Oznaka poročila: ARRS-RPROJ-ZP-2015/47

ZAKLJUČNO POROČILO RAZISKOVALNEGA PROJEKTA

A. PODATKI O RAZISKOVALNEM PROJEKTU

1.Osnovni podatki o raziskovalnem projektu

Šifra projekta	J5-4279
Naslov projekta	Vpliv recesije na interakcije regij v globalnih oskrbovalnih mrežah in rabo zemljišč
Vodja projekta	7799 Marija Bogataj
Tip projekta	J Temeljni projekt
Obseg raziskovalnih ur	3945
Cenovni razred	
Trajanje projekta	07.2011 - 06.2014
Nosilna raziskovalna organizacija	2734 MEDIFAS Mediteranski inštitut za sodobne študije
Raziskovalne organizacije - soizvajalke	792 Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo 2735 Univerza v Mariboru, Fakulteta za energetiko
Raziskovalno področje po šifrantu ARRS	5 DRUŽBOSLOVJE 5.08 Urbanizem
Družbeno-ekonomski cilj	11. Družbenopolitični sistemi, strukture in procesi
Raziskovalno področje po šifrantu FOS	5 Družbene vede 5.09 Druge družbene vede

B. REZULTATI IN DOSEŽKI RAZISKOVALNEGA PROJEKTA

2.Povzetek raziskovalnega projekta[1]

SLO

Projekt je obravnaval motnje, ki jih v oskrbovalne sisteme prinašajo perturbacije, s kakršnii smo se srečali ob nenadni krizi in po letu 2008 in jih Evropejci nismo sposobni premagati.

Samostojno smo razvili lastni sklop simulacijskih modelov, ki omogočajo napovedovanje

sprememb v kriterialnih funkcijah pri spremembi enega ali več parametrov oziroma odločitvenih spremenljivk v enem od bazičnih modelov: tokov blaga z vključeno antipolucijsko dejavnostjo in oskrbo z energijo (Arrighi: "Space of flows"), model človeških virov in oskrbe prebivalstva v regiji ("Space of places"), ter sklop aktuarskih modelov za vrednotenje rizikov v spremembah demografskih struktur in povpraševanju po grajenem prostoru, ki jih vežemo na prvega ali drugega od prej naštetih modelov. Z uvedbo transportnih in alokacijskih matrik v klasični MRP model (zdaj poimenovan extended MRP, kratko EMRP), ki ga je na temelju del Orlickega, Leontijeva in Laplaca predhodno razvil Grubbström, smo omogočili študij lokacijskih prednosti posameznih centralnih krajev kot lokacij celic aktivnosti proizvodno - distribucijskih mrež tudi v globalnih oskrbovalnih sistemih in uvedli v sistem podmatrike razbremenilne logistike. Pokazali smo, da je s povezovanjem in nadgradnjo

- MRP teorije ter
- gravitacijskih modelov Lorijevega tipa *in Intramax* grozdenja

mogoče matematično formalizirati paradigmo o prostoru lokacij (centralni kraji - mesta kot jedra funkcionalnih regij) in prostoru tokov, ki ga opisujemo z razširjenim MRP modelom, poimenovanim EMRP. V model smo uvedli aktuarske metode vrednotenja rizikov za potrebe določanja nujnih rezervacij za stabilno delovanje oskrbovalnih sistemov in s simulacijami napovedali spremembe, ki jih prinašajo perturbacije vhodnih parametrov, še predvsem v času recesije. Poleg ocenjevanja vplivov časovnih zakasnitev na neto sedanjo vrednost aktivnosti v prostoru smo študirali tudi simulacijske "fuzzy" modele pogajanj med celicami aktivnosti v oskrbovalnih sistemih, ki omogočajo napovedovanje teh zakasnitev oziroma povzročajo dodatne dobavne odloge.

Tako ekonomski, kot tudi demografski in energetsko-okoljski faktorji v oskrbovalnih sistemih so značilno vplivali na trg nepremičnin. Zato smo v analizi interakcij med oskrbovalnimi sistemi in rabo prostora ter njihovega vpliva na trg nepremičnin upoštevali v gravitacijskih modelih tako ekonomske, kot tudi demografske in energetsko-okoljske vplive. S tem je mogoče laže ocenili tudi volatilnost trga nepremičnin. Z vpeljavo mehkega modeliranja v vrednotenju prostora (kot npr."Regression-fuzzy approach to land valuation") in objavo rezultatov študij gravitacijskih vplivov v Springer e-book (Uvrstitev poglavja "A fuzzy approach to forecasting the attractiveness of regions for human resources" med 25 % najbolj branih vsebin v Springer eBooks Collection 2013 [6624865]) smo svoje delo uvrstili tudi v zgornjo četrtino najbolj branih Springerjevih monografij.

ANG

The project addressed the modelling and implementation of decision-support systems with disturbances caused by perturbations in supply chains such as were encountered during the 2008–2009 financial crisis and its aftermath. Independently, we developed our own set of simulation models that allow prediction of changes in criteria functions when changing one or several parameters and/or decision variables in one of fundamental models: the core model of the flow of goods which include antipollution activities and energy supply in the region ("Space of Flows"), the model of human resources, remote services from central places and supply of the population in the region ("Space of Places"), and a set of actuarial models for risk evaluation which enable better forecasting of the results of changes in demographic structures and the demand for built environment, which is linked to the first or second of the above models. With the introduction of the transport matrix in the classical MRP model, now called the extended MRP (EMRP), which is based on the seminal work of Orlicky, Leontief and Laplace, previously developed by Grubbström, we allow the study of locational advantages of central places as locations of activity cells where production, distribution or reverse logistics activities are located in Global Supply Systems. Here we also introduced submatrix of reverse logistics. We have shown that by integrating and upgrading

- the MRP theory and

- gravity models and Intramax clustering

it is possible to formalize mathematically the paradigm of "Space of Places" (central places – cities as the core of functional regions) and "Space of Flows", which is described here on the basis of the extended MRP model (EMRP). In the model we introduced the actuarial tools for risk evaluation and determination of emergency provisions for stable operation of supply

systems. Furthermore, we enabled the simulation and forecasting of changes of the values of criterion functions when perturbations of the input parameters arise, in particular in times of recession. In addition to assessing the impact of time delays on the net present value as a result of negotiations, the simulation of "fuzzy" negotiations between activity cells was the subject of an additional study.

3.Poročilo o realizaciji predloženega programa dela na raziskovalnem projektu[2]

