата во сообраќајот“.

Анализа: Матурнтите / млади возачи

Матурнтите (често ученици од средно училиште, во завршната година) се на премин од ученик кон возач (или веќе се возачи), и се изложени на зголемен ризик поради:

- Мало возачко искуство, недостаток на практични ситуации под надзор.

- Празнични активности (матурските прослави), алкохол, возење до или по прославите.
- Склоност кон социјален притисок и потценување на ризикот.

Предности и слабости на сегашните едукации

Предности

- Постоење на конкретни проекти, кампањи и активности насочени кон млади (велосипедисти, пешаци, ученици, матуранти).
- Поддршка на државни институции како МВР и Републички Совет за безбедност во сообраќајот.
- Контроли и превентивни акции што се спроведуваат заедно со едукација.
- **Недостатоци / празнини**
- Недоволно специфични податоци за матурантите како група (возачи-почетници) во статистиката — за да се мери ефектот на едукацијата.
- Недостаток на долгорочни истражувања — дали едукацијата за младите доведува до трајни промени на однесувањето и намалување на незгоди.
- Недоволно вклучување на практични елементи (возење, симулации, сценарија со ризик) во образовните програми за средношколците.
- Можеби недоволна фреквенција и систематичност на едукативните активности.

Предлог покачување на ефикасноста

За да се зголеми влијанието на едукацијата на матурантите врз безбедноста во сообраќајот, може да се предложи:

1. **Факултативна или обавезна предметна настава** по безбедност во сообраќајот во средните училишта, вклучувајќи теоретска и практична обука.
2. **Работилници пред матурските прослави** — со конкретни теми: користење алкохол, безбедно враќање дома, одговорно возење.
3. **Симулации / виртуелна реалност / практично возење** за ученици-возачи-почетници, под надзор.
4. **Вклучување на родителите и наставниците** — да подржуваат и следат однесувањето, да бидат модели на безбедно однесување.
5. **Контролирани и статистички мерења** — собирање на податоци по завршување на едукацијата, следењето на прекршувања/незгоди кај учесниците.
6. **Интеграција на едукацијата со законски мерки и инфраструктура** — знаци, патишта, пешачки премини, осветлување, казни, контроли.

Заклучок

- Едукацијата на матурантите има потенцијал да го намали ризикот во сообраќајот ако е правилно дизајнирана, систематска, и поддржана од институции.
- Во Северна Македонија постојат примери на активности и кампањи, но недостасуваат податоци кои јасно мерат ефектот кај матурантите/млади возачи.
- За да се реализира вистинска промена, потребна е комбинација на едукација, законодавство, контроли, инфраструктура и статистичко следење.

Литература

1. Закон за безбедност на сообраќајот на патиштата, Службен весник на РСМ.
2. Национална стратегија за безбедност во сообраќајот (2021–2030).
3. Европска комисија – Програми за безбедност на учениците во сообраќај.
4. Образовни програми и прирачници за сообраќајна култура.
5. European Commission – Road Safety Programmes.
6. WHO – Global status report on road safety 2023.
7. Програми и прирачници за сообраќајна култура во образованието.
8. Case studies: Germany, Sweden, Slovenia – School Traffic Safety.

AUTO SCHOOL CENTER

“Boro Petrushevski” – of the city Skopje

XV International Symposium

Interdisciplinaryness of logistics and traffic

25-27. september 2025

-“The impact of education of high school students on traffic safety”-

Author:

Zoki Stojmirov, B. Sc. Communication Eng.

Antea Pašoska B. Sc. Prof.

Skopje, 2025

Introduction

Traffic is one of the most dynamic and risky areas of everyday life. Modern society is faced with a number of challenges in terms of traffic safety, and one of the most significant factors is young people, especially high school graduates. They are at the age when they acquire their first driver's license, actively participate in traffic and are often exposed to various temptations and risks. In this context, education is a key element in building awareness and a culture of safe participation in traffic..

Road traffic accidents remain a significant problem in the Republic of North Macedonia. Data shows that in recent years there have been a large number of deaths and injuries, often among young people, including high school graduates. Road safety education can play a key role in preventing the risks posed by this group, given their propensity for risky behavior and lack of driving experience.

The aim of this topic is to analyze:

1. What is the state of traffic safety in Macedonia, especially among high school gradfuater / young drivers,
2. What educational activities are being held and what results are beiung achieved,
3. How education can be improved to increase safety.

Risk for young drivers

Risk factor	Explanation
Lack of experience	Yound people do not have enough practical experience in dealing with critical situations
Risk-taking	Adolescents often prove themselves through speeding or disrespect of rules
Alcohol and drugs	Increased exposure to accidents due to alcohol consumption and psychoactive substances
Using a mobile phone	Attention si diverted from the road, which increases the possibility of accidents

Forms of education Road

Safety education can be implemented in several ways. The most important forms are as follows:

1. Formal education – through curricula and organized lectures.
2. Informal education – through seminars, workshops and simulations.

3. Media education – through media and social networks.
4. Example from adults – following positive models of adult road users.

Theoretical explanation

Education can influence safety through several mechanisms:

1. Increasing knowledge — students learn the rules, traffic signs, risks, and ways to avoid accidents.
2. Changing attitudes — developing values such as responsibility, obeying the rules, understanding the consequences.
3. Developing skills — simulations, practical training (e.g., riding a bike, walking, how to cross the street, practical use of vehicles).
4. Changing behavior — using a seat belt, bicycle helmet, avoiding cell phone use, respecting speed limits, etc.
5. Social and systemic factors — influence of peers, parents, legislation, infrastructure, control (police, fines), road conditions.

Benefits of education for graduates

1. **Early intervention** — before they start actively driving, be drivers, pedestrians, forms of mobility.
2. **Psychosocial benefits** — developing responsibility, empathy, understanding of consequences.
3. **Safety culture** – if schools and society emphasize the importance of safe behavior.
4. **Cumulative effect** – the repetition and deepening of knowledge related to practical experience (e.g., practical simulation, driving, experiential learning).

Limitations and Challenges

1. Often **knowledge** increases, but **behavior** doesn't always change or not enough.
2. The effects can be short-lived, with no long-term follow-ups.
3. Differences by sex, age, and socioeconomic status.
4. Threshold of impact: education must be appropriately designed (relevant materials, methods, context, practical exercises).
5. Need support with infrastructure, legislation, control.
6. Limited resources (time, training resources, approval) and lack of unified access.

Is it effective?

In general, research shows that education has a significant positive effect on **knowledge, attitudes, intentions,** and partly on **behavior** (especially on protection – helmets, seat belt use, mindfulness). But not all interventions lead to a reduction in accidents and harms, especially if they are not supported by other measures (law, control, infrastructure).

Table 2: Proposed Measurement Indicators in Own Research

Indicator	How to measure / instrument	Measurement time
Knowledge of traffic rules/traffic signs	Pre- and post-education surveys	Before Education, Immediately After, and 612 Months Later
Attitudes / Intentions	Scully: How much do you agree with statements like "driving under the influence is unacceptable"	before/after + follow up
Practical behavior	Self-reported (surveys), or direct observation (e.g., percentage of seat belt use, helmet use, sign compliance)	before/after, and stable follow up
Risks of negligence/violation	Surveys, possibly fines/police data	Pre/After
Incidents/accidents	Data from schools, hospitals, police	A period of several years

Practical recommendations for the education of graduates

- Integrate traffic safety education into a high school curriculum, not just as a one-time activity.
- Include practical elements: simulations, hands-on training, riding/cycling, walking, traffic training.
- Peerled programs: Students learn from peers, which can be motivating.
- Using modern methods: video testimonials, virtual reality, online resources, gamification.
- Repetition and monitoring: Education should be applied several times, and follow-up should be done to see if behavior changes in the long term.
- Include legislation/control/infrastructure: it is one thing to educate, but if there is no control (e.g. penalties for violations), good road, cycling infrastructure, road signs, etc., the effect may be limited.
- Personalization: Materials appropriate to the local context (roads, traffic conditions,

students' mental patterns), gender, age, experience.

About S. Macedonia

In the last **five years**, 707 people have died, and over 38,136 injured in road accidents.

In 2024, **8,457** traffic accidents were recorded; **142** people died.

Death rate: ~ **68 per million inhabitants** in 2024.

In 2021: **73% decrease** in the number of victims in September, compared to September 2020 (from 15 victims to 4 victims).

In 2020: **125 victims** of traffic accidents, **5774 injured** persons.

Violations detected: speeding, driving under the influence of alcohol, driving without a driver's license, improper use of a seat belt, mobile phone while driving.

Table 3: Total statistics of traffic accidents/casualties/injuries

Year / Period	Accident number	Number of victims	Number of Injured	Comments
Last 5 years	—	**707**	**38.136**	All adversity, all age groups.
2024	**8.457**	**142**	—	Killed: 142.
2020	—	**125**	**5.774**	Injuries and casualties for a year.

Table 4: Main causes of traffic accidents/violations

Cause	Number of cases/description	Meaning for education and prevention
Fast Driving	A proportion of 7,637 accidents in the last five years have been attributed to speeding.	Education on the risks of speed, the importance of proper speeding, practical training, and punitive measures.
Disregard for Championship (Priority)	~4,151 accidents according to sources.	Training and awareness of the rules of the championship, the meaning of traffic lights, signs, signals are required.
Driving under the influence of alcohol	~1,769 cases.	Campaigns, simulations, practical examples, classrooms, peer learning.
Driving without a driver's license	By 2024, 19,000 people will be identified driving without a license.	Strict control, education before obtaining permission, checks.

Educational activities and campaigns

Here are some examples of activities being carried out in Macedonia:

1. The project *"Bicycle Schools – Safe and Active to School"* in the municipality of Karpoš, which strengthens the culture of safety and active mobility among students and teachers.
2. *"Safe Prom"* is an educational workshop for graduates in Stip, with the aim of raising awareness about the safety and risks associated with holidays, as well as driving.
3. Optional Traffic Safety Instruction — According to a quarterly action (20112012) in all secondary schools, pupils have shown that they would support such instruction if it was professional and relevant.
4. Actions and lectures for pedestrians and cyclists, educational workshops for students in lower grades (2nd, 4th grade) on "Protecting children in traffic".

Analysis: Graduates/Young Drivers

Graduates (often high school students, in their final year) are on the transition from student to driver (or are already drivers), and are at increased risk due to:

1. Little driving experience, lack of practical situations under supervision.
2. Holiday activities (proms), alcohol, driving to or after the celebrations.
3. Tendency to social pressure and underestimation of risk.

Strengths and Weaknesses of Current Education

Advantages

1. Existence of specific projects, campaigns and activities aimed at young people (cyclists, pedestrians, students, graduates).
2. Support of state institutions such as the Ministry of Interior and the Republic Council for Traffic Safety.
3. Controls and preventive actions carried out in conjunction with education.

Disadvantages/gaps

1. Insufficiently specific data on graduates as a group (novice drivers) in the statistics to measure the effect of education.
2. Lack of long-term research on whether youth education leads to lasting behavioural changes and reduced adversity.
3. Insufficient inclusion of practical elements (driving, simulations, risk scenarios) in educational programs for high school students.
4. Perhaps insufficient frequency and systematicity of educational activities.

Proposed Efficiency Gains

To increase the impact of graduate education on traffic safety, it may be proposed:

1. **Optional or compulsory subject instruction** in traffic safety in secondary schools, including theoretical and practical training.
2. **Pre-prom workshops** — with specific topics: alcohol use, safe homecoming, responsible driving.
3. **Simulations/virtual reality/hands-on driving** for beginners, supervised.
4. **Involve parents and teachers** to support and monitor behavior, to be models of safe behavior.
5. **Controlled and statistical measurements** — collection of data after completion of education, tracking violations/accidents among participants.
6. **Integration of education with legal measures and infrastructure** — signs, roads, pedestrian crossings, lighting, fines, controls.

Conclusion

1. Graduate education has the potential to reduce traffic risk if it is properly designed, systematic, and institutionally supported.
2. There are examples of activities and campaigns in North Macedonia, but there is a lack of data that clearly measure the effect on graduates/young drivers.
3. To bring about real change, a combination of education, legislation, controls, infrastructure and statistical monitoring is needed.

Literature

1. Law on Road Traffic Safety, Official Journal of the RSM.
2. National Road Safety Strategy (2021–2030).
3. Student Safety Programs in Traffic.
4. Educational programs and manuals for traffic culture.
5. European Commission – Road Safety Programmes.
6. WHO – Global status report on road safety 2023.
7. Programs and manuals for traffic culture in education.
8. Case studies: Germany, Sweden, Slovenia – School Traffic Safety.

Andrej Prašnikar

SIC Ljubljana
Strokovni izobraževalni center Ljubljana

Ptujska ulica 6, 1000 Ljubljana

andrej.prasnikar@siclj.si

OGLJIKOVI KREDITI



POVZETEK

V zadnjih desetletjih je globalno zavedanje o pomenu zmanjševanja emisij toplogrednih plinov naraslo, kar je pripeljalo do razvoja sistemov trgovanja z ogljikovimi krediti. Ti omogočajo podjetjem in državam, da kompenzirajo svoje emisije s financiranjem projektov za zmanjševanje emisij ali s plačili drugim za zmanjševanje emisij. Članek obravnava pomen ogljikovih kreditov v sodobnem svetu, njihove uporabnike ter primere, med katerimi izstopa podjetje Tesla, ki aktivno sodeluje na tem trgu. Zabeležene so tudi slabosti sistema ogljikovih kreditov. Na koncu predstavim tudi prihodnje trende in izzive, povezane z ogljikovimi krediti, ter njihov potencial za spodbujanje trajnostnega razvoja.

KLJUČNE BESEDE

Ogljikovi krediti, ogljični odtis, emisije CO2, toplogredni plini, ogljikova nevtralnost, ogljikova izravnava (carbon offset), trajnostni razvoj, TSLA ( )

1 UVOD

Sistem ogljikovih kreditov so finančni instrumenti, ki predstavljajo enoto zmanjševanja emisij ogljikovega dioksida (CO_2) ali drugih toplogrednih plinov. En kredit običajno ustreza eni toni CO_2, ki je bila odstranjena iz ozračja ali preprečena v procesu zmanjševanja emisij. Sistem temelji na načelu, da tisti, ki povzročajo emisije, lahko kupijo kredite od tistih, ki izvajajo projekte za zmanjševanje emisij, s čimer ustvarjajo finančne spodbude za trajnostne projekte.

Ogljikovi krediti so del širšega sistema trgovanja s emisijami (cap-and-trade), ki ga uporabljajo številne države in mednarodne organizacije za dosego globalnih podnebnih ciljev. S tem sistemom se omejuje skupna dovoljena emisija, podjetja pa lahko prek trgovanja z krediti prilagajajo svoje emisije, s čimer spodbujajo inovacije in zmanjševanje emisij po najnižjih stroških.

Ogljikovi krediti so enote, ki predstavljajo količino ogljikovega dioksida (CO_2) ali drugih toplogrednih plinov, ki so bile odstranjene iz ozračja ali preprečene pred vstopom vanj. Gre za sistem, ki omogoča podjetjem, organizacijam ali posameznikom, da kompenzirajo svoje emisije toplogrednih plinov z vlaganjem v projekte, ki zmanjšujejo te emisije.

Ogljikovi krediti so del širšega sistema trgovanja z emisijami oziroma trgovanja z ogljikom, ki je bil ustvarjen z namenom spodbujanja podjetij k večji odgovornosti pri zmanjševanju svojih emisij. Če podjetje zaradi proizvodnih procesov ali drugih dejavnosti proizvede več emisij, kot dovoljujejo predpisi, lahko kupi ogljikove kredite, da pokrije presežek emisij. Seveda pa je možno, da z eno panogo proizvodnje porablja, z drugo pa proizvaja – pridobiva ogljikove kredite. Tak primer je podjetje VW (Volksvagen), ki z proizvodnjo električnih vozil, proizvaja

Ogljikove kredite, z proizvodnjo vozil z notranjim izgorevanjem pa le te porablja. Trenutno je še vedno v deficitu ogljikovih kreditov.

2. UPORABA OGLJIKOVIH KREDITOV

Ogljikove kredite najdemo v različnih sektorjih in na različnih ravneh:

- Mednarodni trg emisij: Evropski sistem trgovanja z emisijami (EU ETS) je eden največjih in najstarejših, kjer podjetja v energetskem, industrijskem in letalskem sektorju kupujejo in prodajajo emisijske licence.
- Nacionalne iniciative: Države, kot so Južna Koreja, Kanada in Južna Afrika, izvajajo lastne sisteme trgovanja z emisijami, ki omogočajo podjetjem, da se prilagodijo podnebnim ciljem.
- Samostojni projekti in trgi: Poleg uradnih sistemov obstajajo tudi zasebni in neprofitni projekti, kot so certificirani projekti za zasebne podjetnike ali nevladne organizacije, ki ustvarjajo kredite s pomočjo projektov za obnovljive vire, gozdarstvo ali energetsko učinkovitost.
- Podjetja in posamezniki: Velika podjetja pogosto kupujejo ogljikove kredite za ujemanje svojih ogljikovih odtisov, posamezniki pa lahko prostovoljno financirajo projekte za zmanjševanje emisij preko različnih platform.



Slika 64 Ogljikov odtis (vir: https://aliasplus.si/storitve/izracun_ogljicnega_odtisa/)

3 POMEN OGLJIKOVIH KREDITOV

Ogljikovi krediti igrajo ključno vlogo pri doseganju podnebnih ciljev, saj omogočajo:

Finančno spodbudo za trajnostne projekte: Z nakupom kreditov lahko podjetja financirajo projekte, ki sicer morda ne bi bili ekonomsko upravičljivi, a so pomembni za okolje.

Znižanje stroškov zmanjševanja emisij: Po načelu, da je mogoče zmanjšati emisije tam, kjer je to najceneje, sistem omogoča optimizacijo celotnega zmanjševanja.

Sprejetje odgovornosti: Podjetja in organizacije lahko s pomočjo kreditov izpolnijo svoje podnebne obveznosti, tudi če neposredno ne morejo zmanjšati vseh emisij.

Podpora globalnim ciljem: Sistem spodbuja sodelovanje med državami in podjetji, kar je ključno za dosego Pariškega sporazuma in drugih podnebnih ciljev. Pariški sporazum je mednarodna pogodba, ki podpisnice pravno zavezuje k ukrepanju v boju proti podnebnim spremembam. Leta 2015 so se vlade prvič skupaj dogovorile o pomembnih skupnih prizadevanjih za omejitev globalnega segrevanja in odpravljanje njegovih posledic.

4 UPORABA OGLJIČNIH KREDITOV NA PRIMERU PODJETJA TSLA (TESLA)

TSLA (v nadaljevanjuTesla), vodilno podjetje na področju električnih vozil in obnovljivih virov energije, je odličen primer, kako podjetje lahko koristi sistem ogljičnih kreditov. Tesla je znana po svoji zavezanosti trajnostnemu razvoju, a hkrati se je v preteklosti zanašala tudi na prodajo ogljikovih kreditov drugim proizvajalcem avtomobilov.

Prodaja kreditov: Tesla je skozi leta ustvarila pomembne prihodke s prodajo ogljikovih kreditov drugim proizvajalcem avtomobilov, ki niso dosegli zahtevane ravni emisij. Na primer, Fiat, General Motors in drugi so kupovali kredite od Tesle, da bi izpolnili svoje podnebne obveznosti.

Povečanje dobička: Prodaja kreditov je postala pomemben vir dohodka za Tesla, saj je podjetje s prodajo kreditov pokrilo stroške razvoja električnih vozil in pospešilo širitev. Zanimivo dejstvo je, da podjetje Tesla ustvari več dobička s prodajo ogljikovih kreditov, kot pa s proizvodnjo električnih vozil.

Zeleni image: Poleg finančnega učinka je Tesla s tem okrepila svojo podobo podjetja, ki aktivno prispeva k zmanjševanju emisij in spodbuja prehod na trajnostno mobilnost. Poleg tega pa pozitivno vpliva na kupce izdelkov, ki so vedno bolj ekološko usmerjeni.

Tukaj je strukturiran pregled letne prodaje ogljikovih kreditov (regulativni krediti) podjetja Tesla v zadnjih 10 letih:

Leto	Prihodki (milijard USD)
2015 *	~ 0.314
2016	0.0 (izključeno)
2017	
2018	0.419
2019	0.594
2020	1.580
2021	~ 1.460
2022	1.780
2023	1.790
2024	2.700

Tabela 1: Prihodki podjetja TSLA iz naslova prodaje ogljičnih kreditov



Graf : Prihodki podjetja TSLA s prodajo ogljičnih kreditov po letih

Viri:

* Podatek za 2015 iz Teslinega letnega poročila (314 milijonov USD)

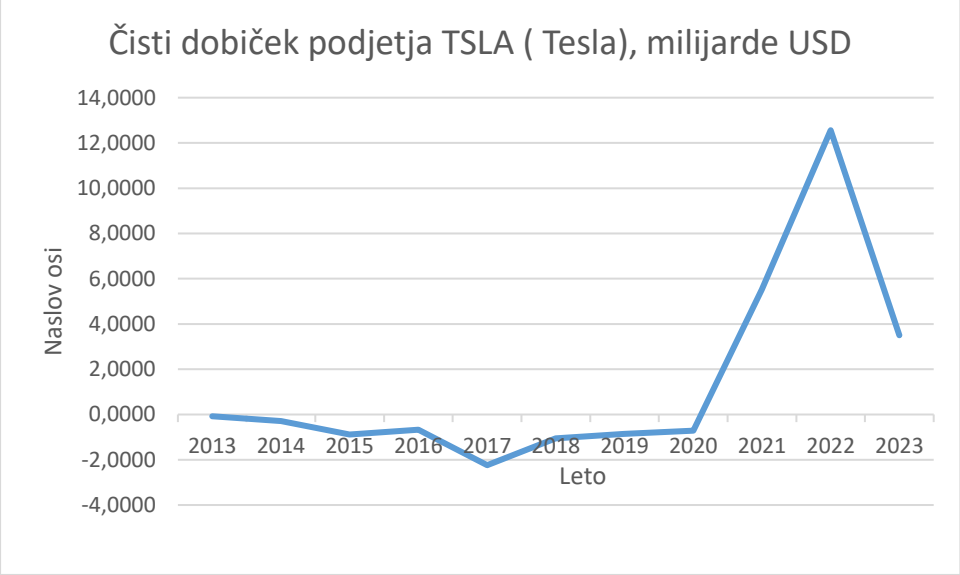
2018–2023 po poročilih (Reccessary, CarbonCredits.com)

2024 po Statistic in CarbonCredits.com

Tukaj so podatki o čistem dobičku podjetja TSLA

Leto	Čisti dobiček TSLA (milijard USD)
2013	-0,074
2014	-0,294
2015	-0,888
2016	-0674
2017	-2,240
2018	-1,060
2019	-0,862
2020	-0,721
2021	+ 5,520
2022	+12,560
2023	+ 3,500

Tabela 2: Čisti dobiček TSLA



Graf : Čisti dobiček podjetja TSLA po letih

5 SLABOSTI OGLJIKOVIH KREDITOV

Ogljikovi krediti (oz. carbon credits) so mehanizem za zmanjševanje emisij ogljikovega dioksida, kjer podjetja ali države dobijo dovoljenje za emisijo določene količine ogljikovega dioksida ali drugih toplogrednih plinov. Kadar podjetje zmanjša svoje emisije pod določeno mejo, lahko proda presežne kredite drugim podjetjem, ki nimajo zadostnih ukrepov za zmanjšanje emisij.

Kljub temu pa obstajajo številne slabosti tega sistema, ki se pogosto navajajo v kritičnih razpravah o ogljikovih kreditih:

Pomanjkanje preglednosti in nadzora:

Ogljikovi trgi so pogosto netransparentni, saj lahko pride do manipulacij z obstoječo zalogo ogljikovih kreditov. Brez strogih regulacij je težko zagotoviti, da se krediti dejansko porabijo za resnične in trajne okoljske koristi.

Tveganje za "zeleno pranje" (greenwashing):

Podjetja lahko pridobijo kredite za projekte, ki so bolj v namen promocije (npr. “zelene” pobude), kot pa dejanskega zmanjšanja emisij. Ta “zeleno pranje” lahko zmanjša učinkovitost sistema in vodi v zavajanje potrošnikov.

Slaba verodostojnost in trajnost projektov:

Čeprav mnogi projekti, ki ustvarjajo ogljikove kredite, obljubljajo zmanjšanje emisij (npr. zasaditev dreves ali obnovljive energetske naložbe), se v praksi lahko izkažejo za neučinkovite, kratkoročne ali pa preprosto neizvedljive na dolgi rok.

Potencialni negativen vpliv na lokalne skupnosti in ekosisteme:

Projekti za pridobivanje ogljikovih kreditov, kot so obsežne zasaditve dreves ali energetske naložbe, lahko imajo neželene učinke na lokalne skupnosti, biodiverziteto in ekosisteme. Na primer, v nekaterih primerih se lahko zgodijo preseljevanja lokalnih prebivalcev ali poškodbe naravnih habitatov.

Premalo spodbujanja resničnih sprememb:

Ogljikovi krediti lahko podjetjem omogočijo, da se izognejo resničnim spremembam v svojih poslovnih praksah in preprosto kupijo pravico za onesnaževalski odtis, ne da bi spremenili svoje proizvodne metode ali zmanjšali porabo fosilnih goriv. To pomeni, da sistem morda ne spodbuja dolgoročnih sprememb v industrijskih praksah.

Pomanjkanje ustreznih in ambicioznih ciljev:

Nekatere države ali podjetja morda ne postavijo dovolj ambicioznih ciljev za zmanjšanje emisij, saj lahko z uporabo ogljikovih kreditov “kupijo čas” in se izognejo nujnim ukrepom za prehod na bolj trajnostne tehnologije.

Odvisnost od tržnih mehanizmov:

Trg ogljikovih kreditov je lahko zelo volatilno naravnan, kar pomeni, da so cene kreditov lahko zelo nestabilne. To pomeni, da podjetja, ki se zanašajo na ogljikove kredite, lahko naletijo na težave, če tržni mehanizmi niso stabilni ali če se cena emisij na trgu zmanjša.

Dvojni račun (Double counting):

Obstaja tveganje, da bi lahko prišlo do podvajanja ogljikovih kreditov, kjer bi ista emisijska zmanjšanja bila upoštevana večkrat (npr. tako za porabo podjetij kot za porabo držav), kar zmanjša verodostojnost celotnega sistema.

Čeprav imajo ogljikovi krediti pomembno vlogo pri spodbujanju podjetij in držav, da zmanjšujejo emisije, so za dosego trajnostnih ciljev nujni tudi drugi ukrepi, kot so zakonodaja, izboljšanje tehnologij in prehod na trajnostne energetske vire.

6 PRIHODNOST OGLJIKOVIH KREDITOV

Napovedi za prihodnost sistema ogljikovih kreditov so mešane, a obstajajo jasne smernice:

Razširitev in izboljšave sistema: Svetovne organizacije si prizadevajo za bolj transparentne, integrirane in pravične trge za ogljikove kredite, z močnejšo regulacijo in nadzorom kakovosti.

Razvoj novih projektov: S povečevanjem povpraševanja po kreditih se bo povečala tudi ponudba projektov za zmanjševanje emisij, vključno z obnovljivimi viri, gozdarstvom, carbon capture tehnologijami in energijsko učinkovitostjo.

Tehnološki napredek: Digitalizacija, blockchain in umetna inteligenca bodo omogočili boljšo sledljivost in preverjanje kreditov, kar bo povečalo zaupanja vrednost sistema.

Izzivi: Kljub temu obstajajo tudi pomisleki glede zanesljivosti nekaterih kreditov, njihovega vpliva na resnično zmanjševanje emisij in morebitne zlorabe sistema za zeleno prikrivanje.

Podnebni cilji in zakonodaja: V skladu z mednarodnimi podnebnimi zavezami bo vloga ogljikovih kreditov verjetno naraščala, vendar bo odvisna od učinkovite politike in regulative.



Slika 65: Cilji ogljikovih kreditov (vir : https://www.varcevanje-energije.si/)

7 ZAKLJUČEK

Ogljikovi krediti so postali ključni instrument v globalni strategiji za ublažitev podnebnih sprememb. Omogočajo financiranje trajnostnih projektov, spodbujajo inovacije in omogočajo podjetjem, da izpolnijo svoje okoljske obveznosti. Primer Tesla dokazujejo, da so krediti lahko tudi pomemben poslovni vir, ki hkrati podpira trajnostne cilje podjetja. Prihodnost ogljikovih kreditov je obetavna, a hkrati zahteva skrbno upravljanje, transparentnost in razvoj tehnologij za preprečevanje zlorab. S pravilnim pristopom lahko ti krediti prispevajo k doseganju svetovnih podnebnih ciljev in prehodu na bolj trajnostno gospodarstvo.

8 LITERATURA

European Environment Agency (EEA)

https://www.eea.europa.eu/en

Mednarodna agencija za energijo (IEA)

https://www.iea.org/

Tesla, uradne spletne strani in finančni poročili
https://www.tesla.com/sl_si/impact
Pariški sporazum in podnebne pogodbe
https://www.consilium.europa.eu/sl/policies/paris-agreement-climate/
Akademske raziskave in strokovni članki o ogljičnih trgih
ChatGPT
https://chatgpt.com/

mag. tekst. inž., Tjaša Rozman

SIC Ljubljana
Strokovni izobraževalni center Ljubljana

Ptujska ulica 6, 1000 Ljubljana

tjasa.rozman@siclj.si

PONOVNA UPORABA TEKSTILNIH MATERIALOV V AVTOMOBILSKI INDUSTRIJI

XV. mednarodni simpozij
INTERDISCIPLINARNOST LOGISTIKE IN PROMETA

Organizator

ŠC Celje, Srednja šola za storitvene dejavnosti in logistiko

25. – 27. september 2025, Portorož

Fakulteta za pomorstvo in promet, Portorož

Povzetek

V avtomobilski industriji ima uporaba tekstilnih materialov ključno vlogo, saj se uporabljajo v oblazinjenju sedežev, stropnih oblogah, tepihih, varnostnih pasovih ter akustičnih in toplotnih izolacijah. Povprečno vozilo vsebuje med 20 – 35 kg tekstila, odvisno od segmenta in stopnje luksuza. V zadnjih desetletjih se industrija sooča z izzivi krožnega gospodarstva in trajnostnega razvoja, kjer je recikliranje in ponovna uporaba materialov eden ključnih ciljev.

Postopki recikliranja vključujejo mehansko (razvlaknjenje, rezanje), kemično (depolimerizacija poliestrov, regeneracija poliamidov) ter toplotno obdelavo. Ponovna uporaba tekstila omogoča izdelavo sekundarnih surovin za nove avtomobilske komponente, izolacijske materiale ali celo tekstil za nove sedežne prevleke. S tem se zmanjšujejo količine odpadkov, emisije CO_2 ter poraba primarnih surovin. Največ napredka dosegajo proizvajalci, kot so BMW, Toyota in Volvo, ki uvajajo reciklirane poliestrske tkanine in bioosnovane tekstile v serijsko proizvodnjo. Članek obravnava vrste tekstilov v vozilih, postopke njihove ponovne uporabe ter prihodnje trende krožne zasnove v avtomobilskem sektorju.

Ključne besede: *ponovna uporaba tekstilnih materialov, tekstilije v avtomobilih, krožno gospodarstvo, netkane tekstilije, avtomobilska industrija*

1 Uvod

Avtomobilska industrija je ena največjih potrošnic tekstilnih materialov. Ocenjuje se, da letno porabi več kot 1 milijon ton tehničnega tekstila. (European Commission, 2000). Tekstilni materiali predstavljajo ključen del sodobnih avtomobilov. Čeprav so pogosto spregledani v primerjavi s kovinskimi in elektronskimi komponentami, tekstili prispevajo k udobju, varnosti, estetiki in trajnosti vozil. Po podatkih združenja *Textile World* je v povprečnem osebnem avtomobilu uporabljenih med 20 in 30 kg tekstilnih materialov, kar predstavlja približno 2 % celotne mase vozila (Textile World, 2022). Avtomobilska industrija letno porabi več kot 1 milijon ton tekstilnih materialov (Oeko-Tex, 2021). Ker vozila ob koncu življenjske dobe predstavljajo pomemben vir odpadkov, se pojavlja potreba po učinkovitem ponovnem kroženju tekstilov. Evropska unija s svojo direktivo o odpadnih vozilih (ELV Directive 2000/53/EC) zahteva vsaj 95 % snovne izrabe vozila (od tega 85 % recikliranja), kar vključuje tudi tekstilne dele.

2 Tekstilni materiali v avtomobilih

2.1 Vrste uporabljenih tekstilov

V avtomobilski industriji se uporabljajo različne vrste tekstilnih materialov, ki jih lahko razdelimo na več kategorij:

- Notranjost: sedežne prevleke, stropne obloge, talne obloge, varnostni pasovi, volanske obloge.
- Tehnični tekstili: filtri za zrak, gorivo in olje, izolacijski materiali, zvočna

absorpcija.

- Zunanja uporaba: mehke strehe kabrioletov, zaščitne obloge prtljažnika, tesnilni materiali.

Slika 66: Tekstilni materiali na vratih v notranjosti avtomobila



Netkane tekstilije

V avtomobilski industriji se netkani tekstil uporablja za zaščito izdelkov v medfazni proizvodnji sestavnih delov avtomobila. Material ima dobre pretržne lastnosti in je reciklažen.

Netkani tekstil se uporablja za izdelavo filtrov, na primer kabinski in zračni filter. Uporablja se tudi v nekaterih tesnilih motorja in pri izpustih plinov. Netkane tekstilije služijo kot zvočna izolacija v avtomobilih.

Akustični netkani tekstilni materiali se uporabljajo za:

- pokrove motorjev - zmanjšanje hrupnosti vozil,
- akustiko v notranjih delih avtomobilov,
- zaščito kolotekov,
- zaščito stropov avtomobilov in
- zaščito vratnih in armaturnih plošč (K-DOM, d.o.o., 2025).

Slika 67: Netkana tekstilija za zvočno izolacijo v avtomobilih



Po podatkih *Grand View Research (2023)* so najpogosteje uporabljena vlakna:

- Poliester (≈ 55 %) – zaradi trpežnosti in odpornosti proti obrabi.
- Polipropilen (≈ 25 %) – lahek, kemijsko odporen, uporaben pri talnih oblogah in oblogah vrat.
- Najlon (≈ 10 %) – uporablja se pri varnostnih pasovih in tehničnih tekstilih.
- Bombaž in volna (< 5 %) – predvsem v luksuznem segmentu zaradi udobja in estetike.

2.2 Funkcionalne lastnosti tekstilov v avtomobilih

Tekstilni materiali niso zgolj estetska komponenta, temveč so zasnovani z jasno funkcionalno vlogo:

1. Varnost
   - Varnostni pasovi in zračne blazine so ključni za zaščito potnikov. Zračne blazine so izdelane iz visoko trdnih najlonskih vlaken, ki se ob sprožitvi razširijo v manj kot 40 ms.
2. Udobje in ergonomija
   - Tekstilne sedežne prevleke omogočajo zračenje, regulacijo vlage in toplotno udobje. Raziskave kažejo, da kakovost sedežnega tekstila vpliva na do 30 % zaznanega udobja voznika.
3. Akustika
   - Tekstilni materiali prispevajo k zmanjšanju hrupa v kabini. Akustične obloge lahko znižajo raven hrupa za 3–5 dB, kar neposredno vpliva na občutek udobne vožnje.
4. Trajnost in ekologija
   - Evropski proizvajalci uvajajo reciklirane PET vlaknine za sedežne tkanine in talne obloge. Na primer, podjetje *Audi* uporablja tkanine iz do 89 % recikliranih plastenk (Audi Sustainability Report, 2022).

3 Postopki ponovne uporabe tekstilov v avtomobilih

3.1 Mehanski postopki

- Demontaža: sedežne prevleke, talne obloge in varnostni pasovi se ločijo od kovinskih in plastičnih delov.
- Razvlaknjevanje: tkanine iz poliestra, polipropilena in najlona se razvlaknijo v osnovna vlakna – netkane strukture.

Ponovna uporaba vlaken: reciklirana vlakna se uporabijo za:

- izolacijske plošče v novih vozilih,
- filce za protihrupno zaščito,
- polnila v sedežih.

Prednost mehanskega postopka je nižja cena, slabost pa degradacija kakovosti vlaken

(Euratex, 2022).

3.2 Termična obdelava

- Toplotno preoblikovanje: sintetična vlakna, kot sta poliester in polipropilen, se lahko talijo in predelajo v nove polimere.

Uporaba: iz sekundarnega granulata nastanejo nove plastične komponente, tekstilne membrane ali netkani materiali.

Izkoristek: približno 70 – 80 % materiala ohrani uporabno kakovost po termični obdelavi.

3.3 Kemični postopki

Kemične metode omogočajo regeneracijo vlaken na molekularni ravni

- Depolimerizacija: poliestrske tkanine (npr. iz sedežnih prevlek) se kemično razgradijo v osnovne monomere (npr. tereftalno kislino in etilenglikol).

Prednost: omogoča pridobitev skoraj enako kakovostnega materiala kot pri primarni proizvodnji.

Uporaba: nova vlakna za sedežne tkanine, PET steklenice, tehnične membrane. (ACEA, 2023).

Primer: Audi uporablja proces kemičnega recikliranja PET tkanin, pri čemer se v novih modelih A3 uporablja do 89 % recikliranega poliestra v sedežnih tkaninah (Audi, 2022).

3.4 Ponovna uporaba brez predelave

- Re-manufacturing: tekstilni deli (npr. usnjene in tekstilne prevleke) se obdelajo, očistijo in ponovno uporabijo kot rezervni deli.
- Upcycling: tekstili iz avtomobilov se lahko uporabijo za izdelavo modnih dodatkov, pohištva ali zaščitnih prevlek.

Prednosti: zmanjšanje odpadkov in podaljšanje življenjskega cikla materiala.

3.5 Energetska izraba

Če recikliranje ni mogoče, se tekstil uporabi kot gorivo v cementarnah.

To sicer zmanjša odpadke, vendar povzroča emisije CO_2, zato velja za najmanj trajnostno rešitev

(European Commission, 2000).

4 Trajnostni izzivi in prihodnost

Avtomobilska industrija je eden večjih porabnikov sintetičnih vlaken, kar povzroča okoljske izzive:

- Omejena reciklaža: Le približno 25 % tekstilnih komponent se danes reciklira, saj so pogosto laminirane ali kombinirane z drugimi materiali (European Environment Agency, 2021).
- Zahteve po lahkih materialih: Tekstili zmanjšujejo skupno maso vozila, kar znižuje porabo goriva za približno 0,3 l/100 km na vsakih 10 kg zmanjšane teže (ACEA, 2020).

- Bio-osnovana vlakna: Trenutno potekajo raziskave uporabe naravnih vlaken, kot so lan, juta in konoplja, v kompozitnih materialih za notranje obloge.
- Onesnaženost materialov: olja, lepila in pena zmanjšujejo kakovost reciklata.
- Razvoj biorazgradljivih materialov: trend je usmerjen k lanenim, konopljinim in PLA vlaknom, ki omogočajo lažjo razgradnjo.
- Digitalno označevanje tekstilov: v EU se razvijajo standardi za digitalne potne liste materialov, ki bodo omogočili lažjo identifikacijo in recikliranje tekstilov ob koncu življenjske dobe vozila (Euratex, 2022).

Slika 68: Trajnostna usmeritev na avtomobilski deponiji



5 Prihodnji trendi krožne zasnove tekstilnih materialov v avtomobilskem sektorju

Krožna zasnova tekstilnih materialov v avtomobilskem sektorju se osredotoča na podaljševanje življenjskega cikla, reciklabilnost in uporabo trajnostnih virov. Prihodnje usmeritve vključujejo:

- Monomaterialne strukture: razvoj enoslojnih ali homogenih tekstilnih materialov, ki omogočajo lažje razstavljanje in recikliranje ob koncu življenjske dobe vozila. To pomeni zmanjšanje uporabe laminiranih materialov, ki so danes največja ovira za učinkovito recikliranje.
- Digitalni potni list materialov: uvedba sledljivosti z vgrajenimi oznakami (QR kode, RFID, blockchain), ki omogočajo natančno identifikacijo vlaknin, barvil in obdelav. To bo pospešilo postopke sortiranja in povečalo delež visokokakovostnega recikliranja.
- Bio-osnovana vlakna in biokompoziti: vse večja uporaba naravnih vlaken (lan, konoplja, juta) ter biopolimerov (PLA, PHA), ki so lahki, trajni in ob ustreznih pogojih biorazgradljivi. Kombinacija z naravnimi smolami zmanjšuje ogljični odtis in spodbuja zapiranje materialnih zank.
- Reciklirani poliestri nove generacije: razvoj kemičnega recikliranja omogoča pridobivanje recikliranega PET enake kakovosti kot primarnega. To bo vodilo do popolne substitucije deviškega poliestra v sedežnih tkaninah in tehničnih tekstilih.
- Upcycling koncepti: preusmerjanje odsluženih tekstilov v nove tržne izdelke (modni dodatki, pohištvo, akustični paneli). S tem se podaljšuje vrednostni tok materialov,

kar je skladno z načeli krožnega gospodarstva.

- Ekodizajn za razstavljanje: avtomobilski proizvajalci vse bolj uvajajo zasnovo »design for disassembly«, kjer so tekstilni deli pritrjeni s spoji, ki omogočajo enostavno ločevanje, kar izboljšuje stopnjo snovne izrabe ob razgradnji vozila (*Innovation in Textiles, 2023).*

Prihodnost temelji na krožnem gospodarstvu, sodelovanju proizvajalcev vozil in tekstilne industrije. Raziskave se usmerjajo v reciklabilne kompozite, biopolimere in povečanje deleža recikliranih materialov. Do leta 2035 se pričakuje, da bo delež recikliranega tekstila presegal 40 % (ACEA, 2023).

Slika 69: Tekstilija iz naravnih, biodegradacijskih materilalov



6 Zaključek

Tekstilni materiali so v avtomobilski industriji nepogrešljivi, saj združujejo tehnično funkcionalnost, udobje in trajnostne zahteve. Z napredkom v recikliranju in razvojem bio-osnovanih vlaken bo njihova vloga v prihodnosti še pomembnejša, zlasti v kontekstu razogljičenja in krožnega gospodarstva. Ponovna uporaba tekstilnih materialov v avtomobilih je ključni element trajnostne transformacije industrije. S kombinacijo mehanskega, kemičnega in termičnega recikliranja ter ponovne uporabe brez predelave je mogoče doseči znatno zmanjšanje odpadkov. Prihodnost pa kaže na večjo vlogo bio-osnovanih materialov in krožnih rešitev, ki bodo omogočili doseganje ciljev EU o skoraj popolni snovni izrabi vozil.

7 Viri in literatura

- https://acea.auto, 13. 9. 2025
- https://www.audi.com, 13. 9. 2025
- https://www.bmwgroup.com, 13. 9. 2025
- https://environment.ec.europa.eu, 13. 9. 2025
- Direktiva evropskega parlamaneta in sveta, *ELV Directive* 2000/53/EC.
- https://euratex.eu, 13. 9. 2025

- https://www.eea.europa.eu, 13. 9. 2025
- Grand View Research (2023). Automotive Textiles Market Size, Share & Trends Analysis Report. https://www.grandviewresearch.com, 13. 9. 2025
- https://www.innovationintextiles.com/sustainable-biobased-materials-for-the-automotive-industry/, 13. 9. 2025
- https://k-dom.si/sl/avto-industrija/, 13. 9. 2025
- https://www.oeko-tex.com, 13. 9. 2025
- Textile World (2022). Automotive Textiles – Current Status and Future Trends. https://www.textileworld.com, 13. 9. 2025

MSc in textile engineering, Tjaša Rozman

SIC Ljubljana
Strokovni izobraževalni center Ljubljana

Ptujska ulica 6, 1000 Ljubljana

tjasa.rozman@siclj.si

REUSE OF TEXTILE MATERIALS IN THE AUTOMOTIVE INDUSTRY

XV. mednarodni simpozij
INTERDISCIPLINARNOST LOGISTIKE IN PROMETA

Organizator

ŠC Celje, Srednja šola za storitvene dejavnosti in logistiko

25. – 27. september 2025, Portorož

Fakulteta za pomorstvo in promet, Portorož

Abstract

In the automotive industry, the use of textile materials plays a key role, as they are applied in seat upholstery, roof linings, carpets, seat belts, as well as in acoustic and thermal insulation. An average vehicle contains between 20 – 35 kg of textiles, depending on the segment and level of luxury. In recent decades, the industry has been facing the challenges of the circular economy and sustainable development, where recycling and reuse of materials are among the main goals. Recycling processes include mechanical (fiberizing, cutting), chemical (polyester depolymerization, polyamide regeneration), and thermal treatments. The reuse of textiles enables the production of secondary raw materials for new automotive components, insulation materials, or even textiles for new seat covers. This reduces waste, CO_2 emissions, and the consumption of primary raw materials. The greatest progress is being made by manufacturers such as BMW, Toyota, and Volvo, who are introducing recycled polyester fabrics and bio-based textiles into serial production. The article discusses the types of textiles in vehicles, their reuse processes, and future trends in circular design within the automotive sector.

Keywords: reuse of textile materials, textiles in automobiles, circular economy, nonwoven textiles, automotive industry

1 Introduction

The automotive industry is one of the largest consumers of textile materials, with an estimated annual use of more than 1 million tons of technical textiles (European Commission, 2000). Textile materials form a crucial part of modern vehicles. Although often overlooked compared to metal and electronic components, textiles contribute to comfort, safety, aesthetics, and sustainability. According to *Textile World* (2022), an average passenger car uses between 20 and 30 kg of textiles, accounting for around 2% of total vehicle mass. The industry consumes more than 1 million tons of textiles annually (Oeko-Tex, 2021). As end-of-life vehicles present a significant waste stream, efficient textile recycling has become essential. The European Union's End-of-Life Vehicles Directive (2000/53/EC) requires at least 95% material recovery of vehicles (including 85% recycling), which also applies to textile components.

2 Textile Materials in Automobiles

2.1 Types of Textiles Used

The automotive industry uses various types of textile materials, divided into several categories:

- Interior: seat covers, roof linings, carpets, seat belts, steering wheel covers.
- Technical textiles: air, fuel, and oil filters, insulation materials, sound absorption.
- Exterior use**:** convertible soft tops, trunk linings, sealing materials.
-

Slika 70: Textile materials on car interior doors



Nonwoven textiles

In the automotive industry, nonwoven fabrics are used to protect components during intermediate production stages. These materials exhibit strong tensile properties and are recyclable. Nonwovens are applied in filters (e.g., cabin and air filters), certain engine seals, exhaust applications, and acoustic insulation.

Applications of acoustic nonwovens include:

- Engine covers – reducing noise levels,
- Cabin acoustics,
- Wheel arch protection,
- Roof insulation,
- Door and dashboard panels (K-DOM, d.o.o., 2025).

Slika 71: Nonwoven textile for sound insulation in automobiles



According to Grand View Research (2023), the most common fibers are:

- Polyester (≈ 55 %) – durable, abrasion-resistant,
- Polypropylene (≈ 25 %) – lightweight, chemically resistant, used in carpets and door linings,
- Nylon (≈ 10 %) – used in seat belts and technical textiles,
- Cotton and wool (< 5 %) – mainly in luxury vehicles for comfort and aesthetics.

2.2 Functional Properties of Automotive Textiles

Textiles are not merely aesthetic but are designed with distinct functional roles:

1. Safety
    - Seat belts and airbags are crucial for passenger protection. Airbags are made of high-strength nylon fibers that deploy in less than 40 ms.
2. Comfort & Ergonomics
    - Seat fabrics provide breathability, moisture regulation, and thermal comfort. Research shows that seat textile quality can influence up to 30% of perceived driver comfort.
3. Acoustics
    - Textiles contribute to noise reduction inside the cabin. Acoustic linings can lower noise levels by 3–5 dB, directly improving driving comfort.
4. Sustainability
    - European manufacturers are adopting recycled PET fibers for seat fabrics and carpets. For example, Audi uses up to 89% recycled bottles in its seat fabrics (*Audi Sustainability Report*, 2022).

3 Textile Reuse Processes in Automobiles

3.1 Mechanical Processes

- Dismantling: seat covers, carpets, and seat belts are separated from metal and plastic parts.
- Fiberizing: polyester, polypropylene, and nylon fabrics are shredded back into fibers.

Reuse of fibers: recycled fibers are used for:

- insulation panels in new cars,
- soundproofing felts,
- seatpadding.

Advantage: low cost; drawback: fiber quality degradation (Euratex, 2022).

3.2 Thermal Treatment

- Thermoforming: synthetic fibers (polyester, polypropylene) are melted and processed into new polymers.

Applications: secondary granulate is used for new plastic components, membranes, or nonwovens.

Yield: approx. 70 – 80 % of material retains usability after thermal processing.

3.3 Chemical Processes

Chemical methods regenerate fibers at the molecular level:

- Depolymerization: polyester fabrics (e.g., seat covers) are chemically broken down

into monomers (terephthalic acid and ethylene glycol).

Advantage: allows production of materials nearly equal in quality to virgin.

Applications: new seat fabrics, PET bottles, technical membranes (ACEA, 2023). *Example:* Audi applies chemical recycling of PET fabrics, with up to 89% recycled polyester in seat fabrics of the A3 model (Audi, 2022).

3.4 Reuse Without Processing

- Re-manufacturing: textile parts (e.g., leather or fabric covers) are refurbished and reused as spare parts.
- Upcycling: automotive textiles can be transformed into fashion accessories, furniture, or protective covers.

Benefit*:* waste reduction and lifecycle extension.

3.5 Energy Recovery

If recycling is not feasible, textiles can be used as fuel in cement plants. While this reduces waste, it generates CO_2 emissions and is considered the least sustainable option (European Commission, 2000).

4 Sustainability Challenges and Future Outlook

The automotive industry is a major consumer of synthetic fibers, creating environmental challenges:

- Limited recycling: only ~25% of textile components are recycled today due to lamination or material blends (EEA, 2021).
- Lightweight material demands: textiles help reduce vehicle weight, saving approx. 0.3 l/100 km for every 10 kg weight reduction (ACEA, 2020).
- Bio-based fibers: research is ongoing into natural fibers (flax, jute, hemp) in composites for interiors.
- Material contamination: oils, adhesives, and foams reduce recyclate quality.
- Biodegradable materials: trends include flax, hemp, and PLA fibers for easier degradation.
- Digital textile labeling: EU is developing digital product passports for easier material identification and recycling (Euratex, 2022).

Slika 72: Sustainable orientation at the automotive landfill



5 Future Trends in Circular Textile Design in the Automotive Sector

Future circular design focuses on extending product life, recyclability, and sustainable sourcing:

- Monomaterial structures: single-layer or homogeneous textiles enabling easier dismantling and recycling.
- Digital product passports: traceability with QR codes, RFID, blockchain, enabling precise fiber identification and improved sorting.
- Bio-based fibers and biocomposites: growing use of natural fibers (flax, hemp, jute) and biopolymers (PLA, PHA), lightweight and biodegradable under suitable conditions.
- Next-generation recycled polyesters: chemical recycling yields PET equal to virgin quality, enabling complete replacement in seat fabrics and technical textiles.
- Upcycling concepts: transforming discarded automotive textiles into fashion items, furniture, or acoustic panels, aligning with circular economy principles.
- Eco-design for disassembly: manufacturers are increasingly applying "design for disassembly," where textiles are attached with easily removable fasteners, improving recycling rates (Innovation in Textiles, 2023).

The future is based on the circular economy, the collaboration between vehicle manufacturers and the textile industry. Research is focused on recyclable composites, biopolymers, and increasing the share of recycled materials. By 2035, the share of recycled textiles in vehicles is expected to exceed 40% (ACEA, 2023).

Slika 73: Textile made from natural, biodegradable materials



6 Conclusion

Textile materials are indispensable in the automotive industry, combining technical performance, comfort, and sustainability. With advancements in recycling and bio-based fibers, their role will grow even more important in the future, especially in decarbonization and circular economy contexts. Reuse of automotive textiles is a key element in the industry's sustainable transition. A mix of mechanical, chemical, and thermal recycling, along with direct reuse, can significantly reduce waste. Future developments point toward greater reliance on bio-based materials and circular solutions to meet the EU's goals of near-

complete vehicle material recovery.

7 References

- https://acea.auto, 13. 9. 2025
- https://www.audi.com, 13. 9. 2025
- https://www.bmwgroup.com, 13. 9. 2025
- https://environment.ec.europa.eu, 13. 9. 2025
- Direktiva evropskega parlamaneta in sveta, *ELV Directive* 2000/53/EC.
- https://euratex.eu, 13. 9. 2025
- https://www.eea.europa.eu, 13. 9. 2025
- Grand View Research (2023). Automotive Textiles Market Size, Share & Trends Analysis Report. https://www.grandviewresearch.com, 13. 9. 2025
- https://www.innovationintextiles.com/sustainable-biobased-materials-for-the-automotive-industry/, 13. 9. 2025
- https://k-dom.si/sl/avto-industrija/, 13. 9. 2025
- https://www.oeko-tex.com, 13. 9. 2025
- Textile World (2022). Automotive Textiles – Current Status and Future Trends. https://www.textileworld.com, 13. 9. 2025

Igor Skukan

SIC Ljubljana
Strokovni izobraževalni center Ljubljana

Ptujska ulica 6, 1000 Ljubljana

igor.skukan@siclj.si

VLOGA UMETNE INTELIGENCE PRI IZBOLJŠANJU VARNOSTNIH SISTEMOV V VOZILIH



dipl. inž. logistike, Igor Skukan

Strokovni izobraževalni center Ljubljana

Povzetek

Umetna inteligenca (UI) ima ključno vlogo pri izboljšanju varnosti v sodobnih vozilih, saj omogoča hitrejše prepoznavanje nevarnosti, samodejno ukrepanje in zmanjšanje prometnih nesreč. Z uporabo naprednih sistemov za pomoč voznikom (ADAS) in samovozečih

tehnologij, ki temeljijo na strojnem učenju, senzorjih in nevronskih mrežah, UI prispeva k zmanjšanju človeških napak, boljši analizi prometa ter večjemu udobju med vožnjo. Kljub prednostim, kot so samodejno zaviranje in zaznavanje utrujenosti, ostajajo izzivi, kot so delovanje v slabih vremenskih razmerah, kibernetska varnost in prevelika odvisnost od tehnologije. Raziskave potrjujejo, da UI ni le marketinški trik, temveč dejanska rešitev za večjo prometno varnost, ki bo v prihodnosti igrala še pomembnejšo vlogo.

---

1 Uvod

Varnostni sistemi v sodobnih vozilih so se v zadnjih desetletjih bistveno razvili, pri čemer ima umetna inteligenca (UI) ključno vlogo. Uvedba naprednih tehnologij temelji na sposobnosti UI, da obdeluje velike količine podatkov v realnem času, kar omogoča izboljšanje prepoznavanja nevarnosti, hitrejše odzivanje na prometne situacije in zmanjšanje števila prometnih nesreč.

Eden izmed glavnih prispevkov UI je razvoj sistemov za pomoč vozniku (ADAS, angl. Advanced Driver Assistance Systems). Ti vključujejo funkcije, kot so samodejno zaviranje v sili, pomoč pri ohranjanju voznega pasu in prilagodljivi tempomat. Algoritmi strojnega učenja omogočajo prepoznavanje in interpretacijo kompleksnih prometnih situacij, kot so nenadne spremembe voznih razmer ali prisotnost ranljivih udeležencev v prometu, kot so pešci in kolesarji (Avtomobilizem, b. d.).

Poleg tega se UI uporablja pri analizi vedenja voznika. Na primer, sistemi za prepoznavanje utrujenosti spremljajo gibe oči, obraza in položaj telesa ter voznika opozarjajo, kadar je zaznana nevarnost zaspanosti. Z naprednimi senzorji in kamerami UI tudi omogoča neprekinjen nadzor nad okolico vozila, kar zmanjšuje možnost nesreč zaradi mrtvih kotov.

Pomemben preboj v avtomobilski industriji je razvoj avtonomnih vozil, ki temeljijo na umetni inteligenci. Ti sistemi uporabljajo tehnologije, kot so računalniški vid, nevralne mreže in algoritme za odločanje, za popolnoma avtonomno upravljanje vozila. Z integracijo teh sistemov se pričakuje drastično zmanjšanje človeških napak, ki so glavni vzrok prometnih nesreč (Gregorčič, 2017).

Statistični podatki kažejo, da lahko uporaba naprednih varnostnih sistemov zmanjša število prometnih nesreč, pri čemer avtonomna vozila obetajo še večjo varnost v prihodnosti. Kljub temu pa so potrebne dodatne raziskave za odpravo tehnoloških omejitev, kot so zanesljivost

delovanja v izjemnih vremenskih razmerah in etična vprašanja pri odločanju v kompleksnih situacijah.

Z integracijo umetne inteligence v varnostne sisteme vozil se ne izboljšuje le prometna varnost, temveč se zmanjšujejo tudi stroški, povezani z nesrečami, ter povečuje zaupanje uporabnikov v prihodnost avtonomne mobilnosti. Vloga UI tako ostaja ključna pri razvoju bolj varnega in zanesljivega prometnega sistema (Napredni asistenčni sistemi, b. d.).

Pri raziskovanju vloge UI pri izboljšanju varnostnih sistemov v vozilih me zanima, ali UI pripomore k preprečevanju prometnih nesreč ali je to le trženjski pristop in inovativnost proizvajalcev vozil?

2 Umetna inteligenca

Umetna inteligenca (AI) je interdisciplinarna znanost, ki se osredotoča na razvoj programov

in sistemov za izvajanje nalog, ki običajno zahtevajo človeške intelektualne sposobnosti. Sem spadajo naloge, kot so prepoznavanje govora, učenje, načrtovanje, razumevanje naravnega jezika, poznavanje in interpretacija okolja ter reševanje problemov. (McCarthy, 2004).

Umetna inteligenca (UI) omogoča strojem, da »razmišljajo« podobno kot ljudje, ki se samostojno uporabljajo ter izboljšajo svoje sposobnosti brez potrebe po neposrednem človeškem posegu. Njene teoretične temelje je že leta 1950 postavil Alan Turing v svojem članku, kjer je predstavil Turingov test za ocenjevanje inteligentnega vodenja strojev (Turing, 1950).

Umetno inteligenco tvorijo številni dejavniki, ki prispevajo k njenemu brezhibnemu delovanju. Analiza sestavnih delov, kot so učenje, utemeljevanje in odločanje, reševanje problemov ter zaznavanje, omogoča boljšo predstavo o tem, kako UI deluje in kako lahko koristi podjetjem in posameznikom (Zavadskaya, 2017).

Med letoma 1960 in 1990 je UI doživela obdobje močnega zanimanja, ki je sledilo tako obdobju stagnacije. Prelomnica za ponovni vzpon UI je nastopila z razvojem naprednih algoritmov, kot so nevronske mreže, tehnološkim napredkom v računalniški zmogljivosti in širjenjem praktičnih aplikacij. Danes se umetna inteligenca nenehno razvija z ambicijo ustvariti sisteme, ki bodo obvladovali širok spekter nalog, še bolj integrirali tehnologijo v vsakodnevno življenje in ljudem olajšali delo ter povečali njihovo učinkovitost.

Umetno inteligenco se bi lahko uporabljalo v zdravstvu na namen razvoja zdravil in napovedovanje bolezni, v poslovanju za analizo podatkov in avtomatizacijo procesov ter v industriji za upravljanje z roboti in optimizacijo proizvodnih procesov.

Umetno inteligenco bi lahko razdelili v sedem podskupin kot je to naredil psiholog Howard Gardner (Gardner, 1999):

- jezikovna inteligenca,
- logično-matematična inteligenca,
- glasbena inteligenca,
- telesno-gibalna inteligenca,
- prostorsko-vizualna inteligenca,
- interpersonalna inteligenca in
- intrapersonalna inteligenca.

3 Varnostni sistemi v vozilih

Varnostni sistemi v vozilih so tehnologije in rešitve, ki zmanjšujejo tveganje za nesreče, varujejo potnike ter zmanjšujejo posledice trkov. Ti sistemi vključujejo:

- Pasivne varnostne sisteme, kot so varnostni pasovi, zračne blazine in ojačana konstrukcija vozila.
- Aktivne varnostne sisteme, ki preprečujejo nesreče, kot so ABS (sistem proti blokiranju koles), ESP (elektronski program stabilnosti), sistemi za pomoč pri zaviranju in opozarjanje pred trkom (Ocenjevanje asistenčnih sistemov, 2020).

- Napredni sistem za pomoč voznikom (ADAS)
- Sistemi za zaznavanje voznika

4 Primeri vloge umetne inteligence pri izboljšanju varnostnih sistemov v vozilih

- Samovozeča vozila: Napredni UI-algoritmi obdelujejo podatke iz radarjev, lidarjev, kamer in senzorjev za natančno prepoznavanje okolice ter preprečevanje trkov.
- Primer: Tesla uporablja nevronske mreže za analizo prometa in prilagoditev vožnje v realnem času.Sistemi za preprečevanje utrujenosti voznika: UI prepozna znake zaspanosti (npr. pogosteje zapiranje oči) in opozori voznika.
- Primer: Mercedes-Benz "Attention Assist".
- Avtonomni zasilni sistemi: Sistemi za samodejno zaviranje in manevriranje za preprečitev nesreč.
- Primer: Volvo City Safety uporablja UI za zaznavanje pešcev, kolesarjev in vozil.
- Varnostna analiza v realnem času: UI spremlja vedenje drugih voznikov in ocenjuje tveganja za nesreče (Umetna inteligenca, 2023).

5 Pomanjkljivosti varnostnih sistemov v povezavi z umetno inteligenco

- Nezanesljivost pri analizi podatkov: Sistemi, ki temeljijo na umetni inteligenci (UI), kot so kamere in senzorji za prepoznavanje okolice, lahko odpovedo v slabih vremenskih razmerah (npr. megla, močan dež) ali zaradi nepravilnega vzdrževanja opreme.
- Lažni alarmi: Sistemi za opozarjanje pred trkom lahko sprožijo napačne alarme, kar vodi do nezaupanja uporabnikov in zmanjšane učinkovitosti.
- Kibernetska varnost: UI-sistemi so ranljivi za kibernetske napade, ki lahko prevzamejo nadzor nad varnostnimi funkcijami vozila (Umetna inteligenca, 2023).
- Zasnova in odločitve AI: Sistemi so lahko pristranski zaradi nepopolnih ali omejenih podatkov med usposabljanjem, kar vpliva na njihove reakcije v nepredvidenih situacijah.
- Prevelika odvisnost od tehnologije: Vozniki se lahko preveč zanašajo na varnostne sisteme in zmanjšajo svojo pozornost na vožnjo, kar povečuje tveganje za nesreče (Ocenjevanje asistenčnih sistemov, 2020).

Preglednica 3: Analiza prometnih nesreč z uporabo UI in brez uporabe UI

	BREZ UPORABE UI	**Z UPORABO UI**
Zaznavanje nevarnosti	Reakcija voznika temelji na vizualnem in slušnem zaznavanju.	Algoritmi UI analizirajo podatke iz senzorjev in zaznajo nevarnosti hitreje kot človek.
Preprečevanje trkov	Sistem zaviranja je odvisen od reakcijskega časa voznika.	Samodejno zaviranje ob zaznavi ovire (npr. pešca, vozila).
Napake voznika	Pogoste napake zaradi utrujenosti, nepozornosti ali napačne ocene situacije.	Sistemi za prepoznavanje utrujenosti ali distrakcije opozorijo voznika.
Odziv na nepredvidene dogodke	Omejeno na zmožnosti voznika in osnovnih varnostnih sistemov.	Avtonomni sistemi prilagodijo vožnjo v realnem času glede na situacijo.
Statistika nesreč	Višja stopnja nesreč zaradi počasnih reakcij ali človeških napak.	Zmanjšanje nesreč za do 20 – 40 % v vozilih z naprednimi UI-sistemi.
Primeri uporabe	ABS, zračne blazine.	Avtonomno zaviranje, prepoznavanje okolice, samo vozeča vozila.

Analiza prometnih nesreč z uporabo umetne inteligence omogoča obdelavo velikih količin podatkov, napovedovanje tveganj v realnem času ter visoko natančnost s pomočjo algoritma strojnega učenja in globokega učenja, medtem ko tradicionalna analiza brez umetne inteligence temelji na statističnih metodah in ročnih pregledih, ki so enostavni za uporabo, a manj prilagodljivi in manj učinkoviti (Digitalni kompas do leta 2030: evropska pot v digitalno desetletje, 2021; Korporativna varnost, 2023).

6 Sklep

Z vključevanjem umetne inteligence v varnostne sisteme vozil ne izboljšujemo zgolj njihove varnosti, temveč tudi udobje vožnje, kar ima pozitiven učinek na psihično stanje voznika. Bolj sproščeni in samozavestni vozniki se lažje osredotočijo na vožnjo, kar prispeva k mirnejšemu in boljšemu prehodu na cesto. To pomeni, da UI ne vpliva zgolj na tehnične vidike varnosti, ampak posredno tudi na človeški dejavnik, ki je pogosto odločen pri razvoju umetne inteligence v najnovejših avtonomnih in samovoznih vozilih se zdi ključna pomena, da te sisteme še dodatno nadgradimo in prilagodimo. Nepredvidljive vremenske razmere, kot tako močan dež, sneg ali megla, ter različne vrste infrastrukture in kakovosti cestišč pogosto povzročajo težave pri poznavanju okolja. Ti izzivi lahko vplivajo na pravilnost in pravočasnost odzivov vozil, kar povzroči tveganje za hude in posledične nesreče. Zato je potrebno posebno pozornost nameniti izboljšavam senzorjev, algoritmov za prepoznavanje okolja in možnosti teh sistemov.

Kljub tem izzivom raziskave in praktične izkušnje potrjujejo, da je vloga umetne inteligence ključna pri razvoju varnejšega in zanesljivejšega prometnega sistema. Njena osrednja naloga je preprečevanje nesreč in drastično zmanjšanje njihovega števila, kar se že odraža v uporabi

naprednih sistemov za pomoč voznikom (ADAS) v sodobnih vozilih. Ti sistemi, ki vključujejo funkcije, kot so izključno zaviranje v sili, prilagodljivi tempomat in pomoč pri ohranjanju voznega pasu, pomembno izboljšajo varnost na cestah. Po pisanju članka in opravljeni raziskavi ugotavlja, da je vloga UI ključna pri razvoju bolj varnega in zanesljivega prometnega sistema, saj teži k ključni stvari, to je preprečitev in drastično zmanjšanje prometnih nesreč. Kljub dobrim razvojem UI, pa se moramo ljudje in vozniki zavedati, da UI ni nadomestilo in nikoli ne bo nadomestilo človeške inteligence.

7 Zaključek

Umetna inteligenca predstavlja ključni element pri razvoju sodobnih varnostnih sistemov v vozilih, saj omogoča boljše zaznavanje, analizo in ukrepanje v prometu. Kljub nekaterim pomanjkljivostim, kot so nezanesljivost v ekstremnih razmerah in ranljivost za kibernetske grožnje, je njen doprinos k zmanjšanju prometnih nesreč in izboljšanju varnosti potnikov nesporen. V prihodnosti bo razvoj varnostnih sistemov v vozilih še bolj temeljil na integraciji umetne inteligence in povečani zanesljivosti teh tehnologij.

8 Viri in literatura

1. Kako delujejo sodobni varnostni sistemi v avtomobilih. (b. d.). Avtomobilizem. https://kulkul.si/kako-delujejo-sodobni-varnostni-sistemi-v-avtomobilih/
2. McCarthy, J.(2004). What is Artificial Intelligence? Stanford: Stanford University.
3. Gardner H. (1999). INTELLIGENCE REFRAMED. Multiple intelligences fro ste 21 st Century.
4. Zavadskaya, A. (2017). Artificial Intelligence in Finance: Forecasting Stock Market Returns Using Artificial Intelligence. Helsinki: Hanken School of Economics.
5. Gregorčič, J. (2017). Umetna inteligenca: kako gleda, misli in sam vozi audi A8?. S.AVTOMOTO. https://siol.net/avtomoto/tehnika/umetna-inteligenca-kako-gleda-misli-in-sam-vozi-audi-a8-video-446001.
6. Napredni asistenčni sistemi – NAS. (b. d.). AMZS. https://www.amzs.si/varnost/projekti-in-kampanje/napredni-asistencni-sistemi-nas.
7. Umetna inteligenca. (b. d.). Wikipedia. https://sl.wikipedia.org/wiki/Umetna_inteligenca.
8. Kaj je umetna inteligenca in kako se uporablja v praksi?. (2020). Evropski parlament.https://www.europarl.europa.eu/topics/sl/article/20200827STO85804/kaj-je-umetna-inteligenca-in-kako-se-uporablja-v-praksi.
9. Varnost: Euro NCAP. (2020). AMZS. Ocenjevanje asistenčnih sistemov.https://www.amzs.si/motorevija/mobilnost/promet/2020-11-05-varnost-euro-ncap-ocenjevanje-asistencnih-sistemovRichards G., Grinsted S., 2020. The logistics and supply chain toolkit. 3rd ed. London: Kogan Page.
10. Umetna inteligenca. (2023). Porsche Slovenija. https://www.poslo.si/aktualno/novice/umetna-inteligenca-v-avtomobilski-industriji
11. Digitalni kompas do leta 2030: evropska pot v digitalno desetletje. (2021). Evropska

komisija. https://eur-lex.europa.eu/legal-content/SL-EN/TXT/?uri=CELEX%3A52021DC0118

12. Korporativna varnost. (2023). Inštitut za korporativne varnostne študije. Tradicionalna 14. mednarodna konferenca »Dnevi korporativne varnosti 2023«. https://www.ics-institut.si/assets/uploads/revija/31-%C5%A1tevilka/31-stevilka-revije-Korporativna-varnost.pdf.

Igor Skukan

SIC Ljubljana
Strokovni izobraževalni center Ljubljana

Ptujska ulica 6, 1000 Ljubljana

igor.skukan@siclj.si

THE ROLE OF ARTIFICIAL INTELLIGENCE IN IMPROVING VEHICLE SAFETY SYSTEMS



BSc in Logistics, Igor Skukan
Secondary Vocational and Technical School Ljubljana

Abstract

Artificial Intelligence (AI) plays a key role in improving safety in modern vehicles by enabling faster hazard recognition, automatic response, and reduction of traffic accidents. Through the use of Advanced Driver Assistance Systems (ADAS) and self-driving technologies based on machine learning, sensors, and neural networks, AI reduces human error, enhances traffic analysis, and improves driving comfort. Despite advantages such as automatic braking and fatigue detection, challenges remain, including poor performance in adverse weather conditions, cybersecurity risks, and overreliance on technology. Research confirms that AI is not just a marketing gimmick but a real solution for improving road safety, which will play an even greater role in the future.

1 Introduction

Vehicle safety systems have significantly evolved over recent decades, with Artificial Intelligence (AI) playing a crucial role. The introduction of advanced technologies is based on AI's ability to process large amounts of data in real time, allowing better hazard recognition, faster responses to traffic situations, and a reduction in traffic accidents.

One of AI's main contributions is the development of Advanced Driver Assistance Systems (ADAS). These include functions such as emergency automatic braking, lane-keeping assistance, and adaptive cruise control. Machine learning algorithms allow recognition and interpretation of complex traffic scenarios, such as sudden changes in driving conditions or the presence of vulnerable road users like pedestrians and cyclists (Avtomobilizem, n.d.).

AI is also used in driver behavior analysis. For example, fatigue detection systems monitor eye movements, facial expressions, and body posture, alerting the driver when drowsiness is detected. With advanced sensors and cameras, AI provides continuous monitoring of the vehicle's surroundings, reducing the likelihood of accidents caused by blind spots.

A major breakthrough in the automotive industry is the development of autonomous vehicles based on AI. These systems use computer vision, neural networks, and decision-making algorithms for fully autonomous vehicle control. The integration of such systems is expected to drastically reduce human errors, which are the main cause of traffic accidents (Gregorčič, 2017).

Statistical data show that the use of advanced safety systems can reduce the number of traffic accidents, while autonomous vehicles promise even greater safety in the future. However, additional research is needed to overcome technological limitations, such as reliability in extreme weather conditions and ethical dilemmas in complex decision-making scenarios.

The integration of AI in vehicle safety systems not only enhances road safety but also reduces accident-related costs and increases consumer trust in the future of autonomous mobility. AI thus remains crucial in developing safer and more reliable transport systems (Advanced Assistance Systems, n.d.).

This research examines whether AI truly contributes to preventing traffic accidents or whether it is primarily a marketing approach and innovation strategy by vehicle manufacturers.

2 Artificial Intelligence

Artificial Intelligence (AI) is an interdisciplinary science focused on developing programs and systems to perform tasks that usually require human intellectual abilities. These include speech recognition, learning, planning, natural language understanding, environmental interpretation, and problem-solving (McCarthy, 2004).

AI enables machines to “think” similarly to humans, autonomously improving their abilities without direct human intervention. Its theoretical foundations were laid as early as 1950, when Alan Turing introduced the Turing Test for evaluating machine intelligence (Turing, 1950).

AI consists of several components that contribute to its seamless functioning. Elements such as learning, reasoning and decision-making, problem-solving, and perception provide a better understanding of how AI operates and how it benefits organizations and individuals (Zavadskaya, 2017).

Between the 1960s and 1990s, AI experienced cycles of rapid interest followed by stagnation. The resurgence came with the development of advanced algorithms, such as neural networks, technological progress in computing power, and expanding practical applications. Today, AI continues to evolve with the ambition of creating systems capable of handling a wide range of tasks, integrating more deeply into everyday life, easing human work, and increasing efficiency.

Potential applications of AI include healthcare (drug development, disease prediction), business (data analysis, process automation), and industry (robotics management, production optimization).

Psychologist Howard Gardner (1999) proposed categorizing AI into seven subgroups:

- Linguistic intelligence
- Logical-mathematical intelligence
- Musical intelligence
- Bodily-kinesthetic intelligence
- Spatial-visual intelligence
- Interpersonal intelligence
- Intrapersonal intelligence

3 Vehicle Safety Systems

Vehicle safety systems are technologies and solutions designed to reduce accident risks, protect passengers, and minimize crash consequences. These include:

- Passive safety systems: seatbelts, airbags, reinforced vehicle structures.
- Active safety systems: technologies that prevent accidents, such as ABS (anti-lock braking system), ESP (electronic stability program), brake assist, and collision warning systems (Euro NCAP, 2020).
- Advanced Driver Assistance Systems (ADAS)
- Driver monitoring systems

4 Examples of AI's Role in Improving Vehicle Safety

- Self-driving vehicles: Advanced AI algorithms process radar, lidar, camera, and sensor data to accurately recognize the environment and prevent collisions.
- *Example*: Tesla uses neural networks for real-time traffic analysis and driving adaptation.
- Driver fatigue prevention systems: AI detects signs of drowsiness (e.g., frequent eyelid closure) and alerts the driver.
- *Example*: Mercedes-Benz "Attention Assist."
- Autonomous emergency systems: AI enables automatic braking and maneuvering to avoid accidents.
- *Example*: Volvo City Safety detects pedestrians, cyclists, and vehicles.
- Real-time safety analysis: AI monitors other drivers' behavior and assesses accident risks (Artificial Intelligence, 2023).

5 Limitations of AI-Based Safety Systems

- Unreliable data analysis: AI-based systems (cameras, sensors) may fail in poor weather (fog, heavy rain) or due to improper equipment maintenance.
- False alarms: Collision warning systems may trigger incorrect alerts, reducing user trust and effectiveness.
- Cybersecurity risks: AI systems are vulnerable to cyberattacks that could take control of safety functions (Artificial Intelligence, 2023).
- Bias and decision-making: Incomplete or limited training data may bias AI systems, affecting responses in unpredictable situations.
- Overreliance on technology: Drivers may depend too heavily on safety systems, reducing attention to driving and increasing accident risks (Euro NCAP, 2020).

Table 1: Comparison of Traffic Accident Analysis With and Without AI

Aspect	*Without AI*	*With AI*
Hazard detection	Relies on driver's visual/auditory perception.	AI algorithms process sensor data, detecting hazards faster than humans.
Collision prevention	Braking depends on driver's reaction time.	Automatic braking upon obstacle detection (e.g., pedestrian, vehicle).
Driver errors	Frequent due to fatigue, distraction, or misjudgment.	Fatigue/distraction detection systems alert the driver.
Response to unforeseen events	Limited to driver abilities and basic safety systems.	Autonomous systems adapt driving in real time.
Accident statistics	Higher accident rates due to slow reactions and human errors.	Reduction in accidents by 20–40% in vehicles equipped with advanced AI systems.
Examples	ABS, airbags.	Autonomous braking, environmental recognition, self-driving cars.

AI-based accident analysis enables processing of large data sets, real-time risk prediction, and high accuracy through machine learning and deep learning algorithms, while traditional non-AI analysis relies on statistical methods and manual reviews—easier to use but less flexible and less effective (European Commission, 2021; Corporate Security, 2023).

6 Discussion

By integrating AI into vehicle safety systems, not only is safety improved, but driving comfort is also enhanced, positively affecting drivers' psychological well-being. More relaxed and confident drivers focus better, contributing to calmer and safer traffic. This means AI impacts not only technical aspects of safety but also human factors.

Unpredictable weather (heavy rain, snow, fog) and variations in infrastructure or road quality still pose challenges for environmental recognition, affecting the timeliness and accuracy of AI responses. Addressing these challenges requires improvements in sensors, recognition algorithms, and system adaptability.

Despite these challenges, research and practical experience confirm AI's crucial role in developing safer and more reliable transport systems. Its core task is accident prevention and drastically reducing their number, already visible through ADAS adoption. These systems—including emergency braking, adaptive cruise control, and lane-keeping assistance—significantly improve road safety.

Nevertheless, it is important to stress that AI cannot and will never replace human intelligence. Drivers must remain aware of their responsibility.

7 Conclusion

Artificial Intelligence represents a fundamental element in the development of modern vehicle safety systems, enabling improved detection, analysis, and response in traffic. Despite limitations such as unreliability in extreme conditions and vulnerability to cyber threats, AI's contribution to reducing accidents and enhancing passenger safety is indisputable. Future developments will increasingly rely on AI integration and the improvement of reliability in these technologies.

8 References

1. Kako delujejo sodobni varnostni sistemi v avtomobilih. (b. d.). Avtomobilizem. https://kulkul.si/kako-delujejo-sodobni-varnostni-sistemi-v-avtomobilih/
2. McCarthy, J.(2004). What is Artificial Intelligence? Stanford: Stanford University.
3. Gardner H. (1999). INTELLIGENCE REFRAMED. Multiple intelligences fro ste 21 st Century.
4. Zavadskaya, A. (2017). Artificial Intelligence in Finance: Forecasting Stock Market Returns Using Artificial Intelligence. Helsinki: Hanken School of Economics.
5. Gregorčič, J. (2017). Umetna inteligenca: kako gleda, misli in sam vozi audi A8?. S.AVTOMOTO. https://siol.net/avtomoto/tehnika/umetna-inteligenca-kako-gleda-misli-in-sam-vozi-audi-a8-video-446001.
6. Napredni asistenčni sistemi – NAS. (b. d.). AMZS. https://www.amzs.si/varnost/projekti-in-kampanje/napredni-asistencni-sistemi-nas.
7. Umetna inteligenca. (b. d.). Wikipedia. https://sl.wikipedia.org/wiki/Umetna_inteligenca.
8. Kaj je umetna inteligenca in kako se uporablja v praksi?. (2020). Evropski parlament.https://www.europarl.europa.eu/topics/sl/article/20200827STO85804/kaj-je-umetna-inteligenca-in-kako-se-uporablja-v-praksi.
9. Varnost: Euro NCAP. (2020). AMZS. Ocenjevanje asistenčnih sistemov.https://www.amzs.si/motorevija/mobilnost/promet/2020-11-05-varnost-euro-ncap-ocenjevanje-asistencnih-sistemovRichards G., Grinsted S., 2020. The logistics and supply chain toolkit. 3rd ed. London: Kogan Page.
10. Umetna inteligenca. (2023). Porsche Slovenija. https://www.poslo.si/aktualno/novice/umetna-inteligenca-v-avtomobilski-industriji
11. Digitalni kompas do leta 2030: evropska pot v digitalno desetletje. (2021). Evropska komisija. https://eur-lex.europa.eu/legal-content/SL-EN/TXT/?uri=CELEX%3A52021DC0118
12. Korporativna varnost. (2023). Inštitut za korporativne varnostne študije. Tradicionalna 14. mednarodna konferenca »Dnevi korporativne varnosti 2023«. https://www.ics-institut.si/assets/uploads/revija/31-%C5%A1tevilka/31-stevilka-revije-Korporativna-varnost.pdf.

Alina Slatinek, dipl. inž. tehnol. prom. (UN)
Srednja šola za storitvene dejavnosti in logistiko

SLOVENSKA SODNA PRAKSA NA PODROČJU ŽELEZNIŠKEGA PREVOZA POTNIKOV, PRTLJAGE IN TOVORA

Povzetek

Železniški prevoz je okolju prijazen, omogoča masovni prevoz ljudi in tovora, kar je spodbudilo razvoj čezmejnega prometa ter železniškega prava. Prevozno pravo je podpanoga gospodarskega prava in vključuje prevoz potnikov, tovora, prtljage ter povezane posle. Pomembni značilnosti sta interdisciplinarnost in internacionalnost, saj transport presega meje držav. Zaradi tega je prišlo do potrebe po unifikaciji oziroma poenotenju prevoznega prava. Leta 1886 je bila sprejeta konvencija CIM, ki jo je 1980 nadomestila konvencija COTIF, ki velja za eno temeljnih in najpomembnejših konvencij v železniškem prometu.

Poenotenje prava temelji na konvencijah, avtonomnih kodifikacijah ter standardiziranih pogodbah.

Pravni viri železniškega prava so EU predpisi, mednarodni sporazumi, nacionalni zakoni, tarife, sodna praksa in doktrina.Sodna praksa zagotavlja enotnost odločanja, pravno varnost in vpogled v pričakovane razplete sporov.

V Sloveniji je sodne prakse na področju železniškega prevoza malo, zaradi slabe razvitosti železnic in manjšega obsega uporabe.

Primeri obravnavajo predvsem zamude potnikov, odtujitev prtljage ter odgovornost prevoznika za tovor.

Sodna praksa opozarja na pomen poznavanja pravic potnikov ter obveznosti pri prevozu prtljage in tovora.

Kljub obsežni zakonodaji ostajajo možnosti za izboljšave, zlasti pri informiranosti potnikov in prilagajanju predpisov sodni praksi.

1. Uvod

Železniški prevoz velja za najbolj ekološko obliko prevoza in omogoča masovni prevoz potnikov ter ekonomičen prevoz velike količine tovora na velikih razdaljah. Omenjena dejstva so botrovala k razvoju čezmejnega železniškega prometa, kar je prispevalo k razvoju železniškega prava in potrebi po njegovem poenotenju. Tako je od izgradnje prve javne železnice leta 1825, pa do prvega pravnega vira železniškega prava minilo le nekaj desetletij.

2. Železniško pravo

Prevozno pravo, s tujko pogosto imenovano tudi transportno pravo, je posebna pravna podpanoga v sklopu gospodarskega prava. Zajema prevoz tovora (stvari, blaga, pošiljk), oseb (potnikov) in njihove prtljage ter posle, povezane s prevozom (špedicija, zavarovanje,

carinjenje).20

Prevozno pravo obsega dva sklopa: javnopravna pravila (upravnopravne določbe) in zasebnopravna pravila (prevozne pogodbe in zunanjpogodbena odškodninska odgovornost prevoznika).[21]

Pomembna značilnost prevoznega prava je nedvomno notranja interdisciplinarnost, ki se odraža kot povezanost različnih pravnih panog, podpanog in področij, ter zunanja interdisciplinarnost oziroma povezanost prava z drugimi vedami, nepravnimi področji (navtika, strojništvo, logistika, meteorologija, matematika, računalništvo in zavarovalništvo).22 Internacionalnost oziroma mednarodnost prevoznega prava, ki se izraža kot posledica dejstva, da transport vsakodnevno premaguje razdalje širom celotnega sveta, botruje dejstvu, da je prevozno pravo že po definiciji mednarodno obarvano. Kot posledica velikih geografskih razdalj ni presenetljivo, da je do poenotenja oziroma unifikacije prava najprej prišlo v prevoznem pravu.[23]

2.1 Razvoj in poenotenje železniškega prava

Poenotenje ali unifikacija prava je proces poenotenja oziroma izenačevanja prava. Do poenotenja prihaja z usklajevanjem, s poenotenjem prakse ali s pravnimi akti. K temu pa v praksi pripomorejo avtonomne kodifikacije, ki nastajajo pod okriljem specializiranih mednarodnih organizacij ali standardizirane pogodbe. V obeh primerih je poenotenje odvisno od volje pogodbenih strank.[24]

Države, ki so poslovale z nemškimi železnicami, so se vse od leta 1860 dvakrat letno dobivale na Evropski konferenci, ki je bila namenja usklajevanju poletnega in zimskega voznega reda. Kmalu za tem je bila sprejeta Konvencija za spodbujanje tehnične skladnosti v železniškem prometu, h kateri je pristopila večina evropskih držav. Leta 1886 je končno obliko dobila tudi Mednarodna konvencija o železniškem blagovnem prometu – CIM, ki je korenito spremembo doživela leta 1980, ko je bila sprejeta Konvencija o mednarodnih železniških prevozih (COTIF).

Železniško pravo združuje vsa javna in zasebna pravila na mednarodni in državni ravni, ki na kakršen koli način urejajo odnose med udeleženci v samem železniškem prevozu. Konvencija COTIF je pomembno spremembo s protokolom doživela leta 1990, kar je bil tudi velik korak za poenotenje oziroma unifikacijo železniškega prava. Kot največjo spremembo, odkar se železniško pravo ureja na mednarodni ravni, štejemo protokol iz leta 1999. Ta odpravlja kontrahirno dolžnost oziroma dolžnost sklepanja pogodb, prav tako pogodba o prevozu blaga po železnici ni več realni kontrakt.[25]

Danes je med članicami organizacije OTIF (Medvladna organizacija za mednarodne

---

[20] Pavliha, M., Vlačič, P., Oblak, K.: *Prevozno pravo: Pogodbe o prevozu tovora, potnikov in prtljage*, 3. spremenjena in dopolnjena izdaja, GV Založba 2017, Ljubljana, str. 33.

[21] Pavliha, Vlačič, Oblak, navedeno delo, opomba 1, str. 33.

[22] Pavliha, Vlačič, Oblak, navedeno delo, opomba 1, str. 36.

[23] Pavliha, Vlačič, Oblak, navedeno delo, opomba 1, str. 38.

[24] Kovač, M. : *Transportno pravo*, el. knjiga, 2010, str. 4.

[25] Pavliha, Vlačič, Oblak, navedeno delo, opomba 1, str. 52.

železniške prevoze) tudi 25 (od 27) članic Evropske unije. Malta in Ciper, ki sta sicer del Evropske unije, nista članici organizacije OTIF, saj trenutno nimata operativne železniške infrastrukture in se tako železniški prevoz na njunem ozemlju ne izvaja. Poslanstvo organizacije je izboljšanje in olajšanje mednarodnega prometa po železnici. Razvija enotne pravne režime na različnih področjih, kamor sodijo tudi mednarodne pogodbe o prevozu potnikov in blaga, prevoz nevarnega blaga, uveljavljanje tehničnih standardov itd. Prav tako vodi in objavlja primere sodne prakse, izdaja periodični bilten in sodeluje pri reševanju sporov z arbitražo.[26]

Večjo stopnjo zanesljivosti pri poenotenju prava dosegamo s pravnimi akti, med katerimi imajo mednarodne konvencije največji pomen. Pomembno je, da se (prevozno) pravo sprva uskladi na področju posamezne države, saj lahko le tako dosežemo unifikacijo tudi na mednarodnem področju.[27]
Poenotenje prava ima z gospodarskega vidika velik pomen v vseh pravnih panogah in podpanogah. Pri prometnem pravu pa ima unifikacija, poleg lažjega poslovanja zaradi vnaprej znanih podobnih ali istih pravil, velik pomen, saj so šele tragične nesreče prepričale javnost, da brez poenotenih in strožjih pravil varnosti ne moremo zagotoviti.

Uspehi poenotenja prava so odraz števila držav, ki določeno mednarodno pogodbo podpišejo, jo ratificirajo, sprejmejo, odobrijo ali k njej pristopijo. Velik pomen imajo tudi mednarodne vladne in nevladne organizacije ter poslovna praksa, sodna in arbitražna praksa ter pravna doktrina (znanstvena in strokovna dela s tega področja).[28].

Preglednica 4: Najpomembnejši pravni akti v železniškem prometu [29]

Železniško pravo	
Železniško javno pravo	Železniško zasebno pravo
Mednarodna raven • Evropski sporazum o važnejših mednarodnih železniških progah (AGC) s prilogama I in II • Evropski sporazum o pomembnejših železniških progah mednarodnega kombiniranega transporta in pripadajočih naprav (AGTC)	Mednarodna raven • Konvencija o mednarodnih železniških prevozih (COTIF) • Enotna pravila za pogodbe o mednarodnem železniškem prevozu potnikov (CIV) ter blaga (CIM) • Zakon o prevozu nevarnega blaga (ZPNB) • Pravilnik o mednarodnem železniškem prevozu blaga (RID) • Konvencija o mednarodnih železniških prevozih

[26] OTIF, 2021 *Mission*.

[27] Pavliha, Vlačič, Oblak, navedeno delo, opomba 1, str. 40.

[28]Pavliha, Vlačič, Oblak, navedeno delo, opomba 1, str. 41.

Državna raven • Zakon o železniškem prometu (ZZelP) • Zakon o varnosti v železniškem prometu (ZVZP)	Državna raven • Zakon o prevoznih pogodbah v železniškem prometu (ZPPŽP) • Tarifa za prevoz blaga Slovenskih železnic • Potniška tarifa SŽ

3. Sodna praksa

Sodna praksa je namenjena tako pravnikom in sodnikom kot tudi aktualnim in potencialnim strankam v pravnih postopkih. Omogoča vplogedvpogled v pretekle sodbe in postopek razrešitve sporov s pomočjo tolmačenja in pojasnjevanja posameznih členov ter odločitve sodišč. To pravnim subjektom v podobnih postopkih omogoča lažji vpogled v pričakovani razplet sojenja. Prepletajo se različni členi posameznega zakona, kot tudi členi in določbe drugih zakonov, ki skupno vplivajo na razrešitev sodnega zahtevka. Pri mednarodnih prevozih pa je potrebno upoštevati tudi mednarodne konvencije ter ostalo veljavno in pravno zavezujočo zakonodajo .

Sodna praksa s konkretizacijo, tolmačenjem in razlago pojasnjuje različne sporne odločitve nižjestopenjskih sodišč in jih tudi dopolnjuje. Odločbe višjih sodišč služijo kot zgled, kako naj bi nižjestopenjska sodišča odločala v podobnih primerih. Enotna sodna praksa podaja večjo varnost in zaupnost v pravne vire ter sodišča.30

3.1 Slovenska sodna praksa

Primerov slovenske sodne prakse na področju železniškega prevoza potnikov, prtljage in tovora je zelo malo. Temu botrujeta majhnost Republike Slovenije in dejstvo, da je železniški promet v Sloveniji slabo razširjen in izkoriščen s strani potnikov, še bolj pa na področju tovora. To lahko pripišemo dotrajani in slabo razširjeni železniški infrastrukturi ter sorazmerno visokim cenam ter zamudnemu času prevoza tovora v primerjavi s cestnim prometom na krajših razdaljah.

Skozi preučevanje sodne prakse sem zasledila, da je večina primerov sorazmerno starih in se za njihovo razrešitev navajajo zakoni, ki so jih do danes že zamenjali novejši oziroma dopolnjeni zakoni in uredbe. Razlog zmanjševanja števila primerov sodne prakse je nedvomno tudi posledica korektno in jasno zapisanih mednarodnih in domačih zakonov, konvencij ter aktov.

3.1.1 Slovenska sodna praksa na področju železniškega prevoza potnikov

Prevoz potnikov velja za specifiko, saj potniki niso pošiljatelji, ki bi utrpeli le materialno škodo, temveč so deležni telesnih in duševnih poškodb ali celo izgubijo življenje. Take škode tudi odškodnina ne more povrniti. Železniški prevoznik v večini primerov za osebne škode odgovarja objektivno, pri čemer lahko denarno omeji svojo odgovornost za smrt potnika, podobno kot pri prevozu prtljage in tovora. Slovenska sodna praksa primerov smrti ali hudih telesnih poškodb ne beleži. V primeru zamude potnika odgovarja subjektivno z obrnjenim dokaznim bremenom. V primeru zamude, daljše od 60 minut, ima potnik pravico

[30] Odvetniška pisarna Verbajs, 2022, *Kaj je sodna praksa?*

do brezplačnega obroka in pijače. Ravno to je bil predmet spora med potnikom in železniškim prevoznikom v sodbi VSL sodba II Cp 1348/2015. Sodišče je potnikovo pritožbo zavrnilo, ker pri zamudi potnik ni utrpel materialne škode, saj si sam ni nabavil obroka, do katerega bi sicer bil upravičen. Skozi razlago sodbe je razvidno, da ni pomembno upoštevati le pravice potnika, temveč tudi okoliščine, ki privedejo do razsodbe.

3.1.2 Slovenska sodna praksa na področju železniškega prevoza prtljage

Prevoz prtljage je vselej združen s prevozom potnika, tako v primeru prevoza ročne kot tudi registrirane prtljage. V železniškem prometu je prevoz prtljage sestavni del prevoza avtomobilov po železnici. Primera slovenske sodne prakse s področja prtljage, obravnavana v tem prispevku, se nanašata na odtujitev prtljage med prevozom le-te v avtomobilu po železnici. Pri tem imata pomembno vlogo tudi potniška tarifa in splošni pogoji poslovanja (posameznega) železniškega prevoznika. Tako v primeru sodbe II Ips 453/95 kot sodbe II IPS 478/93 potnik železniškemu prevozniku očitata malomarnost in krivdo zoper odtujeno prtljago, ki je med prevozom avtomobila na železniškem vozilu bila odtujena. Iz obeh sodb je mogoče razbrati, da nihče izmed potnikov ni sklenil posebnega zavarovanja za prtljago ali prijavil njenega prevoza in s tem zahteval izdajo prtljažnice. To je potnikova dolžnost, ker železniški prevoznik ne more odgovarjati za prtljago, če za njo ne ve. Potnik je v takšnem primeru, ko prtljažnica ni izdana, sam odgovoren za prtljago in jo lahko prinese tudi v prostor, v katerem potuje sam. Prtljaga se tedaj šteje za osebno oziroma ročno prtljago. V obeh sodbah so sodišča takšno tolmačenje tudi navedla. Odgovornost preide s potnika na prevoznika v primeru, ko ta ravna po navodilih prevoznika in odtujitev nastane kot posledica le-teh. Tako je do prenosa odgovornosti prišlo, ko je železniški prevoznik potniku izrecno naročil, naj prtljago pusti v avtomobilu.

3.1.3 Slovenska sodna praksa na področju železniškega prevoza tovora

Najzahtevnejši in tudi najobsežnejši del pri slovenski sodni praksi na področju železniških prevozov predstavlja prevoz tovora. Pri tem imajo poleg nacionalnih pravnih aktov velik pomen tudi zapisi v tovornem listu, razni obrazci (ki se nanašajo na prevoz/prevzem tovora), mednarodne trgovinske klavzule INCOTERMS in mednarodne konvencije, saj se prevoz tovora nemalokrat vrši izven državnih meja.

Sodba III Ips 46/2012 se nanaša na odgovornost prevoznika in zastaralni rok pri mednarodnem železniškem prevozu. Obravnava temelji na primerih odgovornosti prevoznika (kdaj in pod katerimi pogoji je odgovoren). Sodišče je pri tem osredotočeno na razumevanje določb konvencije CIM o odgovornosti, zastaralnih rokih in posledično odškodninski terjatvi. Konvencija CIM tega področja ne ureja, zato je zaradi narave primera potrebno uporabiti tudi nacionalno zakonodajo. Na slovenskih tleh to ureja Zakon o prevoznih pogodbah v železniškem prometu. Revizija je bila na podlagi določb omenjenega zakona in sistemske razlage določb CIM zavrnjena, saj je določbe treba razumeti tako, da urejajo le zastaranje odškodninskih terjatev, ne pa tudi zastaranje terjatev za povrnitev škode, ki nastane prevozniku.

Odgovornosti se razlikujejo glede na status samega pravnega subjekta v posamezni sodbi. Odgovornost prevoznika, naročnika in posrednika niso iste, prav tako se razlikujejo njihove pravice uveljavljanja odškodninskih zahtevkov do ostalih subjektov. Prepletanje odgovornosti različnih subjektov ter pravil tovornega lista, klavzul in železniških pravnih aktov je nedvomno močno izraženo pri zadnji obravnavani sodbi, VSC sodba Cpg 337/2012.

Tožeča stranka meni, da je tožena stranka dolžna poravnati plačilo zamudnine za vagonski prevoz na podlagi obrazca VAG 3, ki potrjuje prevzem vagonov. Tožena stranka vztraja, da po prevozni pogodbi ni prejemnik ali naročnik vagonov, temveč le posrednik, kar pomeni opustitev odgovornosti. Uporabljena trgovinska klavzula EX Works vso odgovornost in stroške pripiše kupcu oziroma pošiljatelju. Upoštevanje vseh obligacijskih razmerij in klavzule je podalo končno odgovornost in odgovor na revizijo.

4. Zaključek

Skozi preučevanje sodne prakse sem spoznala pomen notranje in zunanje interdisciplinarnosti prevoznega prava. Tolmačenje samih pravnih aktov ima velik pomen, zato menim, da je poznavanje tega dela prava, ki je neposredno povezano s sodno prakso, izjemno pomembno.

Po preučitvi nacionalnih predpisov menim, da zakonodaja celovito zajema vse vidike prevoza potnikov, prtljage in tovora. Začudilo me je, kako podrobno je opredeljen in opisan vsak segmet oziroma del prevoza tovora ter obveznosti in dolžnosti deležnikov pri tem. Presenetilo me je, da ima poleg zakonov na nacionalni ravni pomembno vlogo tudi potniška tarifa, ki jo v Sloveniji oblikujejo Slovenske železnice, saj veljajo za edinega nacionalnega prevoznika v Sloveniji. Potniška tarifa ureja različne vidike prevoza in bi lahko imela pomembno vlogo v primeru potniških tožb, ki bi nastale v povezavi s Slovenskimi železnicami. Čeprav je zakonodaja javno dostopna in določeno je, da mora biti potnikom na voljo na železniških postajah, se mi poraja vprašanje, ali so potniki s svojimi pravicami in dolžnostmi dejansko seznanjeni oziroma ali jih sploh poznajo.

Sodna praksa je dober pokazatelj problematike in odraža razlike v razumevanju pravic in obveznosti med posameznimi strankami, kar lahko izhaja bodisi iz nepoznavanja zakonodaje, njene nejasnosti ali napačnega tolmačenja. Njena pomembnost se kaže predvsem v tem, da sodišča pri odločanju o konkretnih primerih uporabljajo abstraktne pravne vire in jih prilagajajo specifičnim okoliščinam. Sodna praksa je za laike pogosto težko razumljiva, kar sem ugotovila tudi pri svojem preučevanju. Pojavlja se veliko kompleksnih pravnih izrazov, sami razlagalni postopki sodb pa zahtevajo veliko mero zbranosti in razumevanja, saj se prepletejo tako nacionalni kot tudi mednarodni zakoni in predpisi.

Pri tem imajo ključno vlogo baze sodne prakse, saj pravnim strokovnjakom omogočajo vpogled v postopkovna in vsebinska vprašanja, vezana na posamezna pravna vprašanja. Čeprav bi morala sodišča vselej ravnati enotno in predvidljivo, so v praksi primeri pogosto individualni, pravna vprašanja pa skoraj nikoli niso identična. Tako pri odločanju ne igra vloge zgolj zakonodaja, temveč tudi okoliščine posameznega primera in argumenti strank, ki se med postopkom ne smejo spreminjati. Sodna praksa dokazuje in hkrati nudi večjo pravno varnost ter strankam omogoča vpogled v pričakovani potek postopka in razplet sojenja.

Odškodnine, ki se priznavajo v primeru škode pri prevozih, se med državami razlikujejo in so se skozi čas spreminjale. Kljub temu menim, da finančno nadomestilo ne more v celoti popraviti vseh posledic škode, še posebej ko gre za nematerialno škodo – škodo povzročeno potnikom .
Nenehno prilagajanje zakonodaje novim razmeram je nujno, saj se s tem upoštevajo spremembe v praksi in težave, ki jih sodna praksa izpostavlja. Sodna praksa lahko sočasno

vpliva na nastanek novih ali prenovljenih pravnih virov.

Prav tako bi bilo treba več pozornosti nameniti poznavanju pravic potnikov v primeru zamud in odpovedi vlakov, kar se odraža tudi v sodbi VSL II Cp 1348/2015. Sklepam lahko, da je pomanjkanje informiranosti in hkrati nejasnost tolmačenja zakona pripeljala do dvoma glede potnikove pravice do odškodnine. Tudi sama nisem vedela, da je potnik v primeru zamude vlaka do nadomestila upravičen le, v kolikor je obrok in pijačo nabavil sam. Pojavi se mi deljeno mnenje, saj bi kot potnik želela prejeti odškodnino (tudi če obroka ne bi nabavila na odhodni postaji), a gledano z druge plati je popolnoma razumljivo, da je potnik do odškodnine opravičen le v primeru, ko zanj le-ta pomeni denarno škodo.

Sodbi II Ips 453/95 in II Ips 478/93 obravnata vprašanje odgovornosti prevoznika za odtujitev prtljage v avtomobilu. Njuno bistvo botruje k dejstvu, da bi bilo treba sodno prakso natančneje spremljati in analizirati ter predpise prilagajati problemom, ki se v sodbah pojavljajo. Predvsem, in tudi tukaj, problem temelji v nejasnosti in ne dovolj dobri seznanjenosti. Čeprav je pravna ureditev železniškega prevoza že zdaj obsežna in relativno dobro razvita, ostaja prostor za izboljšave. Ključni koraki v prihodnje vključujejo skrb za poznavanja pravic potnikov in tudi pravic, ki so vezane na prevoz prtljage ter prevoz prtljage v avtomobilu.

Sodna praksa in zakonodaja vplivata druga na drugo, pri tem pa se poraja vprašanje, v kolikšni meri bi morale sodne odločbe pridobiti status formalnega vira prava, podobno kot v anglosaksonskem pravnem sistemu. Nedvomno pa je ključnega pomena stalno prilagajanje in posodabljanje zakonodaje realnim izzivom, ki jih prikazuje (tudi) sodna praksa.

Viri in literatura

- Pavliha M., Vlačič P., Oblak K.: *Prevozno pravo: Pogodbe o prevozu tovora, potnikov in prtljage*, 3. spremenjena in dopolnjena izdaja, GV založba, Ljubljana, 2017.
- OTIF. (2021). *Mission*. Dostopno (6.11.2024) na: http://otif.org/en/?page_id=3.
- Kovač, M.: *Transportno pravo*: elektronska knjiga. Dostopno (16.11.2024) na: https://www.skupnost-vss.si/impletum/docs/Skriti_dokumenti/Transportno_pravo-Kovac.pdf.

Odvetniška pisarna Verbajs. (2022). *Kaj je sodna praksa?* Dostopno (28.1. 2025) na: https://gregorverbajs.si/kaj-je-sodna-praksa/#:~:text=Izraz%20.

Alina Slatinek, dipl. inž. tehnol. prom. (UN)
Srednja šola za storitvene dejavnosti in logistiko

SLOVENIAN CASE LAW IN THE FIELD OF RAIL TRANSPORT OF PASSENGERS, LUGGAGE AND FREIGHT

Summary

Rail transport is environmentally friendly, enables mass transport of people and freight, which has stimulated the development of cross-border transport and railway law. Transport law is a sub-branch of commercial law and includes the transport of passengers, freight, luggage and related transactions. Important characteristics are interdisciplinarity and internationality, as transport crosses national borders. This has led to the need for unification or standardisation of transport law. In 1886, the CIM Convention was adopted, which was replaced in 1980 by the COTIF Convention, which is considered one of the fundamental and most important conventions in rail transport.The unification of law is based on conventions, autonomous codifications and standardised contracts.
The legal sources of railway law are EU regulations, international agreements, national laws, tariffs, case law and doctrine. Case law ensures uniformity of decision-making, legal certainty and insight into the expected outcome of disputes.

In Slovenia, there is little case law in the field of rail transport, due to the poor development of railways and the small scale of their use. The cases mainly deal with passenger delays, the theft of luggage and the liability of the carrier for cargo. The case law draws attention to the importance of knowing passengers' rights and obligations when transporting luggage and cargo.Despite extensive legislation, there is still room for improvement, especially in terms of passenger information and adapting regulations to case law..

1. Introduction

Rail transport is considered the most ecological form of transport and enables mass passenger transport and economical transport of large quantities of cargo over long distances. The aforementioned facts led to the development of cross-border rail transport, which contributed to the development of railway law and the need for its unification. Due to characteristics such as the possibility of mass passenger transport, large quantities of cargo, and environmental integrity and capacity, rail transport soon became international in nature, which dictated the need for a unified, international legal system as much as possible.

2. Railway law

Transport law, often also called transport law in foreign languages, is a special legal sub-branch within commercial law. It covers the transport of cargo (things, goods, shipments), persons (passengers) and their luggage, and transactions related to transport (freight forwarding, insurance, customs clearance).[31] Transportation law comprises two sections:

[31] Pavliha, M., Vlačič, P., Oblak, K.: *Prevozno pravo: Pogodbe o prevozu tovora, potnikov in prtljage*, 3.

public law rules (administrative law provisions) and private law rules (transport contracts and extra-contractual tort liability of the carrier)..[32]

An important characteristic of transport law is undoubtedly internal interdisciplinarity, which is reflected as the connection of various legal branches, sub-branches and areas, and external interdisciplinarity or the connection of law with other sciences, non-legal areas (nautics, mechanical engineering, logistics, meteorology, mathematics, computer science and insurance). The internationality or internationality of transport law, which is expressed as a consequence of the fact that transport overcomes distances all over the world every day, contributes to the fact that transport law is by definition international in nature. As a result of the large geographical distances, it is not surprising that the unification of law first occurred in transport law..[33]

2.1 Development and unification of railway law

Unification or unification of law is the process of unification or equalization of law. Unification occurs through coordination, through the unification of practice or through legal acts. In practice, this is facilitated by autonomous codifications that are created under the auspices of specialized international organizations or standardized contracts. In both cases, unification depends on the will of the contracting parties.[34]

Since 1860, the countries that operated with German railways had met twice a year at a European Conference, which was intended to coordinate summer and winter timetables. Shortly afterwards, the Convention for the Promotion of Technical Harmonization in Railway Transport was adopted, to which most European countries acceded. In 1886, the International Convention concerning the Carriage of Goods by Rail – CIM – was also finalized, which underwent a radical change in 1980, when the Convention concerning International Carriage by Rail (COTIF) was adopted.

Railway law combines all public and private rules at the international and national level that regulate relations between participants in rail transport in any way. The COTIF Convention underwent a significant change with the Protocol in 1990, which was also a major step towards the unification or unification of railway law. The largest change since railway law has been regulated at the international level is the Protocol from 1999. This eliminates the contractual obligation or the obligation to conclude contracts, and the contract for the carriage of goods by rail is no longer a real contract..[35]

Today, 25 (out of 27) members of the European Union are also members of the OTIF (Intergovernmental Organisation for International Carriage by Rail). Malta and Cyprus, which are part of the European Union, are not members of the OTIF, as they currently do not have an operational railway infrastructure and therefore rail transport is not carried out on their territory. The organisation's mission is to improve and facilitate international rail

spremenjena in dopolnjena izdaja, GV Založba 2017, Ljubljana, str. 33.

[32] Pavliha, Vlačič, Oblak, navedeno delo, opomba 1, str. 33.

[33] Pavliha, Vlačič, Oblak, navedeno delo, opomba 1, str. 38.

[34] Kovač, M. : *Transportno pravo*, el. knjiga, 2010, str. 4.

[35] Pavliha, Vlačič, Oblak, navedeno delo, opomba 1, str. 52.

transport. It develops uniform legal regimes in various fields, including international contracts for the carriage of passengers and goods, the transport of dangerous goods, the enforcement of technical standards, etc. It also maintains and publishes case law, issues a periodic bulletin and participates in the resolution of disputes through arbitration..[36]

A greater degree of reliability in the unification of law is achieved by legal acts, among which international conventions are of the greatest importance. It is important that (transport) law is initially harmonized within the territory of an individual country, as this is the only way to achieve unification also in the international field.

From an economic perspective, the unification of law is of great importance in all legal branches and sub-branches. In the case of traffic law, unification, in addition to making business easier due to similar or identical rules known in advance, is of great importance, since it was only tragic accidents that convinced the public that safety cannot be ensured without unified and stricter rules..[37]

The success of the unification of law is reflected in the number of states that sign, ratify, accept, approve or accede to a particular international treaty. International governmental and non-governmental organizations, as well as business practice, judicial and arbitration practice and legal doctrine (scientific and technical) are also of great importance.

Table 1: The most important legal acts in railway transport [38]

Railway law	
Railway Public Law	Private Railway Law
International level • Evropski sporazum o važnejših mednarodnih železniških progah (AGC) s prilogama I in II • Evropski sporazum o pomembnejših železniških progah mednarodnega kombiniranega transporta in pripadajočih naprav (AGTC)	International level • Konvencija o mednarodnih železniških prevozih (COTIF) • Enotna pravila za pogodbe o mednarodnem železniškem prevozu potnikov (CIV) ter blaga (CIM) • Zakon o prevozu nevarnega blaga (ZPNB) • Pravilnik o mednarodnem železniškem prevozu blaga (RID) • Konvencija o mednarodnih železniških prevozih
National level	National level

[36] OTIF, 2021 *Mission*.

[37] Pavliha, Vlačič, Oblak, navedeno delo, opomba 1, str. 40.

• Zakon o železniškem prometu (ZZelP) • Zakon o varnosti v železniškem prometu (ZVZP)	• Zakon o prevoznih pogodbah v železniškem prometu (ZPPŽP) • Tarifa za prevoz blaga Slovenskih železnic • Potniška tarifa SŽ

3. Case law

Case law is intended for lawyers and judges as well as current and potential parties in legal proceedings. It provides insight into past judgments and the dispute resolution process by interpreting and explaining individual articles and court decisions. This enables legal entities in similar proceedings to gain an easier insight into the expected outcome of the trial. Various articles of an individual law are intertwined, as well as articles and provisions of other laws, which together affect the resolution of a court claim. In international transport, international conventions and other valid and legally binding legislation must also be taken into account.