Pokazali smo, da je MRP teorijo, prvotno razvito za planiranje proizvodnih procesov, mogoče z uvedbo matrike transportnih zakasnitev in transportnih stroškov razširiti na teorijo upravljanja tokov v poljubno razvejanih oskrbovalnih verigah, [ID 2114915]. Ta izhodiščni članek tudi dokazuje, da so za implementacijo nujne navezave na prostorske informacijske baze, iz katerih črpamo parametre celic aktivnosti v verigah in relacije med posameznimi celicami. Pokazali smo tudi, da je s tem novim pristopom mogoče študirati vpliv sprememb različnih parametrov v oskrbovalnih verigah na tokove blaga in človeških virov med celicami aktivnosti v verigi. Takšno orodje pa nam je potrebno še predvsem, ko moramo študirati vpliv nepričakovano velikih perturbacij različnih parametrov, ki so v interakciji, na tokove in s tem na izbrano kriterialno funkcijo. S tovrstnimi perturbacijami se srečujemo še predvsem v času recesije, ko se tokovi med celicami aktivnosti oskrbovalnih mrež trgajo in jih Evropejci nismo sposobni stabilizirati. Do objave tega članka je namreč MRP model služil le planiranju materialnih potreb »pod eno streho«, se pravi, ko ni bilo možno študirati vpliv lokacije na ekonomske ali druge rezultate delovanja celic aktivnosti v mreži. Tu je tudi okvirno opisano, katere ekonomske, okoljske in druge prostorske podatke je potrebno zajemati in kako jih je mogoče vrednostiti preko neto sedanje vrednosti (NPV) ekonomskih in okoljskih rezultatov aktivnosti v celicah, ki imajo svojo prostorsko komponento in jim je mogoče preko GIS baz oceniti razdalje po prometnicah, časovne in stroškovne razdalje. Delo vključno s seznamom prej študirane literature je dostopno preko ScienceDirect. Temeljne ideje smo najprej razdelali v člankih Bogataj in Grubbströma (kategorija A''): (1.) »On the representation of timing for different structures within MRP theory« [2012, ID 21339622], kjer smo podrobneje razdelali vprašanje, kako analizirati vplive časovnih zakasnitev zaradi razdalj med celicami aktivnosti in motenj, ki lahko nastopijo na takih razdaljah. Pri tem smo najprej sistem razdelali glede na štiri podsisteme: proizvodnja, distribucija, potrošnja, razbremenilna logistika. Tako smo bolj poglobljeno sledili cilju zgoraj navedenega članka, kako zgraditi model, ki podpira odločitve v zvezi s strukturo dobavne verige kot alternativo mešani celo-številčni formulacijo linearnega programa, ki ima bistveno manj razširitvenih možnosti. Pokazali smo, da ta alternativa omogoča boljše modeliranje perturbacij v oskrbovalnih sistemih. Razviti model omogoča uporabo zveznih funkcij, ki opisujejo prostorsko razpršenost stroškov in povpraševanja v sistemih, kar pa je že tedaj nakazovalo potrebe po navezavi na modele razmejevanja funkcionalnih regij.
(2.) Drugi članek je: »Transportation delays in reverse logistics« [2013, ID 2230883]. V njem smo časovne zakasnitve, ki so posledica izbire lokacij celic aktivnosti v mrežah, posebej obdelali tudi z vidika polucije in razbremenilne logistike. Pri tem smo izpostavili stroške razdalje do odlagališča, ki jih je mogoče tehtati z vrednostmi antipolucijskih učinkov.
(3) V tem sklopu del navajamo tudi: »Reverse logistics in extended MRP theory and impact on region«. [2011, ID 2212963], kjer so podani prvi nastavki okoljevarstvenih parametrov za delo [2013; COBISS.SI-ID 2230883] in s tem za doktorsko disertacijo Danijela Kovačića pod mentorstvom vodje projekta.

Pri naštetih delih so se za namene implementacije pokazale potrebe po zajemanju podatkov iz prostorskih baz podatkov o prebivalstvu (še posebej po podatkih o človeških virih v prostoru in njihovih dnevnih in stalnih migracijah), iz baz o hišah (centroidih) in gospodinjstvih, dejavnostih v prostoru in transportnih mrežah po različnih nivojih prostorskih enot (NUTS 0 - NUTS 5). Katere dejavnosti in objekte vključevati v analizo so pokazali tudi gravitacijski modeli, ki smo jih razvili v kombinaciji z mednarodnim projektom ATTREG, [2012, ID 6046561; 2012, ID 6047073] v okviru katerega smo poleg poročil za ESPON na evropskem nivoju objavili tudi monografijo »Accessibility and flow of human resources between Slovenian regions« [ID 258509056], ki daje podatke o logit regresijski odvisnosti med tokovi prebivalstva, posebej še človeških virov, razpoložljivostjo delovnih mest in drugimi faktorji atraktivnosti centralnih krajev ter cenami nepremičnin. Te parametre smo podrobneje razdelali in primerjali njihove

vrednosti po krizi in pred njo v članku: »Vpliv recesije na parametre kakovosti regionalnih središč in njihovo privlačnost« [2013, ID 2048200962] in »Regions for Servicing Old People« [2014, ID 6739809]. Čeprav se ta dela ukvarjajo bolj s ceno hiš in stanovanj, pa je pri vsem nujno izhajati iz dejstva, da je cena nepremičnin dejansko anticipacija rente in je grajeni objekt pripojen zemlji. Zato je vedno potrebno izvajati tovrstne študije v kontekstu omejenosti zemlje v celoti, pri vseh rabah in prostorskih politikah, ki omejujejo namensko rabo. S tega vidika pa je bilo potrebno pri končnih ugotovitvah naših študij upoštevati še vrsto drugih rezultatov člankov iz priloge SICRIS.

Modele za določanje funkcionalnih in upravnih regij smo podrobneje proučili in o tem podali v znanstvenih člankih kot npr.: [ID 5557345 [ID 6541409], [ID 6015585], [ID 5787745] in številnih drugih delih, ki obravnavajo to problematiko po posameznih vidikih in so našteta v prilogi: »SICRIS objave 2011-2014«. V poročilu jih zaradi omejenega prostora ni mogoče niti naštevati. Vsa pomembnejša dela so dosegljiva v mednarodnih bazah in vključujejo tudi literaturo, ki je bila predmet študije v prvem semestru.

Študijam, katerih rezultate najdemo v zgoraj navedenih objavah [ID 2175075; 2230883 in 2230883] in vzporednim študijam tokovom prebivalstva so sledile analize nekaterih teoretičnih podproblemov na oskrbovalnih mrežah kot so npr. dela z mehkimi množicami prof. Usenika in dr. Turnška [ID 2048230402]. Ta pomagajo oceniti časovne zakasnitve v verigah, njihove vplive kot rezultate pogajanj med partnerji v verigi [2013, ID 2048215042; 2013, ID 2048206338; 2013, ID 2048216578]. Prav tako so prof. Usenik in njegovi študentje pokazali, kako je brez natančnih podatkovnih baz z mehkimi pristopi mogoče dokaj dobro oceniti pričakovane energetske učinke in optimalno upravljati sisteme ter tako prispevati v oceno NPV celotne verige, ki se vrednoti na višjem nivoju. Poleg disertacije dr.Turnška, magisterijev in diplom pod mentorstvom prof. Usenika in člankov v zbornikih so bili objavljeni tudi naslednji relevantni znastveni članki: [2011, ID 1024074588; 2012, ID 1024110428; 2012, ID 1024081500].
Probleme obvladovanja energije v oskrbovalnih sistemih in simulacijo takih sistemov je skupaj z antipolucijsko industrijo pod mentorstvom prof. Bogataj posebej obdelal Kovačić v svoji disertaciji, ki je nastajala tekom celotne izdelave projekta: »Ekonomsko-okoljsko ravnotežje v razširjeni teoriji planiranja materialnih potreb« [2013, ID 21339622], kjer se je poleg na temeljna ogrodja v zgoraj navedenih člankih [ID 2175075, 2230883 in 2230883] oprl tudi na dela Usenika in ostalih o energetski učinkovitosti. Tako je poleg številnih drugih objav, ki slonijo na rezultatih te disertacije, in simulacijskem modelu, ki je bil tekom dela na disertaciji in po njej razvit, nastalo tudi skupno delo »Evaluation of energy efficiency and environmental costs of production in repeated reverse logistics using also fuzzy approach« [ID 2048225538]. Na temelju tega antipolucijskega modela EMRP pa je nastalo tudi več aplikacij v prehrambeno industrijo v Španiji. Ta dela so nastajala v tesnem sodelovanju s Tehnično Univerzo v Cartageni- UPCT (Ros McDonnell, Hontoria, Campuzano Bolarin in de la Fuente Aragon, glej COBISS!). Eno pomembnejših rezultatov tega sodelovanja je članek »Location and lead-time perturbations in multi-level assembly systems of perishable goods in Spanish baby food logistics« [ID 19073330]. Z UPCT smo organizirali tudi skupno mednarodno konferenco: XV Congress of Industrial Engineering and the 5th International Conference on Industrial Engineering and Industrial management, Cartagena, v jeseni 2011. M.Bogataj je bila tu sourednica v Springerjevi založbi objavljne monografije, ki je vključevala 20% razširjenih najboljših del [ID 2258787; ID 22355174], ki predstavljajo smiselno celoto, med katerii so tudi dela, ki so rezultat študij v okviru tega projekta: »Does the accessibility of CE regions influence investment attractivness?« [ID 2259043], »Contingency between elasticity of demand and bullwhip effect in logistics chains« [ID 2259299] in »A fuzzy approach to forecasting the attractiveness of regions for human resources« [ID 2259555], vsi kategorije A'.