Case law clarifies various controversial decisions of lower-level courts by concretizing, interpreting and explaining them and also supplements them. Decisions of higher courts serve as an example of how lower-level courts should decide in similar cases. Uniform case law provides greater security and confidence in legal sources and courts.[39]

3.1 Slovenian case law

There are very few Slovenian case law cases in the field of rail transport of passengers, luggage and freight. This is due to the small size of the Republic of Slovenia and the fact that rail transport in Slovenia is poorly developed and used by passengers, and even more so in the field of freight. This can be attributed to the dilapidated and poorly developed railway infrastructure and the relatively high prices and delays in freight transport compared to road transport over shorter distances.

Through the study of case law, I have found that most cases are relatively old and that laws are cited to resolve them, which have already been replaced by newer or amended laws and regulations. The reason for the decrease in the number of case law cases is undoubtedly also a consequence of correctly and clearly written international and domestic laws, conventions and acts.

3.1.1 Slovenian case law in the field of rail passenger transport

Passenger transport is considered specific, as passengers are not senders who would only suffer material damage, but also suffer physical and mental injuries or even lose their lives. Such damage cannot be compensated for by compensation. In most cases, the railway carrier is objectively liable for personal injuries, and can financially limit its liability for the death of a passenger, similar to the case of the transport of luggage and cargo. Slovenian case law does not record cases of death or serious bodily injury. In the event of a delay, the passenger is liable subjectively with the burden of proof reversed. In the event of a delay of more than 60 minutes, the passenger has the right to a free meal and drink. This was precisely the

[39] Odvetniška pisarna Verbajs, 2022, *Kaj je sodna praksa?*

subject of the dispute between the passenger and the railway carrier in the judgment of the Supreme Court of Slovenia, judgment II Cp 1348/2015. The court dismissed the passenger's complaint because the passenger did not suffer material damage due to the delay, as he did not purchase the meal to which he would otherwise be entitled. The interpretation of the judgment shows that it is not only important to consider the passenger's rights, but also the circumstances leading to the judgment.

3.1.2 Slovenian case law in the field of rail luggage transport

The transport of luggage is always combined with the transport of passengers, both in the case of the transport of hand luggage and registered luggage. In rail transport, the transport of luggage is an integral part of the transport of cars by rail. The examples of Slovenian case law in the field of luggage discussed in this article relate to the theft of luggage during its transport in a car by rail. The passenger tariff and the general terms and conditions of operation of the (individual) railway carrier also play an important role in this. In both cases of judgment II Ips 453/95 and judgment II IPS 478/93, the passenger accuses the railway carrier of negligence and fault in relation to the stolen luggage, which was stolen during the transport of a car on a railway vehicle. It can be seen from both judgments that none of the passengers took out special insurance for the luggage or reported its transport and thus requested the issuance of a luggage receipt. This is the passenger's duty, because the railway carrier cannot be held liable for luggage if it does not know about it. In such a case, when a luggage check has not been issued, the passenger is personally responsible for the luggage and can also bring it into the room in which he is traveling alone. The luggage is then considered personal or hand luggage. In both judgments, the courts also stated such an interpretation. Liability passes from the passenger to the carrier in the event that the passenger acts on the carrier's instructions and the alienation occurs as a result of them. Thus, the transfer of liability occurred when the railway carrier explicitly instructed the passenger to leave the luggage in the car.

3.1.3 Slovenian case law in the field of rail freight transport

The most demanding and also the most extensive part of Slovenian case law in the field of rail transport is the transport of goods. In addition to national legal acts, the entries in the consignment note, various forms (relating to the transport/acceptance of goods), international trade clauses INCOTERMS and international conventions are also of great importance, since the transport of goods is often carried out beyond national borders.

Judgment III Ips 46/2012 refers to the liability of the carrier and the limitation period in international rail transport. The discussion is based on cases of the carrier's liability (when and under what conditions he is liable). The court focuses on understanding the provisions of the CIM Convention on liability, limitation periods and, consequently, claims for compensation. The CIM Convention does not regulate this area, so due to the nature of the case, national legislation must also be applied. On Slovenian soil, this is regulated by the Railway Transport Contracts Act. The revision was rejected on the basis of the provisions of the aforementioned Act and the systemic interpretation of the provisions of the CIM, since the provisions should be understood as regulating only the limitation of claims for compensation, but not the limitation of claims for compensation for damage incurred by the carrier.

Responsibilities differ depending on the status of the legal entity itself in an individual

judgment. The liability of the carrier, the client and the intermediary are not the same, and their rights to enforce claims for compensation against other entities also differ. The intertwining of the responsibilities of various entities and the rules of the consignment note, clauses and railway legal acts is undoubtedly strongly expressed in the last judgment under consideration. The plaintiff believes that the defendant is obliged to settle the payment of late payment charges for wagon transport on the basis of the VAG 3 form, which confirms the takeover of the wagons. The defendant insists that under the contract of carriage it is not the recipient or client of the wagons, but only the intermediary, which means a waiver of liability. The used EX Works trade clause attributes all responsibility and costs to the buyer or sender. Compliance with all obligation relationships and clauses provided the ultimate responsibility and response to the audit.

4. Conclusion

Through the study of case law, I have come to understand the importance of internal and external interdisciplinary nature of transport law. The interpretation of legal acts themselves is of great importance, therefore I believe that knowledge of this part of the law, which is directly related to case law, is extremely important.

After examining national regulations, I believe that the legislation comprehensively covers all aspects of passenger, baggage and freight transport. I was amazed at how detailed each segment or part of freight transport is defined and described, as well as the obligations and duties of stakeholders in this regard. I was surprised that, in addition to laws at the national level, the passenger tariff, which is formed in Slovenia by Slovenian Railways, as they are considered the only national carrier in Slovenia, also plays an important role. The passenger tariff regulates various aspects of transport and could play an important role in the event of passenger lawsuits that arise in connection with Slovenian Railways. Although the legislation is publicly available and it is stipulated that it must be available to passengers at railway stations, I wonder whether passengers are actually aware of their rights and obligations or whether they even know them.

Case law is a good indicator of the issue and reflects differences in the understanding of rights and obligations between individual parties, which may result from ignorance of the legislation, its ambiguity or misinterpretation. Its importance is mainly reflected in the fact that courts use abstract legal sources when deciding on specific cases and adapt them to specific circumstances. Case law is often difficult for laypeople to understand, which I also found in my study. There are many complex legal terms, and the interpretation procedures of judgments themselves require a great deal of concentration and understanding, as both national and international laws and regulations are intertwined.

Case law databases play a key role in this, as they allow legal experts to gain insight into procedural and substantive issues related to individual legal issues. Although courts should always act uniformly and predictably, in practice cases are often individual and legal issues are almost never identical. Thus, not only the legislation plays a role in decision-making, but also the circumstances of the individual case and the arguments of the parties, which must not change during the procedure. Case law demonstrates and at the same time offers greater legal certainty and allows parties to have insight into the expected course of the procedure and the outcome of the trial.

The compensation that is recognized in the event of damage during transport varies from

country to country and has changed over time. Nevertheless, I believe that financial compensation cannot fully repair all the consequences of the damage, especially when it comes to non-material damage - damage caused to passengers, but this goes beyond the scope of this task. Continuous adaptation of the legislation to new circumstances is necessary, as this takes into account changes in practice and the problems that case law highlights. Case law can simultaneously influence the emergence of new or revised legal sources.

More attention should also be paid to the knowledge of passengers' rights in the event of train delays and cancellations, which is also reflected in the judgment VSL II Cp 1348/2015. I can conclude that the lack of information and at the same time the ambiguity of the interpretation of the law led to doubts about the passenger's right to compensation. I myself did not know that in the event of a train delay, a passenger is only entitled to compensation if he purchased the meal and drink himself. I have a divided opinion, because as a passenger I would like to receive compensation (even if I did not purchase the meal at the departure station), but from the other side it is completely understandable that a passenger is entitled to compensation only if it means financial damage for him. The judgments II Ips 453/95 and II Ips 478/93 address the issue of the carrier's liability for the theft of luggage in a car. Their essence is that case law should be monitored and analyzed more closely and regulations should be adapted to the problems that arise in judgments. Above all, and here too, the problem lies in ambiguity and insufficient familiarity. Although the legal regulation of rail transport is already extensive and relatively well-developed, there remains room for improvement. Key steps in the future include ensuring that passengers' rights are known, as well as rights related to the transport of luggage and the transport of luggage in a car. Case law and legislation influence each other, and this raises the question of to what extent court decisions should acquire the status of a formal source of law, similar to the Anglo-Saxon legal system. However, it is undoubtedly of key importance to constantly adapt and update legislation to the real challenges that are (also) demonstrated by case law.

Sources and literature

- Pavliha M., Vlačič P., Oblak K.: *Prevozno pravo: Pogodbe o prevozu tovora, potnikov in prtljage*, 3. spremenjena in dopolnjena izdaja, GV založba, Ljubljana, 2017.
- OTIF. (2021). *Mission*. Dostopno (6.11.2024) na: http://otif.org/en/?page_id=3.
- Kovač, M.: *Transportno pravo*: elektronska knjiga. Dostopno (16.11.2024) na: https://www.skupnost-vss.si/impletum/docs/Skriti_dokumenti/Transportno_pravo-Kovac.pdf.
- Odvetniška pisarna Verbajs. (2022). *Kaj je sodna praksa?* Dostopno (28.1. 2025) na: https://gregorverbajs.si/kaj-je-sodna-praksa/#:~:text=Izraz%20.

АВТОСООБРАКАЕН УЧИЛИШЕН ЦЕНТАР

“Боро Петрушевски” – на град Скопје

Саобраќајно - техничка школа

"12. февруар"

XV Мегународен симпозиум

ИНТЕРДИСЦИПИЛАНРНОСТ НА ЛОГИСТИКАТА И СООБРАКАЈОТ

25-27 септември 2025

БЕЗБЕДНОСТА ВО СООБРАКАЈОТ НА УЧЕНИЦИТЕ КАКО ДЕЛ ОД ОБРАЗОВНИОТ СИСТЕМ-

Изработиле :

Зоки Стојмиров дипл.сооб.инж.

Далиор Стојанов дипл.сооб.инж

Анета Пашоска дипл.проф.

Скопје, 2025

Вовед

Безбедноста во сообраќајот е глобален предизвик и тема што секојдневно влијае на животите на граѓаните. Безбедноста во сообраќајот е еден од најважните општествени предизвици. Современиот живот бара од учениците секојдневно да учествуваат во сообраќајот, без разлика дали пеш, со велосипед, со јавен или приватен превоз. Затоа, безбедноста на учениците мора да биде приоритет на образовниот систем, кој, покрај знаењето и вештините, треба да обезбеди и соодветно образование за учество во сообраќајот.

Според Светската здравствена организација, сообраќајните несреќи се една од водечките причини за смрт кај младите луѓе на возраст од 5 до 29 години. Во Македонија, статистиката покажува дека голем број жртви во сообраќајот се ученици и млади луѓе. Оваа ситуација го поставува прашањето: како образовниот систем може да помогне во спречувањето на овие несреќи?

Воведувањето на сообраќајната култура како составен дел од наставата има потенцијал да влијае на долгорочно намалување на ризиците. Учениците кои ги усвојуваат основните правила од рана возраст и развиваат свест за опасностите подоцна ќе станат возрасни со одговорен став кон сообраќајот.

1. Важност на сообраќајното образование

Сообраќајното образование е основа за создавање култура на безбедност. Тоа не е само формално познавање на правилата и законите, туку процес на образование, кој ги вклучува когнитивните, емоционалните и практичните аспекти на однесувањето во сообраќајот.

Психолозите истакнуваат дека децата од различни возрасти имаат различно ниво на разбирање и перцепција на ризикот. На пример, децата под 7 години честопати не можат правилно да ја проценат брзината на возилото. Затоа, наставата мора да биде прилагодена на возраста и развојот на учениците.

Во овој контекст, образованието треба да вклучува:

- Основни правила за пешаци и велосипедисти;
- Употреба на заштитна опрема (кациги, рефлектирачки елеци);
- Разбирање на сообраќајните знаци;
- Образование за внимание и одговорност.

2. Образовниот систем како превенција

Образовниот систем има централна улога во промовирањето на безбедноста во сообраќајот. Преку наставни програми, воннаставни активности и соработка со институциите, училиштата можат да изградат генерации свесни учесници во сообраќајот.

Специфични активности што можат да се спроведат:

- Часови по сообраќајна култура во основното образование;
- Организирање натпревари и квизови за сообраќајните правила;

- Посети на сообраќајна полиција и предавања од експерти;
- Симулирани практични вежби на сообраќајни полигони.

Во Македонија постојат иницијативи од Министерството за образование и Министерството за внатрешни работи за интегрирање на сообраќајната култура како дел од наставните програми, но потребна е нивна систематизација и поголема застапеност.

3. Инфраструктурни аспекти на безбедноста

Безбедноста на учениците зависи не само од нивното образование, туку и од условите во кои се движат. Инфраструктурата околу училиштата мора да се прилагоди за да ги заштити децата.

Основни мерки што се применуваат во развиените земји:

- Пешачки премини со јасна сигнализација;
- Семафори пред училиштата;
- Ограничувања на брзината (т.н. „училишни зони“);
- Поставување „брзински пукнатини“ и предупредувачки знаци;
- Организирани „училишни патроли“ со волонтери или полицајци.

Во многу македонски општини, овие мерки делумно постојат, но потребно е нивно обединување и контрола.

4. Улога на наставниците и родителите

Наставниците и родителите имаат двојна улога: како едукатори и како лични модели на улоги. Доколку децата видат возрасни кои не користат безбедносни појаси или не ја преминуваат улицата на црвено светло, ќе го сметаат ова прифатливо однесување.

Затоа, училиштата треба да организираат родителски состаноци посветени на темата безбедност, каде што родителите ќе бидат информирани за важноста на нивната улога. Наставниците, пак, можат да интегрираат примери од сообраќајни ситуации во наставата по различни предмети (на пр. математика, општествени науки).

5. Правни и институционални мерки

Правната рамка е основа за промовирање на безбедноста. Во Македонија, Законот за безбедност во сообраќајот предвидува низа мерки за заштита на пешаците и учениците, но нивната практична имплементација е често проблематична.

Европските стандарди, од друга страна, предвидуваат задолжителни национални стратегии, редовно мерење на индикаторите и финансиски инвестиции во проекти за деца. Усогласувањето на македонското законодавство со европското законодавство е неопходно.

6. Добри практики и европски искуства

Во Германија, учениците полагаат практичен испит за велосипедисти уште во четврто одделение, што гарантира дека знаат како да се движат безбедно. Во Шведска, училиштата соработуваат со општините за да создадат безбедни зони околу

училишните дворови. Во Словенија, постојат национални кампањи за сообраќајно образование во кои се вклучени и медиумите.

Овие практики се доказ дека систематскиот пристап може значително да го намали бројот на сообраќајни несреќи во кои учествуваат ученици.

Позадина и важност на едукација за безбедност во сообраќај за деца

Годишно, над 180.000 деца умираат на патиштата во светот. Вкупно 500 деца на возраст од 0 до 19 години умираат како последица на повреди добиени при учество во сообраќај на патишта секој ден, а повеќе од 90 % товарот паѓа на грбот на земјите со низок и среден приход (UNICEF, 2025).

Сообраќајното образование и воспитување претставува најефикасна мерка за социјална интервенција и како таква има важна улога во развојот на културата на безбедност во сообраќајот и општото зголемување на безбедноста на учесниците во сообраќајот. Прифатено е мислењето дека во периодот од 6 до 14 години од животот се формираат основите на различни интереси, навики и облици на однесување суштински за формирање на особини на личноста. Според тоа, однесувањето на луѓето во сообраќајот главно ќе биде определено од квалитетот на образованието што е усвоен во периодот на посетување основно училиште.

Во поширока смисла, целта на сообраќајното образование е да ги направи децата побезбедни во сообраќајот. Сообраќајното образование обезбедува основа и водич со кој се очекува детето да може да развие своја стратегија за справување со сообраќајните опасности.

Може да се истакнат пет важни елементи кои мора да се земат предвид при креирањето и спроведувањето на сообраќајно воспитниот процес, и тоа:

да започне во предучилишна возраст,

да биде практичен,

да ги следи принципите на детскиот развој,

да има континуитет во презентација кај децата на училишна возраст и

да биде составен дел од содржината на различните училишни активности.

Анализа на безбедноста на децата во сообраќајот

Во овој дел се анализира состојбата со безбедноста на децата во сообраќајот. За време на основното образование, детската популација се движи од 6 до 15 години. Временската рамка на истражувањето е периодот 2022-2023 година.

На годишно ниво во сообраќајните незгоди: 1) околу 5 деца умираат (6 во 2022 година, 4 во 2023 година), 2) околу 80 деца претрпуваат тешки повреди (79 во 2022 година, 87 во 2023 година), 3) над 400 деца претрпуваат лесни повреди (478 во 2022 година, 551 во 2023 година) (Табела 1.1). Вкупниот број на загинати и повредени деца во 2023 година во споредба со 2022 година е за 79 поголем (зголемување од 14,0%). На годишно ниво, повредените деца сочинуваат околу 9% од сите повредени во сообраќајни незгоди, а загинатите деца се околу 4% од вкупниот број на загинати лица. Ова не е во согласност со основните цели на последната Националната

стратегија за безбедност во сообраќајот (период 2015-2020), која има за цел нула загинати деца во сообраќајот.

Table 1.1 Настрадани лица во сообраќајот по возраст, Северна Македонија, 2022-2023.

Година	Возраст	Загинати	Тешки повреди	Лесни повреди	Вкупно
2022	Сите	124	858	5.438	6.420
	Деца (6-15)	6	79	478	563
	%	**4,8**	**8,6**	**8,3**	**8,8**
2023	Сите	127	926	6.052	7.105
	Деца (6-15)	4	87	551	642
	%	**3,1**	**9,1**	**8,8**	**9,0**

Иако обемот на податоци е релативно мал, може да се забележи дека со зголемувањето на возраста на децата, се зголемува и нивниот број во вкупниот број повредени деца (Табела 1.2). Така, децата на возраст од 14-15 години сочинуваат 27,4% (2022) и 31,9% (2023) од вкупниот број повредени деца.

Табела 1.2 Настрадани деца во сообраќајот по возраст, Северна Македонија, 2022-2023.

Година	Возраст	Загинати	Тешки повреди	Лесни повреди	Вкупно	
					n	%
2022	6-7	0	8	89	97	17,2
	8-9	0	10	77	87	15,5
	10-11	1	15	103	119	21,1
	12-13	2	15	89	106	18,8
	14-15	3	31	120	154	27,4
	Вкупно	**6**	**79**	**478**	**563**	**100,0**
2023	6-7	1	10	83	94	14,6
	8-9	0	16	88	104	16,2
	10-11	1	13	102	116	18,1
	12-13	1	18	104	123	19,2
	14-15	1	30	174	205	31,9
	Вкупно	**4**	**87**	**551**	**642**	**100,0**

Децата се најмногу повредени во сообраќајот како патници во патнички автомобили/товарни возила/автобуси и трактори (околу 50% од вкупниот број повредени деца на годишно ниво), потоа како пешаци (околу 25% од вкупниот број повредени деца на годишно ниво), потоа како возачи и патници на мопеди/мотоцикли (околу 11% од вкупниот број повредени деца на годишно ниво) и како возачи и патници на велосипеди/тротинети (околу 11% од вкупниот број повредени деца на годишно ниво).

Табела 1.3 Настрадани деца во сообраќајот по категорија, С. Македонија, 2022-2023.

Година	Категорија	Загинати	Тешки повреди	Лесни повреди	Вкупно	
					n	%
2022	Пешаци	1	25	118	144	25,6
	Велосипеди/Тротинети	1	14	48	63	11,2
	Мопеди/Мотоцикли	3	13	53	69	12,3
	ПМВ/ТМВ/БУС/Трактор	1	22	248	271	48,1
	Друго	0	5	11	16	2,8
	Вкупно	**6**	**79**	**478**	**563**	**100,0**
2023	Пешаци	1	30	133	164	25,5
	Велосипеди/Тротинети	1	14	51	66	10,3
	Мопеди/ Мотоцикли	0	13	52	65	10,1
	ПМВ/ТМВ/БУС/Трактор	2	27	297	326	50,8
	Друго	0	3	18	21	3,3
	Вкупно	**4**	**87**	**551**	**642**	**100,0**

Цел на прегледите и предлог

Главната цел на сообраќајното образование е да им помогне на учениците да станат побезбедни учесници во сообраќајот и да развијат:

- познавање и разбирање на сообраќајната средина,
- сопствено одлучување и потребни вештини за опстанок во сообраќајната средина,
- разбирање на сообраќајните правила и контрола на сообраќајот,
- разбирање на причините и последиците од сообраќајните незгоди,
- одговорни ставови за сопствената безбедност и безбедноста на учесниците во сообраќајот на патиштата.

Ефективноста на сообраќајното образование зависи од голем број фактори, а еден од најважните е местото на сообраќајното образование во училишната програма. Сообраќајното образование може да се појави како индивидуален предмет (поретко во пракса), како дел од други предмети (многу почесто во пракса) и како дел од

воннаставни активности.

Предмет на овој дел од проектот е анализа на достапната литература за безбедност во сообраќајот преку анализа на наставниот материјал и наставните планови и програми од прво до деветто одделение од аспект на сообраќајно образование. Главната цел е да се види до кој степен наставниот материјал и наставните планови и програми се посветени на безбедноста во сообраќајот во овој дел од детскиот училишен развој.

Метод

За ефикасно спроведување на истражувањето и добивање јасни и корисни резултати, врз основа на предметот на истражувањето и поставените цели, идентификувана е потребата од примена на следните научни методи и техники на истражување:

- Истражувачки техники што ќе се користат за преглед на претходни истражувања:
  - Анализа на литературата (преглед) е техника што се применува во процесот на проучување на достапната литература во областа на образованието за безбедност во сообраќајот на децата;
  - Квалитативна обработка на податоци.
- Специфични научни методи и процедури што ќе се користат за анализа на претходни истражувања:
  - Метод на анализа (истражувачка постапка заснована на објаснување на проблеми со разложување на сложени целини на поедноставни компоненти, т.е. што ќе ги одреди најзначајните поединечни аспекти на набљудуваните незгоди) и синтеза (истражувачка постапка заснована на комбинирање на едноставни целини во посложени форми);
  - Метод на генерализација и конкретизација;
  - Метод на класификација (забележување на множества со слични својства).
- Општи научни и технички методи на научно истражување што ќе се користат за собирање и обработка на податоци:
  - Компаративен метод (споредување на исти или слични факти, феномени или процеси, т.е. забележување на нивните сличности и разлики во однесувањето).

Постапка

Имплементацијата на овој дел од Проектната активност се одвиваше низ неколку чекори:

- Спроведена е анализа на најдобрите практики во областа на едукација на децата за безбедност во сообраќајот. Најзначајната област на истражување ја вклучуваше Европската Унија.
- Потоа беше спроведена анализа на моменталната состојба на едукацијата на децата за безбедност во сообраќајот на територијата на Република Северна Македонија.
- Врз основа на претходните анализи, беа согледани потенцијалите за подобрување на наставната програма во областа на едукација на децата за

безбедност во сообраќајот во Република Северна Македонија.

За време на имплементацијата на Проектната активност, беа вклучени и консултирани следните институции преку номинирани претставници:

- Министерство за внатрешни работи,
- Министерство за образование и наука
- Биро за развој на образованието,
- Републички совет за безбедност во сообраќајот на патиштата и
- Заедница на единици на локална самоуправа

Заклучок

Безбедноста во сообраќајот на учениците мора да биде заедничка одговорност на државата, образовниот систем, родителите и самите ученици. Само преку интегриран пристап кој комбинира едукација, инфраструктура, законска рамка и практични мерки, може да се постигне значајно подобрување Задолжително:

- Задолжително воведување на предмет по сообраќајна култура во основното образование;

- Инвестирање во безбедна инфраструктура околу училиштата;

- Редовни кампањи за подигање на свеста кај родителите;

- Соработка меѓу општините, училиштата и полицијата;

- Прилагодување на законите со европските стандарди.

Само на овој начин ќе обезбедиме идни генерации да растат во средина која ја почитува и гарантира нивната безбедност.

Литература

1. Закон за безбедност на сообраќајот на патиштата, Службен весник на РСМ.
2. Национална стратегија за безбедност во сообраќајот (2021–2030).
3. Европска комисија – Програми за безбедност на учениците во сообраќај.
4. Образовни програми и прирачници за сообраќајна култура.
5. European Commission – Road Safety Programmes.
6. WHO – Global status report on road safety 2023.
7. Програми и прирачници за сообраќајна култура во образованието.
8. Case studies: Germany, Sweden, Slovenia – School Traffic Safety.

DRIVING SCHOOL CENTER
"Boro Petruševski" – of the city of Skopje

Traffic - Technical School
"February 12th"





XV International Symposium

INTERDISCIPLINARY LOGISTICS AND TRANSPORTATION

25-27 September 2025

STUDENT TRAFFIC SAFETY AS PART OF THE EDUCATION SYSTEM-

Produced by:

Zoki Stojmirov BSc.sob.eng.

Dalior Stojanov BSob.Eng

Aneta Pashoska, BSc. Prof.

Скопје, 2025

Introduction

Traffic safety is a global challenge and a topic that affects the lives of citizens every day. Traffic safety is one of the most important societal challenges. Modern life requires students to participate in traffic on a daily basis, whether on foot, by bicycle, by public or private transport. Therefore, the safety of students must be a priority of the education system, which, in addition to knowledge and skills, should also provide adequate education for participation in traffic.

According to the World Health Organization, road accidents are one of the leading causes of death among young people aged 5 to 29. In Macedonia, statistics show that a large number of traffic fatalities are schoolchildren and young people. This situation begs the question: how can the education system help prevent these accidents?

Introducing a traffic culture as an integral part of teaching has the potential to impact long-term risk reduction. Students who adopt the basic rules from an early age and develop an awareness of the dangers will later become adults with a responsible attitude towards traffic.

1. Importance of Transportation Education

Traffic education is the foundation for creating a culture of safety. It is not just a formal knowledge of rules and laws, but a process of education, which includes the cognitive, emotional, and practical aspects of traffic behavior.

Psychologists point out that children of different ages have different levels of understanding and perception of risk. For example, children under the age of 7 often cannot correctly assess the speed of a vehicle. Therefore, instruction must be tailored to the age and development of students.

In this context, education should include:

- Basic rules for pedestrians and cyclists;
- Use of protective equipment (helmets, reflective vests);
- Understanding traffic signs;
- Education for Attention and Accountability.

2. The education system as prevention

The education system plays a central role in promoting traffic safety. Through curricula, extracurricular activities, and collaboration with institutions, schools can build generations of conscious traffic participants.

Specific activities that can be carried out:

- Traffic Culture classes in elementary education;
- Organizing competitions and quizzes on traffic rules;
- Traffic police visits and lectures by experts;
- Simulated hands-on exercises at traffic ranges.

In North Macedonia, there are initiatives by the Ministry of Education and the Ministry of Interior to integrate transport culture as part of the curricula, but they need to be systematized

and more represented.

3. Infrastructural aspects of security

The safety of students depends not only on their education, but also on the conditions in which they move. The infrastructure around schools must be adapted to protect children.

Basic measures applied in developed countries:

- Pedestrian crossings with clear signage;

- Traffic lights in front of schools;

- Speed limits (so-called "school zones");

- Posting "speed bumps" and warning signs;

- Organized "school patrols" with volunteers or police officers.

In many Macedonian municipalities, these measures partially exist, but they need to be unified and controlled.

4. Role of teachers and parents

Teachers and parents have a dual role: as educators and as personal role models. If children see adults not wearing seat belts or crossing the street at a red light, they will consider this behavior acceptable.

Therefore, schools should organise parent meetings dedicated to the topic of safety, where parents will be informed of the importance of their role. Teachers, in turn, can integrate examples of traffic situations into teaching a variety of subjects (e.g., mathematics, social sciences).

5. Legal and institutional measures

The legal framework is the basis for promoting safety. In Macedonia, the Traffic Safety Act provides for a number of measures to protect pedestrians and students, but their practical implementation is often problematic.

European standards, on the other hand, provide for mandatory national strategies, regular measurement of indicators, and financial investment in projects for children. Harmonization of Macedonian legislation with European legislation is necessary.

6. Good practices and European experiences

In Germany, students take a practical exam for cyclists as early as the fourth grade, which guarantees that they know how to move safely. In Sweden, schools collaborate with municipalities to create safe zones around schoolyards. In Slovenia, there are national traffic education campaigns involving the media.

These practices are evidence that a systematic approach can significantly reduce the number of traffic accidents in which students participate.

Background and Importance of Traffic Safety Education for Children

Every year, over 180,000 children die on the world's roads. A total of 500 children aged 0 to 19 die as a result of injuries sustained while participating in road traffic every day, and more than 90% of the burden falls on the backs of low- and middle-income countries

(UNICEF, 2025).

Traffic education and upbringing is the most effective measure of social intervention and as such plays an important role in the development of a culture of traffic safety and the general increase in the safety of road users. It is generally accepted that in the period from 6 to 14 years of life, the foundations of various interests, habits and forms of behavior are formed essential for the formation of personality traits. Therefore, the behaviour of people in traffic will be mainly determined by the quality of education that is adopted during the period of attendance at primary school.

In a broader sense, the goal of traffic education is to make children safer in traffic. Traffic education provides a foundation and guide by which a child is expected to be able to develop their own strategy for dealing with traffic hazards.

Five important elements that must be considered when creating and implementing a traffic education process can be highlighted, namely:

1. Start at preschool age,
2. to be practical,
3. to follow the principles of child development,
4. to have continuity in presentation in school-age children, and
5. to be an integral part of the content of the various school activities.

Analysis of children's safety in traffic

This section analyzes the situation with the safety of children in traffic. During primary education, the child population ranges from 6 to 15 years old. The timeline of the survey is 2022-2023.

On an annual basis, traffic accidents are: 1) about 5 children die (6 in 2022, 4 in 2023), 2) about 80 children suffer serious injuries (79 in 2022, 87 in 2023), 3) over 400 children suffer minor injuries (478 in 2022, 551 in 2023) (Table 1.1). The total number of children killed and injured in 2023 compared to 2022 is 79 more (an increase of 14.0%). On an annual basis, injured children account for about 9% of all injuries in traffic accidents, and dead children account for about 4% of the total number of people killed. This is not in line with the basic objectives of the latest National Road Safety Strategy (period 2015-2020), which aims at zero road fatalities.

Table 1.1 Traffic casualties by age, North Macedonia, 2022-2023.

Year	Age	Killed	Serious injuries	Minor injuries	Total
2022	Total	124	858	5.438	6.420
	Children (6-15)	6	79	478	563
	%	**4,8**	**8,6**	**8,3**	**8,8**
2023	Total	127	926	6.052	7.105
	Children (6-15)	4	87	551	642
	%	**3,1**	**9,1**	**8,8**	**9,0**

Although the volume of data is relatively small, it can be observed that as the age of children increases, so does their number in the total number of injured children (Table 1.2). Thus, children aged 14-15 accounted for 27.4% (2022) and 31.9% (2023) of the total number of injured children.

Table 1.2 Child Traffic Injuries by Age, North Macedonia, 2022-2023.

Year	Age	Killed	Seriour injuries	Minor injuries	Total	
					n	%
2022	6-7	0	8	89	97	17,2
	8-9	0	10	77	87	15,5
	10-11	1	15	103	119	21,1
	12-13	2	15	89	106	18,8
	14-15	3	31	120	154	27,4
	Total	**6**	**79**	**478**	**563**	**100,0**
2023	6-7	1	10	83	94	14,6
	8-9	0	16	88	104	16,2
	10-11	1	13	102	116	18,1
	12-13	1	18	104	123	19,2
	14-15	1	30	174	205	31,9
	Total	**4**	**87**	**551**	**642**	**100,0**

Children are most injured in traffic as passengers in passenger cars/trucks/buses and tractors (about 50% of the total number of injured children yearly), then as pedestrians (about 25% of the total number of injured children yearly), then as

drivers and passengers of mopeds/motorcycles (about 11% of the total number of injured children yearly) and as drivers and passengers of bicycles/scooters (about 11% of the total number of injured children yearly).

Table 1.3 Child traffic injuries by category, S. Macedonia, 2022-2023.

Year	Category	Zaginachi	Serious injuries	Minor injuries	Total	
					n	%
2022	Walkers	1	25	118	144	25,6
	Bicycles/Scooters	1	14	48	63	11,2
	Mopeds/Motorcycles	3	13	53	69	12,3
	WMV/TMV/BUS/Tractor	1	22	248	271	48,1
	Other	0	5	11	16	2,8
	Total	**6**	**79**	**478**	**563**	**100,0**
2023	Walkers	1	30	133	164	25,5
	Bicycles/Scooters	1	14	51	66	10,3
	Mopeds/ Motorcycles	0	13	52	65	10,1
	WMV/TMV/BUS/Tractor	2	27	297	326	50,8
	Other	0	3	18	21	3,3
	Total	**4**	**87**	**551**	**642**	**100,0**

Purpose of the reviews and proposal

The main goal of traffic education is to help students become safer road users and develop:

1. knowledge and understanding of the traffic environment,
2. self-decision and necessary skills to survive in a traffic environment,
3. an understanding of traffic rules and traffic control,
4. understanding the causes and consequences of traffic accidents,
5. Responsible attitudes towards their own safety and the safety of road users.

The effectiveness of traffic education depends on a number of factors, and one of the most important is the place of traffic education in the school curriculum. Traffic education may appear as an individual subject (less often in practice), as part of other subjects (much more often in practice), and as part of extracurricular activities.

The subject of this part of the project is the analysis of the available literature on traffic safety through the analysis of the teaching material and curricula from the first to the ninth

grade perspective from the perspective of traffic education. The main objective is to see to what extent the teaching material and curricula are committed to traffic safety in this part of the children's school development.

Method

For the effective conduct of the research and obtaining clear and useful results, based on the subject of the research and the set goals, the need for the application of the following scientific methods and research techniques has been identified:

- Research techniques to be used to review previous research:
    1. Literature analysis (review) is a technique applied in the process of studying the available literature in the field of children's traffic safety education;
    2. Qualitative data processing.
- Specific scientific methods and procedures to be used for the analysis of previous research:
    1. Method of analysis (an exploratory procedure based on the explanation of problems by decomposing complex wholes into simpler components, i.e. determining the most significant individual aspects of the observed occurrences) and synthesis (an exploratory procedure based on combining simple wholes into more complex forms);
    2. Method of generalization and concretization;
    3. Classification method (detection of sets with similar properties).
- General scientific and technical methods of scientific research to be used for data collection and processing:
    1. Comparative method (comparing the same or similar facts, phenomena, or processes, i.e. noticing their similarities and differences in behavior).

Procedure

The implementation of this part of the Project Activity took place through several steps:

- An analysis of best practices in the field of educating children about traffic safety was conducted. The most important area of research involved the European Union.
- An analysis of the current state of education of children on traffic safety on the territory of the Republic of North Macedonia was carried out.
- Based on previous analyses, the potential for improving the curriculum in the field of education of children about traffic safety in the Republic of North Macedonia was seen.

During the implementation of the Project Activity, the following institutions were involved and consulted through nominated representatives:

- Ministry of Internal Affairs,
- Ministry of Education and Science
- Bureau of Education Development,

- National Council on Road Traffic Safety and
- Community Local Government Units

Conclusion

Safety in the transport of students must be a shared responsibility of the state, the education system, parents and the students themselves. Only through an integrated approach that combines education, infrastructure, legal framework and practical measures, can significant improvement be achieved.

Mandatory:

- Mandatory introduction of the subject of traffic culture in primary education;
- Investment in safe infrastructure around schools;
- Regular campaigns to raise awareness among parents;
- Cooperation between municipalities, schools and police;
- Adaptation of laws to European standards.

Only in this way will we ensure that future generations grow up in an environment that respects and guarantees their safety.

Literature

1. Law on Road Traffic Safety, Official Journal of the RSM.
2. National Road Safety Strategy (2021–2030).
3. Student Safety Programs in Traffic.
4. Educational programs and manuals for traffic culture.
5. European Commission – Road Safety Programmes.
6. WHO – Global status report on road safety 2023.
7. Programs and manuals for traffic culture in education.
8. Case studies: Germany, Sweden, Slovenia – School Traffic Safety.

Višja strokovna šola za avtoservisni menedžment

Ali je vodik prava alternativa električnemu in konvencionalnemu pogonu vozil

Avtor prispevka: Matic Turnšek, uni. dipl. inž.

POVZETEK

V avtomobilski industriji je vodik prepoznan kot ena ključnih rešitev za prihodnost trajnostnega transporta. Ta članek raziskuje, kako avtomobilska podjetja pristopajo k razvoju in uporabi vodika v vozilih. V jedru te tehnologije so gorivne celice, ki pretvarjajo vodik v električno energijo. Analizirali bomo lastnosti vodika in delovanje gorivnih celic ter jih primerjali z motorji na notranje zgorevanje, ki kot gorivo uporabljajo vodik. Izpostavili bomo prednosti in slabosti obeh sistemov ter pregledali, katera podjetja že ponujajo takšna vozila. Ocenili bomo tudi ekonomsko plat vodikovega pogona in ga primerjali z baterijskimi, dizelskimi in bencinskimi vozili. Preverili bomo, kakšni so mesečni in letni stroški uporabe ter kakšna je razvitost infrastrukture za polnjenje v Sloveniji in drugod po Evropi. Raziskali bomo tudi mnenje javnosti in potencialnih kupcev o tej tehnologiji. S preučitvijo strategij avtomobilskih podjetij in njihovih vizij za prihodnost bomo ugotovili, kje vidijo največji potencial za vozila na vodik.

1 Uvod

V zadnjih desetletjih se povečuje zaskrbljenost zaradi okoljske onesnaženosti in podnebnih sprememb, zaradi česar je nujno iskanje trajnostnih rešitev za mobilnost. Tradicionalni bencinski in dizelski motorji, ki poganjajo večino današnjih motornih vozil, so glavni vir emisij toplogrednih plinov, ki prispevajo k globalnemu segrevanju. V odgovor na to so se začela razvijati alternativna pogonska sredstva, med katerimi so električna vozila in vodikova gorivna celica postali ključni kandidati. Električna vozila, ki uporabljajo baterije za shranjevanje energije, so že v široki uporabi in omogočajo zmanjšanje emisij, vendar še vedno naletijo na ovire, kot so omejen doseg in dolgi časi polnjenja. Vodik, kot nosilec energije, predstavlja obetaven alternativni pogon, saj lahko omogoči hitrejše polnjenje in daljši doseg vozil, hkrati pa se pri njegovem delovanju sproščajo zgolj vodna para in toplota. V tej nalogi bomo raziskali prednosti in slabosti vodika v primerjavi z električnimi in bencinskimi vozili ter ocenili njegov potencial za prihodnost trajnostne mobilnosti.teoretični del

2 TEORETIČNI DEL

2.1 LASTNOSTI VODIKA

Vodík (latinsko hydrogenium) je kemični element s simbolom H, atomskim številom 1 in atomsko maso 1,00794 u. Je najlažji element v periodnem sistemu elementov. V enoatomnem stanju (H) je najpogostejša kemična snov v vesolju in tvori približno 75 % vse barionske mase. Plinasti vodik so prvič umetno pridobili v zgodnjem 16. stoletju z mešanjem kovin in kislin. V letih 1766-1781 je Henry Cavendish prvi prepoznal vodikov plin kot diskretno snov in ugotovil, da z zgorevanjem tvori vodo. Ta lastnost mu je kasneje dala tudi ime: hidrogen v grščini pomeni vodotvoren.

2.2 PRIDOBIVANJE VODIKA

2.2.1 Termične metode

- Parno preoblikovanje zemeljskega plina (SMR – steam methane reforming)

Proizvodnja vodika s parnim reformiranjem zemeljskega plina (metana) je najpogostejša metoda, saj predstavlja 90 % celotne proizvodnje. Proces je ekonomičen in dosega izkoristek med 70 % in 90 %. Izvedemo ga pri visokih temperaturah (približno 850 °C) in tlaku (25 bar). Metan se z vodno paro in katalizatorjem v dveh stopnjah pretvori v vodik in ogljikov dioksid.

  - **korak:** Metan in vodna para reagirata, pri čemer nastaneta ogljikov monoksid in vodik ($CH_4 + H_2O \rightarrow CO + 3H_2$).
  - **korak:** Ogljikov monoksid in vodna para se pretvorita v končni produkt, ogljikov dioksid in vodik ($CO + H_2O \rightarrow CO_2 + H_2$)

- Termo - kemična ločitev vode

Pri tej metodi za proizvodnjo vodika potrebujemo izredno visoko temperaturo nad 2500°C.

V postopku proizvodnje pride do disociacije vode v enem koraku $H_2O \Rightarrow H_2 + ½\ O_2$. Zaradi uporabe visokih temperatur se ne poslužujemo pridobivanja vodika na opisan način, ampak se disociacija vode doseže v več korakih pri nižjih temperaturah z uporabo ustreznih spojin, ki nam omogočajo krožni kemijski proces.

- Uplinjanje

Pri tem procesu gre predvsem za uplinjanje biomase ali premoga pri visokih temperaturah (okoli 800°C) z dovajanjem kisika. Dobljeni plin, ki je bogat z vodikom nato pridobimo s pomočjo metode SMR, ki je opisana v prejšnjih alinejah.

- Piroliza

Pri tem postopku za proizvodnjo vodika uporabljamo biomaso. Postopek je podoben prejšnjim opisanim postopkom, vendar se pri tem postopku poslužujemo nižjih temperatur do 700°C brez dovajanja kisika. Končni produkt pirolize je plin in bio olje. Tudi pri tem procesu v nadaljevanju sledi parna preobrazba SMR dobljenih plinov oziroma bio olja.

2.2.2 Elektrokemijske metode

- Elektroliza

Pri postopku elektrolize, vodik pridobivamo s pomočjo električnega toka. Pozitivni in negativni delci (elektroni) tečejo iz elektrod v vodo in s tem preko vode tvorijo električni krog. Električni tok (pozitivni ioni) steče iz anode v vodo, izhaja pa pri katodi medtem ko elektroni pa stečejo iz katode v vodo, izhajajo pa pri anodi.

Pri katodi se zato odvija naslednja reakcija: $2H_2O + 2e => H_2 + 2OH^-$, medtem ko se pri anodi odvija sledeča reakcija: $4OH- => O_2 + 2H_2O + 4e$. Celoten proces pa lahko ponazorimo s tole formulo: $2H_2O + 2e- => 2H_2 + O_2$

- Fotoelektroliza

Pri tej metodi se električna energija potrebna za elektrolizo vode pridobi iz sončne energije. Pri tem postopku je potrebna uporaba ustrezne anode, znane tudi kot fotoanoda, ki sončno energijo pretvori v električno.

2.2.3 Biološke metode oz. foto-biološke metode

Pri tej metodi se uporablja sončna energija ter biološke celice alg in bakterij, ki ob izvajanju lastnih procesov kot stranski produkt tvorijo vodik. Ker je večina takih organizmov v vodi, se vodik najpogosteje tvori skupaj s kisikom ob disociaciji vode. [40]

2.3 Shranjevanje vodika

Ko proizvedemo vodik, ga je potrebno za kasnejšo uporabo ustrezno skladiščiti. Pridobljen vodik, lahko shranjujejo na več načinov:

- V plinastem agregatnem stanju (GH2)
- V tekočem stanju (LH2)
- Metal – hidridno shranjevanje
- Shranjevanje v ogljikovih nano cevkah

2.3.1 Shranjevanje vodika v plinastem agregatnem stanju

Za shranjevanje plinastega vodika so potrebni posebni rezervoarji, saj lahko majhne molekule vodika prehajajo skozi porozne materiale. Rezervoarji so zato izdelani iz posebnih zlitin, kar poveča njihovo maso zaradi debelih sten, ali pa iz kompozitnih materialov. V avtomobilski industriji se uporabljajo rezervoarji iz aluminija ali plastike, ojačani s steklenimi vlakni. Vodik se shranjuje pod visokim tlakom, doseženim s prilagojenimi kompresorji. Končni tlak je odvisen od volumna: pri manjših cilindrih (do 50 L) znaša 200–250 bar, medtem ko je pri večjih skladiščih (okoli 15.000 m^3) tlak med 12 in 16 bar.

2.3.2 Shranjevanje vodika v tekočem agregatnem stanju

Shranjevanje utekočinjenega vodika bistveno poveča energijsko gostoto, kar je ključno za aplikacije, kot so vesoljska tehnologija in avtomobilizem, kjer je pomemben majhen volumen. Vodik se utekočini pri izjemno nizki temperaturi -253 °C, kar dosežemo s tekočim

[40] Povzeto po: https://lrtme.fe.uni-lj.si/lrtme/slo/mate_tehn/Vodik_proizv_sklad.pdf, dostop: 21.1.2025

dušikom.

Rezervoarji imajo dvoslojno strukturo z vakuumom med plastema, ki deluje kot toplotni izolator in preprečuje segrevanje vodika. Pomanjkljivost tega postopka je velika poraba energije, saj utekočinjanje porabi 30–40 % energije končnega produkta. Zato je ta metoda primerna le za shranjevanje velikih količin vodika. Pred uporabo je treba tekoči vodik ponovno pretvoriti v plinasto stanje.

2.3.3 Metal – hidridno shranjevanje vodika

Metal-hidridno shranjevanje omogoča vezavo vodikovih atomov v kristalno mrežo kovin in zlitin, kot so Ti, Fe, Al in Mg, kar bistveno poveča energijsko gostoto glede na volumen. Glavna slabost te metode je velika masa rezervoarjev.

Vodik se enostavno veže z injiciranjem v rezervoar, pri čemer se sprošča toplota. Za sprostitev vodika je potreben obraten proces, torej dovajanje toplote. Običajni metal-hidridi zahtevajo temperature med 300 in 350 °C, medtem ko novejši, nizkotemperaturni materiali delujejo pri nižjih temperaturah, a z manjšo kapaciteto. Prednost je možnost natančnega nadzora nad sproščanjem vodika, kar omogoča učinkovito napajanje gorivnih celic za proizvodnjo električne energije.

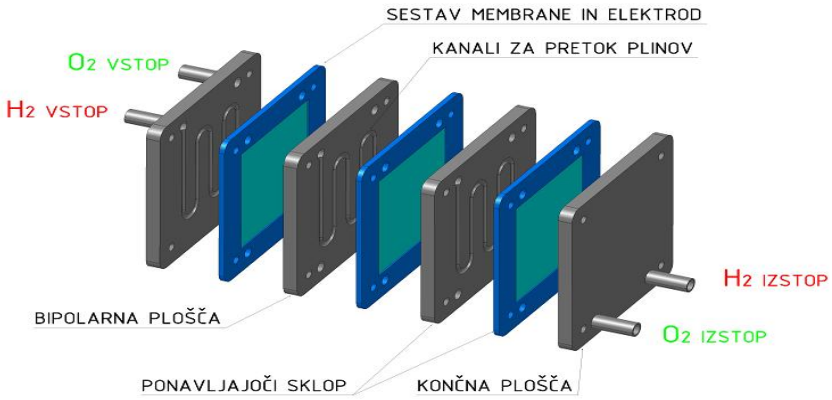
2.3.4 Shranjevanje vodika v ogljikovih nano cevkah

Ogljikove nano - cevke so cevke premerov 2µm. Način uskladiščenja in sproščanja vodika je identičen metal - hidridni tehniki. Prednost je predvsem v zmožnosti večje akumulacije vodika v mikroskopskih porah vzdolž cevke, ki znaša od 4,2% do 65% celotne mase nano – cevk. [41]

2.4 Gorivne celice

Gorivna celica je elektrokemična naprava, ki uporablja gorivo in oksidant (po navadi vodik in kisik) za proizvodnjo elektrike. Čeprav gorivna celica deluje podobno kot baterija, se ne izprazni in ne potrebuje vnovičnih polnjenj. Ker poteka pretvorba goriva v energijo v obliki elektrokemičnega procesa in ne izgorevanja, je gorivna celica tišja in čistejša kot bencinski ali dizelski generator. Možnih je več kombinacij goriv in oksidantov. Vodikova gorivna celica uporablja vodik kot gorivo in kisik (po navadi iz zraka) kot svoj oksidant.

[41] Povzeto po: https://lrtme.fe.uni-lj.si/lrtme/slo/mate_tehn/Vodik_proizv_sklad.pdf, dostop: 21.1.2025



Slika 1: Gorivna celica (Vir: Mebius.si)

2.4.1PEM gorivne celice

Gorivne celice PEM so idealne za uporabo zaradi nizkih delovnih temperatur, hitrega zagona in uporabe vodika ter kisika iz zraka kot goriva.

Osnovni element sistema je sklad gorivnih celic, ki vključuje bipolarne plošče in membransko-elektrodne sklope (MEA), sestavljene iz elektrolita in dveh kataliziranih poroznih elektrod (anode in katode). Dodatne komponente, kot so črpalke, ventili in elektronika, zagotavljajo delovanje sistema.

Princip delovanja:

Anoda: Vodik se z platinskim katalizatorjem razcepi na protone in elektrone.

Membrana: Propustna je le za protone, ki preidejo do katode.

Zunanji tokokrog: Elektroni potujejo po zunanjem vezju, kar generira uporabni električni tok.

Katoda: S protoni in elektroni se združi kisik iz zraka, kar ustvari vodo in toploto.

2.4.2HT-PEM Gorivne Celice

Sistemi HTPEM (High-Temperature PEM) običajno delujejo pri temperaturah nad 150 °C, nekatere celo do 210 °C. Ta povišana delovna temperatura prinaša več ključnih prednosti.

Prvič, poveča se toleranca do nečistoč, kot je ogljikov monoksid (CO) v vodiku, kar zniža zahteve glede čistosti goriva. Drugič, višja kinetika elektrod izboljša splošno učinkovitost celice. Tretja pomembna prednost je poenostavljeno upravljanje z vodo, saj se vsa voda v sistemu upari. To preprečuje poplavljanje celic in zmanjša potrebo po obsežnem hlajenju, kar omogoča manjšo in cenejšo zasnovo sistema. Ker HTPEM membrane običajno ne zahtevajo vlaženja, je končni sistem manj kompleksen in ekonomičnejši..[42]

[42] Povzeto po: https://www.mebius.si/tehnologija, dostop 21.1.2025

3 Anketa

3.1 Analiza ankete

Spletna anketa, v kateri je sodelovalo 156 posameznikov z vozniškim izpitom, je prikazala poznavanje in stališča do vozil na vodikov pogon. Večina anketirancev avtomobil uporablja vsak dan in so aktivni udeleženci v prometu.

Rezultati so pokazali, da je poznavanje vodikove tehnologije že precej visoko – 78 % vprašanih je že slišalo zanjo. Anketiranci dobro poznajo tudi druge alternative klasičnim motorjem z notranjim zgorevanjem, pri čemer so električna in hibridna vozila prepoznana skoraj 100-odstotno, vozila na vodik in zemeljski plin pa prepoznava 70–80 % vprašanih. To kaže na splošno dobro informiranost o alternativnih pogonih.

Ko so vprašani primerjali vozila na vodik z električnimi, jih je večina ocenila kot enakovredno alternativo, kar je verjetno povezano z dejstvom, da gorivne celice v vozilih na vodik prav tako proizvajajo električno energijo.

Glavne skrbi anketirancev pri uporabi vozil na vodik so se izkazale za pomanjkanje infrastrukture (polnilnic), varnost in visoka cena. Kljub temu so anketiranci pokazali pripravljenost za nakup takšnega vozila, če bi bila cena primerljiva z električnimi avtomobili. Spodbude, ki bi jih prepričale v nakup, so predvsem boljša infrastruktura in državne subvencije.

Kar se tiče prihodnosti, so mnenja deljena. Približno 40 % vprašanih pričakuje počasno rast uporabe vodikovih vozil, medtem ko jih 30 % verjame v hiter porast. Največji potencial za uporabo vodika pa anketiranci vidijo v cestnem prometu, zlasti pri osebnih vozilih, pa tudi pri tovornjakih in avtobusih.

4 Vozila, ki za pogon uporabljajo vodik

4.1 Vozila z motorji, z direktnim zgorevanjem vodika (H_2ICE)

Motorji z direktnim zgorevanjem vodika (ali vodikovi motorji) delujejo na podoben način kot običajni motorji z notranjim zgorevanjem, vendar namesto fosilnih goriv uporabljajo vodik kot gorivo. Takšni motorji omogočajo neposredno zgorevanje vodika za proizvodnjo moči, pri čemer nastajata le voda in toplota, kar omogoča zelo čiste emisije.

4.1.1 Osnovno delovanje motorja z direktnim zgorevanjem vodika

Motorji z direktnim zgorevanjem vodika delujejo na osnovi naslednjih osnovnih korakov:

Delovanje motorja na vodik temelji na zgorevanju vodika, ki se iz visokotlačnih rezervoarjev vbrizga v valje motorja in zmeša z zrakom. Zgorevanje vodika v notranjosti valjev proizvaja energijo za pogon vozila. Kot edini stranski produkti nastajata vodna para in toplota, zato so takšni motorji okolju prijazni in ne proizvajajo emisij CO_2.

4.1.2 Prednosti motorjev z direktnim zgorevanjem vodika

Motorji na vodik ponujajo več ključnih prednosti. Predvsem je to čistost emisij, saj njihov edini stranski produkt zgorevanja je voda, kar odpravlja emisije CO_2, dušikovih oksidov (NO_x) in trdnih delcev. Zaradi visoke energijske gostote vodika imajo vozila s tem pogonom tudi dober doseg. Dodatni prednosti sta hitro polnjenje, ki traja le nekaj minut, kar je pomembna prednost v primerjavi z električnimi vozili, ter zmanjšanje odvisnosti od fosilnih

goriv. Uporaba vodika kot goriva prispeva k večji energetski neodvisnosti in trajnostnemu razvoju.

4.1.3 Izzivi in omejitve motorjev z direktnim zgorevanjem vodika

Slabosti in izzivi pri uporabi motorjev na vodik so večplastni. Prvič, njihova učinkovitost je bistveno manjša od gorivnih celic, saj večji del energije izgubijo kot toplotni izpust. To vodi tudi do večje porabe vodika. Drugič, shranjevanje vodika je izjemno zahtevno. Zaradi njegove nizke gostote je potrebno komprimiranje pod visokim tlakom ali utekočinjenje pri zelo nizkih temperaturah, kar terja kompleksno infrastrukturo. Tretjič, lastnosti zgorevanja v samem motorju lahko povzročijo težave, kot so pregrevanje komponent in težave z emisijami dušikovih oksidov (NOx), kar pomeni, da motor ni popolnoma brez emisij. Nazadnje, sam proces proizvodnje vodika predstavlja velik izziv. Večina vodika se še vedno pridobiva iz fosilnih goriv (na primer z reformiranjem metana), kar proces naredi okolju neprijazen, in ključni cilj je prehod na proizvodnjo iz obnovljivih virov.

4.1.4 Primeri vozil in proizvajalcev vozil z direktnim zgorevanjem vodika

Tovornjaki in gospodarska vozila:

- Toyota: Prototipi z vodikovim motorjem
- Volvo Trucks: Razvijajo vodikove tovornjake s H_2 ICE
- MAN & Scania (Volkswagen Group): Razvoj H_2 ICE tovornjakov
- JCB: Vodikovi motorji za gradbene stroje (bagri, nakladalci)

Osebna vozila:

- Toyota GR Corolla H_2: Prototip športnega avtomobila s 3-valjnim motorjem na vodik
- Mazda RX-8 Hydrogen RE: Rotary motor na vodik s posredno vbrizganim in direktnim vbrizgom

4.1 Vozila na gorivne celice (FCEV)

Vozila z gorivnimi celicami veljajo za eno izmed najperspektivnejših rešitev za trajnostni transport, saj za pogon namesto fosilnih goriv uporabljajo vodik.