Probleme, na katere smo naleteli pri razvijanju računalniške podpore, je obravnaval Grubbström sam ali s sodelavci iz Univerze v Linköpingu v naslednjih delih, objavljenih v revijah kategorije A'': »The time-averaged L4L solution - a condition for long-run stability applying MRP theory« [2012, ID 17434162], »The space of solution alternatives in the optimal lotsizing problem for general assembly systems applying MRP theory« [2012, ID 17425970], »Comulative staircase considerations for dynamic lotsizing when backlogging is allowed« [2014, ID 17434930], »Dynamic lotsizing with a finite production rate« [2014, ID

17435186] in »The space of solution alternatives in the optimal lotsizing problem for general assembly systems applying MRP theory" [2014, ID 17425970].

Probleme negotovosti v oskrbovalnih sistemov in perturbacij velikih amplitud smo študirali najprej iz člankov, ki so bogato zastopani v bazi ScienceDirect. Vendar pa je le malo primerov, ki govorijo o vplivu sprememb v oskrbovalnih sistemih na spremembe v rabi zemljišč, kjub temu, da je sedanja kriza najbolj prizadela prav trg nepremičnin in industrijo, ki je na ta trg vezana. Izhajali smo iz rezultatov objave v reviji A": »Measuring the supply chain risk and vulnerability in frequency space«, [ID 16965094]. Preko produkcijskih funkcij smo povezali razširjen model upravljanja z riziki v oskrbovalni verigi, z modelom atraktivnosti regij, ki temelji na gravitacijskem pristopu. Osnovne ideje teh povezav so bile najprej okvirno opisane v A" članku: »The role of free economic zones in global supply chains« [2011, ID 2115171], nato pa smo ta idejni pristop uporabili v članku »Location of production activity cells in the space-of-flows and the space-of-places« [2014, ID 6505057]. Vprašanje negotovih zmogljivosti človeških virov zaradi podaljševanja starosti ob upokojevanju, kar dodatno prinaša motnje v sisteme, pa smo na istem EMRP ogrodju obravnavali tudi v članku, ki je bil objavljen v reviji A": »The extended MRP model for the evaluation and financing of superannuation schemes in a supply chain« [2013, ID 17704754]. Na povpraševanje po človeških virih in rizike negotove proizvodnje v oskrbovalnih sistemih zaradi spremenjenih demografskih struktur smo vezali vprašanje povpraševanja po nepremičninah.

Prav vprašanje negotovosti zaradi spreminjanja demografskih struktur, ki je drastično izbilo v javnost v krizi pa je odprlo novo področje raziskovanja - financiranje prilagajanj grajenega prostora v mestih hitremu staranju prebivalstva in našli rešitve v uvedbi fleksibilne obratne hipoteke. Prva razmišljanja in nadgradnje te teme najdemo v doktorski disertaciji D. Bogataja [2012, ID 2048150018], njegovi monografiji »Vlagaj v svoj dom, da boš dolgo živel in ti bo dobro na zemlji« [2013, ID 266680064], objavah kot so: »Črpanje nepremičnega premoženja starostnikov« [2012, ID 2048181250], »Pensions and home ownership in the welfare mix for older persons« [2013, ID 2048216322] , »The adaptation of extended net present value theory and Solvency II in risk management« [2013, ID 2048215554], »Urban growth in ageing societies«, [2012, ID 513005698], »Residential real estate investments from the perspective of Act on social security benefits« [2013, ID 1024393329] in mnogih vabljenih in drugih predavanjih, ki bodo objavljena v Springer e-Book in rviji A'' tekom leta 2015.

4.Ocena stopnje realizacije programa dela na raziskovalnem projektu in zastavljenih raziskovalnih ciljev[3]

Torej smo v vseh napovedanih aktivnostih predvidevali navezavo na MRP model, za kar je bilo potrebno ponekod model razširiti in obogatiti simulator.

Uspeno smo zaključili evropski raziskovalni projekt ATTREG, iz katerega smo črpali parametre aktraktivnosti za prebivalce evropskih regij in jih posebej ovrednotili v slovenskih regijah.

Indeks števila objavljenih člankov glede na plan je preko 300, od tega preko 200 tudi indeks člankov objavljenih v revijah z IF>0, Mnoga dela sodijo pod A". Nabor del iz SICRISa je v priponki. Večina pomembnejših del je dosegljivih v mednarodnih bazah, člankom pa so dodani tudi nabori uporabljene literature, ki smo jo študirali v prvem semestru in tudi pozneje.

Zaradi zmanjšanja obsega financiranja na polovico smo napovedali organizacijo le dveh kongresov, pa smo sodelovali v organizaciji petih mednarodnih kongresov. Torej je indeks realizacije 250.

Tekom izvedbe projekta so doktorirali trije naši doktorandi. Na temi funkcionalnih regij in okrbovalnih sistemov pa je diplomiralo tudi več dodiplomskih in magistrskih študentov. Eden

od doktorandov je prijavil temo doktorske disertacije s področja razmejevanja funkcionalih regij leta 2013 in pričakujemo, da bo v kratkem oddal doktorsko disertacijo v oceno na Univerzi v Ljubljani - FGG. S te teme pa nadaljujejo delo na doktorski disertaciji še trije drugi doktorandi.

Izdali smo tri monografije, od tega eno pri založbi Springer.

V programu smo napovedali uporabo simulatorja VENSIM ali kakšnega primernejšega, ki bi se pojavil na trgu, vendar smo po preizkusu različnih opcij, ki jih navajamo tudi v objavah v COBISSu, ugotovili, da moramo za svoje potrebe vrednotenja nepremičnin in nanje vezanih oskrbovalnih sistemov razviti lastni simulator, kar nam je tudi uspelo.

Za zmanjševanje rizikov v oskrbovalnih sistemih razvijamo tudi aplikacije, ki jih bomo tržili v "spin off" enoti v Cartageni.

Odprli smo novo temo v okviru ISIR o upravljanju zalog grajenega prostora.

5.Utemeljitev morebitnih sprememb programa raziskovalnega projekta oziroma sprememb, povečanja ali zmanjšanja sestave projektne skupine[4]

Kot smo tudi napovedali kot možnost, ki bi se pokazala tekom študija, smo po poglobljeni analizi simulatorja VENSIM in celo po objavah nekaterih simulacij na VENSIM simulatorju ugotovili, da je primerneje, da za dosego ciljev našega projekta razvijemo lastni simulator, ki bo temeljil na MRP ogrodju Grubbströma z razširitvijo s transportnimi in alokacijskimi matrikami, kar nam je tudi uspelo.

6.Najpomembnejši znanstveni rezultati projektne skupine[5]

	Znanstveni dosežek			
1.	COBISS ID		2315363	Vir: COBISS.SI
	Naslov	*SLO*	Lokacija logistični postrojenj v razbremenilni logistiki z uporabo ciklične EMRP teorije	
		ANG	Reverse logistics facility location using cyclical model of extended MRP theory	
	Opis	*SLO*	Grubbströmova dobro razvito MRP teorija je bila večinoma uporabljajo v modeliranju proizvodnih procesov "pod eno streho". Globalne dobavne verige vsebuje tudi distribucijo, potrošnjo in recikliranja procesov. Iz tega razloga je bila teorija v zadnjem času razširjena tako, da vključi tudi distribucijo in razbremenilno logistiko, predvsem pa omogoča proučevanje vplivov transporta in drugih vplivov na daljše razdalj med celicami aktivnosti. Tako je matrika, ki je sestavljen iz štirih glavnih podsistemov, zaprta in se lahko uporabijo za več podrobnih analiz. Ker se pomen razbremenilne logistike povečuje, se ta članek osredotoča na parametre, ki določajo neto sedanja vrednost celotnega sistema, odvisno od geografske lokacije naprav za recikliranje. Pokazali smo, kako dobavni odlogi, prevozni stroški glede na izbiro lokacije, stroški lokacije, cena delovne sile, ki variira med lokacijami, in cena energije posameznega mesta prispevajo v NPV kriterialno funkcijo. Članek je pomemben predvsem zato, ker je osnova za izgradnjo simulatorja za vrednotenje različnih ekonomskih, demografskih, okoljskih in energetskih odločitev v prostoru, kar smo podrobneje predstvili v članku v prilogi, ki je bil sprejet v objavo v reviji A" in bo objavljen v letu 2015. Kot je razvidno iz priponke je bil namreč v revijo TEDE sprejet članek "Net Present Value evaluation of energy production and consumption in repeated reverse logistics". Že v letih 2011 in 2012, ko smo izvajali simulacije z	

			VENSIM [ID 2259299], smo ugotovili, da za naše študije VENSIM ni najprimernejši in da je smiselno razviti lastni simulator, kar nam je uspelo.	
		ANG	Grubbström's well-developed MRP Theory has been mostly used in modeling production processes. Global supply chains also contain distribution, consumption and recycling processes. For this reason theory was recently further extended to incorporate all kinds of activities. Such extended model, which consists of four main sub-systems, is closed and can be used for several detailed analyses. Since the importance of reverse logistics is increasing, this paper will focus on parameters which determine Net Present Value of the whole system, depending on geographical location of recycling facilities. We will show how lead times, transportation costs, setup costs and price of labor and energy of individual location contribute to overall NPV of the system. The article is particularly important because it is the basis for building a simulator for the evaluation of different decisions on decision variables relevant for economy, demography and land use, environment and energy in the area, which is in details presented in the appended article "Net Present Value evaluation of energy production and consumption in repeated reverse logistics.", accepted in publication in category A" journal. Already in 2011 and 2012, when we carried out simulations with VENSIM [ID 2259299], we find that in our study VENSIM is not the best platform therefore we tried to developed our own simulator, which we succeeded.	
	Objavljeno v		Springer; Central European Journal of Operations Research; 2013; Vol. 21, no. 1; str. 41-57; Impact Factor: 0.787;Srednja vrednost revije / Medium Category Impact Factor: 1.214; A': 1; WoS: PE; Avtorji / Authors: Kovačić Danijel, Bogataj Marija	
	Tipologija		1.01 Izvirni znanstveni članek	
2.	COBISS ID		2230883	Vir: COBISS.SI
	Naslov	*SLO*	Transportne zakasnitve v razbremenilni logistiki	
		ANG	Transportation delays in reverse logistics	
	Opis	*SLO*	V tem članku smo uporabiti teorijo MRP in jo razširili s transportno matriko in podmatriko povratne logistike. S tem smo omogočili analizo vpliva lokacije na NPV oskrbovalnih sistemov in človeških virov iz funkcionalne regije na ekonomske in okoljske vrednosti kriterialne funkcije, predvsem preko vrednotenja NPV. Naš cilj je bil predvsem, da dokažemo vsestranskost rezultatov, pridobljenih z uporabo razširjene teorije MRP pri združevanju input-output analizo in Laplacovih transformacij. Ta pristop omogoča analizo dobavne verige, vključno s štirimi podsistemi, in sicer proizvodnjo, distribucijo, potrošnjo in povratno logistiko, kjer geografska razdalja med dejavnostmi in do zaledja s človeškimi viri igrajo pomembno vlogo. Glavni poudarek v tem dokumentu je na povratni logistiki (recikliranje, predelava) oskrbovalnih sistemov mest. Še posebej želimo modelirati vrednotenje antipolucijskih dejavnosti in njihov vpliv na vrednost nepremičnin, kar bo predmet nadaljnih raziskav, kajti model je zastavljen tako, da ga je mogoče nadgraditi v simulator za študij vplivov različnih faktorjev in njihovih interakcij na izbrane kriterialne funkcije, kar je končni cilj naših raziskav.	
			In this paper we extend and apply MRP theory towards reverse logistics including the considerations of transportation consequences. Our aim is to demonstrate the versatility obtained from using MRP theory when combining Input–Output Analysis and Laplace transforms. This enables an analysis of a supply chain including four sub-systems, namely manufacturing, distribution, consumption and reverse logistics, where the geographical distance between the activities play an important role. The	

		ANG	main focus in this paper is on reverse logistics (recycling, remanufacturing). Especially we wish to model the evaluation of disposal and reverse activities far away from agglomerations, which often means an improved environment for nearby inhabitants. This is also illustrated in a numerical example. We use the Net Present Value as a measure of the economic performance. Our ambition is to show that supply chain sub-systems may accurately be described using input and output matrices collected together in corresponding matrices for the system as a whole. Activity levels in each sub-system govern the speed of the respective processes, and these activity levels, in general, will be considered as decision variables. We now analyse reverse logistics activities in which the flows of materials and goods are typically divergent (arborescent processes), similar to properties of the distribution sub-system, and recent results on the extensions of basic MRP theory introducing the concepts of output delays and the generalised output matrix are also introduced here, when modelling the reverse logistics sub-system.
	Objavljeno v		Elsevier; International journal of production economics; 2013; Vol. 143, no. 2; str. 395-402; A'': 1;A': 1; Avtorji / Authors: Bogataj Marija, Grubbström Robert W.
	Tipologija		1.01 Izvirni znanstveni članek
3.	COBISS ID		17704754 Vir: COBISS.SI
	Naslov	*SLO*	Razširjeni MRP model za valorizacijo in financiranje pokojninskih shem delavcev v oskrbovalnih sistemih
		ANG	The extended MRP model for the evaluation and financing of superannuation schemes in a supply chain
	Opis	*SLO*	Po nastopu krize se upokojitvena starost industrijskih delavcev v nacionalnih pokojninskih sistemih naglo dviguje in kupna moč starostnikov upada. Vendar, mnogi industrijski delavci niso sposobni delati do dosega višje upokojitvene starosti. Ta problem zmanjšuje socialno varnost, povečuje tesnobo delavcev glede prihodnosti ter vpliva na kakovost in efektivnost proizvodnih procesov. Motnje in nižje kakovosti proizvodnih komponent v eni dejavnosti celice dobavne verige je lahko vzrok, da vrednost priozvodnje v celicah, ki sledijo, upade drastično. Da bi rešili ta problem, moramo vzpostaviti programe dodatnega kolektivnega pokojninskega zavarovanja, kot nadomestila podjetjem za zmanjšano sposobnost njihovih starejših delavcev, ko dosežej do sedaj določeno upokojitveno starost, vendar še niso dosegli novo, višje upokojitvene starosti. Ta članek uvaja model preporazdelitve NPV, ki temelji na razširjeni MRP teoriji. Model se lahko uporablja kot osnova za pogajanja med delodajalci in zaposlenimi, za programe dodatnega kolektivnega pokojninskega zavarovanja, da bo proizvodnja tekla na isti kakovostni ravni. Rezultate te študije smo uporabili tudi kasneje v člankih, ki temu sledijo, ko smo obravnavali tudi obratno hipoteko kot enega od štirih stebrov socialne varnosti starejših prebivalcev. Pojasnili smo, kako bi ta rešitev v kombinaciji z obratno hipoteko na nepremičnine dvignila likvidnost nepremičnin in kvaliteto bivanja starostnikov, kar sta dva paralelna problema, ki sta nastopila s krizo in se v njej dokončno razgalila.
			After crisis in 2008 the retirement age of industrial workers in national pension schemes is rising or workers are loosing their job, which often appears very controversial. However, many industrial workers are not able