Te naprave pretvarjajo kemično energijo vodika v električno prek elektrokemične reakcije s kisikom iz zraka. Ta proces ne vključuje zgorevanja, ampak proizvaja elektriko, ki poganja motor vozila, edina stranska produkta pa sta voda in toplota. Zaradi tega so emisije škodljivih snovi, kot sta CO_2 in NO_x, praktično nične.

Vozila na gorivne celice ponujajo hiter doseg in kratko polnjenje, podobno kot pri klasičnih vozilih. Kljub temu je trenutna omejena infrastruktura za polnjenje vodika glavna ovira za njihovo širšo uporabo. Kljub temu številni proizvajalci vlagajo v razvoj te tehnologije, saj predstavlja pomemben korak k zmanjšanju emisij iz prometa in neodvisnosti od fosilnih goriv.

Prednosti:

- Visoka energetska učinkovitost (50–60 %)
- Čiste emisije – izpušča samo vodno paro

- Tiho delovanje – podobno kot baterijski električni avtomobili
- Daljši doseg kot baterijski EV
- Hitro polnjenje (3–5 minut)

Slabosti:

- Draga tehnologija – proizvodnja gorivnih celic je zapletena
- Odvisnost od redkih materialov (platina, titan)
- Občutljivost na temperaturo – slabša učinkovitost v ekstremnem mrazu Zahteva vodikovo infrastrukturo – malo polnilnic

Primeri vozil s FCEV pogonom:

- Toyota Mirai
- Hyundai Nexo
- Honda Clarity Fuel Cell
- BMW iX5 Hydrogen

Primerjava vozil in tehnologije pogonov H2 ICe in FCEV

Tabela1 : Primerjava FCEV in H_2 ICE

	FCEV	H_2 ICE
Lastnost	Gorivna celica (FCEV)	Direktno zgorevanje vodika (H_2 ICE)
Izpusti	Samo vodna para (0 emisij CO_2)	NO_x (dušikovi oksidi), manj CO_2 kot pri bencinu
Učinkovitost	50–60 % (zelo visoka)	30–40 % (nižja zaradi toplotnih izgub)
Moč in odzivnost	Zelo gladka in tiha vožnja	Večja moč in klasičen zvok motorja
Polnjenje	3–5 minut (kot pri klasičnem gorivu)	3–5 minut
Doseg	500–700 km	400–600 km
Kompleksnost	Potrebna draga gorivna celica in baterija	Uporablja obstoječo motorno tehnologijo
Vzdrževanje	Manj mehanskih delov, manjše vzdrževanje	Podobno kot klasični motorji, več gibljivih delov
Uporaba	Osebni avtomobili, avtobusi, tovornjaki	Tovornjaki, športni avtomobili, gradbena mehanizacija

FCEV (gorivne celice) so čistejše in bolj učinkovite, a dražje in zahtevajo posebno infrastrukturo. So idealne za osebna in tovorna vozila na dolge razdalje.

H_2 ICE (direktno zgorevanje vodika) je bolj robusten in lažje uvedljiv, saj uporablja obstoječe motorje, vendar ima manjšo učinkovitost in nekatere emisije. Primeren je za težke

tovornjake, gradbene stroje in športne avtomobile.

4.4 Primerjava stroškov nakupa in uporabe baterijskih vozil in vozil s pogonom na gorivno celico (FCEV) ter konvencionalnim pogonom na neosvinčen bencin

Za primerjavo smo si izbrali dva vozila, ki sta si podobna in sta od istega proizvajalca. Izbrali smo vozilo Hyundai Nexo FCEV in Hyundai Kona electric. Osredotočili bi se na nakupno ceno vozila in stroškov polnjenja oz. uporabe vozila v povprečni dobi dveh let, po predpostavko, da letno prevozimo z avtomobilom okoli 30000 km.

Tabela 2: Primerjava vozila Hyundai NEXO FCEV in Hyundai KONA electric ter KONA bencin

	Hyundai NEXO FCEV	Hyundai Kona electric	Hyundai Kona bencin
Nakupna cena	Okoli 65.000 €	Cena osnovnega modela okoli 35.000 €	Cena osnovnega modela okoli 26.000 €
Izpusti	Samo vodna para (0 emisij CO_2)	0 emisij	CO_2, CO, NO_x itd…
Polnjenje	3–5 minut (kot pri klasičnem gorivu)	Hitro DC polnjenje do 80% cca 41 min Klasično AC polnjenje okoli 8 h	3-5 min
Doseg	650–700 km po WLTP	454–514 km po WLTP	700-750 km
Kompleksnost	Potrebna draga gorivna celica in baterija	Uporablja baterijo in elektromotor	Uporablja klasičen bencinski motor
Poraba na 100 km	0.95 kg	16,6 kWh	7,2 l
Strošek porabe vozila v obdobju dveh let (letno 30000km)	4.845,00 €	1.173,75 €	6.912,00 €

4.5 Infrastruktura polnilnic za vozila na vodik in vozila na električni pogon v Sloveniji in v nemčiji

Razvoj infrastrukture za polnjenje vodikovih vozil v Evropi poteka počasi. Slovenija ima trenutno samo eno polnilnico v Lescah, medtem ko je Nemčija s 113 polnilnicami vodilna v Evropi. Kljub temu Evropska unija načrtuje ambiciozen razvoj s ciljem, da bi do leta 2031

vzpostavili polnilno postajo na vsakih 200 km vzdolž omrežja TEN-T. Po vsem svetu je do konca leta 2024 delovalo 1.160 polnilnic.

Infrastruktura za električna vozila je v obeh državah bistveno bolj razvita. V Sloveniji je registriranih okoli 300 javnih polnilnic, medtem ko jih ima Nemčija več kot 80.000. Ti podatki jasno kažejo, da je Nemčija pri razvoju te tehnologije precej pred Slovenijo. Vse to potrjuje tudi preračun na število prebivalcev, saj ima Nemčija skoraj 7-krat bolj razvito infrastrukturo za električna vozila na prebivalca kot Slovenija.

5 Zaključek

V luči vse večjega zanimanja za vodik kot alternativo baterijskim vozilom smo se v naši raziskavi poglobili v trenutno stanje njegove uporabe in pridobivanja v Sloveniji in po Evropi. S pomočjo ankete med vozniki smo preverili tudi njihova stališča do te tehnologije.

Ugotovili smo, da je uporaba vodika pri nas še v zgodnji fazi. Čeprav sta tehnologiji pridobivanja in skladiščenja dobro razviti, njegova uporaba za pogon vozil še ni množična. Vzroki za to so verjetno v pomanjkanju infrastrukture, saj je v Sloveniji trenutno le ena polnilna postaja za vodik, ter v strahu javnosti pred varnostnimi tveganji.

Poleg tega so stroški polnjenja vodikovih vozil še vedno bistveno višji od stroškov polnjenja baterijskih vozil, čeprav so nižji od tistih za bencin. Zato se glede na to, da imajo vozila na gorivne celice (FCEV) vgrajeno tudi baterijo, postavlja vprašanje o smiselnosti njihove uporabe.

Trenutno na trgu alternativnih pogonov prevladujejo baterijska vozila, vendar je vodik vse bolj prepoznavna opcija. Kljub nekaterim pomanjkljivostim verjamemo, da se bo razvoj obeh tehnologij nadaljeval. Pričakujemo, da bo trg v prihodnosti ponujal širok nabor alternativnih pogonov, pri čemer bo končna izbira odvisna od posameznikov. Pri nakupu se ljudje običajno odločajo na podlagi cene in stroškov, vendar ima pomemben vpliv tudi zavedanje o skrbi za okolje. Zato ne pričakujemo, da bo na trgu prevladal en sam tip alternativnega pogona, temveč bo ponudba raznolika, kar bo vsakemu posamezniku omogočalo izbiro najprimernejše možnosti.

6 Viri in literatura

- MOTORNO vozilo. 29. prenovljena izd., 1. natis. Ljubljana: Tehniška založba Slovenije. 2011.
- SPLETNI VIR - https://www.mebius.si/tehnologija, dostop 21.1.2025
- SLIKA 2 – GORIVNA CELICA. [Online]. Dostopno na spletnem naslovu: https://www.mebius.si/tehnologija

Višja strokovna šola za avtoservisni menedžment

Is hydrogen a real alternative to electric and conventional vehicle propulsion

Author of the article: Matic Turnšek, B.Sc. in Engineering.

ABSTRACT

In the automotive industry, hydrogen is recognized as one of the key solutions for the future of sustainable transport. This article explores how automotive companies are approaching the development and use of hydrogen in vehicles. At the core of this technology are fuel cells , which convert hydrogen into electricity. We will analyze the properties of hydrogen and the operation of fuel cells and compare them with internal combustion engines that use hydrogen as fuel. We will highlight the advantages and disadvantages of both systems and review which companies already offer such vehicles. We will also evaluate the economic side of hydrogen propulsion and compare it with battery, diesel and gasoline vehicles. We will check what the monthly and annual costs of use are and what the development of the charging infrastructure is in Slovenia and elsewhere in Europe. We will also research the opinion of the public and potential customers about this technology. By examining the strategies of automotive companies and their visions for the future, we will determine where they see the greatest potential for hydrogen vehicles.

1 Introduction

Environmental pollution and climate change have increased, making it imperative to find sustainable solutions for mobility. Traditional gasoline and diesel engines, which power most of today's motor vehicles, are a major source of greenhouse gas emissions that contribute to global warming. In response, alternative propulsion systems have begun to be developed, among which electric vehicles and hydrogen fuel cells have become key candidates. Electric vehicles that use batteries to store energy are already in widespread use and enable emission reductions, but they still face obstacles such as limited range and long charging times. Hydrogen, as an energy carrier, represents a promising alternative propulsion system, as it can enable faster charging and longer vehicle ranges, while only

releasing water vapor and heat during operation. In this thesis, we will explore the advantages and disadvantages of hydrogen compared to electric and gasoline vehicles and assess its potential for the future of sustainable mobility

2 Theoretical part

2.1 PROPERTIES OF HYDROGEN

Hydrogen (Latin hydrogenium) is a chemical element with the symbol H, atomic number 1, and atomic mass 1.00794 u. It is the lightest element in the periodic table of elements. In the monoatomic state (H), it is the most abundant chemical substance in the universe, constituting about 75% of all baryonic mass. Hydrogen gas was first produced artificially in the early 16th century by mixing metals and acids. In 1766–1781, Henry Cavendish was the first to recognize hydrogen gas as a discrete substance and found that it forms water upon combustion. This property later gave it its name: hydrogen in Greek means water-forming .

2.2 HYDROGEN PROCESSING

2.2.1 Thermal methods

- Steam reforming of natural gas (SMR – steam methane reforming)

Hydrogen production by steam reforming natural gas (methane) is the most common method, accounting for 90% of total production. The process is economical and achieves efficiencies between 70% and 90%. It is carried out at high temperatures (approximately 850 °C) and pressures (25 bar). Methane is converted into hydrogen and carbon dioxide in two stages using steam and a catalyst.

  - **Step 1:** Methane and water vapor react to produce carbon monoxide and hydrogen ($CH_4 + H_2O \rightarrow CO + 3H_2$).
  - **Step 2:** Carbon monoxide and water vapor are converted into the final product, carbon dioxide and hydrogen ($CO + H_2O \rightarrow CO_2 + H_2$)

- Thermo-chemical water separation

This method requires extremely high temperatures of over 2500°C to produce hydrogen.

In the production process, water dissociation occurs in one step $H_2O \Rightarrow H_2 + \frac{1}{2} O_2$. Due to the use of high temperatures, we do not use the method described to obtain hydrogen, but water dissociation is achieved in several steps at lower temperatures using appropriate compounds that enable a circular chemical process.

- Gasification

This process mainly involves gasifying biomass or coal at high temperatures (around 800°C) with the addition of oxygen. The resulting gas, which is rich in hydrogen, is then obtained using the SMR method described in the previous paragraphs.

- Pyrolysis

In this process, biomass is used to produce hydrogen. The process is similar to the previously described processes, but in this process we use lower temperatures of up to 700°C without the addition of oxygen. The final product of pyrolysis is gas and bio- oil. In this process, too, the steam transformation of the SMR gases or bio- oil obtained is followed.

2.2.2 Electrochemical methods

Electrolysis

In the electrolysis process, hydrogen is produced by passing an electric current through the water. Positive and negative particles (electrons) flow from the electrodes into the water, forming an electrical circuit through the water. The electric current (positive ions) flows from the anode into the water and exits at the cathode, while the electrons flow from the cathode into the water and exit at the anode.

Therefore, the following reaction takes place at the cathode: $2H_2O + 2e \Rightarrow H_2 + 2OH^-$, while the following reaction takes place at the anode: $4OH^- \Rightarrow O_2 + 2H_2O + 4e$. The entire process can be illustrated with this formula: $2H_2O + 2e^- \Rightarrow 2H_2 + O_2$

Photoelectrolysis

In this method, the electrical energy required for the electrolysis of water is obtained from solar energy. This process requires the use of a suitable anode, also known as a photoanode, which converts solar energy into electrical energy.

2.2.3 Biological methods or photo-biological methods

This method uses solar energy and biological cells of algae and bacteria, which produce hydrogen as a byproduct of their own processes. Since most such organisms are in water, hydrogen is most often produced together with oxygen during the dissociation of water. [43]

2.3 Hydrogen storage

Once hydrogen is produced, it needs to be stored properly for later use. The hydrogen produced can be stored in several ways:

- In gaseous state (GH_2)
- In liquid state (LH_2)
- Metal– hydride storage
- Storage in carbon nanotubes

2.3.1 Hydrogen storage in the gaseous state

Special tanks are required to store hydrogen gas, as small hydrogen molecules can pass through porous materials. The tanks are therefore made of special alloys, which increases their mass due to thick walls, or of composite materials. In the automotive industry, tanks made of aluminum or glass-fiber reinforced plastic are used. The hydrogen is stored under high pressure, achieved by adapted compressors. The final pressure depends on the volume: for smaller cylinders (up to 50 L) it is 200–250 bar, while for larger storage tanks (around 15,000 m³) the pressure is between 12 and 16 bar.

[43] Taken from: https://lrtme.fe.uni-lj.si/lrtme/slo/mate_tehn/Vodik_proizv_sklad.pdf , accessed: 21.1.2025

2.3.2 Storage of hydrogen in the liquid state

Storing liquefied hydrogen significantly increases energy density, which is crucial for applications such as aerospace and automotive, where small volume is important. Hydrogen is liquefied at the extremely low temperature of -253 °C, which is achieved with liquid nitrogen.

The tanks have a two-layer structure with a vacuum between the layers, which acts as a thermal insulator and prevents the hydrogen from heating up. The disadvantage of this process is the high energy consumption, as liquefaction consumes 30–40% of the energy of the final product. Therefore, this method is only suitable for storing large quantities of hydrogen. Before use, the liquid hydrogen must be converted back into a gaseous state.

2.3.3 Metal– hydride hydrogen storage

Metal- hydride storage enables the binding of hydrogen atoms into the crystal lattice of metals and alloys such as Ti, Fe, Al and Mg, which significantly increases the energy density per volume. The main disadvantage of this method is the large mass of the reservoirs.

Hydrogen is simply bound by injection into a reservoir, releasing heat. The reverse process, i.e. the application of heat, is required to release hydrogen. Conventional metal hydrides require temperatures between 300 and 350 °C, while newer, low-temperature materials operate at lower temperatures, but with lower capacity. The advantage is the ability to precisely control the release of hydrogen, which allows efficient powering of fuel cells for electricity generation.

2.3.4 Hydrogen storage in carbon nanotubes

Carbon nanotubes are tubes with a diameter of 2μm. The method of storing and releasing hydrogen is identical to the metal hydride technique. The advantage lies primarily in the ability to accumulate hydrogen in microscopic pores along the tube, which ranges from 4.2% to 65% of the total mass of the nanotubes . [44]

2.4 Fuel cells

A fuel cell is an electrochemical device that uses a fuel and an oxidant (usually hydrogen and oxygen) to produce electricity. Although a fuel cell works similarly to a battery, it does not discharge and does not require recharging. Because the conversion of fuel to energy occurs through an electrochemical process rather than combustion, a fuel cell is quieter and cleaner than a gasoline or diesel generator. Several combinations of fuels and oxidants are possible. A hydrogen fuel cell uses hydrogen as its fuel and oxygen (usually from the air) as its oxidant.

[44] Taken from: https://lrtme.fe.uni-lj.si/lrtme/slo/mate_tehn/Vodik_proizv_sklad.pdf , accessed: 21.1.2025

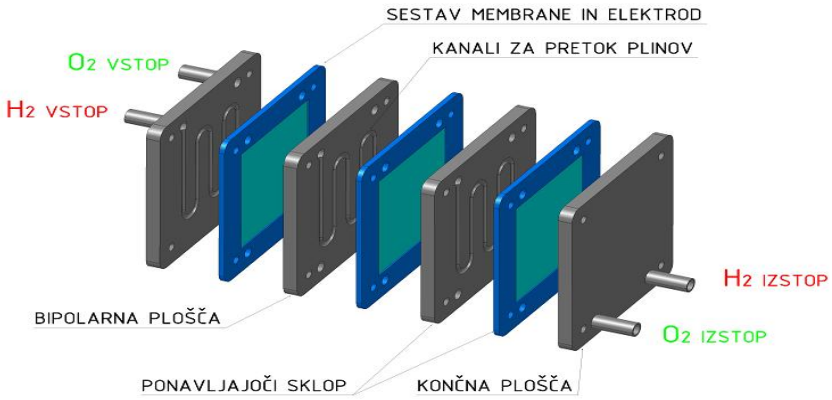


Figure 1: Fuel cell

Source: Mebius.si

2.4.1PEM fuel cells

PEM fuel cells are ideal for use due to their low operating temperatures, fast start-up, and use of hydrogen and oxygen from the air as fuel.

The basic element of the system is a fuel cell stack, which includes bipolar plates and membrane electrode assemblies (MEAs), consisting of an electrolyte and two catalyzed porous electrodes (anodes and cathodes). Additional components such as pumps, valves and electronics ensure the operation of the system.

Operating principle:

Anode: Hydrogen is split into protons and electrons using a platinum catalyst.

Membrane: It is only permeable to protons, which pass to the cathode.

External circuit: Electrons travel through an external circuit, generating a useful electric current.

Cathode: Oxygen from the air combines with protons and electrons, creating water and heat.

2.4.2HT-PEM Fuel Cells

HTPEM (High -Temperature PEM) systems typically operate at temperatures above 150 °C, some even up to 210 °C. This elevated operating temperature brings several key advantages.

First, the tolerance to impurities such as carbon monoxide (CO) in hydrogen is increased, which lowers the fuel purity requirements. Second, the higher electrode kinetics improve the overall efficiency of the cell. A third important advantage is simplified water management, as all water in the system is evaporated. This prevents flooding of the cells and reduces the need for extensive cooling, allowing for a smaller and cheaper system design. Since HTPEM membranes typically do not require wetting, the final system is less complex and more economical .[45]

[45]Taken from: https://www.mebius.si/tehnologija, accessed 21.1.2025

3 Survey

3.1 Survey analysis

An online survey of 156 individuals with a driving license showed their knowledge and attitudes towards hydrogen-powered vehicles. Most respondents use their cars every day and are active road users.

The results showed that awareness of hydrogen technology is already quite high – 78% of respondents have heard of it. Respondents are also well aware of other alternatives to conventional internal combustion engines, with electric and hybrid vehicles being recognized by almost 100% of respondents, and hydrogen and natural gas vehicles being recognized by 70-80% of respondents. This indicates a generally good level of awareness of alternative drives.

When respondents compared hydrogen-powered vehicles with electric vehicles, most rated them as an equivalent alternative, which is likely related to the fact that the fuel cells in hydrogen-powered vehicles also produce electricity.

The main concerns of respondents regarding the use of hydrogen vehicles were the lack of infrastructure (charging stations), safety and high price. Nevertheless, respondents showed a willingness to purchase such a vehicle if the price was comparable to electric cars. Incentives that would convince them to buy are mainly better infrastructure and government subsidies.

As for the future, opinions are divided. Around 40% of respondents expect a slow growth in the use of hydrogen vehicles, while 30% believe in a rapid increase. However, respondents see the greatest potential for the use of hydrogen in road transport, especially in passenger cars, but also in trucks and buses.

4 Vehicles powered by hydrogen

4.1 Vehicles with direct hydrogen combustion engines (H2ICE)

Direct hydrogen combustion engines (or hydrogen engines) operate in a similar way to conventional internal combustion engines, but use hydrogen as fuel instead of fossil fuels. Such engines allow the direct combustion of hydrogen to produce power, producing only water and heat, allowing for very clean emissions.

4.1.1 Basic operation of a direct hydrogen combustion engine

Direct hydrogen combustion engines operate based on the following basic steps:

The operation of a hydrogen engine is based on the combustion of hydrogen, which is injected from high-pressure tanks into the engine cylinders and mixed with air. The combustion of hydrogen inside the cylinders produces energy to propel the vehicle. The only by-products are water vapor and heat, which is why such engines are environmentally friendly and do not produce CO_2 emissions.

4.1.2 Advantages of direct hydrogen combustion engines

Hydrogen-powered engines offer several key advantages. The most important is the cleanliness of emissions, as their only by-product of combustion is water, which eliminates emissions of CO_2, nitrogen oxides (NO_x) and particulate matter. Due to the high energy

density of hydrogen, vehicles powered by this fuel also have a good range. Additional advantages include fast charging, which takes only a few minutes, which is a significant advantage compared to electric vehicles, and reduced dependence on fossil fuels. The use of hydrogen as a fuel contributes to greater energy independence and sustainable development.

4.1.3 Challenges and limitations of direct hydrogen combustion engines

The disadvantages and challenges of using hydrogen engines are multifaceted. First, their efficiency is significantly lower than fuel cells, as they lose most of their energy as heat. This also leads to higher hydrogen consumption. Second, storing hydrogen is extremely challenging. Due to its low density, it requires compression under high pressure or liquefaction at very low temperatures, which requires complex infrastructure. Third, the combustion properties of the engine itself can cause problems such as overheating of components and problems with nitrogen oxides (NOx) emissions, meaning that the engine is not completely emission-free. Finally, the hydrogen production process itself poses a major challenge. Most hydrogen is still obtained from fossil fuels (for example, by reforming methane), which makes the process environmentally unfriendly, and a key goal is to switch to production from renewable sources.

4.1.4 Examples of vehicles and vehicle manufacturers with direct hydrogen combustion

Trucks and commercial vehicles:

- Toyota: Hydrogen engine prototypes
- Volvo Trucks : Developing hydrogen trucks with H_2 ICE
- MAN & Scania (Volkswagen Group): Development of H_2 ICE trucks
- JCB: Hydrogen engines for construction machinery (excavators, loaders)
- Passenger vehicles:
- Toyota GR Corolla H_2: Prototype sports car with 3-cylinder hydrogen engine
- Mazda RX-8 Hydrogen RE: Rotary hydrogen engine with indirect and direct injection

4.2 Fuel cell vehicles (FCEV)

Fuel cell vehicles are considered one of the most promising solutions for sustainable transportation, as they use hydrogen as their propulsion instead of fossil fuels.

These devices convert the chemical energy of hydrogen into electricity through an electrochemical reaction with oxygen from the air. This process does not involve combustion, but produces electricity to power the vehicle's engine, with the only by-products being water and heat. As a result, emissions of harmful substances such as CO_2 and NO_x are practically zero.

Fuel cell vehicles offer fast range and short charging times, similar to conventional vehicles. However, the current limited hydrogen refueling infrastructure is a major obstacle to their widespread use. Nevertheless, many manufacturers are investing in the development of this technology, as it represents an important step towards reducing emissions from transport

and independence from fossil fuels.

Advantages:

- High energy efficiency (50–60%)
- Clean emissions – emits only water vapor
- Quiet operation – similar to battery-powered electric cars
- Longer range than a battery EV
- Fast charging (3–5 minutes)
- Disadvantages:
- Expensive technology – fuel cell production is complicated
- Dependence on rare materials (platinum, titanium)
- Temperature sensitivity – poorer performance in extreme cold Requires hydrogen infrastructure – few filling stations

Examples of vehicles with FCEV powertrain:

- Toyota Mirai
- Hyundai Nexo
- Honda Civic Fuel Cell
- BMW iX5 Hydrogen

4.3 Comparison of vehicles and drive technology H 2 ICe and FCEV

Table 1: Comparison of FCEV and H2ICE

	FCEV	H2ICE
Property	Fuel cell (FCEV)	Direct hydrogen combustion (H_2 ICE)
Releases	Only water vapor (0 CO_2 emissions)	NO_x (nitrogen oxides), less CO_2 than gasoline
Efficiency	50–60% (very high)	30–40% (lower due to heat losses)
Power and responsiveness	Very smooth and quiet ride	More power and classic engine sound
Charging	3–5 minutes (as with conventional fuel)	3–5 minutes
Reach	500–700 km	400–600 km
Complexity	Expensive fuel cell and battery required	Uses existing motor technology
Maintenance	Fewer mechanical parts, less maintenance	Similar to classic engines, more moving parts
Usage	Passenger cars, buses, trucks	Trucks, sports cars, construction machinery

FCEVs (fuel cells) are cleaner and more efficient, but more expensive and require special infrastructure. They are ideal for long-distance passenger and freight vehicles.

H_2 ICE (direct hydrogen combustion) is more robust and easier to deploy , as it uses existing engines, but has lower efficiency and some emissions. It is suitable for heavy trucks, construction machinery and sports cars.

4.4 Comparison of the costs of purchasing and operating battery and fuel cell vehicles (FCEV) and conventional unleaded gasoline

For comparison, we chose two vehicles that are similar and from the same manufacturer. We chose a Hyundai vehicle. Nexo FCEV and Hyundai Kona electric . We would focus on the purchase price of the vehicle and the costs of charging or using the vehicle over an average period of two years, assuming that we drive about 30,000 km per year by car.

Table 2: Comparison of Hyundai NEXO FCEV and Hyundai KONA electric and KONA petrol

	Hyundai NEXO FCEV	Hyundai Kona electric	Hyundai Kona petrol
Purchase price	Around €65,000	Price of the basic model around €35,000	The price of the base model is around €26,000.
Releases	Only water vapor (0 CO_2 emissions)	0 emissions	CO2 , CO , NOx etc ...
Charging	3–5 minutes (as with conventional fuel)	Fast DC charging up to 80% approx. 41 min Classic AC charging takes about 8 hours	3-5 minutes
Reach	650–700 km according to WLTP	454–514 km according to WLTP	700-750 km
Complexity	Expensive fuel cell and battery required	Uses a battery and an electric motor	Uses a classic gasoline engine
Consumption per 100 km	0.95 kg	16.6 kWh	7.2 liters
Cost of vehicle consumption over a period of two years (30,000km per year)	€4,845.00	€1,173.75	€6,912.00

4.5 Charging station infrastructure for hydrogen and electric vehicles in Slovenia and Germany

The development of hydrogen vehicle charging infrastructure in Europe is slow. Slovenia currently has only one charging station in Lesce, while Germany leads Europe with 113 charging stations. Nevertheless, the European Union is planning an ambitious development with the goal of installing a charging station every 200 km along the TEN-T network by 2031. By the end of 2024, 1,160 charging stations were operational worldwide.

The infrastructure for electric vehicles is significantly more developed in both countries. Slovenia has around 300 registered public charging stations, while Germany has more than 80,000. These figures clearly show that Germany is well ahead of Slovenia in the development of this technology. All this is also confirmed by the calculation per population, as Germany has almost 7 times more developed infrastructure for electric vehicles per capita than Slovenia.

5 Conclusion

In light of the growing interest in hydrogen as an alternative to battery-powered vehicles, our research delved into the current state of its use and production in Slovenia and across Europe. We also surveyed drivers to examine their attitudes towards this technology.

We found that the use of hydrogen in Slovenia is still in its early stages. Although the technologies for its extraction and storage are well developed, its use for vehicle propulsion is not yet widespread. The reasons for this are probably the lack of infrastructure, as there is currently only one hydrogen filling station in Slovenia, and public fear of safety risks.

Furthermore, the cost of recharging hydrogen vehicles is still significantly higher than that of battery vehicles, although lower than that of gasoline. Therefore, given that fuel cell vehicles (FCEVs) also have a built-in battery, the question arises as to the feasibility of their use.

Currently, the alternative propulsion market is dominated by battery-powered vehicles, but hydrogen is an increasingly recognized option. Despite some shortcomings, we believe that the development of both technologies will continue. We expect that the market will offer a wide range of alternative propulsion in the future, with the final choice depending on the individual. When purchasing, people usually make decisions based on price and costs, but environmental awareness also has an important influence. Therefore, we do not expect a single type of alternative propulsion to dominate the market, but the offer will be diverse, allowing each individual to choose the most suitable option.

6 Sources and literature

- MOTOR vehicle. 29th revised edition, 1st printing. Ljubljana: Technical Publishing House of Slovenia. 2011.
- ONLINE SOURCE - https://www.mebius.si/tehnologija, accessed 21.1.2025
- FIGURE 2 – FUEL CELL. [Online]. Available at the web address: https://www.mebius.si/tehnologija

Škola za cestovni promet

Zagreb, Trg J. F. Kennedyja 8



Sanja Tirić, dipl. ing. – prof. savjetnik

Lovorka Vidić, dipl. ing. – prof. savjetnik

PROJEKTNA NASTAVA: „KAKO OTPADNI MATERIJAL ISKORISTITI ZA POBOLJŠANJE I ZAŠTITU ZDRAVLJA VOZAČA?“

Sažetak:

Škola za cestovni promet od studenog 2023. godine kao partner sudjeluje na Erasmus+ KA2 projektu „Green Skills 4 VET“ u okviru kojeg tehničke i strukovne škole te proizvodne tvrtke, zajedno sa stručnjacima za strateško savjetovanje, rade na uvođenju tema o ekološkoj održivosti u škole, primjenjujući iskustveno učenje i učenje temeljeno na radu, na četiri europska strateška industrijska sektora: poljoprivredu, strojarstvo, tekstilnu industriju, te promet i logistiku.

Učenici Škole za cestovni promet, metodom „Obrnute učionice“, uz stručno vodstvo svojih nastavnika, samostalno istražuju na koji način se može plastični otpad dobiven tijekom proizvodnje dugmadi iskoristiti u svrhu poboljšanja i zaštite zdravlja vozača. Surađujući s partnerima na projektu: učenicima i nastavnicima srednje strukovne škole, tekstilni smjer (Strokovno Izobraževalni Center – SIC, Ljubljana), tvrtkom TOKIĆ d.o.o. (promet i logistika, Zagreb) te direktoricom tvrtke DOLEJŠI Modni gumbi d.o.o., Ljubljana, Natašom Dolejši, naši učenici su stvarni problem koji se tiče održivosti okoliša usmjerili prema poslovnom okruženju (tvrtki TOKIĆ d.o.o.) kako bi se prevenirale profesionalne bolesti i zaštitilo zdravlje vozača.

Radom na projektnom zadatku učenici razvijaju osobne potencijale, suradnički uče i rade u timu, planiraju i upravljaju aktivnostima te djeluju u skladu s načelima održivog razvoja s ciljem zaštite prirode i okoliša.

Ključne riječi:

- *održivost okoliša*
- *metoda „Obrnute učionice“*
- *učenje temeljeno na radu*

PROJEKTNA NASTAVA: „KAKO OTPADNI MATERIJAL ISKORISTITI ZA POBOLJŠANJE I ZAŠTITU ZDRAVLJA VOZAČA?“

1. O projektnoj nastavi u okviru projekta Green Skills 4 VET

Škola za cestovni promet od studenog 2023. godine kao partner sudjeluje na Erasmus+ KA2 projektu „Green Skills 4 VET“ u okviru kojeg tehničke i strukovne škole te proizvodne tvrtke, zajedno sa stručnjacima za strateško savjetovanje, rade na uvođenju tema o ekološkoj održivosti u škole, primjenjujući iskustveno učenje i učenje temeljeno na radu, na četiri europska strateška industrijska sektora: poljoprivredu, strojarstvo, tekstilnu industriju, te promet i logistiku, u četiri europske države.

Tijekom rada na projektu, učenici Škole za cestovni promet, tehničari cestovnog prometa, su, metodom „Obrnute učionice“, uz stručno vodstvo svojih nastavnika, samostalno istraživali stvarne probleme i izazove održivosti iz industrijskog i poslovnog okruženja, surađujući s tvrtkom iz područja prometa i logistike TOKIĆ d.o.o. iz Hrvatske, a zatim sa slovenskom tvrtkom DOLEJŠI Modni gumbi d.o.o. iz Ljubljane.

Prvi izazov s kojim su se uhvatili u koštac bio je „Zamjena postojećih dostavnih vozila električnim u tvrtki TOKIĆ d.o.o.“. Učenici su trebali pronaći odgovarajuću zamjenu za postojeća vozila uzimajući u obzir tip vozila, nosivost te doseg prijeđenih kilometara s jednim punjenjem, utvrditi mogućnost postavljanja punionica za električna vozila te procijeniti troškove ulaganja.

Nakon ovog uspješno odrađenog problemskog zadatka, slijedio je novi, na kojem se naša škola trebala povezati s partnerskom tvrtkom iz jedne od tri europske države (Italijom, Portugalom ili Slovenijom), surađujući na međusektorskoj razini.

U tvrtki DOLEJŠI Modni gumbi d.o.o., prilikom proizvodnje dugmadi, nastaje znatna količina plastičnog otpada koji bi se mogao pametno i „zeleno“ iskoristiti. Pred naše učenike postavljen je novi problemski zadatak: „Kako otpadni materijal iskoristiti za poboljšanje i zaštitu zdravlja vozača?“

2. Partneri na projektu

Koordinator projekta tvrtka Cisita Parma iz Italije zadužena je za osmišljavanje projektnih aktivnosti i evaluaciju ishoda učenja u sustavu strukovnog obrazovanja i osposobljavanja.

Partneri na projektu su strukovne škole i tvrtke: C. E. Gadda i Frigomeccanica SpA iz Italije (strojarstvo), Escola Profissional Agricola Quinta da Lageosa i Associação de Agricultores para Produção Integrada de Frutos de Montanha iz Portugala (poljoprivreda), Strokovni izobraževalni center Ljubljana i Dolejši Modni Gumbi iz Slovenije (tekstilna industrija), Škola za cestovni promet Zagreb i TOKIĆ d.o.o. iz Hrvatske (promet i logistika) i Prospektiker, Instituto Europeo de Prospectiva y Estrategia SA iz Španjolske (planiranje i diseminacija).

Nastavnici iz srednjih strukovnih škola i predstavnici tvrtki na virtualnim i sastancima u živo razmjenjuju iskustva iz svojih institucija, planiraju aktivnosti u okviru projekta, donose zaključke i smjernice za daljnji rad i usavršavanja kako bi se uvođenjem predmeta o

održivosti okoliša u strukovni kurikulum približilo potrebama tržišta rada, povećala kvaliteta i obim znanja te, primjenjujući iskustveno učenje i učenje temeljeno na radu, strukovna zanimanja postala privlačnija mladima koji bi postali traženi na tržištu rada.

3. Projektne aktivnosti

Tijekom rada na projektu koristi se metoda „Obrnute učionice“ pri čemu se učenici najprije suočavaju s problemskim zadatkom kojeg trebaju riješiti, “izazovom održivosti“, koji im postavlja tvrtka. Zatim slijede individualna i grupna istraživanja, praćena od strane nastavnika, ali bez usmjeravajućih intervencija u pristupu i sadržaju. Na kraju učenici prezentiraju svoje radove, raspravljaju i komentiraju rješenja problemskog zadatka.

Radom na projektnom zadatku, učenjem temeljenom na radu, učenici razvijaju osobne potencijale, suradnički uče i rade u timu, planiraju i upravljaju aktivnostima te djeluju u skladu s načelima održivog razvoja u cilju zaštite prirode i okoliša.

4. Rad na problemskom zadatku: „Kako otpadni materijal iskoristiti za poboljšanje i zaštitu zdravlja vozača?“

4.1 Sastanak u Parmi



Slika 74: Sastanak u Parmi

Na sastanku u Parmi, 29. i 30. siječnja 2025., partneri na projektu, predstavnici tvrtki i nastavnici iz srednjih strukovnih škola iz Portugala, Slovenije, Italije i Hrvatske, pod vodstvom predstavnika tvrtke Cisita iz Parme, dogovarali su nove međusektorske suradnje

i izazove.

Nastavnice Sanja Tirić, Snježana Kovač i Lovorka Vidić su se s mag. Natašom Dolejši, direktoricom tvrtke DOLEJŠI Modni gumbi d.o.o. iz Slovenije, složile da naši učenici na novom projektnom zadatku surađuju s tvrtkom koja bi plastični otpad dobiven tijekom proizvodnje dugmadi iskoristila za novi/e proizvod/e čija uporaba bi doprinijela poboljšanju zdravlja vozača odnosno smanjenju profesionalnih oboljenja vozača.

4.2 Predstavljanje problemskog zadatka



Slika 75: Predstavljanje problemskog zadatka

Nakon uvodnog predavanja i poticajne power point prezentacije o obnovljivim izvorima energije, dana 3. ožujka 2025. održan je on-line sastanak kojem su prisustvovali partneri na projektu „Green Skills 4 VET“: učenici 3.a razreda i nastavnici: Sanja Tirić, Bruno Marković, Snježana Kovač i Lovorka Vidić iz Škole za cestovni promet, Milena Barchi, koordinator projekta GS4VET iz tvrtke Cisita, Parma i mag. Nataša Dolejši, direktorica tvrtke DOLEJŠI Modni gumbi d.o.o. iz Slovenije.



Slika 76: Online sastanak

Gđa Nataša Dolejši upoznala je učenike s poviješću nastanka svoje obiteljske tvrtke, procesom proizvodnje dugmadi, tehnologijama izrade te problemom otpada koji žele upotrijebiti za nešto korisno. Na prezentaciji je pokazala i ideje slovenskih učenika kako od otpada (plastične mreže) napraviti uporabne predmete (držače za ručni alat, podmetače za tanjure, držače za novine i dr.). Granulirani otpadni materijal može se upotrijebiti i kao punilo za utege za vježbanje.

Projektni zadatak, prijedlog gđe Dolejši, koji će naši učenici istraživati je „Kako otpadni materijal iskoristiti za poboljšanje i zaštitu zdravlja vozača?“.

4.3 Istraživanja učenika

Učenici 3.a istraživali su s kojim se profesionalnim bolestima i zdravstvenim problemima najčešće susreću vozači. Od svojih nastavnika dobili su poveznice za materijale i literaturu koje mogu koristiti u svojim istraživanjima i power point prezentacijama. Izradili su upitnik za vozače u tvrtki TOKIĆ d.o.o. i analizirali odgovore na temelju kojih će osmisliti tjelesne vježbe i aktivnosti u kojima će koristiti utege od otpadnog materijala nastalog pri izradi dugmadi u tvrtki DOLEJŠI i prezentirati ih vozačima u tvrtki TOKIĆ d.o.o. kako bi njihovim redovitim korištenjem poboljšali svoje zdravstveno stanje.



Slika 77: Prezentiranje učenika

4.4 Predstavljanje rada na projektu u SIC - Ljubljana

Dana 2. travnja 2025., učenici 3.a bili su na stručnoj ekskurziji u Ljubljani, u Strokovnom Izobraževalnom Centru (SIC). Učenicima i nastavnicama koji sudjeluju u projektu „Green Skills 4 VET“ (sektor: tekstilna industrija), predstavili su Školu za cestovni promet, projekte EU u kojima je škola sudjelovala, tijek rada na izazovu „Kako otpadni materijal iskoristiti za poboljšanje i zaštitu zdravlja vozača?“, power point prezentacije o profesionalnim oboljenjima vozača te mjerama za njihovu prevenciju.



Slika 78: Predstavljanje rada na projektu u SIC Ljubljana

Učenice SIC-a su izradile jastučić za leđa i podlogu za vozačko sjedalo koju će dati na testiranje vozačima tvrtke TOKIĆ. Gđa Nataša Dolejši demonstrirala je različite uporabne predmete izrađene od otpadnog materijala koji je nastao tijekom proizvodnje dugmadi i utege za vježbanje (vrećice napunjene otpadnim plastičnim granulatom) koje će naši učenici proslijediti vozačima tvrtke TOKIĆ.



Slika 79: u SIC Ljubljana

4.5. Radni sastanak u ŠCP: Analiza upitnika o zdravlju vozača u tvrtki TOKIĆ

Dana 22. travnja 2025., u Školi za cestovni promet, učenici 3.a razreda koji sudjeluju u radu na projektu „Green Skills 4 VET“ predočili su Zdravku Tokiću, projektnom partneru, analizu upitnika o zdravstvenim problemima i načinima rješavanja istih kod vozača u tvrtki TOKIĆ d.o.o. Zdravko Tokić dao je svoj osvrt na rezultate upitnika: navedeni odgovori o bolovima na određenim dijelovima tijela uslijed obavljanja poslova vozača su očekivani, a vježbanje je najučinkovitiji način za zaštitu zdravlja od profesionalnih oboljenja.



Slika 80: Ergonomska pomagala za profesionalne vozače

Na osnovu dobivenih odgovora vozača, učenici su uz pomoć nastavnice tjelesne i zdravstvene kulture Martine Sesar snimili video uradak s vježbama za dijelove tijela koji su najčešće izloženi bolovima uslijed dugotrajnog sjedenja tijekom vožnje (leđa, vrat,…). Snimke vježbi i utezi bit će proslijeđeni vozačima tvrtke TOKIĆ kako bi ih se potaknulo

na redovito vježbanje radi zaštite i poboljšanja njihovog zdravlja.



Slika 81: Prezentacija vježbi za profesionalne vozače

4.6. Sastanak s vozačima u tvrtki TOKIĆ



Slika 82: Sastanak s vozačima tvrtke TOKIĆ

Dana 16. svibnja 2025. godine, učenici 3.a razreda su vozačima u tvrtki TOKIĆ d.o.o. u Sesvetama predstavili svoj rad na projektu GS4VET: Uporaba otpadnog materijala za zaštitu i poboljšanje zdravlja vozača.

Anamarija i Ivana su prezentirale istraživanje na temu „Profesionalne bolesti vozača - prevencija i mjere zaštite“. Ivan je zahvalio prisutnima na sudjelovanju u upitniku koji je proslijeđen TOKIĆ-evim vozačima i predočio im rezultate ankete na osnovu kojih su učenici snimili video s vježbama za dijelove tijela najviše izloženim bolovima tijekom

obavljanja radnih zadataka vozača. Šimun im je objasnio da je važno redovito vježbati i pravilno odraditi vježbe sa snimke.

Nakon održanih prezentacija i videa, vozači su dali svoj osvrt na učenička istraživanja.

Vozači su za vježbanje dobili utege napunjene granulatom od otpadnog plastičnog materijala koji je nastao tijekom proizvodnje dugmadi u slovenskoj tvrtki DOLEJŠI, a kako bi im bilo ugodnije i udobnije tijekom vožnje, za potrebe testiranja, su dobili jastučić i podlošku za vozačko sjedalo napunjeno istim otpadnim materijalom, rad učenika tekstilne škole (SIC) iz Ljubljane.

4.7. Kvaliteta i utjecaj ponuđenih vježbi na zdravlje vozača

Učenici su kreirali upitnik kojim su željeli saznati na koji način, i jesu li uopće, prezentirane vježbe za smanjenje utjecaja profesionalnih bolesti na zdravlje vozača, utjecale na njihovo zdravlje.

Većina vozača (71%) koji su odgovorili na upitnik je isprobala neke od ponuđenih vježbi; 29% ih vježba više puta tjedno, 24% jednom tjedno, 18% svaki dan a 29% ih nije vježbalo odnosno ne vježba.

Svi smatraju da vježbanje doprinosi poboljšanju zdravlja, ali neki ne vježbaju jer nemaju vremena ili im se ne da.

5. Zaključak

Radom na projektnom zadatku, učenjem temeljenom na radu, metodom „obrnute učionice“, učenici su, individualnim i grupnim istraživanjem, radom u timu, surađujući, planirali i upravljali aktivnostima te djelovali u skladu s načelima održivog razvoja u cilju zaštite prirode i okoliša.

Učenici su se uključili u provedbu dijela nastave čime se osnažuje: ideal demokracije, osjećaj odgovornosti potreban za razvoj aktivnih građana koji se koriste kritičkim mišljenjem u donošenju odluka, iskustvo istraživanja i pronalaženja rješenja nekog problema zajedničkim radom i suradnjom.

Educirali su se o važnosti društvene i ekonomske održivosti i održivosti okoliša.

Suočili su se sa stvarnim izazovima današnjeg svijeta i suvremenog življenja.

Shvatili su važnost prelaska na obnovljive izvore energije, potrebu smanjenja emisije ugljika i otpada te povećanja uporabe recikliranih materijala jer zdravi eko-sustav nužan je za zdrav planet, za klimatski stabilnu budućnost.

Literatura i korišteni materijali

- Priručnik
    - Vrbanc B., Garašić D., Pašalić A.: Obrazovanje za održivi razvoj, AZOO, Zagreb 2011.
- Web stranice
    - https://www.microsoft.com/hr-hr/sustainability/learning-center/environmental-sustainability 25.6.2025.
    - https://www.vss.hr/odrzivi-razvoj-sto-je-i-kako-mozemo-pridonijeti/ 21.4.2025.

Road Traffic School

Zagreb, J. F. Kennedy Square 8



Sanja Tirić, Graduate Eng., teacher – advisor

Lovorka Vidić, Graduate Eng., teacher – advisor

PROJECT TEACHING: „HOW TO USE WASTE MATERIAL TO IMPROVE AND PROTECT THE HEALTH OF DRIVERS?”

Abstract:

Since November 2023, the Road Traffic School has been as a partner in the Erasmus+ KA2 project „Green Skills 4 VET”, in which technical and vocational schools and manufacturing companies, together with strategic consulting experts, are working on introducing environmental sustainability topics in schools, applying experiential and work-based learning, to four European strategic industrial sectors: agriculture, engineering, textile industry and transport and logistics.

Students of Road Traffic School, using the „Flipped Classroom” method, under the expert guidance of their teachers, independently investigate how plastic waste generated during button manufacturing can be utilized for the purpose of improving and protecting drivers' health.

Cooperating with project partners: students and teachers from secondary vocational school, textile direction (Vocational Education Center – SIC Ljubljana), company TOKIĆ Ltd. (transport and logistics, Zagreb) and the director of DOLEJŠI Fashion Buttons Ltd., Ljubljana, Nataša Dolejši, our students focused on a real problem regarding environmental sustainability towards the business environment (TOKIĆ Ltd.) in order to prevent occupational diseases and protect the health of drivers.

By working on the project task, students develop personal potentials, learn and work collaboratively in a team, plan and manage activities, and act in accordance with the principles of sustainable development with the aim of protecting nature and the environment.

Keywords:

- *Environmental sustainability*
- *„Flipped Classroom” method*
- *Work-based learning*

PROJECT TEACHING: „HOW TO USE WASTE MATERIAL TO IMPROVE AND PROTECT THE HEALTH OF DRIVERS?“

1. About project teaching within the project „Green Skills 4 VET“

Since November 2023, the Road Traffic School has been as a partner in the Erasmus+ KA2 project „Green Skills 4 VET“, in which technical and vocational schools and manufacturing companies, together with strategic consulting experts, are working on introducing environmental sustainability topics in schools, applying experiential and work-based learning, to four European strategic industrial sectors: agriculture, engineering, textile industry and transport and logistics, in four European countries. During the project, students of Road Traffic School, road traffic technicians, independently researched real problems and challenges of sustainability from the industrial and business environment, using the „Flipped Classroom“ method, with the expert guidance of their teachers, collaborating with the transport and logistics company TOKIĆ Ltd. from Croatia, and then with Slovenian company DOLEJŠI Fashion Buttons Ltd. from Ljubljana.

The first challenge the students tackled was „Replacing existing delivery vehicles with electric one sin company TOKIĆ Ltd.“. The students had to find a suitable replacement for existing vehicles, taking into account the type of vehicle, load capacity and range of kilometres travelled on a single charge, determine the possibility of installing charging stations for electric vehicles, and estimate the investment costs.

After this successfully completed problem assignment, a new one followed, in which our school had to connect with a partner company from one of three European countries (Italy, Portugal or Slovenia), cooperating at an inter-sectoral level.

In the company DOLEJŠI Fashion Buttons Ltd., during the production of buttons, a considerable amount of plastic waste is generated that could be used smartly and „green“. To our students was presented a new problematic task: „How to use waste material to improve and protect the health of drivers?“

2. Project Partners

The project coordinator, Cisita Parma from Italy, is responsible for designing project activities and evaluating learning outcomes in the vocational education and training system.

Partners in the project are vocational schools and companies: C.E. Gadda and Frigomeccanica SpA from Italy (mechanical engineering), Escola Profissional Agricola Quinta da Lageosa and Associação de Agricultores para Produção Integrada de Frutos de Montanha from Portugal (agriculture), Vocational Education Centre Ljubljana and Dolejši Modni Gumbi from Slovenia (textile industry), Road Traffic School Zagreb and TOKIĆ d.o.o. from Croatia (transport and logistics) and Prospektiker, Instituto Europeo de Prospectiva y Estrategia SA from Spain (planning and dissemination). Teachers from secondary vocational schools and company representatives exchange experiences from their institutions in virtual and live meetings, plan activities within the project, draw conclusions and guidelines for further work and training in order to bring the subject of environmental sustainability into the professional curriculum closer to the needs of the labour market. The quality and latitude of knowledge would increase and, by applying experiential learning and work-based learning, professional occupations became more attractive to young people who would become in demand on the labour market.

3. Project activities

During the project work, the „Flipped Classroom“ method is used. First, students were faced with a problem task to be solved, a „sustainability challenge“, set by the company. Then followed individual and group research, monitored by the teacher but without any guiding interventions in the approach and content. Finally, students present their work, discuss and comment on the solutions to the problem task.

By working on a project assignment, learning based on work, students develop personal potential, learn collaboratively and work in team, plan and manage activities and act in accordance with the principles of sustainable development in order to protect nature and the environment.

4. Work on the problem task: „How to use waste material to improve and protect the health of drivers?“

4.1. Meeting in Parma



Figure 3: Meeting in Parma

At a meeting in Parma on January 29 and 30, 2025, project partners, company representatives and teachers from secondary vocational schools from Portugal, Slovenia, Italy and Croatia, led by representatives of the Cisita company from Parma, discussed new cross-sectoral collaborations and challenges.

Teachers Sanja Tirić, Snježana Kovač and Lovorka Vidić agreed with Nataša Dolejši, mag., director of the company DOLEJŠI Fashion Buttons Ltd. from Slovenia, that our students would collaborate on a new project assignment with a company that would use plastic waste,

obtained during the production of buttons, for new product(s) whose use would contribute to improving the health of drivers and reducing occupational diseases of drivers.

4.2 Presentation of the problem task



Figure 4: Introduction of project task

After an introductory lecture and an inspiring power point presentation on renewable energy sources, an online meeting was held on March 3, 2025, attended by partners in the project „Green Skills 4 VET“: 3rd grade students and teachers: Sanja Tirić, Bruno Marković, Snježana Kovač i Lovorka Vidić from Road Traffic School, Milena Barchi, GS4VET project coordinator from Cisita, Parma and mag. Nataša Dolejši, director of DOLEJŠI Fashion Buttons Ltd. from Slovenia.



Figure 5: Online meeting

Ms. Nataša Dolejši introduced the students to history of her family business, the button production process, manufacturing technologies, and the problem of waste that they want to use for something useful. During the presentation, she also showed the ideas of Slovenian students on how to make useful objects from waste (plastic nets): hand tool holders, plate mats, newspaper holder, etc. Granulated waste material can also be used as filler for exercise weights.

The project task, proposed by Ms. Dolejši, that our students will explore, is: „How to use waste material to improve and protect the health of drivers?“

4.3. Student research

Students in 3.a class researched the most common occupational diseases and health problems that drivers encounter. From their teachers, they received links to materials and literature that they can use in their research and power point presentations. They created a questionnaire for drivers at TOKIĆ Ltd. and analysed the answers, based on which they will design physical exercises and activities in which they will use weights made from waste material generated during the production of buttons at DOLEJŠI Ltd. and present them to drivers at TOKIĆ Ltd. so that they can improve their health through regular use.



Figure 6: Students’ presentations

4.4. Presentation of project work at SIC – Ljubljana

On April 2, 2025, the students went on a professional excursion to Ljubljana, to the Vocational Education Centre (SIC). They presented Road Traffic School, EU projects in which the school participated, the work process on the challenge „How to use waste material to improve and protect the health of drivers?“, power point presentations on occupational diseases of drivers and measures for their prevention, to students and teachers participating in the project GS4VET (sector: textile industry).



Figure 7: Project work in SIC Ljubljana

Students from SIC made a back cushion and a driver's seat pad that they will give to TOKIĆ drivers for testing. Ms. Nataša Dolejši demonstrated various useful items made from waste material generated during the production of buttons and exercise weights (bags filled with waste plastic granulate) that our students will pass on to TOKIĆ drivers.



Figure 8: In SIC Ljubljana

4.5. Working meeting at Road Traffic School: Analysis of the questionnaire on the health of drivers at TOKIĆ Ltd.

On April 22, 2025, at Road Traffic School, 3rd grade students participating in the GS4VET project, presented to Zdravko Tokić, project partner, an analysis of the questionnaire on health problems and ways to solve them among drivers at the TOKIĆ Ltd. Zdravko Tokić gave his opinion on the results of the questionnaire: the answers given about pain in certain parts of the body due to performing driver duties are expected, and exercise is the most effective way to protect health from occupational diseases.



Figure 9: Ergonomic aids for professional drivers

Based on the responses received from the drivers, the students, with the help of physical education teacher Martina Sesar, recorded a video with exercises for the parts of the body that are most often exposed to pain due to prolonged sitting while driving (back, neck, etc.). The exercise recordings and weights will be forwarded to TOKIĆ drivers to encourage them to exercise regularly to protect and improve their health.



Figure 10: Presentation of exercises for professional drivers

4.6 Meeting with drivers at TOKIĆ Ltd.



Figure 11: Meeting with drivers in company TOKIĆ

On May 16, 2025, students presented their work on the GS4VET project „Using waste materials to protect and improve drivers' health" to drivers at TOKIĆ Ltd. in Sesvete.

Anamarija and Ivana presented research on the topic „Occupational diseases of drivers – prevention and protective measures". Ivan thanked those present for their participation in the questionnaire that was sent to TOKIĆ drivers and presented them the results of the survey, based on which the students recorded a video with exercises for the parts of the body most exposed to pain while performing the driver's work tasks. Šimun explained to them that it is important to exercise regularly and to do exercise from the recording correctly.

After the presentations and videos, the drivers gave their feedback on the students' research. The drivers were given weights filled with granulate from waste plastic material that was created during the production of buttons in the Slovenian company DOLEJŠI, for exercise, and to make it more comfortable and convenient for them while driving, for testing purposes, they were given a cushion and a pad for the driver's seat filled with the same waste material, the work of students from Textile school (SIC) from Ljubljana.

4.7. Quality and impact of offered exercises on driver's health

The students created a questionnaire to find out how, and if at all, the presented exercises for reducing the impact of occupational diseases on the health of drivers have affected their health.