		ANG	to work until they have reached the increased retirement age. This problem is decreasing social security, increasing workers anxiety regarding the future and influencing the quality and timing of production processes. Disruptions and lower quality items produced in one activity cell of a supply chain can have a ripple effect throughout an entire supply chain. To solve this problem, we should put in place supplementary occupational pension schemes, which would compensate firms for the depreciated ability of their elderly workers to work when they have reached the previous retirement age but have not yet reached the new, higher retirement age. This article is introduces a model that is based on extended MRP Theory. The model can be used as a basis for negotiations between employers and employees to keep production at the same level of quality. The trade-off between higher contributions to supplementary occupational pension schemes and lower added values is considered. Contributions enable the early retirement of industrial workers at one or more workplaces in a supply chain, while lower added value is the result of lower quality and the perturbed timing of items that are produced in one or more activity cells of a supply chain: these issues have a ripple effect throughout an entire supply chain. The net present value approach is used. Based on this consideration we also assumed later in papers which followed this article, how to include also reverse mortgage to improve quality of life of seniors also if they are not able to work properly on there working places. We explained how it would influence liquidity of housing market.
	Objavljeno v		Vilnius Gediminas Technical University;Taylor & Francis; Technological and economic development of economy; 2013; Vol. 19, suppl. 1; str. S119-S133; Impact Factor: 2.818;Srednja vrednost revije / Medium Category Impact Factor: 1.086; A'': 1;A': 1; WoS: GY; Avtorji / Authors: Bogataj David, Vodopivec Robert, Bogataj Marija
	Tipologija		1.01 Izvirni znanstveni članek
4.	COBISS ID		2048200962 Vir: COBISS.SI
	Naslov	*SLO*	Vpliv recesije na parametre kakovosti regionalnih središč in njihovo privlačnost
		ANG	The impact of recession on parameters of quality and attractiveness of regional centers
	Opis	*SLO*	Članek podaja spremembe v parametrih atraktivnosti regionalnih središč pred in po nastopu krize. Z logit modelom so bili ovrednoteni vplivi faktorjev zaposljivosti, plač, cen nepremičnin in drugi faktorji, ki vplivajo na atraktivnost centralnih krajev.
		ANG	The paper presents the changes in the parameters of attractiveness of regional centers before and after the onset of the crisis. The parameters in logit model were evaluated like ration of employability, wages, property prices and other factors that affect the attractiveness of central places.
	Objavljeno v		Fakulteta za organizacijske študije; Revija za univerzalno odličnost; 2013; Letn. 2, št. 2; str. A25-A42; Avtorji / Authors: Drobne Samo, Bogataj Marija
	Tipologija		1.01 Izvirni znanstveni članek
5.	COBISS ID		2259555 Vir: COBISS.SI
	Naslov	*SLO*	Mehki pristop k napovedovanju atraktivnosti regij za človeške vire
		ANG	A fuzzy approach to forecasting the attractiveness of regions for human resources
	Opis	*SLO*	Poglavje v monografiji ki s pomočjo teorije meglenih množic (fuzzy set) opisuje atraktivnost evropskih regij. Obveščeni smo bili, da sodi to poglavje

			med 25% najbolj branih poglavij Springerjevih e-knjig v letu 2013.
		ANG	Chapter in a monograph which on the bases of the fuzzy logic describes the attractiveness of European regions. We have been informed that this chapter is included in the first quartile of chapters in Springer's e-books.
	Objavljeno v		Springer; Industrial engineering; 2012; str. 375-384; A': 1; Avtorji / Authors: Bogataj Marija, Drobne Samo, Tuljak Suban Danijela
	Tipologija		1.16 Samostojni znanstveni sestavek ali poglavje v monografski publikaciji

7.Najpomembnejši družbeno-ekonomski rezultati projektne skupine[6]

	Družbeno-ekonomski dosežek			
1.	COBISS ID			Vir: vpis v poročilo
	Naslov	*SLO*	Marija Bogataj: Izvoljena članica izvršnega odbora ISIR ponovno od jeseni 2014 dalje	
		ANG	Marija Bogataj: Elected Member of Executive Committee of ISIR again since 2014	
	Opis	*SLO*	Prof. M. Bogataj je bila že ob ustanovitvi International Society for Inventory Research (ISIR, 1982) pod predsedstvom Nobelovca Kennetha Arrowa, povabljena v ISIR in dvakrat izvoljena v Izvršni komite. V letu 2014 je bila ponovno izvoljena.. Leta 2014 je v ISIRu odprla novo znanstveno temo: Inventory of housing kot temo, ki je v 21. stoletju deležna največ izzivov glede na globalno krizo, ki so jo povzročile slabo upravljane zaloge nepremičnin, in glede na naglo staranje prebivalstva, ki zahteva drugačno strukturo namenske rabe prostora. (Glej: http://isir.hu/about/bodies-and-officials-2) V imenu ISIR bo v jeseni vodila sekcijo na SOR'15, kjer je MEDIFAS soorganizator. (Glej: http://isir.hu). Tu bo obravnavana tudi skupina člankov o vplivu lokacije in transporta na zaloge nepremičnin. Z otvoritvijo ISIR sekcije v okviru SOR pričakujemo, da bomo simpozij bolj približali mednarodnim krogom in pritegnili tuje raziskovalce, da približajo svetovne dosežke slovenskim.	
		ANG	Prof. M. Bogataj was already at the launch of the International Society for Inventory Research (ISIR, 1982), chaired by Nobel Prize winner Kenneth Arrow, invited to join the ISIR and twice elected to the Executive Committee. In 2014 she was elected again. In 2014 she opened at ISIR a new scientific topic: Inventory of housing as one of the most challengin topic in the 21st century, given the global crisis was caused by poorly managed inventory property, and the the rapidly aging population, which requires a different structure of the land use. (See: http://isir.hu/about/bodies-and-officials-2) On behalf of the ISIR she will bi chairing the section on SOR'15 where MEDIFAS is co-organizer. (See: http://isir.hu). There will be discussed a group of articles on the impact of location and transport on real estate stocks.	
	Šifra		D.03 Članstvo v tujih/mednarodnih odborih/komitejih	
	Objavljeno v		See: http://isir.hu/about/bodies-and-officials-2	
	Tipologija		3.25 Druga izvedena dela	
2.	COBISS ID			Vir: vpis v poročilo
	Naslov	*SLO*	Uredništva znanstvenih revij	