The majority of drivers (71%), who responded to the questionnaire, tried some of the offered exercises; 29% exercise several times a week, 24% once a week, 18% every day and 29% do not exercise.

All of them believe that exercise contributes to improving health, but some do not exercise because they do not have time or do not feel like it.

5. Conclusion

Through project work, work-based learning and the „Flipped Classroom" method, students through individual and group research, teamwork, and collaboration, planned and managed activities and acted in accordance with the principles of sustainable development in order to protect nature and environment.

Students participated in the implementation of part of the teaching, which strengthens: the ideal of democracy, the sense of responsibility necessary for the development of active citizens who use critical thinking in decision-making, the experience of researching and finding solutions to a problem through joint work and cooperation.

They were educated about the importance of social, economic and environmental sustainability.

Thea faced the real challenges of today's world and modern living.

Students understood the importance of switching to renewable energy sources, the need to reduce carbon emissions and waste, and increase the use of recycled materials, because a healthy ecosystem is essential for a healthy planet, for a climate-stabile future.

Literature and materials used

- Manual
    - Vrbanc B., Garašić D., Pašalić A.: Obrazovanje za održivi razvoj, AZOO, Zagreb 2011.
- Website
    - https://www.microsoft.com/hr-hr/sustainability/learning-center/environmental-sustainability, 25.6.2025.
    - https://www.vss.hr/odrzivi-razvoj-sto-je-i-kako-mozemo-pridonijeti/ 21.4.2025.

JU SSŠ ”Ivan Uskoković” Podgorica Crna Gora

Gordana Vuksanović, diplomirani menadžer

Radoš Zuković, diplomirani inženjer saobraćaja

Analiza tržišta osiguranja od autoodgovornosti u Crnoj Gori u periodu od 2000. do 2025.godine

Sažetak

Osiguranje ima ključnu ulogu u zaštiti lica i imovine, od različitih rizika.Prema podacima Agencije za nadzor osiguranja, na tržištu osiguranja u Crnoj Gori dominantno se zaključuju polise neživotnog osiguranja, prvenstveno polise osiguranja od autoodgovornosti.To je rezultat zakonske obaveze zaključenja ugovora osiguranja od odgovornosti za štete pričinjene trećim licima, prilikom registracije motornog vozila.U radu ćemo se osvrnuti na vremenski period od 2000. do 2025.godine, pratiti dinamiku rasta zaključenih polisa osiguranja, dinamiku rasta finansijskih pokazatelja i izvršiti komparativnu analizu podataka.

Ključne riječi: Crna Gora, osiguranje, analiza tržišta, autoodgovornost, štete u osiguranju.

Uvod

Crna Gora, mala, prelijepa zemlja u jugoistočnoj Evropi,sa 306.665 registrovanih motornih vozila na oko 480.000 punoljetnih stanovnika, sa prosječnom starošću voznog parka putničkih vozila od 17.6 godina, 6.4 procentom putničkih vozila mlađim od 6 godina, 86.1 procentom putničkih vozila starijih od 10 godina.[46]To dovodi do toga da, na jednoj strani imamo veliku frekvenciju saobraćaja,nisku saobraćajnu kulturu, nedovoljno razvijenu infrastrukturu, veliki broj saobraćajnih nezgoda,zagađenje životne sredine, a na drugoj strani konstantni rast tržišta osiguranja.

Prema podacima Agencije za nadzor osiguranja Crne Gore, nadležne institucije za nadzor i kontrolu osiguranja u Crnoj Gori, na crnogorskom tržištu osiguranja dominantno se zaključuju polise neživotnog osiguranja, prvenstveno polise osiguranja od autoodgovornosti.To je rezultat zakonske obaveze zaključenja ugovora osiguranja od

[46] Uprava za statistiku Crne Gore - MONSTAT

odgovornosti za štete pričinjene trećim licima, prilikom registracije motornog vozila.[47]

Zakonski okvir za oblast osiguranja u Crnoj Gori čine: Zakon o osiguranju, Zakon o obaveznom osiguranju u saobraćaju i Zakon o stečaju i likvidaciji društava za osiguranje[48].

Institucionalni okvir: Agencija za nadzor osiguranja, Nacionalni biro osiguravača.

Tržište osiguranja autoodgovornosti od 2000. do 2007. godine

Početkom devedesetih godina, tržište osiguranja u tadašnjoj Jugoslaviji doživjelo je ekspanziju u smislu povećanja broja novoformiranih osiguravajućih kompanija.Ubrzo, zbog ratnog okruženja, sankcija i inflacije, došlo je do raspada jugoslovenskog tržišta osiguranja. U Crnoj Gori najveći broj građana osiguravao se kod kompanija iz Srbije koje su poslovale na crnogorskom tržištu osiguranja preko svojih filijala.Najveće učešće u ukupnom portfelju crnogorskog tržišta osiguranja, kompanije su realizovale u osiguranju od autoodgovornosti tj. preko 60% vozila u Crnoj Gori bilo je osigurano kod osiguravajućih kompanija iz Srbije.Regulisanje obaveza prema osiguranicima bilo je neažurno, a zbog neizmirenih eksternih šteta i unutrašnjih dugova po osnovu pričinjenih šteta i preuzetih obaveza iz ugovora o osiguranju, doveli su do suspenzije osiguravajućih kompanija iz međunarodnog sistema osiguranja-zelene karte.U avgustu 2000.godine Vlada Republike Crne Gore donijela je Uredbu o osiguranju imovine i lica, kojom je predviđeno da poslove osiguranja u Crnoj Gori obavljaju samo organizacije za osiguranje koje imaju sjedište, kao pravno lice, na teritoriji Crne Gore sa uplaćenim sredstvima fonda sigurnosti kod poslovnih banaka u Crnoj Gori.U periodu od 2000.godine do 2003.godine, u Crnoj Gori poslovala su samo tri društva za osiguranje i to: "Lovćen"a.d. Podgorica, "Montenegro"a.d. Podgorica i "Swiss"a.d. Podgorica.2003.godine dozvolu za rad dobilo je "Zepter osiguranje"a.d. Podgorica, 2004.godine dozvolu za rad dobilo je "Grawe osiguranje"a.d. Podgorica, a 2005.godine dozvolu za rad dobilo je i "Magnat osiguranje" a.d. Podgorica.

Ostvarena bruto premija na tržištu Crne Gore, u navedenom periodu, imala je tendenciju rasta: 2002.godine 22.8 mil.eura, 2003.godine 25.6 mil.eura, 2004.godine 26.1 mil.eura, 2005.godine 36 mil.eura, 2006.godine 39.6 mil.eura.Na osnovu navedenog, ukupna bruto premija u posmatranom periodu ostvarila je rast od 57.64%. U strukturi premije sa 51.1% učestvuju obavezna osiguranja (96% osiguranje od autoodgovornosti), 26.5% imovinska osiguranja, 20.7% osiguranje od nezgode i 1.7% životna osiguranja.[49]

U decembru 2006.godine Skupština Republike Crne Gore je usvojila Zakon o osiguranju ("SL RCG" broj 78/06 od 22.12.2006.godine)

U julu 2007.godine Skupština Republike Crne Gore je usvojila Zakon o obaveznom osiguranju ("SL RCG"broj 46/07 od 31.07.2007.godine).

Tržište osiguranja autoodgovornosti od 2007.godine do 2010.godine

Na tržištu neživotnog osiguranja u periodu od 2007. do 2010.godine u Crnoj Gori poslovalo je šest društava za osiguranje[50].

---

[47] Agencija za nadzor osiguranja Crne Gore

[48] www.skupština.me

[49] Centralna banka Crne Gore

[50] Agencija za nadzor osiguranja Crne Gore

Herfindahl-Hirchman indeks (HHI)

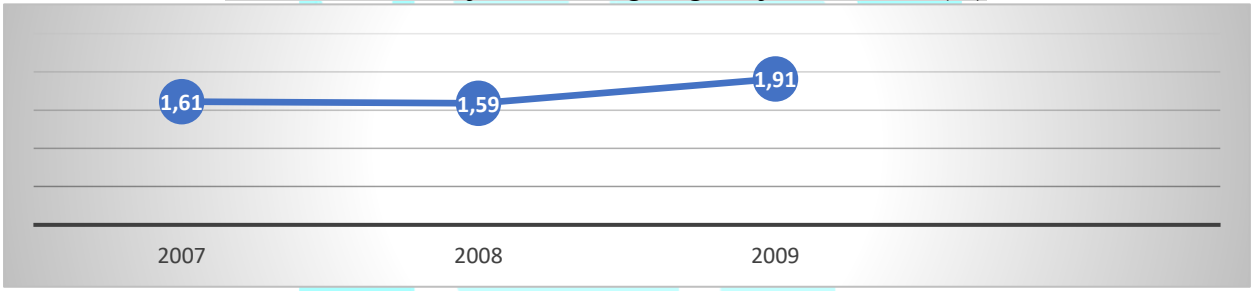
Za utvrđivanje nivoa koncentracije tržišta osiguranja koristi se Herfindahl-Hirchman indeks (HHI) čija se vrijednost može kretati u intervalu od 0 do 10.000. Vrijednost indeksa koja je bliža nuli označava da tržište ima veliki broj društava približno iste veličine tj. da se radi o tržištu sa visokim nivoom konkurencije. Vrijednost indeksa bliža 10.000 označava da je tržište koncentrisano, odnosno da na tržištu postoji monopol.

Za tržište osiguranja u Crnoj Gori, u periodu od 2007. do 2010. godine, vrijednost HHI se kreće u granicama koncentrisanog tržišta (monopol), jer vrijednosti ovog indeksa pripadaju intervalu od 1.800 do 10.000. U 2008.godini HHI je iznosio 4.183,43, u 2009.godini 3.415,83.[51]

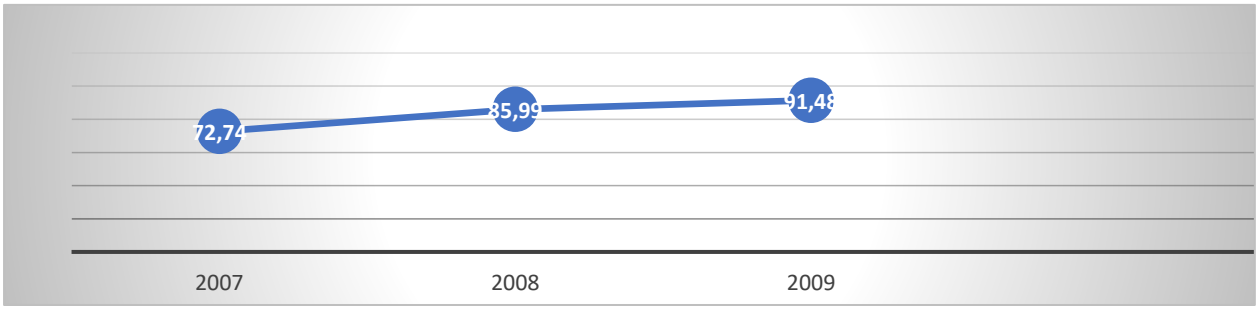
Pokazatelji tržišta osiguranja

Kao osnovni pokazatelji tržišta osiguranja uzima se penetracija osiguranja-učešće bruto fakturisane premije u BDP-u, gustina osiguranja-iznos bruto fakturisane premije po glavi stanovnika i struktura premije[52].

Grafik 1: Penetracija neživotnog osiguranja 2007-2009 (%)



Grafik 2: Bruto fakturisana premija neživotnog osiguranja 2007-2009 (eur)



[51] Agencija za nadzor osiguranja Crne Gore

[52] Kočović, J., Šulejić, P., Antić-Rakonjac, T., Osiguranje, Beograd, 2010.

Tabela 1: Struktura bruto fakturisane premije osiguranja 2007-2009

	2007		2008		2009	
Premija mil.eur Učešće %	P	U	P	U	P	U
životno	5.9	11.58	7.2	11.96	8.08	12.33
neživotno	45.1	88.42	53.3	88.04	57.48	87.67

Tabela 2: Portfelj obaveznih osiguranja 2007-2009

	2007		2008		2009	
Premija mil.eur Učešće %	P	U	P	U	P	U
Obavezna osiguranja	23.7	46.60	26.7	44.05	32.3	49.20

Tabela 3: Fakturisana bruto premija autoodgovornosti 2007-2009

	2007	2008	2009
Iznos premije mil.eur	----	25.9	31.15
Učešće u obaveznom osiguranju %	----	97.18	96.56

Tržište osiguranja u Crnoj Gori u posmatranom periodu karakteriše dominantno učešće neživotnih, obaveznih osiguranja. Premija neživotnog osiguranja učestvovala je u BDP-u Crne Gore sa 1.61% u 2007. godini, 1.59% u 2008.godini i 1.91% u 2009.godini. Neživotno osiguranje po glavi stanovnika (gustina) bilježi konstantni rast, u 2007.godini je iznosilo 72.74 eura , 2008.godini 85.99 eura i 2009.godini 91.48 eura.[53] Premija neživotnog osiguranja ostvarila je rast po stopi od 16.95% u odnosu na 2006.godinu i u 2007. godini iznosila 45.11 mil.eura, da bi u 2009.godini dostigla iznos od 57.5 mil.eura.Učešće neživotnog osiguranja u ukupnoj premiji osiguranja iznosilo je oko 88%. Učešće obaveznih osiguranja u portfelju osiguranja Crne Gore, kretalo se od 46.6% do 49.2%, sa premijom od 23.78 mil.eura u 2007.godini do 32.26 mil.eura u 2009.godini (+35.7%).U strukturi premije obaveznih osiguranja najveći udio ima osiguranje autoodgovornosti 97,18% i premijom od 25.9 mil.eura u 2008.godini, 96.56% i premijom od 31.15 mil.eura u 2009.godini (+20.3%).

Mjerodavni tehnički rezultat kod autoodgovornosti svih društava za osiguranje u Crnoj Gori u posmatranom periodu, bio je negativan, što ukazuje da mjerodavne premije osiguranja

[53] Uprava za statistiku Crne Gore - MONSTAT

nijesu bile dovoljne za isplatu šteta.[54]

Tržište osiguranja autoodgovornosti 2010.-2020.godine

Na tržištu neživotnog osiguranja u Crnoj Gori od 2010.do 2020.godine poslovalo je pet društava za osiguranje.[55]

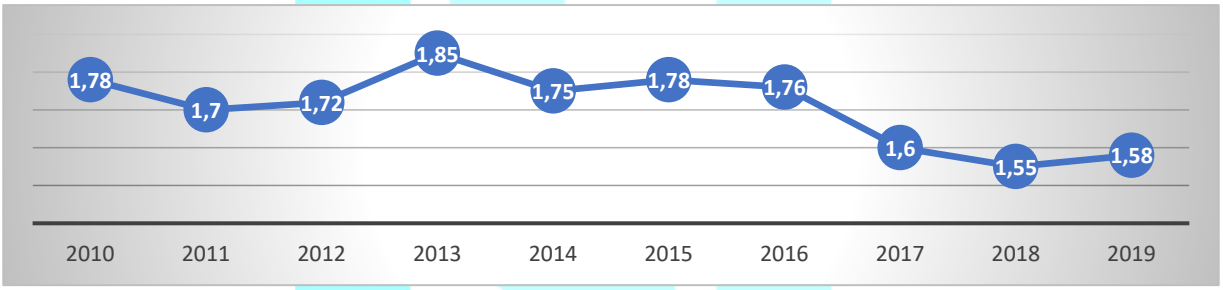
Herfindahl-Hirchman indeks (HHI)

2010.godine-3.176,81; 2011.godine-2.621,12; 2012.godine-2.333,80; 2013.godine-2.209,04; 2014.godine-2.041,14; 2015.godine-2.100,67; 2016.godine-2.049,12; 2017.godine-2.013; 2018.godine-1.945; 2019.godine-1.903,4. Za tržište osiguranja u Crnoj Gori, u periodu od 2010. do 2015. godine. vrijednost HHI se kreće u granicama koncentrisanog tržišta, sa tendencijom umjereno koncentrisanog tržišta.[56]

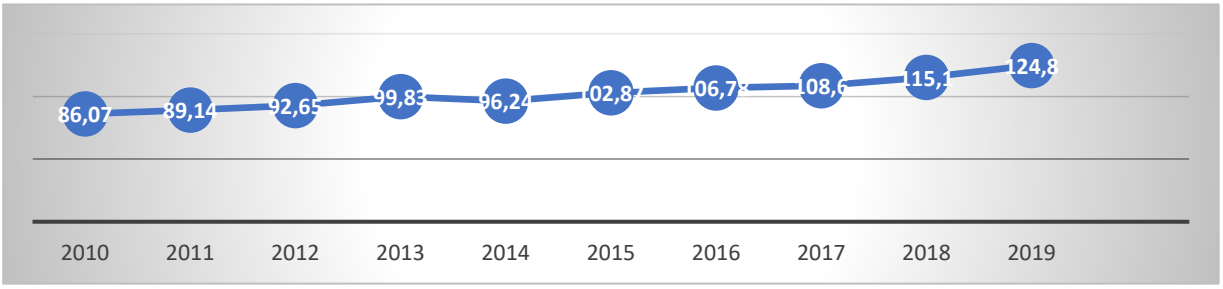
Pokazatelji tržišta osiguranja

Kao osnovni pokazatelji tržišta osiguranja uzima se penetracija osiguranja-učešće bruto fakturisane premije u BDP-u, gustina osiguranja-iznos bruto fakturisane premije po glavi stanovnika i struktura premije[57].

Grafik 3: Penetracija neživotnog osiguranja 2010-2019 (%)



Grafik 4: Bruto fakturisana premija neživotnog osiguranja 2010-2019 (eur)



[54] Agencija za nadzor osiguranja Crne Gore

[55] Agencija za nadzor osiguranja Crne Gore

[56] Agencija za nadzor osiguranja Crne Gore

[57] Kočović, J., Šulejić, P., Antić-Rakonjac, T., Osiguranje, Beograd, 2010.

Tabela 4: Struktura bruto fakturisane premije osiguranja 2010-2019

	2010		2011		2012		2013		2014	
Premija mil.eur Učešće %	P	U	P	U	P	U	P	U	P	U
Obavezna osiguranja	29.7	47.7	31.5	48.6	33.4	49.9	34.8	47.8	34.13	47.1
	2015		2016		2017		2018		2019	
Premija mil.eur Učešće %	P	U	P	U	P	U	P	U	P	U
Obavezna osiguranja	33.9	44.01	36.2	45.14	35.9	43.9	37.8	43.5	39.4	41.6

Tabela 5: Portfolio obaveznih osiguranja 2010-2019

	2010		2011		2012		2013		2014	
Premija mil.eur Učešće %	P	U	P	U	P	U	P	U	P	U
Životno osiguranje	8.37	13.45	9.06	13.98	9.5	14.16	10.9	14.94	12.6	17.34
Neživotno osiguranje	53.82	86.55	55.73	86.02	57.45	85.84	61.9	85.06	59.9	82.7
	2015		2016		2017		2018		2019	
Premija mil.eur Učešće %	P	U	P	U	P	U	P	U	P	U
Životno osiguranje	12.93	16.8	13.7	16.8	14.2	17.3	15.2	17.5	17.1	18.1
Neživotno osiguranje	64	83.2	66.5	82.91	67.6	82.7	71.6	82.5	77.6	81.9

Tabela 6: Fakturisana bruto premija autoodgovornosti 2010-2019

	2010	2011	2012	2013	2014
Iznos (mil.eur)	28.3	30	31.6	33.1	32.9
Učešće u obaveznom osiguranju %	96	96.1	94.5	95.3	96.3
	2015	2016	2017	2018	2019
Iznos	32.9	35.2	34.8	36.7	38
Učešće u obaveznom osiguranju %	96.2	96.5	96.3	96.4	96

Tržište osiguranja u posmatranom periodu i dalje karakteriše dominantno učešće neživotnih, obaveznih osiguranja.Učešće premije neživotnog osiguranja u BDP-u Crne Gore bilježi pad 0.2%, sa 1.78% 2010.godine, na 1.58% 2019.godine. Neživotno osiguranje po glavi stanovnika (gustina) bilježi konstantni rast, 2010.godine je iznosilo 86.07 eura , a 2019.godine 124.8 eura (31%),[58]Posmatrajući strukturu bruto premije konstatujemo da najveću zastupljenost i dalje imaju obavezna osiguranja sa prosječnim učešćem od 46%. U strukturi premije obaveznih osiguranja najveći udio ima osiguranje od autoodgovornosti sa prosječnim učešćem od 96% i bruto fakturisanom premijom od 28.3 mil.eura u 2010.godini do 38 mil.eura u 2019.godini (+34.3%).

Neto mjerodavni tehnički rezultat, za navedeni period je iznosio manje od 1, što ukazuje da je za grupu neživotnog osiguranja neto mjerodavna tehnička premija bila dovoljna za izmirenje šteta i drugih obaveza iz ugovora o osiguranju.

Riješene štete osiguranja od autoodgovornosti:2013.godine 8910 šteta u iznosu od 11.2 mil.eura; 2014.godine 10965 šteta u iznosu od 12.2 mil.eura; 2015.godine 11495 šteta u iznosu od 11.6 mil.eura; 2016.godine 11761 šteta u iznosu od 12.5 mil.eura; 2017.godine 11685 šteta u iznosu od 12.7 mil.eura;

2018.godine 12613 šteta u iznosu od 13.4 mil.eura i 2019.godine 13019 šteta u iznosu od 14.4 mil. eura.[59] Nacionalni biro osiguravača je, iz sredstava Garantnog fonda, isplatio štete u iznosu:2011.godine 1.3 mil.eura; 2012.godine 708.982 eura; 2013.godine 941.569 eura; 2014.godine 928.921 eura; 2015.godine 1.3 mil.eura; 2016.godine 873.644 eura; 2017.godine 1.04 mil.eura; 2018.godine 1.03 mil.eura i 2019.godine 1.2 mil.eura.[60]

[58] Uprava za statistiku Crne Gore-MONSTAT

[59] Agencija za nadzor osiguranja Crne Gore

[60] Nacionalni biro osiguravača Crne Gore

Tržište osiguranja auto-odgovornosti od 2020.godine do 2025.godine

Na tržištu neživotnog osiguranja u Crnoj Gori od 2020.do 2025.godine poslovalo je pet društava za osiguranje.[61]

Herfindahl-Hirchman indeks (HHI)

2020.godine-1.830,1; 2021.godine-1.844,2; 2022.godine-1.820.1; 2023.godine-2.101,5. Za tržište osiguranja u Crnoj Gori, u periodu od 2020. do 2025. godine. vrijednost HHI se kreće u granicama koncentrisanog tržišta (monopol).62

Pokazatelji tržišta osiguranja

Kao osnovni pokazatelji tržišta osiguranja uzima se penetracija osiguranja-učešće bruto fakturisane premije u BDP-u, gustina osiguranja-iznos bruto fakturisane premije po glavi stanovnika i struktura premije[63].

Grafik 5: Penetracija neživotnog osiguranja 2020-2023 (%)



Grafik 6: Bruto fakturisana premija neživotnog osiguranja 2020-2023 (eur)



Tabela 7: Struktura bruto fakturisane premije osiguranja 2020-2024

	2020		2021		2022		2023		2024	
Premija mil.eur Učešće %	P	U	P	U	P	U	P	U	P	U
Životno	19.7	21.1	20.01	20.3	21.4	19.7	23.6	19.8	27.8	20.7
Neživotno	73.9	78.9	78.8	79.7	86.9	80.3	95.8	80.2	106.4	79.3

[61] Agencija za nadzor osiguranja Crne Gore

[62] Agencija za nadzor osiguranja Crne Gore

[63] Kočović, J., Šulejić, P., Antić-Rakonjac, T., Osiguranje, Beograd, 2010.

Tabela 8: Portfelj obaveznih osiguranja 2020-2024

	2020		2021		2022		2023		2024	
Premija mil.eur **Učešće %**	P	U	P	U	P	U	P	U	P	U
Obavezna osiguranja	37.05	50.1	39	49.6	39.7	45.7	43.9	45.9	----	----

Tabela 9: Fakturisana bruto premija autoodgovornosti 2020-2024

	2020	2021	2022	2023	2024
Iznos premije mil.eur	36.04	38	39.6	43.7	47.5
Učešće u obaveznom osiguranju %	96.9	96.7	96.2	96.1	96.5

Tržište osiguranja u posmatranom periodu i dalje karakteriše dominantno učešće neživotnih, obaveznih osiguranja.Učešće premije neživotnog osiguranja u BDP-u Crne Gore bilježi blagi rast sa 1.76% u 2020.godini,da bi se u 2023.godini desio pad na 1.40%. Neživotno osiguranje po glavi stanovnika (gustina) bilježi konstantni rast, 2020.godine je iznosilo 127.6 eura , a 2023.godine 151.4 eura.[64] Posmatrajući strukturu bruto premije konstatujemo da najveću zastupljenost i dalje imaju obavezna osiguranja sa prosječnim učešćem od 48% iako bilježe neznatni pad od 1% u odnosu na prethodni period. U strukturi premije obaveznih osiguranja najveći udio ima osiguranje od autoodgovornosti sa prosječnim učešćem od 96% i bruto fakturisanom premijom od 36 mil.eura u 2020.godini do 47.5 mil.eura u 2025.godini (+31%).

Neto mjerodavni tehnički rezultat, za navedeni period je iznosio manje od 1 (0.67-0.79), što ukazuje da je za grupu neživotnog osiguranja neto mjerodavna tehnička premija bila dovoljna za izmirenje šteta i drugih obaveza iz ugovora o osiguranju.

Riješene štete osiguranja od autoodgovornosti: 2020.godine 11292 štete u iznosu od 13.27 mil.eura

(-8.1%); 2021.godine 13271 šteta u iznosu od 15 mil.eura (+12.7%); 2022.godine 13631 šteta u iznosu od 16.4 mil.eura (+9.9%); 2023.godine 14511 šteta u iznosu od 18.5 mil.eura (+12.6%) i 2024.godine 16762 štete u iznosu od 23.4 mil.eura (+26.5%).[65] Nacionalni biro osiguravača je, iz sredstava Garantnog fonda, isplatio štete u iznosu: 2020.godine 1mil. eura;

[64] Uprava za statistiku Crne Gore - MONSTAT

[65] Agencija za nadzor osiguranja Crne Gore

2021.godine 1 mil.eura; 2022.godine 1 mil.eura; 2023.godine 1.6 mil.eura.[66]

Na osnovu navedenog može se konstatovati da je tržište osiguranja od autoodgovornosti, u posmatranom periodu, bilježilo kontinuirani rast.Već od 2002.-2007. rast bruto premije je iznosio 57.64%.; od 2007.-2010. 20.3%; od 2010.-2020. 34%; od 2020.-2025. 31%.Koncentracija tržišta se kretala, od izrazito koncentrovanog tržišta do granice umjereno koncentrovanog tržišta.Neto mjerodavni tehnički rezultat je već od 2010.godine pozitivan (manji od 1),iznos riješenih šteta u odnosu na bruto fakturisanu premiju u prosjeku bio manji od 20%-30% i taj trend stabilnog tržišta se zadržao do danas.Na to je bitno uticalo i uvođenje novog Sistema tarifa premija osiguranja autoodgovornosti 2016.godine, odnosno uvođenje instituta bonus i malus.Svi pokazatelji nam jasno govore da, što se tiče kretanja na crnogorskom tržištu osiguranja, eventualno može doći do izmjena u strukturi osiguranja, sa malim procentom vjerovatnoće da to može uticati na tržište osiguranja od autoodgovornosti.

Literatura i izvori:

- Kočović, J., Šulejić, P., Antić-Rakonjac, T., Osiguranje, Beograd, 2010.
- Uprava za statistiku Crne Gore – MONSTAT
- Agencija za nadzor osiguranja Crne Gore
- Nacionalni biro osiguravača Crne Gore
- Centralna banka Crne Gore
- www.skupština.me

[66] Nacionalni biro osiguravača Crne Gore

JUSSŠ ”Ivan Uskoković” Podgorica, Montenegro

Gordana Vuksanović, Spec. Sci Manager in customs, forwarding, and insurance

Radoš Zuković, Graduate Transportation Engineer

Analysis of the motor third-party liability insurance market in Montenegro from 2000 to 2025

Abstract

Insurance has a key role in the protection of individuals and property from various risks.

According to data from the Insurance supervision agency, non-life insurance policies, primarily motor third-party liability insurance policies, are the most dominant in the Montenegrin insurance market. This is a result of the legal requirement to obtain liability insurance for damage caused to third parties during motor vehicle registration.

This paper focuses on the period from 2000 to 2025, tracking the growth dynamics of issued insurance policies and financial indicators as well as providing a comparative analysis of the data.

Key words: Montenegro, insurance, market analysis, motor third-party liability insurance, damages

Introduction

Montenegro, a small and beautiful country in south-eastern Europe, has 306,665 registered motor vehicles and approximately 480,000 adult residents. The average age of its passenger vehicle fleet is 17.6 years, with only 6.4% of passenger vehicles being under six years old, while 86.1% are older than ten years.[67] The result of this is that, on one hand, we have high traffic density, poor traffic culture, underdeveloped infrastructure, a high number of traffic accidents, and environmental pollution; and on the other hand, a continuous growth of the insurance market. According to data from the Insurance supervision agency, the authority responsible for overseeing and controlling the insurance sector, non-life insurance policies, primarily motor third-party liability insurance policies, are the most dominant in the Montenegrin insurance market. This is a result of the legal requirement to obtain liability

[67] Statistical Office of Montenegro-MONSTAT

insurance for damage caused to third parties during motor vehicle registration.[68]

The legal framework in the insurance field in Montenegro consists of the Insurance law**,** Law on Compulsory Traffic Insurance, and Law on Bankruptcy and Liquidation of Insurance Companies.[69]

The institutional framework: Insurance supervision agency, National Bureau of Insurers.

Motor third-party liability insurance market 2000 - 2007

In the early 1990s, the insurance market in the former Yugoslavia experienced an expansion marked by the establishment of a significant number of new insurance companies. However, due to the war environment, sanctions, and inflation, the insurance market in Yugoslavia disintegrated. In Montenegro, the majority of citizens were insured through companies based in Serbia, which operated on the Montenegrin market via local branches.

The largest share of the Montenegrin insurance portfolio was realized in the field of motor third party liability insurance, with over 60% of registered vehicles in Montenegro insured by insurance companies in Serbia. The fulfilment of obligations towards the insured was inconsistent and due to unpaid external claims and internal debts from incurred damages and contractual obligations, these companies were suspended from the international Green Card system.

In August 2000, the Government of the Republic of Montenegro issued the Regulation on Property and Personal Insurance, stipulating that only insurance companies with a registered office in Montenegro, established as legal entities, and with a paid-in security fund assets held at commercial banks in Montenegro, were allowed to operate in the insurance market. Between 2000 and 2003, only three insurance companies were active in Montenegro: Lovćen j.s.c. Podgorica, Montenegro j.s.c. Podgorica, and Swiss j.s.c. Podgorica. In 2003, a license was granted to Zepter Insurance j.s.c. Podgorica; in 2004, to Grawe Insurance j.s.c. Podgorica; and in 2005, to Magnat Insurance j.s.c. Podgorica. The realized gross premium in Montenegro showed growth during this period: in 2002: €22.8 million, in 2003: €25.6 million, in 2004: €26.1 million, in 2005: €36 million, in 2006: €39.6 million. Based on these figures, the total gross premium grew by 57.64% in the observed period. The structure of the premium consists of compulsory insurance with a 51.1% share (96% of which was motor third-party liability insurance), followed by property insurance with 26.5%, accident insurance with 20.7%, and life insurance with 1.7%.[70]

In December 2006, the Parliament of the Republic of Montenegro passed the Law on Insurance (Official Gazette of the Republic of Montenegro, No. 78/06 of 22 December 2006).
In July 2007, the Parliament passed the Law on Compulsory Insurance (Official Gazette of the Republic of Montenegro, No. 46/07 of 31 July 2007).

Motor third-party liability insurance market 2007-2010

In the non-life insurance market in Montenegro, six insurance companies operated during

[68] Insurance Supervision Agency of Montenegro

[69] www.skupstina.me

[70] Central Bank of Montenegro

the period from 2007 to 2010.[71] Herfindahl-Hirschman Index (HHI) is used to assess the level of market concentration in the insurance sector. The value of this index ranges from 0 to 10,000. A value closer to 0 indicates that the market is composed of a large number of similarly sized companies, suggesting a highly competitive market, while a value approaching 10,000 reflects a highly concentrated market, indicating the presence of a monopoly. In the case of Montenegro's insurance market during the 2007–2010 period, the HHI values fell within the range of a concentrated market (1,800-10,000), implying limited competition and monopoly. Specifically, in 2008**,** the HHI was 4,183.43 and in 2009**,** the HHI was 3,415.83.[72]

Insurance market indicators

The key indicators of the insurance market include: Insurance penetration – the share of gross written premium in the gross domestic product (GDP), Insurance density **–** the amount of gross written premium per capita, and structure of the premium.[73]

Chart 1: Non-life insurance penetration 2007-2009 (%)

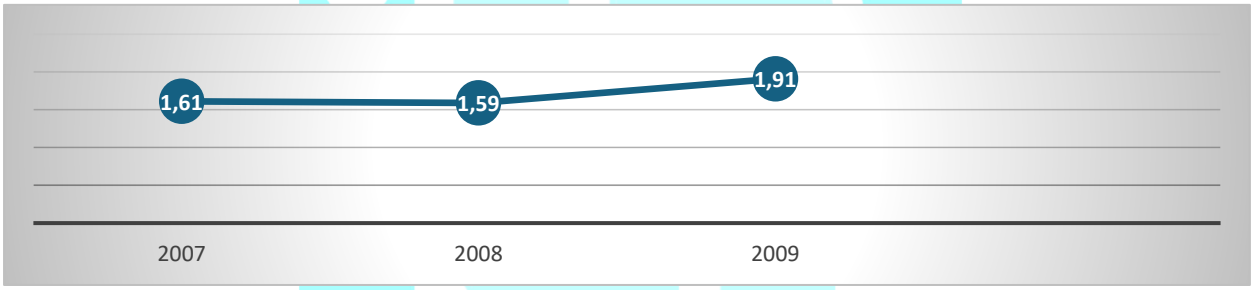
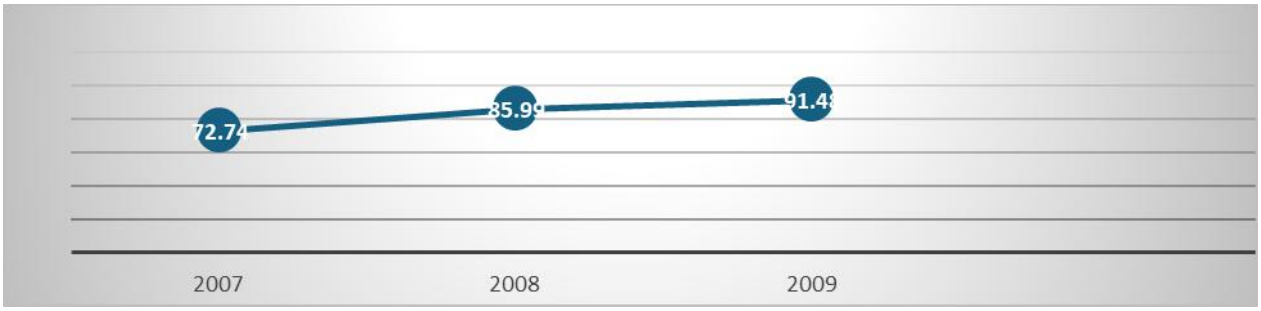


Chart 2: Non-life gross written premium 2007-2009 (euro)



[71] Insurance Supervision Agency of Montenegro

[72] Insurance Supervision Agency of Montenegro

[73] Kočović, J., Šulejić, P., Antić-Rakonjac, T., Osiguranje, Belgrade, 2010.

Table 1: The structure of gross written premium 2007-2009

	2007		2008		2009	
Premium mil.eur Share %	P	S	P	S	P	S
Life insurance	5.9	11.58	7.2	11.96	8.08	12.33
Non-life insurance	45.1	88.42	53.3	88.04	57.48	87.67

Table 2: Portfolio of compulsory insurance 2007-2009

	2007		2008		2009	
Premium mil.eur Share %	P	S	P	S	P	S
Compulsoryinsurance	23.7	46.60	26.7	44.05	32.3	49.20

Table 3: Gross written premium for motor third-party liability 2007-2009

	2007	2008	2009
Premium mil.eur	----	25.9	31.15
Compulsory insurance share %	----	97.18	96.56

The insurance market in Montenegro during the observed period was characterized by a dominant share of non-life, compulsory insurance. The non-life insurance premium accounted for 1.61% of Montenegro's GDP in 2007, 1.59% in 2008, and 1.91% in 2009. Non-life insurance per capita (insurance density) showed a steady increase, amounting to €72.74 in 2007, €85.99 in 2008, and €91.48 in 2009.[74] The non-life insurance premium grew at a rate of 16.95% compared to 2006, reaching €45.11 million in 2007, and increasing to €57.5 million in 2009. The share of non-life insurance in the total insurance premium amounted to approximately 88%. The share of compulsory insurance in Montenegro's insurance portfolio ranged between 46.6% and 49.2%, with a premium of €23.78 million in 2007, increasing to €32.26 million in 2009 (+35.7%).

Within the structure of compulsory insurance premiums, motor third-party liability (MTPL) insurance had the largest share—97.18% with a premium of €25.9 million in 2008, and 96.56% with a premium of €31.15 million in 2009 (+20.3%).

The relevant technical result for MTPL insurance across all insurance companies in

[74] Statistical Office of Montenegro - MONSTAT

Montenegro during the observed period was negative, indicating that the premiums were insufficient to cover incurred claims.[75]

Motor third-party liability insurance market 2010–2020

In the non-life insurance market in Montenegro from 2010 to 2020, five insurance companies operated.[76] **Herfindahl-Hirschman Index (HHI):** 2010 – 3,176.81; 2011 – 2,621.12; 2012 – 2,333.80; 2013 – 2,209.04; 2014 – 2,041.14; 2015 – 2,100.67; 2016 – 2,049.12; 2017 – 2,013; 2018 – 1,945; 2019 – 1,903.4. For the insurance market in Montenegro, in the period from 2010 to 2015, the HHI value ranged within the limits of a concentrated market, with a tendency toward a moderately concentrated market.[77]

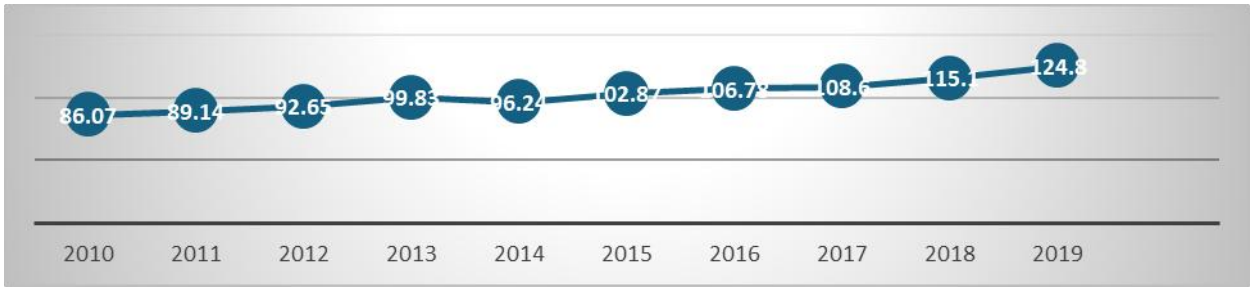
Insurance market indicators

The key indicators of the insurance market include: Insurance penetration – the share of gross written premium in the gross domestic product (GDP), Insurance density – the amount of gross written premium per capita, and structure of the premium.[78]

Chart 3: Non-life insurance penetration 2010-2019 (%)



Chart 4: Non-life gross written premium 2010-2019 (euro)



[75] Insurance Supervision Agency of Montenegro

[76] Insurance Supervision Agency of Montenegro

[77] Insurance Supervision Agency of Montenegro

[78] Kočović, J., Šulejić, P., Antić-Rakonjac, T., Osiguranje, Belgrade, 2010.

Table 4: The structure of gross written premium 2010-2019

	2010		2011		2012		2013		2014	
Premium mil.eur Share %	P	S	P	S	P	S	P	S	P	S
Life insurance	8.37	13.45	9.06	13.98	9.5	14.16	10.9	14.94	12.6	17.34
Non-life insurance	53.82	86.55	55.73	86.02	57.45	85.84	61.9	85.06	59.9	82.7
	2015		2016		2017		2018		2019	
Premium mil.eur Share %	P	S	P	S	P	S	P	S	P	S
Life insurance	12.93	16.8	13.7	16.8	14.2	17.3	15.2	17.5	17.1	18.1
Non-life insurance	64	83.2	66.5	82.91	67.6	82.7	71.6	82.5	77.6	81.9

Table 5: Portfolio of compulsory insurance 2010-2019

	2010		2011		2012		2013		2014	
Premium mil.eur Share %	P	S	P	S	P	S	P	S	P	S
Compulsory insurance	29.7	47.7	31.5	48.6	33.4	49.9	34.8	47.8	34.13	47.1
	2015		2016		2017		2018		2019	
Premium mil.eur Share %	P	S	P	S	P	S	P	S	P	S
Compulsory insurance	33.9	44.01	36.2	45.14	35.9	43.9	37.8	43.5	39.4	41.6

Table 6: Gross written premium for motor third-party liability 2010-2019

	2010	2011	2012	2013	2014
Premium (mil.eur)	28.3	30	31.6	33.1	32.9
Compulsory insurance share %	96	96.1	94.5	95.3	96.3
	2015	2016	2017	2018	2019
Premium	32.9	35.2	34.8	36.7	38
Compulsory insurance share %	96.2	96.5	96.3	96.4	96

The insurance market in the observed period continued to be characterized by the dominant share of non-life, compulsory insurance. The share of non-life insurance premiums in Montenegro's GDP recorded a decline of 0.2%, from 1.78% in 2010 to 1.58% in 2019. Non-life insurance per capita (density) showed constant growth: in 2010 it amounted to €86.07,

and in 2019 €124.8 (+31%).[79] Looking at the structure of gross premiums, we note that compulsory insurance continues to have the highest share, with an average share of 46%. In the structure of compulsory insurance premiums, motor third party liability (MTPL) has the highest share, with an average of 96% and gross written premium growing from €28.3 million in 2010 to €38 million in 2019 (+34.3%).The net relevant technical result for the given period was less than 1, indicating that for the non-life insurance, the net relevant technical premium was sufficient to cover claims and other obligations from insurance contracts. Settled MTPL claims: 2013: 8,910 claims, adds up to €11.2 million, 2014: 10,965 claims, adds up to €12.2 million, 2015: 11,495 claims, adds up to €11.6 million, 2016: 11,761 claims, adds up to €12.5 million, 2017: 11,685 claims, adds up to €12.7 million, 2018: 12,613 claims, adds up to €13.4 million, 2019: 13,019 claims, adds up to €14.4 million.[80] The National Bureau of Insurers, from the resources of the Guarantee Fund, paid claims in the following amounts: 2011: €1.3 million, 2012: €708,982, 2013: €941,569, 2014: €928,921, 2015: €1.3 million, 2016: €873,644, 2017: €1.04 million, 2018: €1.03 million, 2019: €1.2 million.[81]

The motor third-party liability insurance market 2020-2025

In the non-life insurance market in Montenegro from 2020 to 2025, five insurance companies operated.[82] **Herfindahl-Hirschman Index (HHI):** 2020: 1,830.1,2021: 1,844.2, 2022: 1,820.1, 2023: 2,101.5. For the insurance market in Montenegro, in the period from 2020 to 2025, the value of the HHI falls within the range of a concentrated market (monopoly).[83]

Insurance market indicators

The key indicators of the insurance market include: Insurance penetration – the share of gross written premium in the gross domestic product (GDP), Insurance density – the amount of gross written premium per capita, and structure of the premium.[84]

Chart 5: Non-life insurance penetration 2020-2023 (%)



[79] Statistical Office of Montenegro – MONSTAT

[80] Insurance Supervision Agency of Montenegro

[81] National Bureau of Insurers

[82] Insurance Supervision Agency of Montenegro

[83] Insurance Supervision Agency of Montenegro

[84] Kočović, J., Šulejić, P., Antić-Rakonjac, T., Osiguranje, Belgrade, 2010.

Chart 6: Non-life gross written premium 2020-2023 (euro)



7: The structure of gross written premium 2020-2024

	2020		2021		2022		2023		2024	
Premium mil.eur Share %	P	S	P	S	P	S	P	S	P	S
Life insurance	19.7	21.1	20.01	20.3	21.4	19.7	23.6	19.8	27.8	20.7
Non-life insurance	73.9	78.9	78.8	79.7	86.9	80.3	95.8	80.2	106.4	79.3

Table 8: Portfolio of compulsory insurance 2020-2024

	2020		2021		2022		2023		2024	
Premium mil.eur Share %	P	S	P	S	P	S	P	S	P	S
Compulsory insurance	37.05	50.1	39	49.6	39.7	45.7	43.9	45.9	----	----

Table 9: Gross written premium for motor third-party liability 2020-2024

	2020	2021	2022	2023	2024
Premium mil.eur	36.04	38	39.6	43.7	47.5
Compulsory insurance share %	96.9	96.7	96.2	96.1	96.5

The insurance market in the observed period is still characterized by the dominant share of non-life, mandatory insurance. The share of non-life insurance premiums in Montenegro's

GDP recorded a slight increase from 1.76% in 2020, followed by a decrease to 1.40% in 2023. Non-life insurance per capita (density) showed constant growth, in 2020 it amounted to €127.6, and in 2023 it reached €151.4.[85] Observing the structure of gross premiums, we note that compulsory insurance still holds the largest share with an average of 48%, although it recorded a slight decrease of 1% compared to the previous period. Within the structure of compulsory insurance premiums, motor third-party liability insurance has the largest share with an average of 96%, and gross written premium increased from €36 million in 2020 to €47.5 million in 2025 (+31%). The net relevant technical result for the given period was below 1 (0.67–0.79), which indicates that, for the non-life insurance, the net relevant technical premium was sufficient to cover claims and other obligations from insurance contracts. Settled motor third-party liability (MTPL) claims: 2020: 11,292 claims in the amount of €13.27 million (−8.1%), 2021: 13,271 claims in the amount of €15 million (+12.7%), 2022: 13,631 claims in the amount of €16.4 million (+9.9%), 2023: 14,511 claims in the amount of €18.5 million (+12.6%), 2024: 16,762 claims in the amount of €23.4 million (+26.5%)[86]

The National Bureau of Insurers paid claims from the Guarantee Fund in the following amounts: 2020: €1 million, 2021: €1 million, 2022: €1 million, 2023: €1.6 million.[87]

Based on the previously stated facts, we can note that the motor third-party liability insurance market had a continuous growth. From 2002 to 2007, the growth of gross premiums amounted to 57.64%; from 2007 to 2010, it was 20.3%; from 2010 to 2020, 34%; and from 2020 to 2025, 31%. Market concentration ranged from a highly concentrated market to a moderately concentrated one. Since 2010, the net relevant technical result has been positive (less than 1), and the ratio of settled claims to gross written premiums was, on average, below 20%–30%. This trend of market stability has remained up to this day. A significant contributing factor was the introduction of the new motor third-party liability (MTPL) insurance premium tariff system in 2016, specifically the implementation of the bonus-malus. All indicators clearly suggest that, in terms of development in the Montenegrin insurance market, potential changes may occur in the structure of insurance, however, there is a low probability that such changes could affect the motor third-party insurance market.

References:

- Kočović, J., Šulejić, P., Antić-Rakonjac, T., Osiguranje, Belgrade, 2010.
- Statistical Office of Montenegro – MONSTAT
- Insurance Supervision Agency of Montenegro
- National Bureau of Insurers
- Central Bank of Montenegro
- www.skupstina.me

[85] Statistical Office of Montenegro – MONSTAT

[86] Insurance Supervision Agency of Montenegro

[87] National Bureau of Insurers

IMPLEMENTACIJA DUALNOG OBRAZOVANJA - TEORIJA I PRAKSA

Milica Vukašinović

Traffic and Technical School Zemun

Uvod u dualno obrazovanje

Dualno obrazovanje je organizovan proces tokom kojeg učenici pod nadzorom instruktora ili menadžera stiču znanja koja su im neophodna za efikasan i produktivan rad. Ne radi se o klasičnoj praktičnoj nastavi, već o učenju kroz rad. Ovakav model obrazovanja skrenuo je pažnju na zanatske i tehničke profesije, doprinoseći njihovoj revitalizaciji. Mladi kroz ovaj sistem stiču znanja, proveravaju ih u praksi, razvijaju komunikacione veštine, timski rad, otpornost na stres i sposobnost rešavanja problema.

Dualno obrazovanje prisutno je u srednjim školama širom sveta i u mnogima se pokazalo kao veoma uspešan model. Učenici u školi savladavaju osnovne pojmove i definicije, dok u firmama praktično primenjuju i usavršavaju stečena znanja i veštine. Na ovaj način, plan i program srednjoškolskog stručnog obrazovanja obogaćen je radom kod poslodavaca, čime učenici stiču praktične kompetencije. Jedan od najčešćih problema prilikom zapošljavanja – zahtev za prethodnim radnim iskustvom – uspešno se rešava ovim modelom. Učenici lakše dolaze do zaposlenja, postaju konkurentniji na tržištu rada i doprinose razvoju društveno-ekonomskog sistema.

Razvoj dualnog obrazovanja zahteva aktivno učešće privrede. Privreda treba da se uključi u sistem, obezbedi njegovu kvalitetnu realizaciju i omogući zapošljavanje mladih. Kompanije kroz dualni obrazovni model učestvuju u obuci budućih radnika prema sopstvenim standardima, obezbeđujući kvalifikovanu radnu snagu usklađenu sa zahtevima tržišta.

Dualno obrazovanje u Srbiji

Traženi su i profili u oblastima gde su razvijeni ugostiteljstvo i turizam**,** poput Zlatiborskog okruga i pojedinih delova juga Srbije, gde postoji velika potreba za kuvarima, konobarima, turističkim tehničarima i tehničarima hotelskih operacija.

Važno je napomenuti da poslodavac mora da ispuni određeme uslove i da nije svaka firma podobna za saradnju sa školom i Privrednom komorom.

Poslodavci se svake godine prijavljuju za uključivanje u dualno obrazovanje za prijem nove generacije učenika. Uključivanje se vrši putem veb portala i podrazumeva otvaranje profila poslodavca, kao i podnošenje Zahteva za proveru ispunjenosti uslova za izvođenje učenja kroz rad za svaki obrazovni profil koji je potreban poslodavcu. Uz Zahtev se podnosi i prateća dokumentacija i izjava o spremnosti za uključivanje u dualno obrazovanje. Broj učenika koje kompanije primaju na praksu varira i zavisi od pojedinačne firme. Neophodan je predlog izrađenog programa realizacije učenja kroz rad i zaključen predugovor o dualnom obrazovanju. Poslodavcu koji ispunjava uslove za izvođenje učenja kroz rad Privredna komora Srbije izdaje Potvrdu o ispunjenosti uslova za izvođenje učenja kroz rad.

Dualno obrazovanje u Saobraćajno-tehničkoj školi Zemun

Jedan od osnovnih uslova jeste da kompanija poseduje skladište i da se bavi međunarodnim

transportom.

U okviru obrazovnog profila tehničar za logistiku i špediciju učenici tokom prve godine cele nedelje idu u školu, u drugoj godini četiri dana provode u školi, a jedan dan na praksi. U trećoj i četvrtoj godini dva dana nedeljno provode na praksi, uz novčanu nadoknadu, mentorsku podršku i osiguranje.

Na početku druge godine kompanije se predstavljaju učenicima i njihovim roditeljima, a učenici sastavljaju listu želja kompanija. Međutim, raspodela učenika je izazovna jer škola insistira da kompanije prvo biraju najbolji đaci u skladu sa listama želja, dok kompanije traže one učenike koji odgovaraju njihovim potrebama, a to nisu nužno oni sa najboljim uspehom, već ih biraju na osnovu intervjua. Takođe, kompanije često ne biraju najbolje učenike, jer oni najčešće odlučuju da nastave školovanje umesto da odmah počnu da rade.

Profesori praktične nastave obilaze učenike po firmama i prate njihov napredak, a u svakoj kompaniji učenici imaju instruktora. Instruktori su uglavnom logističari, ali to može biti bilo koji zaposleni koji poseduje licencu za instruktora.

Poteškoće nastaju ako učenici nisu dovoljno pripremljeni kada ulaze u svet rada. Potrebno je učenicima unapred jasno staviti do znanja da se od njih očekuje drugačije ponašanje nego u školi - uz poštovanje radne etike i odgovorno izvršavanje obaveza.

Tokom godina, škola se susretala sa brojnim izazovima u implementaciji dualnog obrazovanja. Pandemija Covid-19 usporila je razvoj. Taj period je bio izuzetno izazovan, jer je nekoliko kompanija prekinulo saradnju pozivajući se na ugovor u kome je naznačeno da kompanija može da izađe iz projekta u svakom trenutku ako više ne bude imala uslova za prijem učenika. Kompanije su prešle na rad od kuće, uključujući i mentore, pa su poremećeni koordinacija i planovi obuke. Zbog izolacije bio je ograničen pristup praktičnom treningu u mnogim sektorima.

Profesori praktične nastave godinama se suočavaju sa brojnim problemima, posebno sa brojnim problemima, posebno finansijske prirode, a troškovi prevoza tokom obilaska učenika veoma visoki.

Dešava se da se mimoiđu očekivanja učenika i očekivanja firmi. Firme očekuju da učenici nakon završetka srednje škole ostanu u kompaniji kao zaposleni, a veliki broj učenika želi da nastavi školovanje. Više od 50% učenika ne želi da se obavezuje prema firmama. Primer za to je kompanija Lagermax koja je prve godine primila 9 đaka, a nijedan nije ostao, svi su otišli na fakultet, što je pomenuta kompanija ocenila kao neefikasno ulaganje resursa.

Jedan od najvećih izazova je i obezbeđivanje adekvatne infrastrukture i resursa. Pod tim se na prvom mestu misli na kvalifikovane instruktore, dovoljnu količinu opreme i pristup savremenim tehnologijama, kao i poteškoće u pružanju potrebne podrške za obuku učenika i osiguranje jednakog pristupa obrazovanju za sve učenike. Samo kompanija Gebrüder Weiss plaća instruktore, što takođe predstavlja problem.

Većinu poteškoća je moguće rešiti uz visok nivo koordinacije između škola i kompanija. Ovo zahteva pažljivo usklađivanje sa aktuelnim trendovima u industriji, kao i obezbeđivanje potrebnih resursa kako bi obrazovne strategije, planovi i programi, mogli biti uspešno implementirani. Ova integracija je krucijalna za razvoj kompetentne radne snage. Jasno je da državni sektor ima ključnu ulogu u pružanju zakonodavne i infrastrukturne podrške i time obezbedi jednake šanse za obrazovanje svim učenicima.

Učenje kroz rad

Logistika je multidisciplinarna delatnost koja zahteva znanja iz mnogih oblasti: saobraćaja, ekonomije, prava i regulative, marketinga, menadžmenta, informatike, ekologije, političke situacije u zemlji i svetu, psihologije i ponašanja potrošača... Zahtevi za ovako širokim spektrom znanja proističu iz potrebe da se integrišu različiti aspekti poslovanja, tehnologije i organizacije kako bi se optimizovali resursi i postigli konkurentski ciljevi. Zaposlene u ovoj oblasti treba da karakteriše visok nivo tačnosti, brzine, kolegijalnosti, multitaskinga i kreativnosti. Posao ume biti izuzetno stresan, a učenici u okviru dualnog obrazovanja stiču uvid u veliki broj izazova i svesni su da moraju uložiti veliki napor i biti posvećeni ako žele napredak u ovoj oblasti.

Engleski jezik je izuzetno značajan jer je brojna korespodencija na engleskom, kao i saradnja sa inostranim klijentima preko maila.

Učenicima je u firmama potrebno znanje excela, ali rade i na brojnim specijalizovanim programima. U firmama su različiti programi u upotrebi:

- Soft design
- NCTS (New Computerised Transit System)
- NAP (Nacionalni aplikativni portal)
- Elšped
- CIEL
- WMS (Warehouse Management System)
- TIS
- MSC One vision
- Fleet portal
- SALOG
- SAP

Procedure i korišćeni programi se razlikuju od kompanije do kompanije, a učenici imaju priliku da razmenjuju svoja iskustva i da o naučenom gradivu diskutuju i na teorijskim časovima u školi.

Soft Design – „Špedicija v2011“ je najrasprostranjeniji program kod mnogih špediterskih firmi u Srbiji. Koristi se za elektronsko podnošenje carinske dokumentacije (JCI, sažeta deklaracija, EUR.1, CMR, FORM-A i dr.).

NCTS je elektronski sistem koji se koristi za praćenje međunarodnog tranzita robe. Odnosi se samo na zemlje članice Zajedničkog tranzitnog postupka, kao što su npr. zemlje EU i nekoliko pridruženih zemalja. NCTS ubrzava i olakšava carinski postupak prilikom međunarodnog prevoza robe, omogućava bolju kontrolu robe i smanjuje mogućnost prevara i nepotrebnu papirologiju. Funkcioniše tako što pošiljalac podnosi tranzitnu deklaraciju elektronski putem specijalnog softvera ili portala. U Srbiji su to e-Customs ili CEFTA NCTS. Izvozna carina odobrava tranzit i izdaje broj MRN (Movement Reference Number). Roba se potom prevozi do carinske kancelarije u zemlji odredišta. Carina zatvara tranzitni

postupak kada roba stigne, čime se potvrđuje da je roba stigla neoštećena i u celosti. Koriste ga gotovo sve veće špediterske kompanije, a od onih koje primaju učenike logistike na praksu su: Intereuropa, Kuehne+Nagel, Transfera i Cargo Partner.

NAP je elektronska platforma Uprave carina u našoj zemlji koja se koristi za podnošenje carinskih deklaracija i izvršavanje carinskih postupaka. Koristi se za uvoz, izvoz i tranzit. Ovaj program znatno ubrzava i olakšava posao firmama i špediterima jer omogućava elektronsko podnošenje deklaracije. Učenici kroz praksu uče kako se brzo obrađuju carinske deklaracije, smanjuje dokumentacija i prati status carinskih deklaracija u realnom vremenu. Firme koje ga koriste, a imaju saradnju sa Saobraćajno-tehničkom školom su Intereuropa, Transfera, Kuehne+Nagel, DB Scheker, Gebruder Weiss… Učenici uglavnom imaju priliku samo da se upoznaju sa carinskom deklaracijom, ali ne i da samostalno rade na njenoj izradi.

Program Elšped je specijalizovani softverski paket razvijen za špediterske agencije, logističke operatere, transportne firme i spoljnotrgovinska preduzeća, prvenstveno u Srbiji i Crnoj Gori. Koristi se za brže kreiranje i kontrolu ključnih uvozno/izvoznih dokumenata, radnih naloga i faktura.

CIEL je integrisana globalna operativna platforma koja se koristi za kreiranje dokumentacije, planiranje transporta i upravljanje logistikom širom sveta. Često ga koriste u kompaniji Kuehne+Nagel, pre svega kod pomorskog transporta.

WMS je softver koji se koristi u skladištima za upravljanje skladištem. Pomaže pri kontrolisanju i upravljanju brojnim operacijama u skladištu. Koristi se kod prijema zaliha, optimizuje izbor i isporuku narudžbine i pomaže pri upravljanju zalihama, što predstavlja jedan od glavnih poteškoća menadžera skladišta. Zaposleni u skladištu nailaze na brojne poteškoće poput troškova koji nastaju postojanjem zaliha, stvaranje otpada, maksimalno iskorišćenje skupog skladišnog prostora, stalni zahtevi za povećanjem produktivnosti, problemi sa skupom opremom, česte reklamacije, brojna papirologija, a za smanjenje ovih problema i odgovor na brojne izazove daje upravo WMS softver.

TIS je modularna telematika za vozila i skladišta, a često je koriste i zaposleni u kancelariji. To je program vezan za rutiranje pošiljaka po vozilima, praćenje vozača/pošiljki, skeniranje, dokumentaciju. Zasniva se na rešenjima za mobilnu telematiku i “paperless” upravljanje transportom pod brendom TISLOG. Ovo je vrsta modularnog softvera za logistiku i telematiku namenjena vozačima, skladištarima i dispečerima. TISLOG mobile se koristi kao aplikacija za vozače na terenu, sa podrškom za skeniranje, slike i dokumentaciju tovara, a postoje i varijante koje se koriste za radnike u skladištu, za obradu robe ili prijem pošiljki. Ovaj softver je izuzetno značajan jer uključuje praćenje pošiljki, popis oštećenja, kontrolu vremena rada vozača. Program je zastupljen kod srednjih i velikih transportnih i logističkih firmi, pretežno u Nemačkoj i Švajcarskoj, a od firmi sa kojima Saobraćajno-tehnička škola sarađuje na prvom mestu to je Gebrüder Weiss. Rešenje je tehnički zahtevno, pa je namenjeno transportnim i skladišnim firmama sa više lokacija i većim voznim parkom.

MSC One vision se koristi u kompaniji MSC za otvaranje bukinga, pravljenje teretnica, za postavljanje plombi na kontenerima…

Fleet Portal je integrisano rešenje za upravljanje flotom vozila razvijeno u cilju pomoći korporativnim korisnicima i „mobility managerima“. Često se koristi u transportnim i distributivnim centrima. Često je upotrebljivano rešenje za firme koje žele efikasno da kombinuju tehničke i servisne potrebe vozila, sve unutar jedne digitalne platforme.

SALOG je globalni sistem interno razvijen i korišćen u okviru Kuehne + Nagel kompanije koji podržava tokove kao što su uvoz/izvoz kontenera, planiranje prevoza i upravljanje dokumentacijom. Koristi se u sektorima pomorskog i avio špedicionog poslovanja. Iako nije komercijalno dostupan drugim kompanijama, rad na njemu pomaže učenicima u razumevanju čitavog procesa rada u špediciji.

SAP je integrisan softver za upravljanje poslovanjem koji se, između ostalog, koristi i za finansije i nabavke, logistiku i skladišta. Za ono sto je značajno u logističkom sektoru, SAP se koristi u WM (Warehouse Management) za upravljanje skladištem i u tokovima robe, u MM (Materials Management) za upravljanje materijalima, nabavkom i zalihama, TM (Transportation Management) za upravljanje logistikom i transportnim procesima. Znanje o ovom programu je značajno je značajno jer se koristi u različitim sektorima, privatnim firmama, ali i državnim institucijama i komunalnim preduzećima, što učenicima pruža značajno predznanje ako se u budućnosti odluče za rad u drugim firmama ili potpuno drugačijim oblastima.

Učenici rade u skladištima, kancelarijama, administraciji, finansijama. Upoznaju se sa uvozno-izvozno procedurama i dokumentima. Izuzetno im je zanimljiv zbirni transport, domaći i međunarodni, home delivery, kao i carinski magacin gde im je najviše bilo dopušteno da rade samostalno.

Nakon u školi obrađenih termina FTL (FULL Truck Load, odnosno „puno tovarno vozilo" ili „kompletan kamion") i LTL (Less Than Truck Load, što se prevodi kao „manje od punog tovara kamiona" ili „delimični tovar") sa tim su se susreli i na praksi, što kasnije komentarišu sa profesorima teorijskih predmeta u školi i mnogo lakše uče razliku između ovih pojmova.

U pomorskom sektoru (Sea Freight/Ocean Freight) učenici se upoznaju sa organizacijom kontenerskog, Ro-Ro ili bulk transporta morem, bukingom, carinjenjem, praćenjem isporuka, komunikacijom sa lukama i terminalima. Avio sektor (Air Freight) ih takođe uči o oblicima saradnje sa avio-kompanijama, cargo terminalima, carinom, ali i načinom organizacije transporta robe avionom, uglavnom za hitne i vredne pošiljke. O dokumentaciji u avio sektoru učenici najpre uče u školi, prvenstveno o AWB (Air Waybill), a zatim se sa tim i sa IATA pravilima susreću i na praksi. Drumski sektor (Road Freight/Trucking) pokriva transport kamionima (FTL, LTL, grupni tovari), a učenici na praksi upotpunjuju svoje znanje o vrstama prevoza, nacionalnom i međunarodnom, hladnjačama, pravilima o prevozu opasne robe, kombi distribuciji, CMR-u i tovarnom listu. Železnički sektor (Rail Freight) je ređe zastupljen u Srbiji, ali je prisutan kod prevoza kontenera i bulk robe, a naročito je važno da se učenici neposredno upoznaju sa saradnjom sa železničkim operatorima, organizacijom utovara/istovara na terminalima i potvrde znanje o komplikovanoj organizacijom železničkog transporta o čemu su slušali na teorijskoj nastavi. Carinski sektor (Customs Clearance) je naročito značajan zbog izrade i podnošenja carinskih deklaracija (JCI), pripreme dokumenata: faktura, pak lista, EUR.1, ATR, FORM A i saradnje sa carinskim ispostavama. Skladišni sektor (Warehousing & Distribution) praktično predstvlja učenicima upravljanje skladištima, ulaz/izlaz robe, cross-docking, evidenciju i upravljanje zalihama. Učenici praktično uče o organizaciji vanstandardnih isporuka, planiranju ruta, koordinaciji više vrsta transporta, pripremi i kontroli dokumentacije, pripremi ponuda za klijente, upravljanju odnosima sa kupcima.

Učenici su u obavezi da pišu dnevnik prakse, koji im pomaže da sagledaju nove programe i veštine koje su savladali, da povežu praktično naučeno sa znanjem sa školskih časova, a

pomaže i profesorima prakse da prate i ocenjuju napredak učenika i eventualne nedostatke.

Budućnost dualnog obrazovanja

Moderna era brzih ekonomskih i tehnoloških promena proširile su značaj dualnog obrazovnog sistema. Stariji radnici sve više koriste sistem da bi stekli nove veštine na tržištu rada koji se stalno razvija. Ova praksa se naziva kontinuiranim stručnim obrazovanjem. Dualno obrazovanje i u budućnosti može pomoći različitim zemljama da se brže prilagode tekućoj ekonomskoj situaciji u zemlji i svetu i da doprinese razvoju stručnih zanimanja. Očekuje se da će dualno obrazovanje i u narednim godinama biti prepoznato kao efikasan način rešavanja problema deficitarnih zanimanja.

Kroz dualno obrazovanje, mladi testiraju razmišljanja i ideje u vezi sa svojom karijerom. U godinama kada polako odlučuju o daljem toku svog profesionalnog razvoja, učenicima izuzetno odgovara mogućnost da zarađuju i osamostaljuju se, ali i da provere sebe - da li žele da nastave da se školuju ili žele da ostanu da rade u logistici ili potpuno promene zanimanje. Procenat učenika koji ostaju zaposleni u firmama zavisi od generacije, npr. mali procenat učenika prve generacije su ostali da rade, ali su se onda u velikom broju zaposlili u drugim špediterskim firmama.

Zanimljiva su zapažanja do kojih dolaze profesori prakse u saradnji sa mentorima u firmama. Najčešće se dešavada učenici koji su u školi slabiji nemirni i nezainteresovani, tokom prakse pokažu visok nivo zalaganja i želju za napredovanjem. Uklapanje učenika u sam proces zavisi od firme gde pohađaju praktičnu nastavu, tj. od zalaganja mentora koji im je dodeljen. Većini učenika najprivlačniji je špediterski sektor, imaju želju da dodatno nauče i da ostanu da rade baš u tom sektoru. Ipak, zamerka im je najčešće nedovoljno mesta. Zbog toga predlažu obezbeđivanje dodatnog radnog prostora za samostalan rad.

Nakon završenog dualnog obrazovanja veliki procenat učenika ostaje da radi u firmama gde su prvobitno raspoređeni. Dopada im se što je praksa plaćena, izuzetno su zadovoljni što svako želi da im pomogne, objasni i odgovori na svako pitanje, otvoreni su za dogovore i što ima menadžera koji su im izuzetno posvećeni. Kompanije sa kojima škola ima višegodišnju saradnju iskazuju visoko zadovoljstvo, čak su spremne i da ih stipendiraju ako se učenici obavežu ugovorom. Učenici koji istovremeno studiraju i rade potvđuju da im kompanije izlaze u susret kada treba da idu na obavezna predavanja ili na ispit i da su veoma zainteresovani da ulažu u svoje buduće radnike.

Učenici su videli kako izgledaju radni dani, posetili luku i carinski sektor, većini se praksa dopada više nego časovi provedeni u školi i princip rada koji su naučili za kratko vreme.

Učenicima je zanimljivo što imaju priliku da neposredno upoznaju oblasti koje su ranije proučavali samo kroz lekcije – doživljaj je potpuno drugačiji kada vide mašine, regale, skladišta, tok pošiljaka i razgovore sa kupcima i vozačima.

Učenici ističu da čak i ako ne ostanu u prvenstveno odabranoj kompaniji, dovoljno su obučeni da imaju velike šanse da zaposlenje nađu u drugoj firmi. Većina učenika smatra da im se nakon završene četvorogodišnje srednje škole u sistemu dualnog obrazovanja povećalo samopouzdanje za rad u oblasti logistike i špedicije, ali i generalno, smatraju da imaju više sigurnosti u radu u raznim drugim oblastima, jer su se obučavali u različitim programima, sarađivali sa velikim brojem kolega i menadžera.

Ono čime učenici nisu zadovoljni je kada ostanu da rade preko Omladinske zadruge.

Smatraju da firma treba da ponudi ugovor i da imaju organizovan prevoz u svakoj firmi. Učenicima ne odgovara menadžment koji im nije dovoljno posvećen i koji im uglavnom daje iste poslove, poput poslova u skladištima i lepljenja deklaracija. Učenici izražavaju želju da aktivnije učestvuju u poslovima, a ne samo da posmatraju, i da im se pristupa kao sa ravnopravnim članovima tima. Problem je i nepridržavanje plana i programa i nedostatak osoblja koji bi se samo njima posvetio. Naime, u većini kompanija obim posla je veoma veliki i zaposleni često nemaju dovoljno vremena da se kontinuirano posvete učenicima i njihovoj obuci.

Zaključak

Pre upisa u srednju školu, učenici često nisu potpuno sigurni u svoj izbor zanimanja. Informacije uglavnom prikupljaju preko interneta, društvenih mreža i saveta prijatelja ili starijih članova porodice. Međutim, snalaženje u određenoj oblasti je vrlo individualno, i tek kada učenici neposredno iskuse radno okruženje, mogu sa sigurnošću proceniti da li se žele time baviti u budućnosti.

Iako interesovanje za određena zanimanja opada pre samog upisa u školu, dualno obrazovanje nije jedini faktor koji može uticati na motivaciju učenika, ali ako se učenicima pruži jasna perspektiva zapošljavanja i mogućnost da odabrano zanimanje bude njihovo osnovno sredstvo za život, očekuju se pozitivni rezultati.

Država treba da sagleda ulogu privrede i da, ukoliko postoji potreba, pruži odgovarajuću finansijsku podršku. Jedna od mogućnosti jeste uvođenje poreskih olakšica za kompanije koje aktivno učestvuju u sistemu dualnog obrazovanja.

Istraživanja su pokazala da dualni sistem obrazovanja značajno povećava motivaciju i angažman učenika. Kroz rad u realnim uslovima, učenici postaju aktivni učesnici u procesu obrazovanju, što im pruža osećaj svrhe i dodatno doprinosi njihovom profesionalnom razvoju.

Logistika je jedno od najperspektivnih zanimanja, čija se ekspanzija intenzivno očekuje u narerdnim godinama, a dokaz za to je i veliko interesovanje, pa od školske 2025/2026. godine Saobraćajno-tehnička škola u Zemunu prima dva odeljenja učenika.

Uz podršku nastavnog kadra, privrednih subjekata i kompanija, očekuje se nastavak ovog pozitivnog trenda

i da će se još veći broj učenika zainteresovati da stekne obrazovanje koje će moći odmah praktično da primeni u random okruženju. Time se ne doprinosi samo ličnom razvoju učenika, već i jačanju različitih privrednih sektora i ukupnom razvoju države. Dualno obrazovanje, kao spoj teorije i prakse, predstavlja snažan mehanizam za izgradnju kompetentne i motivisane radne snage u budućnosti.

Literatura:

- Zakon RS o dualnom obrazovanju (2017) i podzakonski akti
- Biznis.rs
- Politika Magazin
- Aktual.rs
- Euronews Srbija
- Bizlife.rs

IMPLEMENTATION OF DUAL EDUCATION – THEORY AND PRACTICE

Milica Vukasinovic (Teacher)
Traffic and Technical School Zemun

Introduction to Dual Education

Dual education is a structured process in which students, under the supervision of instructors or managers, acquire the skills necessary for efficient and productive work. This is not traditional practical training—it is learning through work. This educational model has drawn attention to craft and technical professions, contributing to their revitalization. Through this system, young people gain knowledge, test it in real-world situations, and develop communication skills, teamwork, resilience to stress, and problem-solving abilities.

Dual education is present in secondary schools worldwide and has proven to be a highly successful model in many countries. In schools, students learn fundamental concepts and definitions, while in companies, they apply and refine that knowledge through hands-on experience. In this way, the vocational secondary education curriculum is enriched with workplace learning, helping students gain practical competencies. One of the most common challenges in employment—requiring prior work experience—is effectively addressed through this model. Students find jobs more easily, become more competitive in the labor market, and contribute to the development of the socio-economic system.

The development of dual education requires active participation from the business sector. Industry must engage in the system, ensure its quality implementation, and support youth employment. Through the dual education model, companies participate in training future employees according to their own standards, ensuring a qualified workforce aligned with market needs.

Dual Education in Serbia

There is also strong demand for educational profiles in sectors such as hospitality and tourism—particularly in the Zlatibor region and certain parts of southern Serbia—where there is a high need for chefs, waiters, tourism technicians, and hotel operations technicians.

It is important to note that not every company is eligible to participate in dual education; employers must meet specific criteria to collaborate with schools and the Serbian Chamber of Commerce.

Each year, companies apply to participate in the dual education system and to host a new generation of students. The application process is conducted through an online portal and includes creating a company profile and submitting a request to verify that the necessary conditions for work-based learning are met for each educational profile they require. This request must be accompanied by supporting documentation and a formal statement of willingness to participate in dual education.

The number of students accepted for internships varies depending on the company. It is also necessary to submit a proposed plan for the implementation of work-based learning and to sign a preliminary agreement on dual education. Once all conditions are met, the Serbian Chamber of Commerce issues a Certificate of Compliance, confirming the company's eligibility to conduct work-based training.

Dual Education at the Transport-Technical School in Zemun

One of the basic requirements for company participation is that the company must have a warehouse and be engaged in international transport.

In the logistics and freight forwarding technician program, students spend their entire first year in school. In the second year, they attend school four days a week and spend one day at practical training. In the third and fourth years, they spend two days a week at company-based training, where they receive financial compensation, mentorship support, and insurance coverage.

At the beginning of the second year, companies present themselves to students and their parents, after which students create a list of preferred companies. However, the allocation process is often challenging. The school insists that top-performing students get the first choice based on their preference lists, while companies prefer to select candidates who meet their specific needs — often not the students with the best grades, but those who perform well in interviews. Additionally, companies are sometimes reluctant to choose the best students because these students usually plan to continue their education instead of entering the workforce right after high school.

Practical training teachers regularly visit students at their companies to monitor progress. Each student is assigned an instructor — usually a logistics professional, though any employee with an instructor's license can take on the role.

Difficulties arise when students are not adequately prepared for the workplace. It's important to clearly communicate in advance that workplace behavior is expected to differ from school behavior — emphasizing work ethics and responsibility.

Over the years, the school has faced numerous challenges in implementing dual education. The COVID-19 pandemic significantly slowed progress. That period was especially difficult, as several companies ended their cooperation based on contractual clauses allowing withdrawal if they could no longer provide adequate conditions for hosting students. Many companies transitioned to remote work, including mentors, which disrupted coordination and training plans. Isolation also limited access to hands-on training in many sectors.

Practical training teachers have long faced numerous issues, particularly financial ones. Travel expenses related to student visits are especially high.

There is often a mismatch between student expectations and those of the companies. While companies hope students will remain as employees after graduation, many students aim to continue their education. More than 50% of students are unwilling to commit to staying with a company. For instance, the company Lagermax accepted nine students in the first year, none of whom stayed after graduation — all chose to enroll in university, which the company saw as an inefficient use of resources.

One of the biggest ongoing challenges is ensuring adequate infrastructure and resources. This includes having qualified instructors, sufficient equipment, access to modern technologies, and the ability to provide necessary support for student training and equal access to education for all. So far, only the company Gebrüder Weiss compensates their instructors, which presents another obstacle.

Most of these challenges can be overcome through strong coordination between schools and companies. This requires careful alignment with current industry trends and securing the necessary resources for effective implementation of educational strategies and programs. Such integration is crucial for developing a competent workforce. The public sector clearly plays a vital role in providing legislative and infrastructural support, ensuring equal educational opportunities for all students.

Learning Through Work

Logistics is a multidisciplinary field that requires knowledge from various areas, including transportation, economics, law and regulations, marketing, management, IT, environmental science, global and national political dynamics, psychology, and consumer behavior. This wide scope of expertise stems from the need to integrate different aspects of business, technology, and organization in order to optimize resources and achieve competitive goals. Professionals in this field must demonstrate precision, efficiency, teamwork, multitasking, and creativity. It can be an extremely stressful job, and through dual education, students gain insight into many of these challenges and quickly realize that progress in this industry demands significant effort and dedication.

English language proficiency is essential, as much of the correspondence and collaboration with international clients takes place via email in English. Students in companies need to be familiar with Excel but also work with numerous specialized software programs, which vary across companies. Some of the key programs in use include:

- Soft Design
- NCTS (New Computerised Transit System)
- NAP (National Customs Application Portal)
- Elšped
- CIEL
- WMS (Warehouse Management System)
- TIS
- MSC One Vision
- Fleet Portal
- SALOG
- SAP

Software and procedures vary from company to company, giving students the opportunity to exchange experiences and discuss what they've learned during theoretical classes at school.

Soft Design – “Špedicija v2011” is the most widely used system among freight forwarding companies in Serbia. It facilitates electronic submission of customs documents such as JCI, summary declarations, EUR.1, CMR, FORM A, and others.

NCTS is an electronic system for tracking international goods in transit, used among

countries that are part of the Common Transit Convention (EU members and a few others). It simplifies customs procedures, improves shipment control, and reduces fraud and paperwork. The sender submits a transit declaration electronically, and customs authorities issue a Movement Reference Number (MRN). The shipment is transported to the destination country's customs office, which closes the transit procedure upon arrival. Major logistics firms using this system and hosting students include Intereuropa, Kuehne+Nagel, Transfera, and Cargo Partner.

NAP is Serbia's national customs platform used for submission and processing of customs declarations for import, export, and transit. It streamlines operations for companies and freight forwarders, and students learn how to process declarations, reduce paperwork, and monitor status in real time. Companies involved in dual education with the school that use NAP include Intereuropa, Transfera, Kuehne+Nagel, DB Schenker, and Gebrüder Weiss. Students usually observe the process rather than completing declarations independently.

Elsped is a specialized software suite developed for freight forwarders, logistics operators, transport companies, and foreign trade enterprises, primarily in Serbia and Montenegro. It facilitates the rapid creation and control of key import/export documents, job orders, and invoices.

CIEL is an integrated global operations platform used to create documentation, plan transport, and manage logistics worldwide. It is often used by Kuehne+Nagel, especially in sea freight.

WMS manages warehouse operations such as inventory intake, order picking and delivery, and inventory control — all key challenges for warehouse managers. This software helps address stockholding costs, space optimization, waste reduction, productivity pressure, costly equipment, frequent complaints, and excessive paperwork.

TIS is a modular telematics system for vehicles and warehouses, often used by office staff as well. It covers routing, driver/shipment tracking, scanning, and documentation — all part of the TISLOG mobile telematics and paperless transport management ecosystem. It's mainly used in larger logistics and transport companies, especially in Germany and Switzerland. Gebrüder Weiss, a partner of the Zemun Transport-Technical School, is one example. Due to its complexity, this solution is best suited for companies with multiple locations and large vehicle fleets.

MSC One Vision is used by MSC for creating bookings, issuing bills of lading, and sealing containers.

Fleet Portal is an integrated fleet management solution designed to help corporate users and mobility managers handle technical and service needs through a single digital platform. It's commonly used in transport and distribution centers.

SALOG is Kuehne+Nagel's proprietary global system that supports container import/export flows, transport planning, and document management in maritime and air freight sectors. Though not available to other companies, working with it helps students understand the entire freight forwarding process.

SAP is an enterprise resource planning (ERP) software that, in logistics, includes:

- WM (Warehouse Management) for warehouse and goods flow management

- MM (Materials Management) for procurement and stock control
- TM (Transportation Management) for managing transport processes

Since SAP is used in private firms, public institutions, and utilities, it gives students valuable transferable knowledge.

Students gain experience across various departments — warehouses, offices, admin, and finance — and become familiar with import-export procedures and documentation. They show particular interest in consolidated shipping (both domestic and international), home delivery, and customs warehouses, where they often have the most hands-on experience.

Terms like FTL (Full Truck Load) and LTL (Less Than Truck Load), first introduced during theoretical classes, are reinforced during practical training, helping students fully grasp the differences through real-world examples and later discussions in school.

In Sea Freight, students learn about container, Ro-Ro, and bulk shipping, booking, customs clearance, tracking, and port/terminal communication.
In Air Freight, they explore cooperation with airlines, cargo terminals, customs procedures, and the logistics of urgent and high-value shipments. They first study AWB (Air Waybill) and IATA rules in school, then encounter them in practice.
In Road Freight, students deepen their understanding of national and international trucking, cold chain logistics, transport of dangerous goods, van distribution, CMR, and bills of lading.
Rail Freight is less common in Serbia but still relevant for container and bulk transport. Students gain exposure to terminal operations and coordination with rail operators.
In the Customs sector, they get familiar with customs declarations (JCI), supporting documents (invoices, packing lists, EUR.1, ATR, FORM A), and cooperation with customs offices.
Warehousing & Distribution provides insight into warehouse management, inbound/outbound logistics, cross-docking, inventory management, and planning non-standard deliveries. Students also gain experience in route planning, multimodal coordination, documentation checks, client offer preparation, and customer relationship management.

Students are required to maintain a practice journal, which helps them reflect on the software and skills they've acquired, connect practical experiences with school lessons, and allows practice instructors to track progress and identify areas for improvement.

The Future of Dual Education

In today’s era of rapid economic and technological change, the relevance of dual education has significantly expanded. Increasingly, older workers are also turning to this model to gain new skills in a constantly evolving labor market — a practice known as continuous professional development. Looking ahead, dual education is expected to help countries adapt more swiftly to shifting economic conditions both domestically and globally, while also contributing to the development of skilled professions. It is likely to continue being recognized as an effective strategy for addressing labor shortages in key sectors.

For young people, dual education offers a chance to explore and test their career ideas. At an age when they are making critical decisions about their professional paths, the opportunity to earn money and gain independence is especially appealing. It also allows

them to assess whether they want to pursue higher education, stay in the logistics sector, or shift to a completely different field. The percentage of students who stay with the companies after graduation varies by cohort — for example, only a few from the first generation remained, but many later found employment in other freight forwarding firms.

Insights gathered by vocational teachers in collaboration with company mentors are particularly revealing. It is often the students who are less engaged or underperforming in school who show the most initiative and motivation during their internships. A student's ability to integrate into the work environment depends greatly on the company they're placed in — particularly on the commitment of their assigned mentor. Most students are drawn to the freight forwarding sector and express a strong desire to stay and learn more in that area. However, their main complaint is the lack of space for independent work, which leads them to suggest that companies provide additional workspace for trainees.

After completing dual education, many students remain with the companies where they did their training. They appreciate the fact that the internships are paid, that the staff is helpful and willing to answer questions, and that many managers are deeply committed to mentoring them. Long-standing partner companies express high satisfaction with the program, with some even offering scholarships in exchange for contractual commitments from students. Those who continue their education while working confirm that companies are flexible with class schedules and exams, showing strong interest in supporting their development as future employees.

Students experience real working days, visit ports and customs offices, and often find the hands-on training more engaging than traditional classroom lessons. They enjoy seeing and interacting with the systems and processes they previously learned about in textbooks — the machinery, warehouse racks, shipment flows, and conversations with clients and drivers make everything more tangible and real.

Even if they don't stay with their initial company, students feel confident that they are well-prepared to secure jobs elsewhere. Most of them report an increase in self-confidence after completing the four-year dual education program, not only for careers in logistics and freight forwarding but also in general — thanks to the variety of software, tasks, and interactions with different colleagues and managers.

However, not everything meets their expectations. Many are dissatisfied when they are kept on through temporary youth employment agencies without being offered direct contracts. They believe companies should provide formal employment and organized transport to the workplace. Students are frustrated when management is disengaged or assigns them repetitive tasks like warehouse work or labeling. They want to be more actively involved, not just observers, and to be treated as equal members of the team.

There are also issues with the failure to follow training plans and a lack of staff dedicated solely to student development. In many companies, the workload is heavy, and employees simply don't have enough time to fully commit to mentoring students consistently.

Conclusion

Before enrolling in secondary school, many students are not entirely certain about their career choices. Most of the information they gather comes from the internet, social media, and advice from friends or older family members. However, adapting to a particular

profession is a highly individual process, and only by directly experiencing a real work environment can students truly assess whether they want to pursue a certain career.

Although interest in specific professions may decline even before enrollment, dual education is not the sole factor influencing student motivation. Still, if students are offered a clear path to employment and see the chosen profession as a viable livelihood, the outcomes are expected to be overwhelmingly positive.

The state should take into account the role of the private sector and, where needed, provide financial support. One possible measure could be the introduction of tax incentives for companies actively participating in the dual education system.

Studies have shown that dual education significantly boosts student motivation and engagement. By working in real-world conditions, students become active participants in their own education, gaining a sense of purpose that further supports their professional growth.

Logistics is one of the most promising fields, with significant expansion expected in the coming years. A clear sign of this growing interest is that, starting from the 2025/2026 school year, the Transport-Technical School in Zemun will enroll two full classes of students in the logistics program.

With continued support from educators, businesses, and companies, this positive trend is expected to grow — encouraging even more students to pursue an education they can immediately apply in the workplace. This not only contributes to the individual development of students but also strengthens various economic sectors and supports the broader development of the country.

Dual education, as a blend of theory and practice, represents a powerful tool for building a competent and motivated workforce for the future.

References:

- Law on Dual Education, Republic of Serbia (2017) and accompanying by-laws
- Biznis.rs
- Politika Magazin
- Aktual.rs
- Euronews Serbia
- Bizlife.rs

STROJARSKA I PROMETNA ŠKOLA VARAŽDIN, Varaždin,

Autor: Ivana Zagrajski, dipl.oec.

MARKETING I LOGISTIKA – SINERGIJA ZA USPJEH

Sažetak:

Cilj ovog rada je prepoznati važnost i specifičnost marketinga uslužnih djelatnosti prvenstveno logistike kao jedne od gospodarske djelatnosti u neprekidnom rastu. Uslužni sektor će dominirati zapošljavanjem, povećavajući interes za učinkovito upravljanje marketingom u logistici.

Logistička usluga je nematerijalna i ne može se skladištiti, stoga je potrebno definirati njezinu vrijednost i diferencijaciju.

U moru logističkih poduzeća naglasak je na proširenom marketing mix 7P, koji oblikuje strategiju pružanja i promocije usluga. Snažna integracija elemenata marketing mix povećava konkurentsku prednost i lojalnost kupaca. Kako bi osigurali prednost i lojalnost kupaca, priviklu nove kupce potrebno je osnažiti brend logističke tvrtke prvenstveno stvaranjem jedinstvenog identiteta i percepcije u svijesti potrošača. Također je potrebno brendiranje usluga u logistici kroz proces razvijanja ponude različitih usluga u okviru logističkog lanca s ciljem izgradnje povjerenja i prepoznatljivosti.

Uspješan primjer brendiranja prikazan je na poduzeću TerraLog. Brendiranje usluga logističkog lanca potrebno je provoditi u srednjoškolskom obrazovanju kroz Poslovnu komunikaciju i Međunarodno poslovanje. Strojarska i prometna škola ima vježbeničku tvrtku gdje učenici provode aktivnosti biranja naziva tvrtke, loga, dizajna, boje i slogana.

Ključne riječi: marketing, marketing mix usluga, brend, brendiranje i logistika

1. UVOD

U današnjem konkurentnom poslovnom okruženju, uspješno poslovanje zahtijeva integriranu strategiju koja povezuje ključne funkcije unutar organizacije, među kojima su marketing, marketing usluga i logistika. Ove oblasti su međusobno povezane i njihova međusobna ovisnost postaje temelj za efikasnu i održivu poslovnu politiku, omogućavajući organizacijama da stvore snažnu konkurentsku prednost. Marketing oblikuje očekivanja i lojalnost potrošača, dok marketing usluga pruža prilagođene pristupe za nematerijalne proizvode, fokusirajući se na kvalitetu i iskustvo kupaca. Logistika osigurava pravovremenu isporuku, što je ključno za zadovoljstvo i povjerenje potrošača.

Sposobnost logistike da osigura efikasne kanale robe i informacija direktno utječe na uspjeh marketinških aktivnosti i zadovoljstvo kupaca. Kvalitetne logističke usluge, kada se brendiraju i prikazuju kao dijelovi brenda, jačaju povjerenje potrošača i diferenciraju poduzeće na tržištu. Transparentnost, pouzdanost i visoki standardi u isporuci logističkih usluga doprinose jačanju ukupnog brenda i stvaranju konkurentske prednosti.

Razumijevanje sinergije između marketinga i logistike ključno je za oblikovanje holističkih strategija koje omogućavaju ostvarenje dugoročnog rasta. Kada ove dvije funkcije djeluju u harmoniji, mogu značajno povećati vrijednost za potrošače, poboljšati korisničko iskustvo i stvoriti dodatnu vrijednost za organizaciju. Takav integrirani pristup omogućava bolju prilagodbu tržišnim zahtjevima i jačanju tržišne pozicije.

Primjeri i strategije koje ističu važnost sinergije uključuju usklađivanje tržišnih kampanja s optimizacijom logističkih procesa, te brendiranje logističkih usluga kao dijela ukupnog brenda. Ulaganje u transparentne i pouzdane logističke usluge, s fokusom na kvalitetu i iskustvo kupaca, omogućava organizacijama da izgrade povjerenje i lojalnost, te da se izdvoje od konkurencije.

U konačnici, integracija marketinga i logistike stvara temelje za dugoročni uspjeh, povećava zadovoljstvo potrošača i jača tržišnu poziciju. Kada ove funkcije djeluju u harmoniji, organizacije mogu maksimalno iskoristiti potencijal svoje ponude, stvoriti održivu konkurentsku prednost i osigurati kontinuirani rast na tržištu.

2. ULOGA MARKETINGA U POSLOVANJU

„Marketing je proces planiranja i izvršavanja koncepta cijene, promocije, distribucije i promocije ideja, proizvoda i usluga radi stvaranja razmjene koja zadovoljava potrebe pojedinaca i organizacija.“[88]

2.1 Marketing mix usluge – 7P MODEL

„Usluge su aktivnosti, djela ili koristi koje jedna strana može ponuditi drugoj, a čiji su ishodi uglavnom neopipljivi i ne rezultiraju vlasništvom.“[89]

Marketing mix usluga proširuje klasični **4P model** - proizvod, cijena, promocija i distribucija, dodajući tri dodatna elementa – ljudi, proces i fizički dokazi. Ovaj prošireni **7P model** pomaže poduzećima u oblikovanju strategije za promociju i pružanje usluga.

---

[88] Kotler P. 1967. Marketing Management. Prvo izdanje. Boston, SAD

[89] Haramija P. , Miličević K., Babić A., Kuštrak A., Čaić K. 2014. Marketing usluga. Nakladnik MATE, Zagreb, str.15

Slika 1: Prošireni marketinški miks usluga



Izvor: https://atauctus.hr/blog/sto-je-marketinski-miks/

- Proizvod/Usluga = **P**roduct; je sama usluga s karakteristikama, kvalitetom i pogodnostima.
- Cijena = **P**rice; određuje vrijednost, ali treba biti konkurentna na tržištu.
- Distribucija – **P**lace; uključuje lokacijama, poput fizičke lokacije, online platform ili mobilne aplikacije.
- Promocija- **P**romotion; obuhvaća promidžbene poruke, odnosi s javnošću i društveni mediji.
- Ljudi – People; koji pružaju uslugu imaju ključnu ulogu u oblikovanju iskustva kupaca.
- Proces – **P**rocese; je način pružanja usluga tj. na aktivnosti i postupke.
- Fizičko okruženje –**P**hysical evidence; uključuje prostor i ambalažu koji utječu na percepciju kvalitete.

3. BRENDIRANJE USLUGA

Brendiranje je skup aktivnosti i procesa za kreiranje, komuniciranje i isporuku marketinških poruka

Cilj brendiranja je:

- povećati poslovanje
- potaknuti svijest o brendu
- podignuti njegovu privlačnost, ugled i odanost.
- Brend je skup vrijednosti, osobina i emocija koje čine "osobnost" poslovanja, simbol pouzdanosti i kvalitete te utječu na podsvijest potrošača, pomažući prepoznati proizvod ili tvrtku.

Fizički elementi brend identiteta čine ga prepoznatljivim i doprinose snažnom, jedinstvenom i inovativnom vizualnom identitetu ključnom za marketinšku komunikaciju.

Brend identitet je alat za jasnu komunikaciju sastoji se od vizualnog i verbalnog identiteta.

1. Vizualni identitet brenda čine:

- znak/logo,
- simbol,
- dizajn.

2. Verbalni identitet brenda odnosi se na:

- ime brenda
- slogan brenda
- ključne brend poruke
- brend priču.

3.1 Brendiranje logističkih usluga

Brendiranje logističke usluge ključno je za stvaranje prepoznatljivosti, povjerenje i lojalnosti kod klijenata, čime se povećava konkurentnost na tržištu. Sinergija između marketinga i logistike jača cjelokupnu strategiju brenda.

Ključni aspekti brendiranja logističke usluge uključuju:

Identitet brenda – kreiranje prepoznatljivog vizualnog identiteta, koji odražava vrijednosti i profesionalnost tvrtke.

Kvaliteta usluge – konstantno pružanje usluga visoke kvaliteta, točnosti i pouzdanosti.

Percepcija i ugled – stvaranje pozitivnih iskustava kod klijenata koja doprinose dobrom imidžu i preporukama.

Komunikacija i marketing – efikasno isticanje prednosti, inovacija i jedinstvenih rješenja putem različitih kanala, kao što su web stranice, društvene mreže i oglasni prostori.

Lojalnost i odnosi – izgradnja dugoročnih odnosa s klijentima kroz personalizirane usluge, podršku i transparentnost.

Razlikovanje od konkurencije – naglašavanje specifičnih prednosti, poput brze isporuke, sigurnosti ili ekoloških inicijativa, koje čine brend prepoznatljivim.

U suštini, brendiranje logističke usluge pomaže tvrtkama da se izdvoje na tržištu, povećaju povjerenje kod klijenata i stvaraju dodatnu vrijednost za svoje usluge.

4. PRIMJER USPJEŠNOG BRENDA NA PODUZEĆU „TerraLog Varaždin, Hrvatska“

Poduzeće TerraLog d.o.o. specijalizirana je za organizaciju međunarodnih i domaćih prijevoza raznovrsne robe, koristeći sve dostupne načine transporta. Njihov temelj je povjerenje i poštovanje, koje grade s partnerima i klijentima, to je osnova uspješnog poslovanja.

Slika 2: Logo poduzeća TerraLog



Izvor: *https://www.terralog.hr/#about_us*

- **Identitet brenda** - to su stilizirana slova **L, O** i **G**, što bi činilo kraj naziva poduzeća i početak pojma „logistika“ ili „logistics“.
- **L** je izvana, a **O** i **G** su zajednički dizajn.
- Latinska riječ **„terra“** što znači **zemlja** ovdje se našla prikladna u prijevodu zamislili kao **„planetarna logistika“**.
- **Kvaliteta usluge** – pronalaženjem najoptimalnijeg rješenja koje zadovoljava potrebe svih uključenih strana. Ključni faktori rada su kvaliteta usluge, brzina, pouzdanost i preciznost, te očuvanje dobrog ugleda naše tvrtke.

„Povjerenje, poštovanje i motivacija su naše glavne kvalitete.“

- **Percepcija i ugled** - tim sastoji se od motiviranih stručnjaka koji su dostupni 24 sata dnevno te su u potpunosti posvećeni svojem poslu. Znanje i dugogodišnje iskustvo koje su stjecali u srodnim tvrtkama omogućili su pružanje širokog spektra usluga krojenih prema potrebi naših klijenata.
- **Komunikacija i marketing** – poduzeće se promovira s pomoću društvenih mreža kao što se Facebook, Linkedin, Instagram gdje ima oko 1,5 tisuća pratitelja
- **Lojalnost i odnosi** – organizacija team building druženja te božićnih darivanja djece i djelatnika „Secret Santa“, osnažuje međuljudske odnose unutar poduzeća, čime se stvara povjerenje i timski rad.
- **Razlikovanje konkurencije** – postiže se izjavom francuskog književnika i nobelovca, Anatole France, gdje se naglašava važnost sinergije aktivnosti, snova, planiranja, vizije i vjere za postizanje velikih uspjeha.

„Želimo li postići velike stvari, moramo ne samo djelovati, nego i sanjati, ne samo planirati, nego i vjerovati.“[90]

Obratite nam se s povjerenjem i zajedno ćemo ostvariti vaše ciljeve.

5. VIRTUALNA VJEŽBENIČKA TVRTKA STROJARSKE I PROMETNE ŠKOLE VARAŽDIN „GAVRAN-šped“ d.o.o.

Učenici u sklopu Praktične nastave osnivaju virtualnu vježbeničku tvrtku gdje provode aktivnosti, od osnivanja, biranja naziva tvrtke, loga, dizajna, boje i slogana.

[90] Anatole France, francuski književnik i nobelovac

Brend virtualne vježbeničke tvrtke kojoj je djelatnost otpremništvo, zastupanje u prometu roba i usluga skladištenja, vidimo u primjeru.

Slika 3: Logo virtualne vježbeničke tvrtke Strojarske i prometne škole



SLOGAN:

„Vaš teret naša briga - od skladišta do cilja.“

Izvor: gavran.sped@gmail.com

Učenici koriste elemente marketinga kao što su brendiranje, promocija, komunikacija i angažman da bi kreirali i razvijali svoj brend, čime se ističu u svojoj zajednici i grade svoju buduću prepoznatljivost.

6. ZAKLJUČAK

Marketing i logistika su usko povezani jer zajedno igraju ključnu ulogu u uspješnom poslovanju. Marketing se fokusira na stvaranje potražnje za proizvodima ili uslugama, dok logistika osigurava da ti proizvodi ili usluge budu dostupni kupcima na pravom mjestu i u pravo vrijeme.

Kada marketing uspješno promovira proizvod, logistika mora biti spremna da ga isporuči. To uključuje upravljanje skladištima, transportom i distribucijom. Ako logistika ne može zadovoljiti potražnju koju je marketing stvorio, to može dovesti do nezadovoljstva kupaca i gubitka prodaje.

S druge strane, informacije iz logistike mogu pomoći marketingu da bolje razumije tržišne trendove i potrebe kupaca, što može poboljšati strategije promocije i prodaje. U suštini, uspješan poslovni model zahtijeva sinergiju ovih dviju funkcija kako bi se postigla maksimalna učinkovitost i zadovoljstvo kupaca.

7. LITERATURA

1. Knjige

Haramija P. , Miličević K., Babić A., Kuštrak A., Čaić K.: Marketing usluga. Nakladnik MATE, Zagreb, 2014. str.15

Čižmek Vujnović O., Krupa Z., Pavičić J., Vlašić G.: Marketing. Školska knjiga, Zagreb, 2021.

Kotler P. 1967. Marketing Management. Prvo izdanje. Boston, SAD

2. Web stranice:

https://atauctus.hr/blog/sto-je-marketinski-miks/ , 10.4.2025.

https://www.terralog.hr/#about_us, 10.4.2025.

3. Popis slika:

Slika 1: Prošireni marketinški miks usluga

Izvor: https://atauctus.hr/blog/sto-je-marketinski-miks/

Slika 2: Logo poduzeća TerraLog

Izvor: https://www.terralog.hr/#about_us

Slika 3: Logo virtualne vježbeničke tvrtke Strojarske i prometne škole

Izvor: gavran.sped@gmail.com

MECHANICAL ENGINEERING AND TRAFFIC SCHOOL VARAŽDIN,

Author: Ivana Zagrajski, BSc in Economics

MARKETING AND LOGISTICS – SYNERGY FOR SUCCESS

Summary:

The aim of this paper is to recognize the importance and specificity of marketing in service activities, primarily logistics, as one of the growing economic sectors. The service sector will dominate employment, increasing interest in effective marketing management within logistics.

Logistic service is intangible and cannot be stored, so it is necessary to define its value and differentiation.

Amidst numerous logistics companies, emphasis is placed on the extended marketing mix 7Ps, which shapes the strategy for providing and promoting services. A strong integration of the marketing mix elements enhances competitive advantage and customer loyalty. To ensure advantage and loyalty, attracting new customers requires strengthening the brand of the logistics company, primarily through creating a unique identity and perception in consumers' minds. It is also essential to brand logistics services by developing a range of offerings within the logistics chain to build trust and recognition.

A successful branding example is demonstrated by the company TerraLog. Branding of logistics chain services should be implemented in secondary education through Business Communication and International Business courses. Mechanical and Traffic Schools have apprentice companies where students carry out activities such as selecting company names, logos, designs, colors, and slogans.

Keywords: marketing, service marketing mix, brand, branding, logistics

INTRODUCTION

In today's competitive business environment, successful operations require an integrated strategy that connects key functions within the organization, including marketing, marketing services, and logistics. These areas are interconnected, and their interdependence forms the foundation for effective and sustainable business policy, enabling organizations to create a strong competitive advantage. Marketing shapes consumer expectations and loyalty, while marketing services provide tailored approaches for intangible products, focusing on quality and customer experience. Logistics ensures timely delivery, which is crucial for customer satisfaction and trust.

The ability of logistics to ensure efficient channels for goods and information directly influences the success of marketing activities and customer satisfaction. High-quality

logistics services, when branded and presented as part of the brand identity, strengthen consumer trust and differentiate the company in the marketplace. Transparency, reliability, and high standards in the delivery of logistics services contribute to enhancing the overall brand and creating a competitive edge.

Understanding the synergy between marketing and logistics is essential for developing holistic strategies that enable long-term growth. When these two functions operate in harmony, they can significantly increase value for customers, improve user experience, and generate additional value for the organization. This integrated approach allows for better adaptation to market demands and strengthening of market position.

Examples and strategies emphasizing the importance of synergy include aligning marketing campaigns with the optimization of logistics processes and branding logistics services as part of the overall brand. Investing in transparent and reliable logistics services, with a focus on quality and customer experience, enables organizations to build trust and loyalty, and to stand out from the competition.

Ultimately, the integration of marketing and logistics creates a foundation for long-term success, enhances customer satisfaction, and strengthens market position. When these functions work in harmony, organizations can maximize the potential of their offerings, create sustainable competitive advantages, and ensure continuous growth in the marketplace.

THE ROLE OF MARKETING IN BUSINESS

"Marketing is the process of planning and executing the concept of price, promotion, distribution, and ideas, products, and services to create exchanges that satisfy the needs of individuals and organizations."[91]

2.1 Marketing mix for services – 7P MODEL "Services are activities, deeds, or benefits that one party can offer to another, with the primary outcomes being intangible and not resulting in ownership."[92]

The marketing mix for services extends the traditional 4P model—product, price, promotion, and distribution—by adding three additional elements: people, process, and physical evidence. This expanded 7P model helps businesses in shaping strategies for the promotion and delivery of services.

[91] Kotler P. 1967. Marketing Management. First Edition. Boston, USA

[92] Haramija P., Miličević K., Babić A., Kuštrak A., Čaić K. 2014. Services Marketing. MATE Publishing, Zagreb, p.15

Picture 1: Extended Marketing Mix of Services



Source: https://atauctus.hr/blog/sto-je-marketinski-miks/

- Product/Service = Product; the service itself with its characteristics, quality, and benefits.
- Price = Price; determines value but should be competitive in the market.
- Distribution – Place; includes locations such as physical locations, online platforms, or mobile applications.
- Promotion = Promotion; encompasses promotional messages, public relations, and social media.
- People = People; those who provide the service play a key role in shaping the customer experience.
- Process = Processes; the way services are delivered, including activities and procedures.
- Physical Environment = Physical Evidence; includes the space and packaging that influence perceptions of quality.

BRANDING OF SERVICES

Branding is a set of activities and processes aimed at creating, communicating, and delivering marketing messages. The goal of branding is: to increase business performance to raise awareness of the brand to enhance its attractiveness, reputation, and loyalty.

A brand is a collection of values, characteristics, and emotions that form the "personality" of a business, serving as a symbol of reliability and quality, and influencing the subconscious of consumers, helping to recognize a product or company.

The physical elements of brand identity make it recognizable and contribute to a strong, unique, and innovative visual identity, which is key to marketing communication.

Brand identity is a tool for clear communication and consists of visual and verbal identity.

1. The visual identity of the brand includes:

• logo,

• symbol,

• design.

2. The verbal identity of the brand refers to:

• brand name,

• brand slogan,

• key brand messages,

• brand story.

3.1 Branding of logistics services

Branding a logistics service is crucial for creating recognition, trust, and loyalty among clients, thereby increasing competitiveness in the market. The synergy between marketing and logistics strengthens the overall brand strategy.

Key aspects of branding a logistics service include:

• **Brand identity** – creating a recognizable visual identity that reflects the company's values and professionalism.
• **Service quality** – consistently providing high-quality, accurate, and reliable services.
• **Perception and reputation** – creating positive experiences for clients that contribute to a good image and recommendations.
• **Communication and marketing** – effectively highlighting advantages, innovations, and unique solutions through various channels such as websites, social media, and advertising spaces.
• **Loyalty and relationships** – building long-term relationships with clients through personalized services, support, and transparency.
• **Differentiation from competitors** – emphasizing specific advantages like fast delivery, safety, or eco-friendly initiatives that make the brand recognizable.

Ultimately, branding a logistics service helps companies stand out in the market, increase client trust, and create additional value for their services.

EXAMPLE OF A SUCCESSFUL BRAND AT THE COMPANY "TerraLog Varaždin, Croatia"

The company TerraLog d.o.o. specializes in organizing both international and domestic transportation of various types of goods, utilizing all available modes of transport. Their foundation is built on trust and respect, which they develop with partners and clients; this is the basis of their successful business.

Picture 2: TerraLog Company Logo



Source: https://www.terralog.hr/#about_us

- **Brand identity** – stylized letters L, O, and G, which form the end of the company name and the beginning of the words "logistics." L is from the outside, while O and G share a common design. The Latin word "terra," meaning "earth," is fittingly used here as a translation, envisioned as "planetary logistics."

- **Service quality** – finding the most optimal solution that satisfies the needs of all involved parties. The key factors of our work are service quality, speed, reliability, and precision, as well as maintaining our company's good reputation.

"Trust, respect, and motivation are our main qualities."

Perception and reputation – our team consists of motivated experts who are available 24 hours a day and are fully dedicated to their work. The knowledge and years of experience gained in related companies enable us to offer a wide range of services tailored to our clients' needs.

Communication and marketing – the company promotes itself through social media platforms such as Facebook, LinkedIn, and Instagram, where it has approximately 1,500 followers.

Loyalty and relationships – organizing team-building gatherings and Christmas gift exchanges for employees and children, such as "Secret Santa," strengthen interpersonal relationships within the organization, fostering trust and teamwork.

Differentiation from competitors – achieved through a quote from French writer and Nobel laureate Anatole France, emphasizing the importance of synergy in activities, dreams, planning, vision, and faith to achieve great success.

"We do not only need to act to achieve great things, but also to dream; we do not only need to plan, but also to believe."[93]

Contact us with confidence, and together we will achieve your goals.

VIRTUAL TRAINING COMPANY OF THE MECHANICAL AND TRANSPORTATION SCHOOL OF VARAŽDIN "GAVRAN-ŠPED" Ltd.

Students, as part of Practical Training, establish a virtual training company where they carry out various activities, including founding the company, choosing the company name, logo, design, colors, and slogan. The brand of the virtual training company, whose activity is freight forwarding, representation in goods transportation, and storage services, is shown in the example.

[93] Anatole France, French writer and Nobel laureate

Picture 3: Logo of the Virtual Traineeship Company of the Mechanical and Traffic School



SLOGAN:

„Your cargo is our care – from warehouse to destination.“

Source: gavran.sped@gmail.com

Students use elements of marketing such as branding, promotion, communication, and engagement to create and develop their brand, thereby standing out in their community and building their future recognition.

CONCLUSION

Marketing and logistics are closely interconnected because they both play a key role in successful business operations. Marketing focuses on creating demand for products or services, while logistics ensures that these products or services are available to customers at the right place and at the right time.

When marketing successfully promotes a product, logistics must be ready to deliver it. This includes managing warehouses, transportation, and distribution. If logistics cannot meet the demand generated by marketing, it can lead to customer dissatisfaction and loss of sales.

On the other hand, information from logistics can help marketing better understand market trends and customer needs, which can improve promotion and sales strategies. Essentially, a successful business model requires the synergy of these two functions to achieve maximum efficiency and customer satisfaction.

LITERATURE

BOOKS

Haramija P., Miličević K., Babić A., Kuštrak A., Čaić K.: Marketing of Services. Publisher MATE, Zagreb, 2014. p.15

Čižmek Vujnović O., Krupa Z., Pavičić J., Vlašić G.: Marketing. Školska knjiga, Zagreb, 2021.

Kotler P. 1967. Marketing Management. First edition. Boston, USA

Websites:

https://atauctus.hr/blog/sto-je-marketinski-miks/_, 10.4.2025.

https://www.terralog.hr/#about_us, 10.04.2025.

List of picture:

- Picture 1: Extended marketing mix of services
- Source: https://atauctus.hr/blog/sto-je-marketinski-miks/
- Picture 2: Logo of the TerraLog company
- Source: https://www.terralog.hr/#about_us
- Picture 3: Logo of the virtual internship company of the Mechanical and Traffic School

Source: gavran.sped@gmail.com

Uroš Zajec dipl. inž. str.