		ANG	Editors of journals
	Opis	*SLO*	Central European journal of operations research. Bogataj, Marija (član uredniškega odbora 2010-). Heidelberg: Springer, 1999-. ISSN 1435-246X. http://www.springerlink.com/content/1435-246X/. [COBISS.SI-ID 21414917] Ekonomske teme. Vodopivec, Robert (član uredniškega odbora 2006-). Niš: Ekonomski fakultet, 1990-. ISSN 0353-8648. [COBISS.SI-ID 17960194] Geodetski vestnik. Lisec, Anka (glavni in odgovorni urednik 2014-). [Tiskana izd.]. Ljubljana: Zveza geodetov Slovenije, [197-]-. ISSN 0351-0271. http://www.geodetski-vestnik.com/. [COBISS.SI-ID 5091842] Geodetski vestnik. Lisec, Anka (urednik 2010-2013). [Tiskana izd.]. Ljubljana: Zveza geodetov Slovenije, [197-]-. ISSN 0351-0271. http://www.geodetski-vestnik.com/. [COBISS.SI-ID 5091842] International Journal of Economic Sciences. Bogataj, Marija (član uredniškega odbora 2012-). Prague: International Institute of Social and Economic Sciences, 2012-. ISSN 1804-9796. [COBISS.SI-ID 17956146] International journal of logistics systems and management. Grubbström, Robert W. (član uredniškega odbora 2004-). Olney (PO Box 735, Olney, Buckinghamshire MK46 5WB): Inderscience, 2004-. ISSN 1742-7967. http://www.inderscience.com/browse/index.php?journalCODE=ijlsm. [COBISS.SI-ID 512208701] International journal of operations and quantitative management. Grubbström, Robert W. (član uredniškega sveta 1995-). Gary, IN: Indiana University Northwest. ISSN 1082-1910. [COBISS.SI-ID 10449430] International journal of production economics. Grubbström, Robert W. (glavni in odgovorni urednik 1991-). [Print ed.]. Amsterdam; London; New York; Tokyo: Elsevier, 1991-. ISSN 0925-5273. [COBISS.SI-ID 11488261]; Marija Biogataj, gostujoča urednica 2015- International Journal of Production Research. Grubbström, Robert W. (član uredniškega odbora 1998-). London: Taylor & Francis, 1962-. ISSN 0020-7543. [COBISS.SI-ID 4673034] ISPRS SC NewsLetter. Lisec, Anka (član uredniškega odbora 2008-2012). [Spletna izd.]. Beijing: International Society for Photogrammetry and Remote Sensing; Ljubljana: Fakulteta za gradbeništvo in geodezijo, 2007-. http://www.isprs-sc.org/materials/newsletter. [COBISS.SI-ID 4627553] Journal of energy technology. Usenik, Janez (urednik 2013, član uredniškega odbora 2008, 2009, 2013). [Tiskana izd.]. [Krško]: Fakulteta za energetiko, 2008-. ISSN 1855-5748. http://www.fe.um.si/sl/jet-opis/jet-on-line.html. [COBISS.SI-ID 243311360] Kybernetes. Grubbström, Robert W. (področni urednik 1971-). Bradford [etc.]: MCB university press, 1972-. ISSN 0368-492X. [COBISS.SI-ID 28709889] Logistics and sustainable transport. Usenik, Janez (področni urednik 2005-,

			član uredniškega sveta 2005-). [Tiskana izd.]. Celje: Evropsko združenje za logistiko in transport, 2005-. ISSN 1854-3332. http://jlst.fl.uni-mb.si/. [COBISS.SI-ID 222476800] MDE. Managerial and decision economics. Grubbström, Robert W. (gostujoči urednik 1988-). Chichester (UK): Wiley, 1980-. ISSN 0143-6570. [COBISS.SI-ID 224796] Production engineering. Grubbström, Robert W. (član uredniškega odbora 2008-). [Print ed.]. Heidelberg; Berlin: Springer, 1993-. ISSN 0944-6524. [COBISS.SI-ID 10743835] Regionální studia. Bogataj, Marija (član uredniškega odbora 2011-). Praha: Vysoká škola ekonomická v Praze. ISSN 1803-1471. [COBISS.SI-ID 2265443] Suvremeni promet. Bogataj, Marija (član uredniškega sveta 1994-). Zagreb: Institut prometnih znanosti, 1987-. ISSN 0351-1898. [COBISS.SI-ID 832260]
			Central European journal of operations research. Bogataj, Marija (član uredniškega odbora 2010-). Heidelberg: Springer, 1999-. ISSN 1435-246X. http://www.springerlink.com/content/1435-246X/. [COBISS.SI-ID 21414917] Ekonomske teme. Vodopivec, Robert (član uredniškega odbora 2006-). Niš: Ekonomski fakultet, 1990-. ISSN 0353-8648. [COBISS.SI-ID 17960194] Geodetski vestnik. Lisec, Anka (glavni in odgovorni urednik 2014-). [Tiskana izd.]. Ljubljana: Zveza geodetov Slovenije, [197-]-. ISSN 0351-0271. http://www.geodetski-vestnik.com/. [COBISS.SI-ID 5091842] Geodetski vestnik. Lisec, Anka (urednik 2010-2013). [Tiskana izd.]. Ljubljana: Zveza geodetov Slovenije, [197-]-. ISSN 0351-0271. http://www.geodetski-vestnik.com/. [COBISS.SI-ID 5091842] International Journal of Economic Sciences. Bogataj, Marija (član uredniškega odbora 2012-). Prague: International Institute of Social and Economic Sciences, 2012-. ISSN 1804-9796. [COBISS.SI-ID 17956146] International journal of logistics systems and management. Grubbström, Robert W. (član uredniškega odbora 2004-). Olney (PO Box 735, Olney, Buckinghamshire MK46 5WB): Inderscience, 2004-. ISSN 1742-7967. http://www.inderscience.com/browse/index.php?journalCODE=ijlsm. [COBISS.SI-ID 512208701] International journal of operations and quantitative management. Grubbström, Robert W. (član uredniškega sveta 1995-). Gary, IN: Indiana University Northwest. ISSN 1082-1910. [COBISS.SI-ID 10449430] International journal of production economics. Grubbström, Robert W. (glavni in odgovorni urednik 1991-). [Print ed.]. Amsterdam; London; New York; Tokyo: Elsevier, 1991-. ISSN 0925-5273. [COBISS.SI-ID 11488261]; Marija Biogataj, gostujoča urednica 2015- International Journal of Production Research. Grubbström, Robert W. (član

			ANG	uredniškega odbora 1998-). London: Taylor & Francis, 1962-. ISSN 0020-7543. [COBISS.SI-ID 4673034] ISPRS SC NewsLetter. Lisec, Anka (član uredniškega odbora 2008-2012). [Spletna izd.]. Beijing: International Society for Photogrammetry and Remote Sensing; Ljubljana: Fakulteta za gradbeništvo in geodezijo, 2007-. http://www.isprs-sc.org/materials/newsletter. [COBISS.SI-ID 4627553] Journal of energy technology. Usenik, Janez (urednik 2013, član uredniškega odbora 2008, 2009, 2013). [Tiskana izd.]. [Krško]: Fakulteta za energetiko, 2008-. ISSN 1855-5748. http://www.fe.um.si/sl/jet-opis/jet-on-line.html. [COBISS.SI-ID 243311360] Kybernetes. Grubbström, Robert W. (področni urednik 1971-). Bradford [etc.]: MCB university press, 1972-. ISSN 0368-492X. [COBISS.SI-ID 28709889] Logistics and sustainable transport. Usenik, Janez (področni urednik 2005-, član uredniškega sveta 2005-). [Tiskana izd.]. Celje: Evropsko združenje za logistiko in transport, 2005-. ISSN 1854-3332. http://jlst.fl.uni-mb.si/. [COBISS.SI-ID 222476800] MDE. Managerial and decision economics. Grubbström, Robert W. (gostujoči urednik 1988-). Chichester (UK): Wiley, 1980-. ISSN 0143-6570. [COBISS.SI-ID 224796] Production engineering. Grubbström, Robert W. (član uredniškega odbora 2008-). [Print ed.]. Heidelberg; Berlin: Springer, 1993-. ISSN 0944-6524. [COBISS.SI-ID 10743835] Regionální studia. Bogataj, Marija (član uredniškega odbora 2011-). Praha: Vysoká škola ekonomická v Praze. ISSN 1803-1471. [COBISS.SI-ID 2265443] Suvremeni promet. Bogataj, Marija (član uredniškega sveta 1994-). Zagreb: Institut prometnih znanosti, 1987-. ISSN 0351-1898. [COBISS.SI-ID 832260]
	Šifra		C.04 Uredništvo mednarodne revije	
	Objavljeno v		vse objave so na www.	
	Tipologija		4.00 Sekundarno avtorstvo	
3.	COBISS ID		21339622	Vir: COBISS.SI
	Naslov	*SLO*	Ekonomsko-okoljsko ravnotežje v razširjeni teoriji planiranja materialnih potreb	
		ANG	Economic-environmental balance in EMRP	
	Opis	*SLO*	Mentorstvo doktorske disertacije V tem obdobju so bile zaključene tri doktorske disertacije s področja	
		ANG	Suprvisor of doctoral thesis in 2011-2014 has been defended 3 doctoral thesis	
	Šifra		B.06 Drugo	
	Objavljeno v		[D. Kovačić]; 2013; 172 str.; Avtorji / Authors: Kovačić Danijel	

	Tipologija		2.08 Doktorska disertacija	
4.	COBISS ID		2258787	Vir: COBISS.SI
	Naslov	SLO	Industrijsko inženirstvo: Inovativne mreže	
		ANG	Industrial engineering: Innovative Networks	
	Opis	SLO	Uredništvo Springerjeve monografije kot zbirke razširjenih 20% najboljših del kongresa, katerega sooganizator je bil MEDIFAS v jeseni 2011 v Cartageni. MEDIFAS oziroma člani projektne skupine so bili soorganizatorji še dveh IWSPE konferenc v Innsbrucku 2012, 2014 in dveh SOR simpozijev 2011,2013. Sodelovali so v uredništvih pripadajočih zbornikov in bili člani organizacijskih in znanstvenih odborov.	
		ANG	Editors of 20% of the best papers from the conference, here extended, where MEDIFAS was coorganising the conference in 2011 in Cartagena Member of this project group have been also members of organizing committee or scientific committee at IWPSE 2012, IWPSE 2014,SOR'11 and SOR'13. They were also editors of proceedings from these conferences.	
	Šifra		C.01 Uredništvo tujega/mednarodnega zbornika/knjige	
	Objavljeno v		Springer; 2012; XIV, 396 str.; A'': 1;A': 1; Avtorji / Authors: Sethi S. Prakash, Bogataj Marija, Ros McDonnell Lorenzo	
	Tipologija		2.01 Znanstvena monografija	
5.	COBISS ID		6624353	Vir: COBISS.SI
	Naslov	SLO	Tehnologije in finančni mehanizmi za pametna mesta	
		ANG	Technologies and financial mechanisms for smart cities	
	Opis	SLO	Vabljeno uvodno predavanje na mednarodni konferenci o pametnih mestih	
		ANG	Invited lectures at international conference on smart cities	
	Šifra		F.23 Razvoj novih sistemskih, normativnih, programskih in metodoloških rešitev	
	Objavljeno v		2014; Avtorji / Authors: Bogataj Marija	
	Tipologija		3.16 Vabljeno predavanje na konferenci brez natisa	

8.Drugi pomembni rezultati projetne skupine[7]

Več pomembnih raziskovalnih rezultatov je šele sprejetih v objavo in bodo objavljeni tekom leta 2015 oziroma šele v začetku leta 2016.

9.Pomen raziskovalnih rezultatov projektne skupine[8]

9.1.Pomen za razvoj znanosti[9]

SLO

Množica znanstvnih objav s področja upravljanja z riziki v oskrbovalnih verigah (supply chain risk management, število znanstvenih objav v ScienceDirect je okoli 30.000) kaže na pomembnost te teme. Vendar pa je le malo primerov, ki govorijo o vplivu sprememb v oskrbovalnih sistemih na spremembe v rabi zemljišč, kjub temu, da je sedanja kriza pokazala neločljivo povezanost gospodarstva in življenja prebivalcev razvitega sveta s trgom nepremičnin, in je najbolj prizadela prav trg nepremičnin in industrijo, ki je na ta trg vezana.

Objava naših del v revijah A" in drugih pomembnih znanstvenih publikacijah, kot npr. Springerjeve objave, kot tudi velika mednarodna odmevnost naših del (glej SICRIS prilogo) in

vabila na mednarodne konference dokazujejo izvirnosti pristopov, metod uporabljenih v projektu in uporabnost rezultatov za nadaljnje raziskovalno delo na področju prostorskih analiz in rabe prostora. Predvsem pa so rezultati pomembni za tri smeri nadaljnega znanstveno-raziskvalnega dela:

1. Razvoj posameznih modelov: njihova povezava prispeva h kvantifikaciji Arrighijeve teorije o povezanosti prostora tokov in prostora teritorianih enot (regij, lokacij).

2. Razvit je nov simulacijski model za vrednotene posledic perturbacij v prostoru, tudi na trgu nepremičnin, kar je nov prispevek k znanosti.

3.- Izvedba simulatorja omogoča napovedovanje rezultatov perturbacij v gospodarstvu in okolju kot vplivov na postavljene kriterialne funkcije, ki jih lahko spreminjamo glede na percepcije odločevalcev od mestnih oblasti do gospodarskih subktov in nevladnih organizacij. Kompaktna predstavitev modela obratne logistike v globalnih oskrbovalnih mrežah in razviti simulator dajejo možnosti senzitivnostne analize parametrov modelov in nov pristop k odločanju med ukrepi za višje direktne ekonomske vplive ali boljše varovanje okolja in oskrbo prebivalstva, ki se mu naglo spreminja demografska struktura.

4. Nadgrajena je Intramax metoda, kar širi njeno uporabnost v analizi centralnih krajev in njihovem funkcionalnem področju.

5. Tekom študij na tem projektu smo prišli do spoznanja, da je globoka in dolgo trajajoča kriza nepremičninskega trga predvsem v vzhodni in južni Evropi rezultat spremenjenih pričakovanj, ki jih je povzročil šok padca vrednosti finančnih instrumentov najprej na trgu ZDA, ki se je hitro razširil globalno. Zavedati se moramo, da so vlaganja v nepremičnine v zadnjih 50 letih pomenila 40% novo ustvarjenega bogastva družbe razvitega sveta (Harvey, "Crisis of Capital", 2009). Tok selitev starejše populacije v primernejša področja, predvsem v regije s primernejšo klimo, in tudi utečenimi storitvami zanje se je nenadoma ustavil na slabi tretjini prejšnje intenzivnosti. Nepravilna reakcija bank, ki so množično začele uveljavljati instrumente zavarovanja posojil, je trg preplavila z milijoni neprodanih stanovanj (samo v Španiji jih je 3,5 milijonov) in industrijskih objektov. Zaostreni pogoji pridobitve novih posojil pa so onemogočili mladim družinam nakup stanovanjskih nepremičnin, da bi si ustvarile svoj prvi dom, kar vse je preoblikovalo sliko razvijajočih se mest. Da je smiselno razvijati to teorijo še naprej narekuje tudi dejstvo, da se enake nepremičnine na področjih z boljšo, inovativnejšo oskrbo, prodajajo tudi za 50% dražje kot tam, kjer je oskrba klasična. Na bolje oskrbovanih področjih je tudi likvidnost trga nepremičnin daleč večja.

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Europeans are leaving in watershed time when the main drivers of economy are falling in crises and should change their strategies. Decreasing fertility decreased population growth while increasing life expectancy increase the population growth of older cohorts which influence also a demand in the real estate industry, but the needs of this part of population are different than the needs of industrial society in the last two centuries, which should reflect in designing and renewal of towns. The financial crisis in Europe has caused oversupply of housing units on the real estate market and heavy losses for older people by increasing average retirement age, decreasing the value of pensions, decreasing ECB interest rate and decreasing returns on assets held by pension funds. Stated problems present a new set of challenges regarding management of real estate assets especially those owned by senior citizens. Multiple decrement model as a case of multistate transition was studied also in our project as an appropriate model for better understanding supply and demand on residential real estate market caused by aging population and can improve spatial planning based on demographic changes, as stated in the contributions: "Forecasting demand of housing in crisis and in time of recovery when the older cohorts are the main buyers" [COBISS.SI-ID 6624609] and "Planning and financial mechanisms for more liquid housing market" [COBISS.SI-ID 6624097] both invited lectures at: Technologies and Financial Mechanisms for Smart Cities, TeFiMeSmaci 2014, Technical University Cartagena, Spain, June, 2014, being part of forthcoming Springer e-Book.