SIC Ljubljana
Strokovni izobraževalni center Ljubljana

Ptujska ulica 6, 1000 Ljubljana

uros.zajec@siclj.si

UPORABA SODOBNIH MATERIALOV V AVTOMOBILSKI INDUSTRIJI

XV. mednarodni simpozij
INTERDISCIPLINARNOST LOGISTIKE IN PROMETA

Organizator

ŠC Celje, Srednja šola za storitvene dejavnosti in logistiko

25. – 27. september 2025, Portorož

Fakulteta za pomorstvo in promet, Portorož

Povzetek

Razvoj materialov v avtomobilski industriji je danes eden ključnih dejavnikov prehoda v trajnostno mobilnost. Klasično jeklo in aluminij se nadgrajujeta z visoko-trdnostnimi zlitinami, lahkimi kovinami, kompoziti in naravnimi vlakni, ki omogočajo zmanjšanje mase vozila ter nižji ogljični odtis. Hkrati se povečuje delež recikliranih materialov, skladno z zahtevami EU, medtem ko pametni materiali – kot so samoobnavljajoči premazi, solarni sloji in barve, ki spreminjajo odtenek – karoserijo spreminjajo v aktiven del vozila. Varnost ostaja prednostna naloga, zato se uveljavljajo hibridne strukture, ki združujejo ultratrdna jekla, aluminij in kompozite ter omogočajo enako ali višjo stopnjo zaščite ob manjši masi. Izziv predstavljajo stroški in proizvodna hitrost, saj morajo novi materiali omogočati množično uporabo, kar dokazujejo inovacije, kot sta giga-casting in hitri RTM. Avtomobil prihodnosti bo zato lažji, varnejši, trajnostnejši in pametnejši, kar potrjuje prehod iz tradicionalnih k celovitim, trajnostno naravnanim materialnim rešitvam.

Ključne besede: trajnostni materiali, zmanjšanje mase, recikliranje, pametni materiali, varnost

Uvod

Avtomobilska industrija je danes v obdobju najintenzivnejših sprememb v svoji več kot stoletni zgodovini, saj razvoj materialov ne sledi več zgolj klasičnemu cilju zmanjševanja mase vozil, temveč vse bolj vključuje zahteve po trajnosti, krožnem gospodarstvu in pametnih funkcionalnostih. Tradicionalni materiali, kot sta jeklo in aluminij, so doživeli temeljite nadgradnje – v uporabi so visoko- in ultra-trdnostna jekla, hibridne aluminijeve zlitine ter lahke kovine, kot je magnezij, ki omogočajo oblikovanje tanjših, a varnejših konstrukcij. Vzporedno se širijo tudi kompozitni materiali, kjer poleg steklenih in ogljikovih vlaken vse večji pomen dobivajo naravna vlakna, kot so lan, konoplja in bambus, ki v kombinaciji s sodobnimi polimeri prinašajo zmanjšan ogljični odtis in nove estetske možnosti. Prihodnost oblikujejo tudi povsem novi koncepti, kot so samoobnavljajoči premazi, ki zacelijo drobne praske, solarni sloji, ki karoseriji omogočajo proizvodnjo električne energije, ter trajnostne pnevmatike, izdelane iz recikliranih ali bioloških virov. Vozilo prihodnosti tako ne bo zgolj lažje in energetsko učinkovitejše, temveč tudi pametnejše, okolju prijaznejše in bolj prilagojeno zahtevam krožnega gospodarstva, ki postavlja nove standarde za celotno industrijo.

Sedanjost kot prehodno obdobje

Kovine še vedno tvorijo osnovo sodobne avtomobilske industrije, saj predstavljajo največji delež mase vozila. Jeklo, ki je prisotno že od začetkov avtomobilizma, danes obsega približno polovico mase avtomobila. Klasične pločevine so zamenjala visoko- in ultra-trdnostna jekla, ki omogočajo tanjše plošče, manjšo maso in hkrati večjo odpornost proti trkom. Pomemben delež ima tudi aluminij, ki ga proizvajalci uporabljajo za motorne pokrove, vrata, prtljažna vrata ter pri t. i. “megacastingih”, kjer se iz enega ulitka izdela velik nosilni del karoserije. Magnezij in titan sta še vedno omejeno prisotna, a pridobivata pomen pri lahkih konstrukcijah, kjer je ključno razmerje med maso in trdnostjo, na primer pri sedežnih okvirjih, volanskih ogrodjih in športnih komponentah.

Ob kovinah imajo vse večjo vlogo plastika in kompoziti, saj združujejo lahkost, odpornost proti koroziji in prilagodljivost pri oblikovanju. Plastika danes predstavlja že do petino mase vozila in kar polovico prostornine komponent. Najpogosteje uporabljeni so polipropilen, poliamidi, ABS in poliuretani, ki služijo za izdelavo odbijačev, notranjih oblog, rezervoarjev in izolacij. Kompoziti, ojačani s steklenimi vlakni, omogočajo izdelavo lažjih zunanjih panelov, streh in notranjih struktur. Ogljikova vlakna so zaradi visoke cene še vedno omejena na športne in premium modele, a njihova uporaba počasi prehaja tudi v električna vozila, kjer je zmanjšanje mase odločilno za doseg. V notranjosti pa vse bolj najdemo naravna vlakna, kot so lan, konoplja, kenaf in bambus, ki so lažja in okolju prijaznejša ter nadomeščajo steklena vlakna.

Vzporedno se krepi uporaba recikliranih in trajnostnih materialov. Reciklirano jeklo in aluminij sta postala standardna izbira, saj imata občutno manjši ogljični odtis od primarne proizvodnje. Aluminij se lahko reciklira z do 95 % manj porabljene energije, kar je eden ključnih razlogov za njegovo širšo rabo. Plastika iz recikliranih virov je še v fazi razvoja, a njena uporaba hitro raste – Ford uporablja plastiko iz recikliranih PET plastenk za sedežne prevleke, Volvo pa vključuje materiale iz ribiških mrež in oceanske plastike v notranje obloge električnih vozil. Tudi pnevmatike doživljajo spremembe: proizvajalci razvijajo zmesi na osnovi sojinega olja, riževih luščin in recikliranega kavčuka, pri čemer je dolgoročni cilj 100-odstotna trajnostna pnevmatika.

Poleg trajnosti se industrija usmerja tudi v pametne materiale in nove funkcionalnosti. Nissan je razvil samoobnavljajoče premaze, ki lahko sami zacelijo manjše praske, BMW pa je s prototipom iX Flow predstavil karoserijo z e-ink tehnologijo, ki lahko spremeni barvo. Takšne rešitve ne prinašajo le estetskih novosti, temveč tudi praktične koristi, kot je zmanjšana poraba energije zaradi prilagajanja barve okolju. Hyundai in Mercedes eksperimentalno vgrajujeta solarne panele v strehe vozil, kar omogoča pridobivanje dopolnilne energije, obetavne pa so tudi raziskave prevodnih kompozitov, ki bi lahko združevali mehansko in elektronsko funkcijo.

Sedanja avtomobilska industrija je tako v izrazitem prehodnem obdobju. Tradicionalni materiali, kot sta jeklo in aluminij, ostajajo ključni, vendar jih vse bolj dopolnjujejo plastika, kompoziti, reciklati in naravna vlakna. Hkrati pa se vgrajujejo prvi pametni materiali, ki vozilom dodajajo nove sposobnosti. Rezultat so avtomobili, ki združujejo lahkost, varnost, trajnost in tehnološko naprednost. Sedanjost torej predstavlja most med tradicijo in prihodnostjo, saj avtomobili postajajo lažji, pametnejši in bolj prijazni okolju, pri čemer je prav izbor in kombinacija materialov eden najpomembnejših dejavnikov njihovega nadaljnjega razvoja.

Cilji avtomobilske industrije pri materialih

Avtomobilska industrija je v zadnjem desetletju stopila v obdobje intenzivnih sprememb, kjer razvoj materialov ne pomeni več le iskanja lahkih konstrukcij, temveč celovit pristop k trajnosti, varnosti, pametnim funkcionalnostim in proizvodni učinkovitosti. Globalni pritiski, kot so zahteve po zmanjšanju emisij CO_2, hitra elektrifikacija voznega parka in strožji varnostni standardi, usmerjajo proizvajalce k iskanju inovativnih rešitev, ki bodo kos tem izzivom. Materiali tako postajajo ključni dejavnik prihodnosti avtomobilov – od njihove mase in vpliva na energetsko učinkovitost, do možnosti recikliranja in integracije novih funkcij, ki presegajo klasično vlogo karoserije kot zaščitnega oklepa. Cilji razvoja

materialov v avtomobilski industriji se danes lahko strnejo v pet glavnih področij, ki skupaj oblikujejo strategijo za naslednjih 10 do 20 let.

- **Zmanjšanje mase (lightweighting)**

  Vsakih 10 % manj mase pomeni približno 6–7 % manjšo porabo goriva oziroma 5–7 % večji doseg električnih vozil (U.S. DoE, 2022). Cilj industrije je ohraniti enako ali večjo stopnjo varnosti ob manjši masi, kar se dosega z uporabo naprednih jekel (AHSS, Gen3), aluminija, magnezija, kompozitov iz ogljikovih vlaken ter hibridnih kompozitov.

- **Trajnost in krožno gospodarstvo**

  Evropska unija je določila, da morajo biti do leta 2035 vsa nova vozila brezemisijska, do leta 2030 pa mora vsak avtomobil vsebovati določen delež recikliranih materialov, kot so jeklo, aluminij in plastika. Cilj je doseči popolno reciklabilnost materialov ter povečati delež naravnih kompozitov, kot so lan, konoplja in bambus. Reciklirano jeklo in aluminij sta že standard, saj je pri aluminiju stopnja recikliranosti več kot 90 %.

- **Varnost in trdnost**

  Materiali morajo prenesti vse strožje crash-teste, kot bo to veljalo pri EuroNCAP po letu 2030. Rešitev so hibridne strukture, ki združujejo lahkost in sposobnost absorpcije energije. Primer je kombinacija ultratrdnih jekel in aluminija v karoseriji, ki omogoča do 30 % manj mase ob enaki stopnji zaščite potnikov.

- **Pametni in večfunkcionalni materiali**

  Karoserija prihodnosti ne bo več le zaščitni oklep, temveč aktivni del vozila. V razvoju so samoobnavljajoči premazi, ki zacelijo manjše praske, barve, ki spreminjajo odtenek (BMW iX Flow z e-ink tehnologijo), ter solarni premazi, ki omogočajo proizvodnjo električne energije. Vzporedno se razvijajo prevodni kompoziti, ki omogočajo integracijo senzorjev in elektronike v samo strukturo karoserije. Cilj so materiali, ki združujejo več funkcij hkrati – zaščito, estetiko in energetsko učinkovitost.

- **Nižji stroški in serijska proizvodnja**

  Napredni materiali, kot so ogljikova vlakna, prozorni aluminij (ALON) in perovskitni premazi, so trenutno dragi in zahtevni za obdelavo. Industrija si zato prizadeva razviti procesno učinkovite materiale, ki bodo omogočali visoko serijsko proizvodnjo v nekaj deset sekundah, kar je standard v avtomobilski industriji. Med rešitvami so gigacasting pri Tesli (veliki aluminijasti ulitki) ter hitri RTM procesi za kompozite, ki omogočajo bistveno krajše proizvodne čase in nižje stroške.

Zmanjševanje mase vozila

Zmanjševanje mase vozila je ključna naloga sodobne avtomobilske industrije, saj vpliva na energetsko učinkovitost, vozno dinamiko in doseg električnih vozil. Cilj proizvajalcev ni le lažje vozilo, ampak predvsem kombinacija manjše mase ob enaki ali večji stopnji varnosti. To dosežejo s prepletom lahkih materialov, optimizacije konstrukcij in novih proizvodnih procesov.

- napredna jekla (AHSS, Gen3) – tanjše pločevine z enako trdnostjo
- aluminij in magnezij – lahki kovinski deli karoserije, podvozja in sedežnih okvirjev
- kompoziti (CFRP, GFRP) – strešni paneli, varnostne celice, zunanje obloge
- naravna vlakna (lan, konoplja, bambus) – trajnostna zamenjava steklenih vlaken
- topološka optimizacija – računalniško zasnovane strukture z manj materiala
- integracija funkcij – manj delov, manj spojev in vijakov
- strukturne baterije – baterijski paket kot nosilni del vozila

V praksi to pomeni, da proizvajalci ne zamenjujejo zgolj materialov, ampak pogosto na novo razmišljajo o sami zasnovi vozila. Tesla na primer z giga casting tehnologijo izdela celoten zadnji del karoserije iz enega ulitka in s tem odpravi več deset manjših delov, kar zmanjša maso in stroške hkrati. BMW je pri modelu i3 uvedel karoserijo iz ogljikovih vlaken, s čimer je pridobil več kot 200 kilogramov prihranka. Audi pa s svojo aluminijasto konstrukcijo ASF pri limuzini A8 dokazuje, da je možno prihraniti več sto kilogramov tudi v velikem luksuznem vozilu.

Pri električnih avtomobilih pa postajajo najpomembnejši lahki materiali za baterijska ohišja in uporaba strukturnih baterij, kjer baterijski paket hkrati deluje kot nosilni element karoserije. S tem se ne zmanjša le masa, ampak tudi poveča togost vozila. Pnevmatike, platišča in vzmetenje so dodatna področja, kjer aluminij in kompoziti omogočajo prihranke pri nepodprti masi, kar izboljša lego vozila in udobje.

Recikliranje materialov

Trajnost in krožno gospodarstvo sta danes eno od osrednjih izhodišč razvoja avtomobilske industrije. Namen ni le zmanjševanje emisij med vožnjo, temveč tudi zmanjšanje okoljskega odtisa v celotnem življenjskem ciklu vozila – od proizvodnje do recikliranja. To pomeni, da mora biti že sama zasnova avtomobila prilagojena ponovni uporabi in učinkovitemu kroženju materialov.

- EU zahteva do leta 2035: vsa nova vozila morajo biti brez emisij CO_2
- do leta 2030: določen delež recikliranih materialov v vsakem avtomobilu (jeklo, aluminij, plastika)
- cilj industrije: 100 % reciklabilnost materialov
- večja uporaba naravnih kompozitov (lan, konoplja, bambus)
- reciklirano jeklo in aluminij sta že standard; pri aluminiju je stopnja recikliranosti nad 90 %

V praksi to pomeni, da proizvajalci vlagajo v razvoj novih materialov, ki omogočajo preprostejše recikliranje, hkrati pa zmanjšujejo ogljični odtis proizvodnje. Aluminij in jeklo imata pri tem pomembno prednost, saj je mogoče ta materialna tokova skoraj v celoti ponovno vključiti v proizvodnjo brez izgube kakovosti. Plastika predstavlja večji izziv, zato proizvajalci uvajajo reciklirane polimere, pogosto pridobljene iz odpadnih plastenk ali drugih virov. Naravna vlakna, kot so lan, konoplja in bambus, ponujajo trajnostno alternativo umetnim vlaknom in so vse pogosteje uporabljena v notranjih in zunanjih kompozitnih delih.

Kljub zmanjševanju teže se povečuje varnost

Varnost in trdnost materialov sta za avtomobilsko industrijo ključnega pomena, saj morajo vozila kljub zmanjševanju mase zagotavljati enako ali celo višjo stopnjo zaščite potnikov. V prihodnosti bodo crash-testi (npr. EuroNCAP 2030+) še strožji, kar pomeni, da bodo materiali morali prenesti večje obremenitve ob hkratnem zagotavljanju manjše mase in večje energetske učinkovitosti.

- materiali morajo prestati strožje varnostne preizkuse (EuroNCAP 2030+)
- cilj so hibridne strukture, ki združujejo lahkost in sposobnost absorpcije energije
- kombinacija ultratrdnih jekel in aluminija v karoseriji omogoča do 30 % manjšo maso ob enaki zaščiti

Pristop k varnosti danes temelji na kombinaciji različnih materialov v eni strukturi. Ultratrdna jekla se uporabljajo na mestih, kjer je potrebna največja togost, na primer pri stebrih karoserije in varnostni kletki. Aluminij in kompoziti se vključujejo tam, kjer je mogoče doseči prihranek mase brez kompromisov pri varnosti, npr. v vratih, pokrovih in pomožnih konstrukcijah. Takšna hibridna zasnova omogoča optimalno porazdelitev sil ob trku ter učinkovito absorpcijo energije, hkrati pa zagotavlja, da vozilo ostane lažje in bolj energetsko učinkovito.

Večfunkcionalni materiali predstavljajo prihodnost

Pametni in večfunkcionalni materiali pomenijo enega največjih preskokov v razvoju avtomobilov, saj karoserija ni več zgolj pasiven zaščitni element, ampak postaja aktiven del vozila. Ti materiali združujejo strukturno funkcijo z dodatnimi lastnostmi, kot so samodejno obnavljanje, spreminjanje barve, proizvodnja energije ali integracija elektronike. Njihov cilj je povečati trajnost, zmanjšati potrebo po vzdrževanju in hkrati izboljšati uporabniško izkušnjo.

- samoobnavljajoči premazi, ki samodejno zacelijo manjše praske
- barvno prilagodljiva karoserija (primer: BMW iX Flow z e-ink tehnologijo)
- solarni premazi, ki pretvarjajo sončno svetlobo v električno energijo
- prevodni kompoziti za vgradnjo senzorjev in elektronskih sistemov
- cilj: materiali, ki združujejo zaščito, energijsko učinkovitost in estetiko

V praksi to pomeni, da bo vozilo prihodnosti aktivno sodelovalo v svojem delovanju: površina avtomobila bo sposobna regeneracije ob manjših poškodbah, barva se bo lahko prilagodila okolju ali vremenskim razmeram, kar bo prispevalo tudi k energetski učinkovitosti, solarni premazi pa bodo vozilu omogočili delno energijsko samooskrbo. Prevodni kompoziti dodatno omogočajo vgradnjo senzorjev neposredno v strukturo karoserije, kar zmanjšuje potrebo po ločenih elektronskih komponentah in hkrati zmanjšuje maso. Takšni materiali nakazujejo prihodnost, kjer bo avtomobil postal inteligentna celota, ki bo združevala mehanske, estetske in energetske funkcije v enotno zasnovo.

Pridobivanje surovin in proizvodnja

Eden od največjih izzivov pri uvajanju novih materialov v avtomobilsko industrijo so stroški in zahtevnost proizvodnje. Čeprav napredni materiali, kot so ogljikova vlakna (CFRP), prozorni aluminij (ALON) ali perovskitni premazi, ponujajo odlične lastnosti, njihova visoka cena in počasni proizvodni postopki omejujejo njihovo širšo uporabo v serijski proizvodnji. Avtomobilska industrija pa temelji prav na hitri in stroškovno učinkoviti izdelavi, kjer mora nastajati ena komponenta v nekaj deset sekundah, da je proizvodnja ekonomsko vzdržna.

- napredni materiali so danes dragi in zahtevni za obdelavo (CFRP, ALON, perovskiti)
- cilj: razviti procesno učinkovite materiale za serijsko proizvodnjo (< 60 sekund na kos)
- primer: giga-casting pri Tesli z aluminijastimi ulitki
- primer: hitri RTM (Resin Transfer Molding) procesi za izdelavo kompozitov

V praksi to pomeni, da morajo proizvajalci iskati ravnotežje med zmogljivostjo materiala in njegovo predelovalnostjo. Ogljikova vlakna so na primer izjemno lahka in trdna, a njihova izdelava je počasna in draga, zato jih najdemo predvsem v športnih in prestižnih modelih. Tesla je s tehnologijo giga-casting pokazala, da je mogoče z enim velikim aluminijastim ulitkom nadomestiti več deset delov karoserije, kar ne samo zmanjša maso in število sestavnih kosov, temveč tudi bistveno zniža stroške. Podobno hitri RTM procesi omogočajo, da se kompoziti oblikujejo v nekaj minutah, kar jih približuje standardom serijske proizvodnje. Prihodnji razvoj bo zato usmerjen v materiale in procese, ki omogočajo enako raven inovativnosti, a ob bistveno nižjih stroških in hitrejših proizvodnih časi

Zaključek

Zaključimo lahko, da avtomobilska industrija na področju materialov stoji na prelomnici, kjer se tradicionalne rešitve prepletajo z naprednimi tehnologijami in trajnostnimi usmeritvami. Jeklo in aluminij ostajata temelj vozil, vendar se vse bolj dopolnjujeta s kompoziti, reciklati in naravnimi vlakni, ki prinašajo manjšo maso in nižji ogljični odtis. Vzporedno se razvijajo pametni in večfunkcionalni materiali, ki karoserijo spreminjajo v aktiven element vozila – sposobno samozdravljenja, proizvodnje energije ali integracije elektronike. Cilj industrije je oblikovati avtomobil prihodnosti, ki bo lahek, varen, energetsko učinkovit in popolnoma vključen v krožno gospodarstvo. To pomeni, da vozila ne bodo več le sredstvo prevoza, temveč inteligentni, trajnostni sistemi, ki bodo povezovali mehanske, estetske in digitalne funkcije v enotno celoto. Ključ do tega prehoda pa leži prav v izbiri in kombinaciji materialov, ki bodo hkrati omogočali množično proizvodnjo, stroškovno učinkovitost in izpolnjevanje vse strožjih okoljskih ter varnostnih zahtev.

Viri in literatura

- Švajger, G. (2010) *Sodobni materiali v vozilih in njihov vpliv na okolje in varnost v cestnem prometu* (diplomsko delo). Univerzitetni študijski program, mentor Matjaž Šraml. Openscience.si.
- U.S. Department of Energy. *Lightweight Materials for Cars and Trucks*. Energy.gov. Pridobljeno s https://www.energy.gov/eere/vehicles/lightweight-materials-cars-and-

trucks

- Euro NCAP. *Vision 2030: A Safer Future for Mobility*. Euro NCAP, november 2022. Pridobljeno s https://cdn.euroncap.com/media/74468/euro-ncap-roadmap-vision-2030.pdf
- BMW Group. *The BMW iX Flow Featuring E Ink*. BMW Press Release, 5 januar 2022. Pridobljeno s https://www.press.bmwgroup.com/global/article/detail/T0363158EN/magical-exterior-colour-change%3A-the-bmw-ix-flow-featuring-e-ink?language=en
- National Renewable Energy Laboratory (NREL). *Quantitative Effects of Vehicle Parameters on Fuel Consumption and Fuel Economy by Modeling and Simulating Heavy-Duty Trucks.* FASTSim Study
- U.S. Department of Energy, Vehicle Technologies Office. *Reducing Vehicle Weight and Improving U.S. Energy Efficiency Using Integrated Computational Materials Engineering*
- European Commission / Euro NCAP. *SAFE-UP Project: Key Research for Euro NCAP's Future Vehicle Safety Assessment*. Pridobljeno s Urban Mobility Observatory, 2022.
- Inštitut za kovinske materiale in tehnologije. *Odkovki iz gnetnih magnezijevih zlitin (GMZ) in Mg/SiC-kompozit MELRAM*. Materiali in tehnologije, 36(1-2), str. 15-24.

Uroš Zajec M. Sc. Eng.

SIC Ljubljana
Strokovni izobraževalni center Ljubljana

Ptujska ulica 6, 1000 Ljubljana

uros.zajec@siclj.si

USE OF MODERN MATERIALS IN THE AUTOMOTIVE INDUSTRY



Abstract

The development of materials in the automotive industry is today one of the key factors in the transition to sustainable mobility. Conventional steel and aluminum are being upgraded with high-strength alloys, lightweight metals, composites, and natural fibers, which enable vehicle weight reduction and a lower carbon footprint. At the same time, the share of recycled materials is increasing, in line with EU requirements, while smart materials – such as self-healing coatings, solar layers, and color-changing paints – are transforming the car body into an active part of the vehicle. Safety remains a priority, which is why hybrid structures combining ultra-high-strength steels, aluminum, and composites are being implemented, providing equal or higher levels of protection at reduced weight. Costs and production speed represent a challenge, as new materials must be suitable for mass production, as demonstrated by innovations such as giga-casting and rapid RTM. The car of the future will therefore be lighter, safer, more sustainable, and smarter, confirming the transition from traditional to comprehensive, sustainability-oriented material solutions.

Keywords: sustainable materials, lightweighting, recycling, smart materials, safety

Introduction

The automotive industry is currently undergoing one of the most intensive periods of change in its more than century-long history, as the development of materials no longer follows only the classical goal of reducing vehicle weight, but increasingly incorporates the requirements of sustainability, circular economy, and smart functionalities. Traditional materials, such as steel and aluminum, have been significantly upgraded – high- and ultra-high-strength steels, hybrid aluminum alloys, and lightweight metals such as magnesium are now in use, enabling the design of thinner yet safer structures. At the same time, composite materials are expanding, where in addition to glass and carbon fibers, natural fibers such as flax, hemp, and bamboo are becoming increasingly important. In combination with modern polymers, they provide reduced carbon footprints and new aesthetic possibilities. The future is also shaped by entirely new concepts such as self-healing coatings that repair minor scratches, solar layers that allow the bodywork to generate electricity, and sustainable tires made from recycled or biological sources. The car of the future will therefore not only be lighter and more energy-efficient but also smarter, more environmentally friendly, and better adapted to the requirements of the circular economy, which is setting new standards for the entire industry.

The present as a transitional period

Metals still form the basis of the modern automotive industry, as they represent the largest share of vehicle mass. Steel, which has been present since the beginning of the automotive era, today accounts for about half of a vehicle's weight. Classic sheet metal has been replaced by high- and ultra-high-strength steels, which allow for thinner panels, lower weight, and at the same time greater crash resistance. Aluminum also plays an important role, being used for hoods, doors, trunk lids, and in so-called "megacastings," where a large load-bearing body component is manufactured from a single casting. Magnesium and

titanium are still used in limited amounts but are gaining importance in lightweight structures where the ratio of weight to strength is crucial, for example in seat frames, steering columns, and sports components. Alongside metals, plastics and composites are gaining an increasingly important role, as they combine lightness, corrosion resistance, and design flexibility. Plastics already represent about one-fifth of a vehicle's weight and almost half of its component volume. The most commonly used are polypropylene, polyamides, ABS, and polyurethanes, which are used to produce bumpers, interior trim, tanks, and insulation. Composites reinforced with glass fibers allow the production of lighter exterior panels, roofs, and interior structures. Carbon fibers, due to their high cost, are still limited to sports and premium models, but their use is gradually expanding into electric vehicles, where weight reduction is crucial for range. In interiors, natural fibers such as flax, hemp, kenaf, and bamboo are increasingly being used, as they are lighter and more environmentally friendly, replacing glass fibers. At the same time, the use of recycled and sustainable materials is strengthening. Recycled steel and aluminum have become standard choices, as they have a significantly lower carbon footprint compared to primary production. Aluminum can be recycled with up to 95% less energy consumption, which is one of the key reasons for its wider use. Plastics from recycled sources are still in development, but their use is growing rapidly – Ford uses plastic from recycled PET bottles for seat covers, while Volvo includes materials from fishing nets and ocean plastics in the interior trim of electric vehicles. Tires are also changing: manufacturers are developing compounds based on soybean oil, rice husks, and recycled rubber, with the long-term goal of achieving a 100% sustainable tire. In addition to sustainability, the industry is also focusing on smart materials and new functionalities. Nissan has developed self-healing coatings that can repair minor scratches, while BMW presented the iX Flow prototype with e-ink technology, which can change color. These solutions do not only bring aesthetic innovations but also practical benefits, such as reduced energy consumption due to color adaptation to the environment. Hyundai and Mercedes are experimenting with solar panels integrated into vehicle roofs, enabling the generation of supplementary energy, while research into conductive composites is promising, as they could combine mechanical and electronic functions.
The current automotive industry is thus in a pronounced transitional period. Traditional materials such as steel and aluminum remain key, but they are increasingly being complemented by plastics, composites, recyclates, and natural fibers. At the same time, the first smart materials are being introduced, giving vehicles new capabilities. The result is cars that combine lightness, safety, sustainability, and technological advancement. The present therefore represents a bridge between tradition and the future, as cars become lighter, smarter, and more environmentally friendly, with the choice and combination of materials being one of the most important factors in their further development.

Goals of the automotive industry in terms of materials

Over the last decade, the automotive industry has entered a period of intense change, where material development no longer means just the search for lightweight structures but a comprehensive approach to sustainability, safety, smart functionalities, and production efficiency. Global pressures such as the demand to reduce CO_2 emissions, the rapid electrification of fleets, and stricter safety standards are driving manufacturers to seek innovative solutions capable of meeting these challenges. Materials thus become a key factor in the future of automobiles – from their weight and impact on energy efficiency to

recycling potential and integration of new functions that go beyond the classical role of the car body as a protective shell. The goals of material development in the automotive industry today can be summarized in five main areas, which together shape the strategy for the next 10 to 20 years.

• Weight reduction (lightweighting)

Every 10% reduction in weight means approximately 6–7% lower fuel consumption or 5–7% greater range for electric vehicles (U.S. DoE, 2022). The industry's goal is to maintain the same or higher level of safety with less weight, achieved through the use of advanced steels (AHSS, Gen3), aluminum, magnesium, carbon-fiber composites, and hybrid composites.

• Sustainability and circular economy

The European Union has mandated that all new vehicles must be emission-free by 2035, and by 2030 each car must contain a certain share of recycled materials such as steel, aluminum, and plastics. The goal is to achieve complete recyclability of materials and increase the share of natural composites such as flax, hemp, and bamboo. Recycled steel and aluminum are already standard, with aluminum having a recycling rate of more than 90%.

• Safety and strength

Materials must withstand increasingly stringent crash tests, as will be the case with EuroNCAP after 2030. The solution lies in hybrid structures that combine lightness with energy absorption. An example is the combination of ultra-high-strength steels and aluminum in the car body, which allows up to 30% less weight while maintaining the same level of passenger protection.

• Smart and multifunctional materials

The body of the future will no longer be just a protective shell but an active part of the vehicle. Developments include self-healing coatings that repair minor scratches, color-changing paints (BMW iX Flow with e-ink technology), and solar coatings that generate electricity. At the same time, conductive composites are being developed that allow sensors and electronics to be integrated directly into the car's structure. The goal is materials that combine multiple functions simultaneously – protection, aesthetics, and energy efficiency.

• Lower costs and mass production

Advanced materials such as carbon fiber, transparent aluminum (ALON), and perovskite coatings are currently expensive and difficult to process. The industry therefore aims to develop process-efficient materials that will enable high-volume production in just a few tens of seconds, which is the standard in the automotive industry. Solutions include Tesla's gigacasting (large aluminum castings) and rapid RTM processes for composites, which allow significantly shorter production times and lower costs.

Vehicle weight reduction

Reducing vehicle weight is a key task of the modern automotive industry, as it affects energy efficiency, driving dynamics, and the range of electric vehicles. The goal of manufacturers is not only lighter vehicles but above all the combination of lower weight with the same or higher level of safety. This is achieved through a mix of lightweight materials, optimized designs, and new production processes.

• advanced steels (AHSS, Gen3) – thinner sheets with the same strength

• aluminum and magnesium – lightweight metal parts for bodywork, chassis, and seat frames

• composites (CFRP, GFRP) – roof panels, safety cells, exterior panels

• natural fibers (flax, hemp, bamboo) – sustainable replacement for glass fibers

• topology optimization – computer-designed structures with less material

• function integration – fewer parts, fewer joints and fasteners

• structural batteries – battery pack as a load-bearing element of the vehicle

In practice, this means that manufacturers not only replace materials but often rethink the very design of the vehicle. Tesla, for example, uses giga casting technology to produce the entire rear body section from a single casting, eliminating dozens of smaller parts, which reduces weight and costs simultaneously. BMW introduced a carbon-fiber body in the i3 model, resulting in a weight saving of more than 200 kilograms. Audi's aluminum ASF construction in the A8 luxury sedan demonstrates that it is possible to save several hundred kilograms even in a large vehicle.

In electric cars, the most important lightweight applications are for battery housings and structural batteries, where the battery pack also serves as a load-bearing part of the car body. This not only reduces weight but also increases vehicle stiffness. Tires, wheels, and suspensions are additional areas where aluminum and composites provide reductions in unsprung mass, improving handling and comfort.

Recycling of materials

Sustainability and circular economy are today one of the central foundations of automotive industry development. The aim is not only to reduce emissions during driving but also to minimize environmental impact throughout the entire life cycle of the vehicle – from production to recycling. This means that the design of the car itself must already be adapted to reuse and efficient material circulation.

• EU requirement by 2035: all new vehicles must be CO_2 emission-free

• by 2030: a certain share of recycled materials in every car (steel, aluminum, plastics)

• industry goal: 100% recyclability of materials

• greater use of natural composites (flax, hemp, bamboo)

• recycled steel and aluminum already standard; aluminum recycling rate over 90%

In practice, this means that manufacturers are investing in the development of new materials that allow easier recycling while reducing the carbon footprint of production. Aluminum and steel have a major advantage here, as these material streams can be almost fully reintegrated into production without loss of quality. Plastics represent a greater challenge, so manufacturers are introducing recycled polymers, often obtained from discarded plastic bottles or other sources. Natural fibers such as flax, hemp, and bamboo offer a sustainable alternative to synthetic fibers and are increasingly used in interior and exterior composite parts.

Despite weight reduction, safety is increasing

Safety and strength of materials are crucial for the automotive industry, as vehicles must ensure the same or even higher level of passenger protection despite weight reduction. In the future, crash tests (e.g., EuroNCAP 2030+) will be even stricter, which means that materials will have to withstand greater loads while providing lower weight and higher energy efficiency.

• materials must pass stricter safety tests (EuroNCAP 2030+)

• the goal is hybrid structures combining lightness and energy absorption

• combination of ultra-high-strength steels and aluminum in the car body enables up to 30% less weight with the same protection

Today's approach to safety is based on combining different materials within one structure. Ultra-high-strength steels are used where maximum stiffness is required, for example in pillars and the safety cage. Aluminum and composites are incorporated where weight savings can be achieved without compromising safety, e.g., in doors, hoods, and auxiliary structures. Such hybrid designs allow optimal force distribution in a crash and effective energy absorption, while ensuring the vehicle remains lighter and more energy efficient.

Multifunctional materials represent the future

Smart and multifunctional materials represent one of the biggest leaps in automotive development, as the car body is no longer merely a passive protective element but is becoming an active part of the vehicle. These materials combine structural function with additional properties such as self-healing, color change, energy production, or electronics integration. Their goal is to increase sustainability, reduce maintenance needs, and at the same time improve the user experience.

• self-healing coatings that automatically repair minor scratches

• color-changing bodywork (example: BMW iX Flow with e-ink technology)

• solar coatings that convert sunlight into electricity

• conductive composites for integrating sensors and electronic systems

• goal: materials that combine protection, energy efficiency, and aesthetics

In practice, this means that the vehicle of the future will actively participate in its operation: its surface will be capable of regeneration from minor damage, the color will be able to adapt to the environment or weather conditions, contributing to energy efficiency, and solar coatings will enable partial energy self-sufficiency. Conductive composites further allow sensors to be embedded directly into the car body structure, reducing the need for separate electronic components and simultaneously lowering weight. Such materials point to a future where the car becomes an intelligent whole, integrating mechanical, aesthetic, and energy functions into a unified design.

1 Raw material acquisition and production

One of the biggest challenges in introducing new materials into the automotive industry is the cost and complexity of production. Although advanced materials such as carbon fibers

(CFRP), transparent aluminum (ALON), or perovskite coatings offer excellent properties, their high cost and slow production processes limit their wider use in mass production. The automotive industry, however, is based precisely on fast and cost-effective production, where a component must be manufactured in a few tens of seconds to make production economically viable.

• advanced materials are currently expensive and difficult to process (CFRP, ALON, perovskites)

• goal: develop process-efficient materials for mass production (< 60 seconds per part)

• example: Tesla's giga-casting with aluminum castings

• example: rapid RTM (Resin Transfer Molding) processes for composites

In practice, this means that manufacturers must find a balance between material performance and manufacturability. Carbon fibers, for example, are extremely light and strong, but their production is slow and expensive, so they are mostly found in sports and premium models. Tesla, with its giga-casting technology, has shown that it is possible to replace dozens of car body parts with a single large aluminum casting, which not only reduces weight and the number of components but also significantly lowers costs. Similarly, rapid RTM processes enable composites to be formed in a few minutes, bringing them closer to the standards of mass production. Future development will therefore focus on materials and processes that provide the same level of innovation but at significantly lower costs and faster production times.

Conclusion

In conclusion, the automotive industry stands at a crossroads in terms of materials, where traditional solutions intertwine with advanced technologies and sustainability-oriented approaches. Steel and aluminum remain the foundation of vehicles, but are increasingly complemented by composites, recyclates, and natural fibers that reduce weight and carbon footprint. At the same time, smart and multifunctional materials are being developed, transforming the car body into an active element of the vehicle – capable of self-healing, generating energy, or integrating electronics. The goal of the industry is to design the car of the future, which will be light, safe, energy-efficient, and fully integrated into the circular economy. This means that vehicles will no longer be merely means of transport but intelligent, sustainable systems that will connect mechanical, aesthetic, and digital functions into a single whole. The key to this transition lies precisely in the choice and combination of materials, which will simultaneously enable mass production, cost efficiency, and compliance with increasingly strict environmental and safety requirements.

References and Literature

Švajger, G. (2010) *Sodobni materiali v vozilih in njihov vpliv na okolje in varnost v cestnem prometu* (diplomsko delo). Univerzitetni študijski program, mentor Matjaž Šraml. Openscience.si.

U.S. Department of Energy. *Lightweight Materials for Cars and Trucks*. Energy.gov. Pridobljeno s https://www.energy.gov/eere/vehicles/lightweight-materials-cars-and-trucks

Euro NCAP. *Vision 2030: A Safer Future for Mobility*. Euro NCAP, november 2022. Pridobljeno s https://cdn.euroncap.com/media/74468/euro-ncap-roadmap-vision-2030.pdf

BMW Group. *The BMW iX Flow Featuring E Ink*. BMW Press Release, 5 januar 2022. Pridobljeno s https://www.press.bmwgroup.com/global/article/detail/T0363158EN/magical-exterior-colour-change%3A-the-bmw-ix-flow-featuring-e-ink?language=en

National Renewable Energy Laboratory (NREL). *Quantitative Effects of Vehicle Parameters on Fuel Consumption and Fuel Economy by Modeling and Simulating Heavy-Duty Trucks.* FASTSim Study

U.S. Department of Energy, Vehicle Technologies Office. *Reducing Vehicle Weight and Improving U.S. Energy Efficiency Using Integrated Computational Materials Engineering*

European Commission / Euro NCAP. *SAFE-UP Project: Key Research for Euro NCAP's Future Vehicle Safety Assessment*. Pridobljeno s Urban Mobility Observatory, 2022.

Inštitut za kovinske materiale in tehnologije. *Odkovki iz gnetnih magnezijevih zlitin (GMZ) in Mg/SiC-kompozit MELRAM*. Materiali in tehnologije, 36(1-2), str. 15-24.

Mag. Klavdija Živko Pal, univ. dipl. ekon.
Prometna šola Maribor

KROŽNO GOSPODARSTVO V LOGISTIKI

Povzetek:

V prispevku izpostavljamo digitalni potni list kot ključno orodje krožnega gospodarstva, katerega cilji so zmanjšanje uporabe naravnih virov, optimizacija distribucije in zmanjševanje odpadkov v dobavnih verigah. Krožno gospodarstvo temelji na delitvi, ponovni uporabi, popravilu, prenovi in recikliranju obstoječih materialov. Digitalni potni list omogoča sledenje materialov skozi celoten proces. V prispevku predstavljamo primer medpredmetnega povezovanja, kjer dijaki razvijajo poslovne ideje ob upoštevanju smernic krožnega gospodarstva. Povezovanje vsebin podjetništva in logistike v srednješolskem izobraževalnem programu logistični tehnik omogoča prenos znanja in veščin tudi na višje nivoje izobraževanja in v različne oblike šolskega dela.

Uvod

Na Zemlji trenutno živi več kot osem milijard prebivalcev in to število se dnevno povečuje. Večanje števila ljudi pomeni vedno večje potrebe, kar posledično predstavlja rast potreb po surovinah, ki pa niso neomejene. Surovine so omejene, njihovo pridobivanje in uporaba pa predstavljata velik vpliv na okolje.

V prispevku je predstavljena primerjava med linearnim in krožnim gospodarstvom, s poudarki na prednostih in pozitivnih učinkih krožnega gospodarstva, podkrepljeno s primeri dobrih praks.

V kontekstu logistike zahteva krožno gospodarstvo celovit prehod k optimizaciji tokov materialov, podaljšanju življenjske dobe izdelkov in učinkovitemu vračanju virov v proizvodne procese. Evropska unija je začrtala natančen načrt, kako bo do leta 2050 uvedla krožno in podnebno nevtralno gospodarstvo. Med ukrepi je tudi uvajanje digitalnega potnega lista za izdelke. Vendar pa je sprejemanje krožnega gospodarstva dolgotrajen proces, kratek in preprost prehod je skoraj nemogoč, zato je potrebno uvajanje znanja o krožnem gospodarstvu tudi v srednješolske izobraževalne programe. Konkreten primer se navezuje na izobraževalni program logistični tehnik na Srednji Prometni šoli Maribor.

Krožno gospodarstvo

V poglavju bo predstavljena primerjava med linearnim in krožnim modelom gospodarstva, s poudarkom na slednjem modelu, ki izpostavlja predvsem prednosti oziroma učinke krožnega gospodarstva.

Primerjava linearnega modela in krožnega modela gospodarstva

Svetovna gospodarstva delujejo po različnih principih oz. načelih delovanja. Sodobna

gospodarstva si prizadevajo za hiter prehod iz linearnega modela gospodarstva v model krožnega gospodarstva. V nadaljevanju sledi primerjava obeh modelov. Slika 1 prikazuje shematsko primerjavo med linearnim in krožnim modelom gospodarstva.

Slika 1: *Shematska primerjava obeh modelov (https://kimi.si/wp-content/uploads/2018/04/2.jpg, 30. 5. 2025)*



Kot je razvidno s slike 1, temelji linearno gospodarstvo na načelu vzemi – izdelaj – porabi – odvrzi, kar se nanaša na velike količine surovin in energije. Ta model vključuje načrtno zastaranje izdelkov, ki so zasnovani z omejenim rokom trajanja z namenom, da se zavržejo in kupijo novi. Takšen način delovanja gospodarstva povečuje količino odpadkov in ustvarja pritisk na okolje.

Linearni model proizvodnje in potrošnje zahteva nenehno izrabo naravnih virov, surovin in energije, kar povzroča izčrpavanje naravnih virov in negativne okoljske odtise. Emisija toplogrednih plinov se pojavlja predvsem pri proizvodnji in transportu, kar ima prav tako negativne učinke na okolje. Linearni model proizvaja velike količine odpadkov, saj se večina surovin uporabi samo enkrat in nato zavrže kot odpadek, kar posledično vodi do negospodarnega in neustreznega ravnanja s surovinami, ki izgubljajo vrednost tako z ekonomskega kot tudi potrošniškega vidika.

Krožno gospodarstvo pa predstavlja trajnostno alternativo linearnemu modelu gospodarjenja, saj je to gospodarstvo, pri katerem proizvodnja in potrošnja temeljita na delitvi, ponovni uporabi, popravilu, prenovi in recikliranju obstoječih materialov in izdelkov, dokler je to možno. Ko se izdelku izteče življenjska doba, se materiali v največji možni meri obdržijo v gospodarstvu in vedno znova uporabijo. Na ta način se podaljšuje življenjska doba izdelkov in posledično zmanjšuje količina odpadkov. (https://www.zeos.si/krozno-gospodarstvo/, 5. 6. 2025)

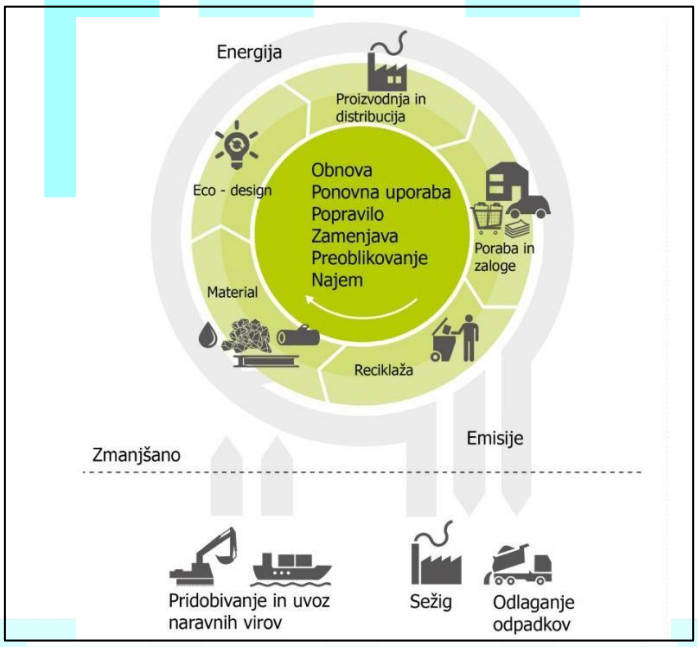
Krožno gospodarstvo je nov vzorec, ki izhaja iz dejstva, da so viri omejeni, da se njihova razpoložljivost zmanjšuje in da ima naš planet realne omejitve. Je instrument, ki omogoča različne vire zadržati v potrošnem ciklu čim dlje. Za uspešno delovanje tega sistemskega in kompleksnega instrumenta so potrebni preobrazba poslovnih modelov, preobrazba navad potrošnikov in povečanje zavedanja o pravilnem ravnanju z viri. Recikliranje je pomemben element krožnega gospodarstva in zadnji element v ciklu rabe virov. (Godina Košir, 2016)

Model krožnega gospodarstva

Obstajajo različne vizualizacije krožnega gospodarstva. Na sliki 2 je predstavljen poenostavljen model. Osnovna ideja tega modela je maksimalno omejiti nastajanje odpadkov in vnosa novih virov z ekodizajnom, reciklažo in ponovno uporabo. To ustvarja številne prednosti, ki so predstavljene v naslednjem poglavju. (Circular economy – European Environment Agency, 2016)

Slika 2 prikazuje poenostavljen model krožnega gospodarstva za materiale in energijo. Zunanji krog krožnega toka modela krožnega gospodarstva predstavlja krožni tok energije. Pomembna parametrasta energijska učinkovitost in delež obnovljivih virov energije, ki naj bi se povečala v primerjavi z linearnim modelom. Čeprav se skozi sežig odpadkov proizvede energija, ki lahko nadomesti goriva, mora biti sežig minimalen, saj je energija, pridobljena s sežigom, uporabna le enkrat, hkrati pa iz gospodarskega toka odstranimo obnovljive vire. Vmesni krog predstavlja blagovni tok v krogu reciklaže, ločene med kovinami, minerali in biološkimi viri. Biološki viri so razgradljivi, medtem ko materialni viri niso razgradljivi v kratkem času. V praksi se pogosto dogaja, da so biološki in materialni viri med seboj pomešani, kar privede do težav pri razgradnji in reciklaži. Uporaba bioloških materialov privede do večje rabe naravnega kapitala, kar posledično predstavlja večji pritisk na odpornost ekosistema. Notranji krog modela krožnega gospodarstva predstavlja ponovno uporabo, redistribucijo, popravilo, predelavo in obnovo, stranske odpadke in reciklažo ob hkratnem minimalnem vnosu virov. (Circular economy – European Environment Agency, 2016, str. 9)

Slika 2: *Poenostavljen model krožnega gospodarstva za materiale in energijo (Circular economy – European Environment Agency, 2016, str. 10)*



Učinki krožnega gospodarstva

Posledice uvajanja krožnega gospodarstva so predvsem pozitivne, kažejo se kot okoljski, gospodarski in družbeni učinki. V nadaljevanju so sprva predstavljeni pozitivni učinki tega modela in nato še negativni.

Zmanjšanje odpadkov in okoljskih vplivov

Strategija krožnega gospodarstva za razliko od linearnega spoštuje naravo in meje okolja, kar pomeni, da je poudarek na ohranjanju okolja. Ta strategija uvaja nova pravila in nove možnosti za izboljšanje življenja vseh. Ponovna uporaba in recikliranje izdelkov upočasnita porabo naravnih virov, zmanjšata posege v naravno okolje in življenjski prostor ter omejita izgubo biotske raznovrstnosti. Korist krožnega gospodarstva je tudi zmanjšanje skupnih letnih emisij toplogrednih plinov. Oblikovanje učinkovitejših in trajnostnih izdelkov pripomore k zmanjšanju porabe energije in virov. S prehodom na zanesljivejše izdelke, ki jih je mogoče ponovno uporabiti, nadgraditi in popraviti, bi se zmanjšala tudi količina odpadkov. V povezavi z izdelki predstavlja embalaža vedno večji problem, saj povprečni Evropejec v povprečju ustvari 186,8 kg odpadne embalaže letno (https://www.europarl.europa.eu/topics/sl/article/20151201STO05603/krozno-gospodarstvo-definicija-pomen-in-prednosti, 5. 6. 2025).

Z učinkovitejšo uporabo virov in krajšimi transportnimi verigami se manjša ogljični odtis. Hkrati se zmanjša onesnaževanje vode, zraka in tal, saj se materiali obnavljajo in ne zavržejo.

Gospodarski učinki

Prehod na krožno gospodarstvo poveča konkurenčnost, spodbuja inovacije, pospeši gospodarsko rast in ustvarja nova delovna mesta. Uvajanje krožnega gospodarstva na dolgi rok povečuje bruto domači proizvod. Potrošniki pridobijo trajnejše in inovativnejše izdelke, ki bodo povečali kakovost življenja in dolgoročno prihranili denar. (Ellen MacArthur Foundation, 2015, str. 15)

Odpornost in fleksibilnost

Model krožnega gospodarstva vpliva na prilagodljivost in odpornost dobavnih verig, saj se zmanjša odvisnost od posameznih nedostopnih virov. Tako se spodbuja uporaba lokalnih virov, kar posledično zmanjša ovire pri dobavnih verigah. S podpiranjem lokalnega okolja se pozitivno prispeva k izkoriščenosti domačih materialov. (Ellen MacArthur Foundation, 2015, str. 15)

Družbene koristi

Z modelom krožnega gospodarstva se uvajajo nove storitve, ki omogočajo nove zaposlitve in nove priložnosti. Ta model omogoča zaposlitve za vse stopnje izobraženosti ljudi, kar ima pozitiven vpliv na korist prebivalcev in njihov življenjski stil. (Bressanelli in drugi, 2021)

Slabosti krožnega gospodarstva

Učinki krožnega gospodarstva so v pretežni meri pozitivni, vendar pa se tudi ta model gospodarstva sooča z nekaterimi negativnimi učinki, saj vključuje zahtevnost implementacije, finančne omejitve, tehnične omejitve in logistične izzive. Uspeh krožnega gospodarstva je v veliki meri odvisen od sprememb potrošniških navad, torej navad porabnikov izdelkov in njihove aktivne vloge pri ločevanju in recikliranju odpadkov. (Kirchherr in drugi, 2017)

Vloga logistike v krožnem gospodarstvu

Logistika je eden ključnih gradnikov krožnega gospodarstva, saj omogoča:

- obratno logistiko: zbiranje, sortiranje in vračanje uporabljenih izdelkov in embalaže v proizvodne in reciklažne centre;
- povezovanje tokov materialov: omogoča učinkovito izmenjavo stranskih proizvodov med podjetji kot industrijska simbioza;
- sledenje materialov in izdelkov: uporaba tehnologij za izboljšano transparentnost in učinkovitost;
- logistiko storitev: prehod iz prodaje izdelkov v prodajo storitev, kot na primer najem ali lizing, kjer logistika omogoča nemoteno vračilo in ponovno uporabo.

Aktivnosti uvajanja krožnega gospodarstva v Evropski uniji

Z naraščanjem evropske in svetovne populacije narašča tudi povpraševanje po surovinah, čeprav so te zaloge omejene. Prav zaradi omejenih zalog so nekatere države Evropske unije odvisne od drugih. Po podatkih Eurostata (Statistični urad Evropske unije) Evropska unija uvozi polovico surovin, ki jih potrebuje. Recikliranje surovin tako zmanjšuje tveganja, ki so povezana z dobavo, kot so nestabilnost cen, razpoložljivost surovin in odvisnost od uvoza.

S tehnološkim napredkom se raba surovin in energije na globalni ravni nenehno povečuje. Z naraščanjem prebivalstva in potrošnje posledično obremenjujemo okolje. Danes je gospodarstvo še v veliki meri linearno, saj se le del materialov reciklira in ponovno uporabi.

Po podatkih Evropskega parlamenta Evropska unija letno proizvede 2,2 milijona ton odpadkov. Evropska unija želi s posodabljanjem zakonodaje spodbuditi prehod na bolj trajnostni model, imenovan krožno gospodarstvo.

(https://www.europarl.europa.eu/topics/sl/article/20151201STO05603/krozno-gospodarstvo- definicija-pomen-in-prednosti, 5. 6. 2025)

Krožno gospodarstvo lahko poveča učinkovitost rabe primarnih virov v Evropi in po svetu. Z ohranjanjem materialov v visokokakovostnih produktih ali ponovno rabo sekundarnih virov bi se lahko zmanjšala potreba po novih virih. Rezultat reciklaže, preprečevanja nastajanja odpadkov in ekodizajna je zmanjšanje celotne porabe materiala za 6–12 %. Z uporabo inovativnih tehnologij in izboljšanjem učinkovitosti virov bi do leta 2030 lahko dosegli za 24 % manjšo porabo materiala. (Circular economy – European Environment Agency, 2016)

Evropska unija želi do 2050 zgraditi krožno in podnebno nevtralno gospodarstvo. Za doseganje tega cilja je v zadnjih letih uvedla številne nove ukrepe za zmanjšanje odpadkov in bolj trajnostne izdelke. Nova, posodobljena zakonodaja uvaja okoljsko primerno zasnovo, embalažo, zeleno zavajanje, pravico do popravila, ravnanje z odpadki in druga področja.

(https://www.europarl.europa.eu/topics/sl/article/20180328STO00751/ravnanje-z-odpadki-v-eu, 1. 6. 2025)

Okvir podnebne in energetske politike Evropskega zelenega dogovora (v izvirniku ang. European Green Deal) do leta 2030 določa cilje za zmanjšanje toplogrednih plinov in povečanje deleža obnovljivih virov energije in energetske učinkovitosti. Eden glavnih gradnikov tega zelenega dogovora je prav krožno gospodarstvo.

V zadnjih štiridesetih letih je bil sprejet širok spekter okoljske zakonodaje, ki predstavlja obsežen sklop standardov na svetu – okoljsko pravo Evropske unije, poznano tudi kot

okoljski pravni red, ki vsebuje več kot 500 direktiv, uredb in sklepov. (Fric, 2023, 28).

Republika Slovenija sledi politiki Evropske unije pri načrtu za prehod na podnebno nevtralno gospodarstvo. Razširitev krožnega gospodarstva bo odločilno prispevala k doseganju podnebne nevtralnosti.

3.2 Digitalni potni list izdelka

V svetu, kjer se trajnostni razvoj in krožno gospodarstvo vse bolj uveljavljata kot ključna cilja, postaja pomembno, da potrošniki, proizvajalci in zakonodajalci tesno sodelujejo pri zagotavljanju trajnostnih proizvodov. Eden od pomembnejših korakov v tej smeri je uvedba digitalnega potnega lista proizvoda (kratica DPP), ki ga uvaja Evropska unija v sklopu Uredbe št. 2024/1781 in se načrtuje kot bistven del prehoda v krožno gospodarstvo. DPP naj bi izboljšal materialno in energetsko učinkovitost proizvodov, podaljšal njihovo življenjsko dobo, zagotovil optimalno ravnanje z odpadki ter olajšal prehod v krožno gospodarstvo. (https://www.bens-consulting.com/blog/492/digitalni-potni-list-proizvoda-kaj-ta- pomeni-za-vas, 7. 6. 2025)

DPP je digitalna identiteta fizičnega izdelka, ki omogoča dostop do ključnih informacij o izdelku skozi njegov celotni življenjski cikel. Je pomembno orodje za prehod v krožno in trajnostno gospodarstvo, ker podjetjem omogoča preverjanje, upravljanje in izboljšanje trajnosti njihovih proizvodov. Vsak izdelek pridobi z DPP svojo edinstveno in globalno identiteto, ki je povezana z enim ali več standardiziranimi viri podatkov.

Vsi izdelki in njihovi sestavni deli, s katerimi se trguje na območju Evrope, morajo biti povezani z DPP, kar vključuje izdelke, ki so proizvedeni v EU in tudi izven nje. Prednosti DPP sledijo prednostim oziroma pozitivnim učinkom krožnega gospodarstva, kot so: učinkovito recikliranje in ponovna uporaba zmanjšujeta vpliv na okolje, z izboljšanjem sledljivosti se povečuje preglednost, povečuje produktivnost, ustvarja nove poslovne priložnosti, pospešuje digitalni prehod in druge.

Uredba EU št. 2024/1781 vzpostavlja okvire za določitev zahtev za okoljsko primerno zasnovo za trajnostne izdelke. Uredba zajema velik spekter fizičnih izdelkov, ki so dostopni na trgu Evropske unije, vključno s surovinami in polproizvodi. Izjeme so hrana, krma, zdravila, žive rastline, živali, vozila idr. Namen uredbe je predvsem zmanjšati okoljski odtis izdelkov skozi celoten življenjski cikel, od zasnove izdelka do njegove odstranitve. Uredba določa, da se bo DPP prednostno uporabljal za naslednje izdelke oz. skupine izdelkov: železo, jeklo, aluminij, tekstil, predvsem oblačila in obutev, pohištvo, vključno z vzmetnicami, pnevmatike, detergenti, barve, izdelki IKT in druga elektronika.

Uredba EU št. 2024/1781 določa nove dolžnosti in pravice za proizvajalce, uvoznike in distributerje, trgovce, serviserje, pridelovalce, predelovalce, strokovnjake za vzdrževanje, stranke, končne uporabnike, potrošnike, nacionalne organe, organizacije javnega interesa, Evropsko komisijo ali katere druge organizacije, ki delujejo v njihovem imenu.

Časovni okvir predvideva, da bodo po letu 2027 predstavljene podrobnejše zahteve za posamezne skupine, do leta 2030 pa bo končan zakonodajni postopek in bo DPP v celoti uporaben. Vključevati bo moral natančne informacije, ki bodo omogočale boljšo preglednost in sledljivost izdelkov, kar vključuje povezavo z edinstvenim identifikatorjem izdelka (DPP-koda), fizično prisotnostjo podatkovnega nosilca na izdelku (recimo QR-kodo) ter

zagotavljanjem prostega dostopa do podatkov za različne uporabnike, kot so proizvajalci, potrošniki in carinski organi.

Uredba EU št. 2024/1781 predvideva vzpostavitev registra DPP ter javno dostopnega spletnega portala za iskanje in primerjavo podatkov o proizvodih. Digitalni potni list proizvoda (DPP) bo vključeval nabor podatkov o posameznem proizvodu od izvora surovin, sestave materialov, energetske učinkovitosti, možnosti reciklaže do trajnostnih lastnosti proizvoda.

Uvajanje vsebin krožnega gospodarstva v pouk

Krožno gospodarstvo si torej prizadeva zmanjšati razkorak med proizvodnim ciklom in naravnimi ekosistemi, ki so ključni za preživetje družbe. Namen tega modela je ustvariti gospodarstvo, ki z daljšo uporabo izdelkov, opreme in infrastrukture izboljša produktivnost virov in hkrati zmanjšuje povpraševanje po njih. Na ta način ustvarjamo trajnostno družbo za sedanje in prihodnje generacije. Kot smo spoznali skozi teoretičen del, ima krožno gospodarstvo svoje izzive in eden izmed njih je prav gotovo uvajanje spremembe v vedenje in dejanja potrošnikov.

Godina Košir (2016) v članku poudarja, da so za generacijo milenijcev ti vzorci že del vsakdana, saj uporabljajo Uber, Airbnb, Amazon, Skype, co-working prostore, ne želijo kreditov in cenijo enostavno upravljanje denarja prek aplikacij na mobilnih telefonih. Usmerjeni so v souporabo in ne v posedovanje.

Če velja rek, da na mladih svet stoji, je smiselno miselnost krožnega gospodarstva uvajati v izobraževalne vsebine. V nadaljevanju predstavljamo primer iz razreda 3. letnikov programa logistični tehnik, kjer smo idejo krožnega gospodarstva vnesli v pouk podjetništva. V 3. letniku dijaki pri predmetu podjetništvo in gospodarsko poslovanje (kratica PGP) razvijajo svoje lastne podjetniške ideje in pripravljajo zanje poslovne načrte.

Teoretična izhodišča

Dijaki so najprej spoznavali razliko med linearnim in krožnim modelom gospodarstva, s poudarkom na pozitivnih učinkih slednjega. V ospredju niso bile teoretične podlage, temveč iskanje vseh prednosti in koristi, ki jih omenjeni model ponuja. Za popestritev pouka so bili dijakom predvajani videoposnetki s spletnih portalov, na katerih najdemo poučne in ilustrativno podkrepljene učne vsebine s to tematiko.

Skupinsko delo

Po spoznanih osnovnih teoretičnih izhodiščih so se dijaki po interesu razporedili v štiri skupine, kjer je imela vsaka skupina svojo zadolžitev.

Vsaka skupina je imela eno od zadolžitev:

- iskanje statističnih podatkov o odpadkih v Sloveniji in EU ter odpadni embalaži (SURS, EUROSTAT),
- raziskovanje vloge logistike pri vzpostavljanju krožnega gospodarstva,
- iskanje dobrih praks uvajanja krožnega gospodarstva,
- iskanje dobrih praks trajnostne potrošnje.

Pouk je potekal v računalniški učilnici, kjer so imeli dijaki na voljo osebne računalnike z dostopom do spleta. Naloge so bile precej kompleksno zastavljene, zato so si dijaki v skupinah razdelili delo.

Po opravljenih raziskavah je sledilo poročanje skupin. Dijaki so ponosno ugotovili, da se nekatere prakse že dobro utečene tudi v našem okolju. Izpostavljamo le nekaj primerov dobrih praks, ki so jih predstavili dijaki:

- skupinski nakupi aparatov in njihova souporaba,
- promocija lokalnih serviserjev,
- gospodarjenje z odpadki in njihovo recikliranje,
- uvajanje projektov za spodbujanje krožnega gospodarstva,
- 100-odstotno reciklirana embalaža,
- oblačila iz druge roke,
- ponovna uporaba odpadnega gradbenega materiala,
- industrijska simbioza,
- ekodizajn in druge.

Implementacija vsebin krožnega gospodarstva v poslovne načrte

Tovrsten način dela, kjer so dijaki sami raziskovali primere dobrih praks, je predstavljal dobro izhodišče za iskanje poslovnih idej, priložnosti in zamisli, ki temeljijo na tem modelu. Pri iskanju lastnih poslovnih idej so dijaki upoštevali načela krožnega gospodarstva ter v svoje projekte vključevali predstavljene primere dobrih praks iz domačega okolja in tujine. Uvodoma postavljena ideja, da navdušimo mlade, da preučujejo podjetništvo z vidika krožnega gospodarstva, je bila dobro sprejeta, saj so dijaki pri svojih podjetniških idejah vključevali trajnostno potrošnjo, recikliranje, ponovno uporabo izdelkov ipd.

Zaključek

Spoznali smo, da si je Evropska unija zastavila močan cilj uvesti krožno in podnebno neodvisno gospodarstvo do leta 2050. V dosego tega cilja je usmerila številne reforme in uvedla pravno podlago. Za doseganje tako visokih ciljev niso dovolj le regulative, pomembno je sodelovanje vseh akterjev gospodarstva, še posebej potrošnikov. Mladi potrošniki se šele razvijajo, oblikujejo svoje navade, se izobražujejo, so prilagodljivi in hitreje sprejemajo vse možne spremembe, zato je smiselno tovrstne vsebine vključiti dovolj zgodaj v vse ravni in nivoje izobraževanja. Mi smo imeli možnost in priložnost pri pouku PGP v programu logistični tehnik dijake podučiti o vlogi in pomenu krožnega gospodarstva ter jih spodbuditi v trajnostno, ekološko in preudarno odločanje.

Viri in literatura

1. Bressanelli, G., Pigosso, C. A., Saccani, N. & Perona, M.: Enablers, levers and benefits of Circular Economy in the Electrical and Electronic Equipment supply chain. Journal of Cleaner Production, 298, 264–271, 2021.
2. Circular economy — European Environment Agency. Circular economy in Europe. Developing the knowledge base, 2016.

3. Ellen MacArthur Foundation. (2015). Growth within: a circular economy vision for a competitive Europe, https://www.ellenmacarthurfoundation.org/growth-within-a-circular-economy-vision-for-a-
4. competitive-europe, 5. 6. 2025.
5. Fric, U.: Pristopi za dosego krožnega gospodarstva in primeri dobrih praks. Revija za trajnostni razvoj EGS
6. 182. September 2023, https://www.fis.unm.si/objava-strokovnega-clanka-doc-dr-urske-fric-v-reviji-egs- 182/.
7. Godina Košir, L.: Če želimo biti konkurenčni, mora biti naše poslovanje trajnostno usmerjeno. (2016), https://metinalista.si/ce-zelimo-biti-konkurencni-mora-biti-nase-poslovanje-trajnostno-usmerjeno/,
8. 30. 5. 2025
9. Kirchherr, J., Reike, D. & Hekkert, M.: Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221–232, 2017.
10. https://kimi.si/wp-content/uploads/2018/04/2.jpg, 30. 5. 2025.
11. https://www.zeos.si/krozno-gospodarstvo/, 5. 6. 2025.
12. https://www.europarl.europa.eu/topics/sl/article/20151201STO05603/krozno-gospodarstvo-definicija-
13. pomen-in-prednosti, 5. 6. 2025
14. https://www.europarl.europa.eu/topics/sl/article/20180328STO00751/ravnanje-z-odpadki-v-eu,
    a. 6. 2025.
15. https://www.bens-consulting.com/blog/492/digitalni-potni-list-proizvoda-kaj-ta-pomeni-za-vas,
16. 6. 2025.
17. Uredba EU št. 2024/1781.

Mag. Klavdija Živko Pal
Traffic School Maribor

CIRCULAR ECONOMY IN LOGISTICS

Summary

This paper highlights the digital product passport as a key tool of the circular economy, whose goals include reducing the use of natural resources, optimizing distribution, and minimizing waste in supply chains. The circular economy is based on sharing, reusing, repairing, refurbishing, and recycling existing materials. The digital product passport enables the tracking of materials throughout the entire process. The paper presents an example of interdisciplinary integration, where students develop business ideas in accordance with circular economy principles. The integration of entrepreneurship and logistics content within the secondary education program for logistics technicians facilitates the transfer of knowledge and skills to higher levels of education and into various forms of school activities.

Introduction

Currently, more than eight billion people live on Earth, and this number is increasing every day. This growing population means increasing needs, which consequently leading to a higher demand for finite raw materials that are not unlimited. This resources are finite, and extracting and using them has a significant environmental impact.

The paper compares the linear and circular economies, highlighting the latter's advantages and positive effects and providing examples of best practice.

In logistics, the circular economy requires a comprehensive transition towards optimising material flows, extending product lifecycles and efficiently returning resources to production processes. The European Union has outlined a detailed plan to implement a circular, climate-neutral economy by 2050. This includes the introduction of digital product passports. However, adopting the circular economy is a long-term process and a quick and simple transition is almost impossible. Therefore, it is necessary to incorporate knowledge about the circular economy into secondary education programmes. One concrete example is the logistics technician programme at the Secondary Traffic School Maribor.

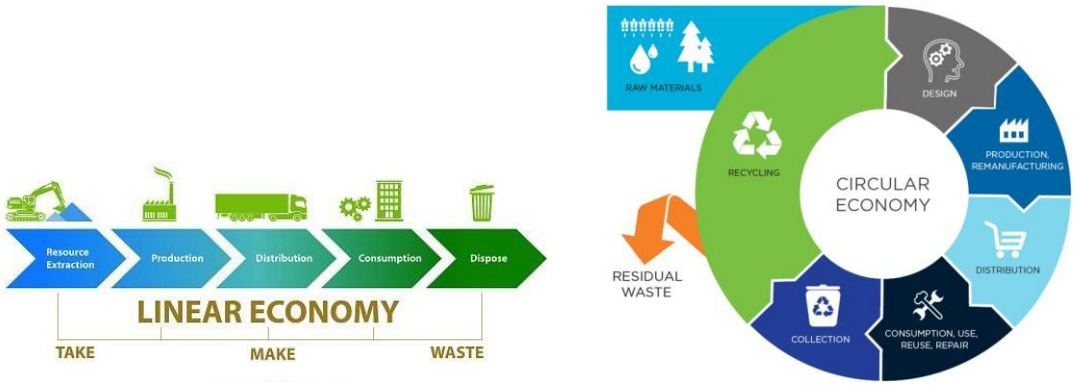
Circular Economy

The chapter will compare the linear and circular economy models, focusing primarily on the latter to highlight its advantages and effects.

A comparison of the linear and circular economy models

World economies operate based on different principles and operating models. Modern economies are striving to transition rapidly from the linear to the circular model. The following comparison illustrates the differences between the two models. Figure 1 shows a schematic comparison of the two models.

Figure 1: A schematic comparison of the two models



As shown in Figure 1, the linear economy is based on the principle of 'take – make – use – dispose', involving large quantities of raw materials and energy. It includes planned obsolescence, whereby products are designed to have a limited lifespan so that they can be discarded and replaced with new ones. This increases waste generation and puts pressure on the environment.

The linear production and consumption model requires the continuous extraction of natural resources, raw materials and energy. This leads to the depletion of natural resources and has a negative impact on the environment. Greenhouse gas emissions primarily occur during production and transportation, which also have a negative environmental impact. The linear model generates large amounts of waste because most raw materials are only used once before being discarded. This consequently results in the inefficient and improper management of raw materials, causing them to lose value from both economic and consumer perspectives.

The circular economy is a sustainable alternative to the traditional linear economic model. It is based on the principle of sharing, reusing, repairing, refurbishing and recycling existing materials and products for as long as possible. When a product reaches the end of its life, its materials are retained within the economy and continuously reused to the greatest extent possible. This approach extends products' lifespans and consequently reduces waste. (https://www.zeos.si/krozno-gospodarstvo/, 5. 6. 2025)

The circular economy is a new model that recognises the limited availability of resources and the real constraints of our planet. It enables different resources to be retained in the consumption cycle for as long as possible. The successful operation of this systemic and complex tool requires business models to be transformed, consumer habits to change, and awareness of proper resource management to increase. Recycling is a key part of the circular economy, representing the final stage in the resource use cycle. (Godina Košir, 2016)

A Model of the circular economy

There are various visualizations of the circular economy. Figure 2 presents a simplified model. The basic idea of this model is to minimize waste generation and the input of new resources through eco-design, recycling, and reuse. This creates numerous benefits, which are presented in the next chapter. (Circular economy – European Environment Agency,

2016)

Figure 2 shows a simplified circular economy model for materials and energy. The outer loop of this model represents the circular flow of energy. Two important parameters are energy efficiency and the proportion of energy sourced from renewable resources, both of which should be higher than in the linear model. While energy can be produced through waste incineration to replace fuels, incineration should be minimised because the energy obtained from incineration can only be used once. At the same time, renewable resources are removed from the economic cycle. The middle loop illustrates the flow of materials within the recycling process, divided into metals, minerals and biological resources. While biological resources are biodegradable, material resources are not. In practice, however, these two types of resources are often mixed, which causes problems with degradation and recycling. Using biological materials leads to greater use of natural capital, consequently placing more pressure on ecosystem resilience. The inner loop of the circular economy model encompasses reuse, redistribution, repair, refurbishment and restoration, as well as by-product waste and recycling, all with the aim of minimising resource input. (Circular economy – European Environment Agency, 2016, p. 9)

Figure 2: Simplified Circular Economy Model for Materials and Energy *(Circular economy – European Environment Agency, 2016, p. 10)*



The impacts of the circular economy

The consequences of implementing the circular economy are primarily positive, taking the form of environmental, economic and social effects. The positive effects of this model are presented first, followed by the negative ones.

Reducing waste and environmental impacts

Unlike the linear model, the circular economy strategy recognises the importance of respecting environmental limits and emphasises environmental preservation. It introduces new rules and opportunities that improve the lives of everyone. The reuse and recycling of products slows down the consumption of natural resources, reduces interventions in natural

habitats and limits biodiversity loss. Another benefit of the circular economy is a reduction in total annual greenhouse gas emissions. Designing more efficient and sustainable products helps to decrease energy and resource consumption. Using more reliable products that can be reused, upgraded and repaired would also reduce waste generation. Packaging is becoming an increasingly significant issue, with the average European generating approximately 186.8 kg of packaging waste annually.

(https://www.europarl.europa.eu/topics/sl/article/20151201STO05603/krozno-gospodarstvo- definicija-pomen-in-prednosti, 5. 6. 2025)

Using resources more efficiently and shortening supply chains reduces the carbon footprint. At the same time, water, air and soil pollution decreases because materials are recycled rather than thrown away.

Economic impacts

The transition to a circular economy increases competitiveness, encourages innovation, accelerates economic growth, and creates new jobs. In the long term, implementing the circular economy boosts the gross domestic product. Consumers gain more durable and innovative products, which improve quality of life and save money in the long term. (Ellen MacArthur Foundation, 2015, p. 15)

Resiliance and flexibility

The circular economy model increases the adaptability and resilience of supply chains by reducing their dependence on scarce resources. It encourages the use of local resources, consequently reducing obstacles in supply chains. Supporting the local environment also has a positive impact on the utilisation of domestic materials. (Ellen MacArthur Foundation, 2015, p. 15)

Social benefits

The circular economy model introduces new services that create new jobs and opportunities. This model enables employment for people of all education levels, which has a positive impact on the well- being of the population and their lifestyle. (Bressanelli and others, 2021)

Disadvantages of the circular economy

The effects of the circular economy are mostly positive; however, this economic model also faces some negative effects, including challenges in implementation, financial constraints, technical limitations, and logistical issues. The success of the circular economy largely depends on changes in consumer habits, meaning the behaviours of product users and their active role in waste separation and recycling. (Kirchherr and others, 2017)

The role of logistics in the circular economy

Logistics is one of the key pillars of the circular economy because it enables:

- reverse logistics: collecting, sorting, and returning used products and packaging to production and recycling centres;
- connecting material flows: enables the efficient exchange of by-products between companies through industrial symbiosis;
- tracking materials and products: using technologies to improve transparency and

efficiency;

- service logistics: the transition from selling products to selling services, such as rental or leasing, where logistics enables smooth return and reuse.

Activities for implementing the circular economy in the European Union

With the increasing population in Europe and worldwide, the demand for raw materials is also rising, even though these reserves are limited. Due to limited supplies, some European Union countries depend on others. According to Eurostat (the Statistical Office of the European Union), the EU imports half of the raw materials it needs. Recycling raw materials reduces the risk of supply issues such as price instability, resource availability, and dependence on imports.

Technological advancements have led to an increase in the global use of raw materials and energy. As the population grows and consumption increases, the environment is consequently placed under greater strain. Currently, the economy remains largely linear, with only a small proportion of materials being recycled and reused.

The European Parliament reports that the European Union produces 2.2 million tonnes of waste each year. The EU is updating legislation in order to encourage the transition to a more sustainable model called the circular economy.

(https://www.europarl.europa.eu/topics/sl/article/20151201STO05603/krozno-gospodarstvo- definicija-pomen-in-prednosti, 5. 6. 2025)

The circular economy could increase the efficiency with which primary resources are used in Europe and worldwide. By keeping materials in high-quality products or reusing secondary resources, the demand for new resources could be lowered. Recycling, waste prevention and eco-design could reduce total material consumption by 6–12%. The use of innovative technologies and improved resource efficiency could reduce material consumption by up to 24% by 2030. (Circular economy – European Environment Agency, 2016)

The European Union's goal is to establish a circular and climate-neutral economy by 2050. To this end, it has introduced a variety of new measures in recent years to reduce waste and encourage the use of more sustainable products. The updated legislation covers environmentally friendly design and packaging, greenwashing prevention, the right to repair and waste management, among other areas. (https://www.europarl.europa.eu/topics/sl/article/20180328STO00751/ravnanje-z-odpadki-v-eu, 1. 6.

2025)

The European Green Deal's climate and energy policy framework sets out targets for 2030 to reduce greenhouse gas emissions, increase the use of renewable energy sources, and improve energy efficiency. A key pillar of the Green Deal is the circular economy.

Over the past forty years, the European Union has adopted a wide range of environmental legislation, creating one of the world's most comprehensive sets of standards. This legislation is also known as the environmental acquis and includes more than 500 directives, regulations and decisions. (Fric, 2023, 28).

The Republic of Slovenia follows the European Union's policy in the plan for the transition

to a climate- neutral economy. The expansion of the circular economy will make a decisive contribution to achieving climate neutrality.

Digital Product Passport

In a world where sustainable development and the circular economy are becoming key goals, it is crucial that consumers, manufacturers and legislators work together to ensure that products are sustainable. A significant step in this direction is the introduction of the Digital Product Passport (DPP), which the European Union is implementing under Regulation No. 2024/1781 as an essential part of the transition to a circular economy. The DPP aims to enhance the material and energy efficiency of products, extend their lifespan, optimise waste management and facilitate the transition to a circular economy.. (https://www.bens-consulting.com/blog/492/digitalni-potni-list-proizvoda-kaj-ta-pomeni-za-vas, 7. 6. 2025)

The DPP is a digital representation of a physical product, providing access to essential information about the product throughout its entire life cycle. It is an important tool for transitioning to a circular and sustainable economy, as it enables companies to verify, manage and improve the sustainability of their products. Each product receives a unique global identity with the DPP, which is linked to one or more standardised data sources.

All products and their components traded within the European area must be linked to the Digital Product Passport (DPP), including those manufactured inside and outside the EU. The DPP offers many of the same advantages as the circular economy, such as efficient recycling and reuse, reduced environmental impact, improved traceability, increased transparency and productivity, and the creation of new business opportunities and acceleration of the digital transition.

EU Regulation No. 2024/1781 establishes a framework for setting eco-design requirements for sustainable products. It covers a wide range of physical products available on the European market, including raw materials and semi-finished products. Exceptions include food, feed, medicines, live plants and animals, and vehicles. The regulation's primary objective is to minimise the environmental impact of products throughout their entire life cycle, from design to disposal. It specifies that the DPP will primarily apply to products such as iron, steel, aluminium, textiles (especially clothing and footwear), furniture (including mattresses), tyres, detergents, paints, ICT products and other electronics.

EU Regulation No. 2024/1781 sets out new obligations and rights for manufacturers, importers, distributors, traders, service providers, producers, processors, maintenance experts, clients, end– users, consumers, national authorities, public interest organizations, the European Commission, and other organizations acting on their behalf.

The timeline anticipates the introduction of more detailed requirements for specific product groups after 2027, with the legislative process expected to be completed by 2030, rendering the Digital Product Passport (DPP) fully operational. The DPP will need to include precise information to enable better transparency and traceability of products. This will involve linking to a unique product identifier (DPP code) and ensuring the physical presence of a data carrier (such as a QR code) on the product. It will also require providing free access to data for various users, including manufacturers, consumers, and customs authorities.

EU Regulation No. 2024/1781 provides for the creation of a Digital Product Passport (DPP)

registry and a publicly accessible online portal for searching and comparing product data. The DPP will include data on each product ranging from the origin of the raw materials and material composition to energy efficiency, recyclability options and sustainability attributes.

Integrating circular economy content into education

The circular economy therefore aims to reduce the gap between production cycles and natural ecosystems, the latter of which are essential for societal survival. This model aims to create an economy that improves resource productivity by maximising the use of products, equipment and infrastructure while reducing demand for them. In this way, we can create a sustainable society for present and future generations. As we learned in the theoretical section, implementing changes in consumer behaviour and actions is certainly one of the challenges of the circular economy.

Godina Košir (2016) in the article emphasises that these patterns are already part of everyday life for the millennial generation, who use Uber, Airbnb, Amazon and Skype, work in co-working spaces, avoid loans and value easy money management through mobile phone apps. They are more oriented towards sharing than ownership.

If the saying 'the future rests on the youth' is true, then it makes sense to incorporate the concept of the circular economy into educational content. Below, we present an example from a third-year logistics technician class, in which the concept of the circular economy was incorporated into an entrepreneurship course. In their third year, students on the Entrepreneurship and Business Operations course (abbreviated as PGP) develop their own business ideas and prepare business plans for them.

The theoretical foundations

First, students learned about the differences between the linear and circular economy models, with a particular focus on the positive effects of the latter. Rather than focusing on the theoretical foundations, the focus was on exploring the advantages and benefits offered by the circular economy model. To make the lessons more engaging, students were shown videos from online portals providing educational content on this topic.

Teamwork

Once they had learned the basic theoretical foundations, the students were divided into four groups based on their interests. Each group was then assigned its own task.

Each group had one of the following tasks:

- researching statistical data on waste in Slovenia and the EU (including packaging waste), from sources such as SURS and EUROSTAT,
- investigating the role of logistics in establishing a circular economy,
- searching for the best practices for implementing the circular economy,
- searching for the best sustainable consumption practices.

The lessons took place in a computer lab, where students had access to personal computers with an internet connection. As the tasks were quite complex, the students divided the work among group members.

After completing their research, the groups presented their reports. The students proudly

discovered that some practices are already well established in our environment. Here are just a few examples of the best practices presented by the students:

- group purchases of appliances for shared use,
- promotion of local repair services,
- waste management and recycling,
- implementation of projects to promote the circular economy,
- 100% recycled packaging,
- second-hand clothing,
- reuse of construction waste materials,
- industrial symbiosis,
- eco-design and others.

Implementation of circular economy content in business plans

This way of working, where students independently researched examples of good practices, provided a solid foundation for discovering business ideas, opportunities, and concepts based on the circular economy model. While developing their own business ideas, students took into account the principles of the circular economy and incorporated examples of good practices from both local and international environments into their projects. The initial goal of inspiring young people to explore entrepreneurship through the lens of the circular economy was well received, with students incorporating themes such as sustainable consumption, recycling and product reuse into their business ideas.

Conclusion

We have learned that the European Union is committed to implementing a circular, climate-neutral economy by 2050. To this end, it has introduced numerous reforms and established a legal framework. Such ambitious targets require more than just regulations; the cooperation of all economic actors, especially consumers, is crucial. Young consumers are still developing — they are forming habits, receiving an education and are adaptable and more readily accept changes. Therefore, it makes sense to introduce this subject early on at all levels of education. In the Entrepreneurship and Business course (PGP) within the Logistics Technician programme, we had the opportunity to educate students about the role and importance of the circular economy, and encourage sustainable, ecological and thoughtful decision-making.

Sources and literature

1. Bressanelli, G., Pigosso, C. A., Saccani, N. & Perona, M.: Enablers, levers and benefits of Circular Economy in the Electrical and Electronic Equipment supply chain. Journal of Cleaner Production, 298, 264–271, 2021.
2. Circular economy — European Environment Agency. Circular economy in Europe. Developing the knowledge base, 2016.
3. Ellen MacArthur Foundation. (2015). Growth within: a circular economy vision for a competitive Europe, https://www.ellenmacarthurfoundation.org/growth-within-a-

circular-economy-vision-for-a-

4. competitive-europe, 5. 6. 2025.
5. Fric, U.: Pristopi za dosego krožnega gospodarstva in primeri dobrih praks. Revija za trajnostni razvoj EGS
6. 182. September 2023, https://www.fis.unm.si/objava-strokovnega-clanka-doc-dr-urske-fric-v-reviji-egs- 182/.
7. Godina Košir, L.: Če želimo biti konkurenčni, mora biti naše poslovanje trajnostno usmerjeno. (2016), https://metinalista.si/ce-zelimo-biti-konkurencni-mora-biti-nase-poslovanje-trajnostno-usmerjeno/,
8. 30. 5. 2025
9. Kirchherr, J., Reike, D. & Hekkert, M.: Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221–232, 2017.
10. https://kimi.si/wp-content/uploads/2018/04/2.jpg, 30. 5. 2025.
11. https://www.zeos.si/krozno-gospodarstvo/, 5. 6. 2025.
12. https://www.europarl.europa.eu/topics/sl/article/20151201STO05603/krozno-gospodarstvo-definicija-
13. pomen-in-prednosti, 5. 6. 2025
14. https://www.europarl.europa.eu/topics/sl/article/20180328STO00751/ravnanje-z-odpadki-v-eu,
    a. 6. 2025.
15. https://www.bens-consulting.com/blog/492/digitalni-potni-list-proizvoda-kaj-ta-pomeni-za-vas,
16. 6. 2025.
17. Uredba EU št. 2024/1781.

STROKOVNI IZOBRAŽEVALNI CENTER LJUBLJANA

Trajnostna rešitev za delovanje skladišča podjetja BTC d.d.

Avtor: Matej Žunko, dipl. inž. Log.

Povzetek

V članku je na kratko predstavljena rešitev za delovanje skladišča podjetja BTC d.d.. V uvodu je kratek povzetek o zgodovini podjetja, nato pa je predstavljen način delovanja obravnavanega skladišča. V nadaljevanju pa so predstavljene možne rešitve za dano skladišče. V zaključku, ki je tudi bistven del članka pa so možne implementacije predstavljene bolj podrobno, ter njihov vpliv na delovanje skladišča.

Ključne besede

Skladišče, trajnost, rešitev

1 Uvod

"Družba BTC predstavlja eno izmed vodilnih podjetij v regiji na področju upravljanja in razvoja poslovnih nepremičnin. Pod blagovno znamko BTC City v Ljubljani upravlja enega izmed največjih nakupovalnih, poslovnih, rekreativno-zabaviščnih in kulturnih središč v Evropi, poleg tega pa upravlja še nakupovalni središči v Novem mestu in Murski Soboti." Tako je na uradni spletni strani podjetja BTC zapisano, da delovanje tega podjetja obsega širši spekter dejavnosti kot le logistika. BTC d.d. se namreč ukvarja tudi z različnimi drugimi storitvami, ne zgolj samo z logističnimi storitvami. Med njimi je oddaja poslovnih zgradb v najem, ponudba raznolikih zabavnih in športnih dejavnosti (kot so Go-kart, Trampolin park, Fun walls, Escape rooms, Kolosej Ljubljana, Vodni park Atlantis), gostinske storitve ter prodaja izdelkov za vsakodnevno rabo. BTC City Ljubljana, ki je del podjetja BTC d.d., vsako leto privabi več kot 20 milijonov obiskovalcev, ki izkoristijo ponudbo storitev in nakupov na različnih področjih. Poleg tega podjetje BTC d.d. usmerja svoje delovanje tudi v smeri industrije 4.0 in koncepta družbe 5.0. S tem želijo doseči čim bolj učinkovito ter trajnostno delovanje, pri čemer uporabljajo sodobno tehnologijo in pristope. V zadnjem obdobju se podjetje BTC d.d. prav tako vse bolj usmerja v investicije v razvoj prihodnjih tehnologij. Te bodo sčasoma postale ključno orodje za delovanje podjetja BTC d.d. in bodo igrale pomembno vlogo v njihovem poslovanju.

Podjetje BTC d.d. je bilo ustanovljeno leta 1954 kot Centralna skladišča in je do leta 1975 postalo eno največjih kopenskih skladišč v Evropi z 180.000 m² skladiščnih površin. Leta 1990 se je preimenovalo v Blagovno trgovski center (BTC), se preoblikovalo v delniško družbo in začelo razvijati trgovsko dejavnost. Do sredine 90. let so odprli prvi nakupovalni center, pivovarno Kratochwill, se uvrstili na Ljubljansko in kasneje tudi Londonsko borzo. V naslednjih letih so sledili številni infrastrukturni in komercialni projekti, kot so tržnica, kongresna dvorana, Emporium, Millenium, kino Kolosej, poslovna stolpnica in vodni park Atlantis. Leta 2011 so odprli Kristalno palačo in postavili sončne elektrarne v Ljubljani in Murski Soboti, s čimer se je začelo njihovo trajnostno usmerjeno delovanje. BTC je v letih 2015–2017 razvil start-up ekosistem (ABC Accelerator in ABC Hub), ustanovil enoti BTC Digit in BTC Living Lab ter moderniziral prometno infrastrukturo. Do leta 2022 je postal BTC City sinonim za inovativnost in trajnost, z mednarodno prepoznavnostjo (npr. Expo Dubaj 2021) ter načrtovanimi velikimi projekti, kot sta stanovanjski kompleks v Ljubljani in nov logistični center v Zalogu s kapaciteto 45.000 paletnih mest. BTC se je s tem preoblikoval iz skladiščnega podjetja v sodobno urbano, inovativno in trajnostno središče.

2 Trenutno stanje in obratovanje skladišča

2. 1 Cona 901

Cona 901 je tudi prvotna cona tega skladišča, tukaj delo poteka po najbolj preprostem načinu dela. Komisijonar se tukaj celoten dan sprehaja med petimi vrstami regalov in s pomočjo terminala, ki mu prikazuje delovni nalog, nabira kosovni tovor, ki ga naloži na RLC voziček. Na terminalu se mu prikazuje različne številke, ki določajo vrsto, odsek in del odseka, kjer se nahaja dani tovor. Primer pozicije tovora pa izgleda tako: 904 28 20. Prva številka "904" predstavlja številko vrste, druga številka "28" predstavlja številko odseka v dani vrsti. Vsaka vrsta pa ima 30 odsekov, ki se nahajajo na levi in desni strani komisijonarjeve poti, odseki so vedno razdeljeni tako, da so na levi strani vedno lihe števila, torej 1,3,5,7,… vse do 29, ter na desni strani soda števila, 2,4,6,8,… vse do 30. Zadnja številka "20" pa nam pove v

katerem delu znotraj odseka se nahaja tovor. V danem primeru se tovor nahaja v sredinskem odseku, saj se vsak odsek deli na tri dele, levega, ki je lahko označen s "10" ali "01", srednji odsek, ki je označen s "20" ali "02", ter desni odsek, ki je lahko zančen s "30" ali "03". V nekaterih odsekih lahko najdemo tudi dve nadstropji, v takem primeru pa se spodnja vrsta označi s "01", zgornja pa s "11". Poleg palet na regalu so tudi nalepke s danimi številkami za pomoč pri iskanju. Na terminalu lahko komisijonar vidi tudi ime izdelka ter koliko le tega mora vzeti. Komisijonar vedno začne pot na začetku regalov in nadaljuje pot v obliki "kače" skozi vse regale. Ko pobere zadnji izdelek mora natisniti dobavnico za dano naročilo, jo namestiti na RLC voziček in zapreti ponjavo na le tem. Voziček se nato odpelje na mesto, ki ga določi skladiščnik.

2. 2 Cona 9000

V coni 9000 se delo podobno izvaja kot v coni 901, vendar komisijonarji ne nabirajo tovora po lokacijah, ampak ga skladiščijo po lokacijah iz palete. Na terminalu dobijo informacijo samo o poziciji, na katero morajo odložiti tovor. Lokacije so označene primer: "lok-102" in so razporejene vse od 1 do 185. Tudi tukaj so razporejene tako, da so na levi strani liha števila na desni pa soda števila. Za določene lokacije mora komisijonar odložiti več istih izdelkov, na le teh mu na terminalu piše primer: "kos 4". To pomeni, da mora na dani lokaciji odložiti 4 kose. Ko komisijonar določeno vrsto artiklov razporedi na vse lokacije, lahko vzame naslednjo vrsto artiklov na paleti in ponovno nadaljuje razporejanje, dokler mu ne zmanjka le teh. Kode na artiklih, po katerih so razporejeni v lokacije, določi sprejemnik tovora ob sprejemu tovora v skladišče.

2. 3 Kletna cona in vrtna cona

V kletni coni poteka komisioniranje enako kot v coni 901, vendar se tu nahaja samo potrošni material. Delo v kleti je fizično zahtevnejše, zato ga opravljajo samo moški.

V coni za vrtni oddelek se komisionira sezonsko blago, kot so stoli, mize in zemlja. Kljub krajšemu času dela je delovanje podobno kot v drugih conah. Ta cona je ločena od glavnega skladišča in se nahaja v zunanjem skladišču.

2. 4 Obratovanje skladišča in opis problema

Obratovanje danega skladišča je precej zastarelo, posledično ta problem povzroča velike stroške obratovanja. Dano skladišče bo ostalo v obratovanju samo če lahko poiščemo primerno rešitev, ki bo zmanjšala stroške delovanja in negativen vpliv na okolje.

Skladišče se ogreva s pomočjo plina, to sicer ni najslabši način ogrevanja, če ga primerjamo s ogrevanjem na drva ali nafto je ta še vedno bolj efektiven in bremenilen za okolje. Vendar v današnjem času, kjer poznamo že kar nekaj rešitev za trajnostno delovanje bi se lahko namesto plinskega ogrevanja uporabilo ogrevanje s pomočjo toplotne črpalke. Skladišče ni tako volumensko zahtevno, prav tako pa se ne ogreva vseh prostorov, večina se ogreva smo pisarniške prostore ter kletne prostore. Pridobivanje električne energije bi se tudi dalo izboljšati, saj je lokacija na kateri se skladišče nahaja zelo osvetljena s sončno svetlobo (letališka cesta 12, Ljubljana). BTC d.d. ima prav tako že postavljene sončne elektrarne na nekaterih drugih objektih že nekaj let in so z njimi zelo zadovoljni, zato bi se lahko isto storilo za dano skladišče. Sama osvetljava v danem skladišču je tudi velik problem, saj se le to osvetljuje s starimi rumenimi lučmi, ki gorijo celoten dan, čeprav skladišče deluje samo 9 ali 10 ur dnevno, prav tako pa se vseh delov skladišča ne uporablja redno. Že med samo

malico se polovica skladišča ne uporablja 30 min, vendar luči ta čas ostanejo prižgane. Malica pa se začne ob 10:00, takrat gre na malico prva skupina, ob 10:30 pa druga. To pomeni da dnevno 1uro polovico skladišča se ne uporablja a se vseeno osvetljuje in troši energijo. Izven delovnih ur pa so luči prav tako prižgane v skoraj vseh prostorih zaradi varnosti, kar tudi ni ekonomična rešitev. Zadnja stvar, ki pa tudi povzroča nepotrebne stroške in co2 emisije pa je en viličar s notranjim izgorevanjem, ki se ne uporablja tako pogosto kot ostali električni viličarji, vendar vseeno predstavlja določen strošek podjetju.

3 Zaključek – predlagane rešitve

Pri prvi rešitvi smo se lotili problema pridobivanja električne energije in ogrevanja. Dani predlogi so bili postavitev sončne elektrarne v velikosti 2500 m2 s močjo 400W, ter nakup toplotne črpalke za ogrevanje prostorov. S sončno elektrarno bi nam uspelo zmanjšati porabo mesečne energije iz 17263.167 kWh električne energije na 12763.167 kWh. Pri samem ogrevanju pa bi z toplotno črpalko zmanjšali porabo ogrevanja za 43.3%, torej če vzamemo podatek, da 50% celotne porab energije prepisujemo ogrevanju in hlajenju, je pri naši porabi 50% mesečne porabljene energije 8631.58 kWh. Z uvedbo toplotne črpalke pa bi to zmanjšali na 4894.12 kWh električne energije. Kar pomeni, da bi lahko skoraj celotno ogrevanje pokrili s sončno elektrarno.

Druga rešitev se je lotila problema razsvetljave skladišča. Trenutno uporabljene stare luči bi se zamenjale s novimi bolj varčnimi LED lučmi. S tem predlogom bi zmanjšali porabo energije za osvetlitev prostorov iz 6214.74 kWh na 932.21 kWh električne energije. Poleg LED luči pa bi dodali še senzorje gibanja, ki bi porabo dodatno zmanjšali še za 35%, kar nam prinese končno porabo 605.94 kWh električne energije.

Zadnji predlog pa se je nanašal na manipulacijska sredstva. Trenutno se uporablja viličar s notranjim izgorevanjem, ki mesečno porabi 440 litrov goriva, kar predstavlja 670.12 EUR stroškov. Prav tako pa proizvede 1152.8 kg co2 na mesečni ravni. S nabavo hibridnega viličarja pa bi porabo goriva zmanjšali na 469.08 EUR, ter emisije co2 zmanjšali na 806.96 kg.

Tabela 1:Prikaz spermembe stroško obratovanja

Trenutno stanje	Trenutna poraba kWh energije ali goriva	Trenuten strošek podjetja	Predlog izboljšave	Poraba kWh energije po uvedbi predlogov	Strošek podjetja po uvedbi predlogov
Pridobivanje energije	17263.167 kWh	1759.98 EUR	Sončna elektrarna	12763.167 kWh	
Ogrevanje - plin	8631.58 kWh	**517.03 EUR**	Ogrevanje – toplotna črpalka	4894.12 kWh	**704.75 EUR**
Razsvetljava – stare luči	6214.74 kWh	**894.922 EUR**	Razsvetljava – LED+senzor gibanja	932.21 kWh	**134.24 EUR**
Poraba goriva - dizel	440 l	**670.12 EUR**	Poraba goriva – plin/elektrika		**469.08 EUR**
Ostali stroški	2416.85 kWh	**348.02 EUR**	Ostali stroški	2416.85 kWh	**348.02 EUR**
KONČNA PORABA	17263.167 kWh + 440 l	**2430.1 EUR**		8243.18 kWh – 4500 kWh = 3743.18 kWh	**1008.09 EUR**

Torej po uvedbi vseh predlogov se obratovalni stroški zmanjšajo za 58.5 % kar je izjemen dosežek na ekonomičnosti delovanja skladišča.

Sedaj pa lahko ugotovimo še količino co2 izpustov pri trenutnem stanju in pri predlaganih rešitvah. Pri ogrevanju nam je uspelo zmanjšati porabo energije za 77%, to izhaja iz podatka, da se za 1kwh ogrevanja s pomočjo plina proizvede 0.215 kg co2 plina, med tem, ko se pri 1kWh ogrevanja s pomočjo toplotne črpalke proizvede 0.08 kg co2 plina. V našem primeru smo z plinom porabili 8631.58 kWh, po izboljšavi pa smo porabili 4894.12 kWh električne energije. Iz tega lahko izračunamo, da je količina co2 pri plinski kurjavi 1855.79 kg co2 mesečno, med tem, ko pri toplotni črpalki samo 391.53 kg co2 mesečno (Mittens, 2023). Z

uvedbo LED luči v kombinaciji s senzorji pa se je poraba električne energije zmanjšala za kar 90%. In z uvedbo hibridnega viličarja pa smo količino co2 izpustov zmanjšali za 30%. Torej če vzamemo povprečje vseh izboljšav skupaj smo zmanjšali emisije co2 plina za približno 65.66 %, kar je prav tako izjemen dosežek.

Tabela 2:Prikaz spremembe emisij co2 plina

Trenutno teh.	Trenutna emisija co2	Predlagana teh.	Emisija co2 po uvedbi predlogov
Ogrevanje - plin	**1855.79 kg**	Ogrevanje – toplotna črpalka	**391.53 kg**
Luči – stare rumene	**1590.97 kg**	Luči – LED+senzor	**74.58 kg**
Vozilo - dizel	**1152.8 kg**	Vozilo - hibrid	**806.96 kg**
SKUPAJ	**4599.56 kg**		**1273.07 kg**

Viri in literatura

- Ahačič, U. (2009). Ra Ademola A. Adenle, David J. Pannell, Ellen H. M. Moors, Marian R. Chertow (2020). Science, Technology, and Innovation for Sustainable Development Goals. Oxford University Press. 2020.
- Jožica Ekart (2023). Varčevanje enrgije - Sončne elektrarne v Sloveniji - pregled trga. 2023. https://www.varcevanje-energije.si/fotovoltaicne-elektrarne/soncne-elektrarne-pregled-trga-v-sloveniji.html
- Arcadia Blog (2020). Blog.Arcadia.com - LED vs. regular lightbulbs: Do they really make a difference?. 2020. https://blog.arcadia.com/led-vs-regular-lightbulbs-do-they-really-make-a-difference/
- EP Equipment (2023). Lithium Forklift VS Diesel Forklift: CO2 Emissions Comparison. https://ep-equipment.com/blog/2023/05/12/lithium-forklift-vs-diesel-forklift-co2-emissions-comparison/
- BTC d.d. (2025). O družbi. https://www.btc.si/o-druzbi

TECHNICAL EDUCATION CENTRE LJUBLJANA

A sustainable solution for the operation of BTC d.d.'s warehouse

Author: Matej Žunko, dipl. inž. Log.

Summry

The article briefly presents a solution for the operation of BTC d.d.'s warehouse. The introduction includes a short overview of the company's history, followed by a description of how the warehouse in question operates. The subsequent section outlines possible solutions for the warehouse. In the conclusion, which is also a key part of the article, potential implementations are presented in greater detail, along with their impact on the warehouse's operations.

Key words

Warehouse, Sustainability, Solution

1 Introduction

"BTC is one of the leading companies in the region in the field of management and development of commercial real estate. Under the BTC City brand in Ljubljana, it manages one of the largest shopping, business, recreational-entertainment and cultural centers in Europe. In addition, it also operates shopping centers in Novo mesto and Murska Sobota." This is how the official website of BTC describes the company, highlighting that its operations extend far beyond logistics alone. BTC d.d. is also engaged in a variety of other services, not limited to logistics. These include leasing office buildings, offering diverse entertainment and sports activities (such as go-karting, trampoline park, fun walls, escape rooms, Kolosej cinema, and Atlantis water park), food and beverage services, and the sale of everyday consumer goods.

BTC City Ljubljana, a part of BTC d.d., attracts more than 20 million visitors annually, who take advantage of the diverse service and shopping offerings across multiple sectors. Furthermore, BTC d.d. directs its development toward Industry 4.0 and the Society 5.0 concept, aiming for more efficient and sustainable operations by leveraging modern technologies and approaches. In recent years, BTC d.d. has also increasingly focused on investing in the development of future technologies, which are expected to become essential tools for its business and play a vital role in its operations. BTC d.d. was founded in 1954 as Centralna skladišča (Central Warehouses) and by 1975 had become one of the largest inland warehouses in Europe, with 180,000 square meters of storage space. In 1990, it rebranded as Blagovno Trgovski Center (BTC), transformed into a joint-stock company, and began developing retail operations. By the mid-1990s, the company had opened its first shopping center, the Kratochwill brewery, and had listed its shares on both the Ljubljana and later the London stock exchanges. In the following years, numerous infrastructural and commercial projects were developed, including the market, Mercurius congress hall, Emporium, Millenium sports center, Kolosej cinema, business tower, and the Atlantis water park. In 2011, BTC opened the Crystal Palace (Kristalna palača) and installed solar power plants in Ljubljana and Murska Sobota, marking the beginning of its sustainability-oriented operations. Between 2015 and 2017, BTC developed a start-up ecosystem (ABC Accelerator and ABC Hub), established BTC Digit and BTC Living Lab, and modernized its transport infrastructure. By 2022, BTC City had become synonymous with innovation and sustainability, gaining international recognition (e.g., Expo Dubai 2021) and launching major development projects such as a residential complex in Ljubljana and a new logistics center in Zalog, with a capacity of 45,000 pallet spaces. With these transformations, BTC has evolved from a warehousing company into a modern, urban, innovative, and sustainable hub.

2 Current state and operation of the warehouse

2. 1 Zone 901

Zone 901 is the original zone of the warehouse, where work is carried out in the simplest way. The order picker spends the entire day walking among five rows of racks, using a terminal that displays the work order to collect piece goods and load them onto an RLC cart. The terminal shows numbers indicating the row, section, and part of the section where the item is located—for example, position 904 28 20. The first number (904) represents the rack row, the second (28) is the section within that row, and the third (20) indicates the part of

the section: left (10 or 01), middle (20 or 02), or right (30 or 03). Each row has 30 sections, with odd numbers (1–29) on the left and even numbers (2–30) on the right. Some sections also have two vertical levels: the lower marked as 01 and the upper as 11. Pallets on the racks are labeled accordingly to assist in locating items. The terminal also displays the product name and required quantity. The picker starts at the beginning of the rack area and follows a snake-like path through the rows. After collecting the last item, the delivery note is printed, attached to the cart, the tarpaulin is closed, and the cart is taken to a location assigned by the warehouse manager.

2. 2 Zone 9000

In zone 9000, the work is carried out similarly to zone 901; however, instead of picking goods from locations, the order pickers store goods at specific locations from a pallet. The terminal only provides information about the position where the goods need to be placed. These locations are labeled, for example, as “loc-102” and are numbered from 1 to 185. The layout follows the same pattern as in zone 901, with odd numbers on the left and even numbers on the right. For certain locations, the order picker must place multiple units of the same product; in such cases, the terminal displays a note like “pcs 4,” which means four units must be placed at that specific location. Once the order picker distributes one type of item to all the designated locations, they move on to the next item on the pallet and continue the process until all goods are stored. The codes on the items used to assign them to specific locations are determined by the receiving clerk at the time the goods are accepted into the warehouse.

2. 3 Basement and garden zone

In the basement zone, order picking is carried out in the same way as in zone 901; however, only consumable materials are stored there. The work in the basement is physically more demanding, which is why it is performed exclusively by male workers.

In the garden department zone, seasonal goods such as chairs, tables, and soil are picked. Despite the shorter working period, operations are similar to those in other zones. This zone is separated from the main warehouse and is located in an external storage area.

2. 4 Warehouse Operation and Problem Description

The operation of the given warehouse is quite outdated, which consequently results in high operating costs. This warehouse will remain in use only if a suitable solution can be found to reduce operational expenses and its negative environmental impact. The facility is currently heated using gas, which is not the worst heating method—compared to wood or oil heating, it is still more efficient and less environmentally damaging. However, in today’s context, where various sustainable solutions are available, gas heating could be replaced with a heat pump system. The warehouse is not highly space-demanding in terms of volume, and not all areas are heated—mostly the office spaces and the basement. Electricity generation could also be improved, as the location (Letališka cesta 12, Ljubljana) receives abundant sunlight. BTC d.d. has already installed solar power plants on several of its other buildings with great satisfaction, so the same could be done for this warehouse. Lighting is another major issue; the warehouse is lit with outdated yellow lights that remain on all day, even though operations only take place for 9 to 10 hours daily, and many areas are not regularly in use. Even during lunch breaks, half of the warehouse remains unused for 30

minutes, yet the lights stay on. The first lunch group starts at 10:00 and the second at 10:30, meaning that for one hour daily, half the warehouse is unused but still fully lit, wasting energy. Outside working hours, lights are also left on in almost all areas for security reasons, which is not an economical solution. Lastly, there is one internal combustion forklift that is rarely used compared to the electric forklifts but still contributes to unnecessary costs and CO_2 emissions.

3 Conclusion – Proposed Solutions

In the first proposed solution, we addressed the issues of electricity generation and heating. The suggested measures included installing a 2,500 m² solar power plant with a capacity of 400 W and purchasing a heat pump for space heating. With the solar power plant, monthly electricity consumption could be reduced from 17,263.167 kWh to 12,763.167 kWh. Regarding heating, the heat pump would reduce heating energy consumption by 43.3%. Assuming that 50% of the warehouse's total energy consumption is attributed to heating and cooling, this represents 8,631.58 kWh of the total monthly energy usage. With the heat pump, this would decrease to 4,894.12 kWh, meaning that nearly all the heating needs could be covered by the solar power system.

The second solution targeted the warehouse lighting problem. The currently used outdated lights would be replaced with new, energy-efficient LED lights. This replacement would reduce energy consumption for lighting from 6,214.74 kWh to 932.21 kWh. Additionally, the installation of motion sensors would further reduce consumption by 35%, bringing the total down to 605.94 kWh per month.

The final proposal focused on material handling equipment. The current internal combustion forklift consumes 440 liters of fuel per month, resulting in a cost of €670.12 and generating 1,152.8 kg of CO_2 emissions. By switching to a hybrid forklift, fuel costs could be reduced to €469.08, and monthly CO_2 emissions would drop to 806.96 kg.

Table 1: Overview of Operational Cost Changes

Current state	Current usage of kWh energy or gas	Current cost of the company	Advised solutions	Usage of kWh energy after implemented solutions	Operational costs after the implementation of solutions
Energy	17263.167 kWh	1759.98 EUR	Solar panels	12763.167 kWh	
Heating - gas	8631.58 kWh	**517.03 EUR**	Heating – heat pump	4894.12 kWh	**704.75 EUR**
Lighting – old lights	6214.74 kWh	**894.922 EUR**	Lighting – LED + sensor	932.21 kWh	**134.24 EUR**
Fuel consumption - diesel	440 l	**670.12 EUR**	Fuel consumption – gas/electricity		**469.08 EUR**
Other costs	2416.85 kWh	**348.02 EUR**	Other costs	2416.85 kWh	**348.02 EUR**
FINAL CONSUMPTION	17263.167 kWh + 440 l	**2430.1 EUR**		8243.18 kWh – 4500 kWh = 3743.18 kWh	**1008.09 EUR**

After implementing all the proposed measures, operational costs are reduced by 58.5%, which represents a significant achievement in terms of warehouse cost-efficiency.

We can now also determine the CO_2 emission levels under current conditions and compare them with those under the proposed solutions. For heating, energy consumption was reduced by 77%, based on the fact that 1 kWh of gas heating produces 0.215 kg of CO_2, while 1 kWh of heat pump heating produces only 0.08 kg of CO_2. In our case, gas heating originally consumed 8,631.58 kWh, and after the improvement, this dropped to 4,894.12 kWh of electricity. This means CO_2 emissions from gas heating were 1,855.79 kg per month, while the heat pump results in only 391.53 kg CO_2 per month.

By installing LED lighting combined with motion sensors, electricity consumption for lighting was reduced by 90%. Additionally, switching to a hybrid forklift reduced CO_2 emissions by 30%.

Taking the average reduction across all improvements, the total CO_2 emissions decreased by approximately 65.66%, which is likewise an outstanding achievement in environmental performance.

Table 2: Overview of CO_2 Emissions Changes

Current state	Current co2 emissions	Post solution state	Co2 emissions after implemented solution
Heating - gas	**1855.79 kg**	Heating – heat pump	**391.53 kg**
Lights – old lights	**1590.97 kg**	Lights – LED/sensor	**74.58 kg**
Vehicle – diesel	**1152.8 kg**	Vehicle - hybrid	**806.96 kg**
TOTAL	**4599.56 kg**		**1273.07 kg**

Sources and literature

- Ahačič, U. (2009). Ra Ademola A. Adenle, David J. Pannell, Ellen H. M. Moors, Marian R. Chertow (2020). Science, Technology, and Innovation for Sustainable Development Goals. Oxford University Press. 2020.
- Jožica Ekart (2023). Varčevanje enrgije - Sončne elektrarne v Sloveniji - pregled trga. 2023. https://www.varcevanje-energije.si/fotovoltaicne-elektrarne/soncne-elektrarne-pregled-trga-v-sloveniji.html
- Arcadia Blog (2020). Blog.Arcadia.com - LED vs. regular lightbulbs: Do they really make a difference?. 2020. https://blog.arcadia.com/led-vs-regular-lightbulbs-do-they-really-make-a-difference/
- EP Equipment (2023). Lithium Forklift VS Diesel Forklift: CO2 Emissions Comparison. https://ep-equipment.com/blog/2023/05/12/lithium-forklift-vs-diesel-forklift-co2-emissions-comparison/
- BTC d.d. (2025). O družbi. https://www.btc.si/o-druzbi