The large number of scientific articles in the field of risk management in the supply chain (in ScienceDirect over 30,000) shows the importance of this topics. However, only a few papers

deal with the impact of changes in supply systems to changes in land use, despite the fact that the current crisis has demonstrated the inseparable link between the economy and life of the inhabitants of the developed world with the real estate market, and is most affected by the real estate market and industry which is related to this market.

The publication of our works in journals A" and other relevant scientific publications, such as Springer publications, as well as international recognition of our research (see Annex SICRIS) and invitations to international conferences prove the originality of approaches, methods used in the project and the applicability of the results for further research work in the field of spatial analysis and use of space. Above all, the results are important for the three directions of further research:

1. The development of individual models: their combinations contribute to the quantification Arrighi's theory on the relationship between the space of flows and space of places (regions, locations).

2. Developed a new simulation model evaluated the effects of perturbations in space, even in the property market, which is a new contribution to science.

3.- The implementation of the simulator to predict the results of perturbations in the economy and the environment as impacts on set criterion function that can be changed depending on the perception of decision-makers from local authorities to economic entities and non-governmental organizations.

The compact representation of a model of reverse logistics in global supply networks and provide an opportunity to develop a simulator sensitivity analysis of parameters of models and a new approach to deciding between measures of higher direct economic impacts and better protect the environment and care for the population, which is rapidly changing demographic structure.

4. Intramax method is upgraded which is expanding its usefulness in the analysis of the central places and their functional areas.

9.2. Pomen za razvoj Slovenije[10]

SLO

S perturbacijami, ki jih obdelujemo v naših modelih in aplikacijah, se srečujemo še predvsem v času recesije, ko se tokovi med celicami aktivnosti oskrbovalnih mrež trgajo in se le s težavo ustvarjajo nove povezave, kar posredno vpliva tudi na problematiko človeških virov in nenazadnje na trg nepremičnin, ki je ne samo človeškim virom nekega prostora kot produkcijskim faktorjem, ampak tudi ostalim članom gospodinjstev oziroma uporabnikom nekega prostora bolj ali manj dostopen.

Iz tega sledi, da je realizacija projekta ne samo znanstveno pomembna, ampak tudi relevantna za aplikacijo v slovenski ali širši evropski prostor.

1.) Izdelani so modeli za boljše napovedovanje povpraševanja po nepremičninah in ocenjevanje rizikov za nastop motenj na trgu nepremičnin. Laže bo oceniti tudi odločitve o spremembi namenske rabe prostora, kar smo na prelomu tisočletja opravljali zelo slabo, kljub temu, da je prav naša projektna skupina v monografiji za "Prostor 2020" napovedovala probleme na tem področju že leta 2004. V gravitacijskem modelu pa smo omogočili vrednotenje vpliva davčne politike na trg nepremičnin, na čemer nadaljuje delo doktorandka vodje projekta.

2.) Od leta 2001 nadalje je Službo Vlade RS za lokalno samoupravo in regionalno Politika Republike Slovenije intenzivno usklajevala dejavnosti izvajanje Zakona o spodbujanju skladnega regionalnega razvoja in regionalne razvojne politike. Prostorsko načrtovanje, načrtovanje spremembe rabe zemljišč in urbanizacija vključno z načrtovanjem industrijske rabe zemljišč je pomemben del regionalne politike in razvoja centralnih krajev. To pomeni, da mora lokacija teorija in teorija o oskrbovalnih sistemih dati tem službam tudi boljšo interdisciplinarno

teoretsko platformo. Z razširitvijo Intramax metode in povezavo z modeli Lowrijevega tipa se bo lažje odločiti o funkcionalnih regijah, ki jih posamezne dejavnosti optimalno pokrivajo, kakor tudi o formalni regionalizaciji slovenskega prostora glede na dolgoletne nezaključene teme o uvedbi pokrajin.

3.) Izdelane so tehnične osnove za uvedbo fleksibilnih obratnih hipotek kot četrti steber socialne varnosti starostnikov v Sloveniji in Evropi nasploh, kar bi oživilo trg nepremičnin in stabiliziralo logistične verige, v katerih se s podaljševanjem upokojitvene starosti znižuje kvaliteta proizvodnje.

4.) Postavljeni so temelji za boljše napovedovanje potreb po nepremičninah glede na staranje prebivalstva. Ugotovljeno je bilo, da je treba nepremičninski trg kakor tudi človeške vire v oskrbovalnih verigah segmentirati po starostnih skupinah zaradi različnih funkcionalnih zmožnostih posameznikov v starajočih se družbah in predvideti prilagajanje delovnih mest in bivališč tem spremembam.

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The perturbations in supply chains and in the property real estate market which are considered in our models, and applications are topical in times of financial crises and specially during the recessions, when the flows between activity cells of supply networks are disturbed and only with difficulty the companies are able to create new links. Those perturbations influence also the demand for human resources and destroyed the real estate market, which represents not only the space of production for human resources as factor of production, but also influences accessibility of build environment to other members of households.

It follows that the realization of the project, is not only of a scientific importance, but also relevant for implementation of some solutions in the Slovenian or the wider European area.

1) Project team has developed models for better prediction of demand in the real estate market and enable assessment of disruption risk of real estate market. Models represent decision support tool for planning of the land use, which was performed very poorly before crisis. despite the fact that our project team in the monograph for "Space 2020" predicted oversupply on Slovenian housing market already in 2004.
2) Since 2001 the Government Office for Local Self-Government and Regional Policy was intensively Coordinating Activities of the Implementation of Promotion of Balanced Regional Development Act and the regional development policy. Location theory, regional science and business logistics must offer a common, more compact, interdisciplinary theoretic platform to these activities in the space. With extension of Intramax methods and gravity models it will be easier to delineate functional regions, covered by individual activities of a supply chain optimally, investment policies and also the formal regionalization of Slovenian space as longstanding indoubt threads on the introduction of Provinces.

3) We also have developed technical basis for the introduction of flexible reverse mortgages in Slovenia and Europe in general, as fourth pension pillar which would revitalize the real estate market.

4.) As demand for housing among the younger population declines and rises among the elderly, many housing units will need to be adapted for older populations, which will have spatial implications for provision of welfare. Such trends may produce demographic and spatial pressures for cities, as well as issues regarding social service delivery and organization of retirement communities in the existing town or in their surroundings. We must have a plan how to amalgamate communities with integrative part of elderly together by investments in facilities which can push down the disability threshold. The asset tied in real property, properly released, could provide additional sources for better cover of those needs. New sources of finance will be required to adapt housing units for aging cohorts, therefore the financial support through flexible equity release mortgages may be a solution.

5.)While migration flow can be forecaster using gravity model for structured flows regarding age cohorts (Drobne and Bogataj, 2012), forecasting of housing supply and demand of different cohorts, regarding decreasing functional capacity could be improved by multiple decrement

model, which has to be further developed to improve the housing market in Slovenia..

10. Samo za aplikativne projekte in podoktorske projekte iz gospodarstva!
Označite, katerega od navedenih ciljev ste si zastavili pri projektu, katere konkretne rezultate ste dosegli in v kakšni meri so doseženi rezultati uporabljeni

Cilj		
F.01	**Pridobitev novih praktičnih znanj, informacij in veščin**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.02	**Pridobitev novih znanstvenih spoznanj**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.03	**Večja usposobljenost raziskovalno-razvojnega osebja**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.04	**Dvig tehnološke ravni**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.05	**Sposobnost za začetek novega tehnološkega razvoja**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.06	**Razvoj novega izdelka**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.07	**Izboljšanje obstoječega izdelka**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.08	**Razvoj in izdelava prototipa**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.09	**Razvoj novega tehnološkega procesa oz. tehnologije**	

	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.10	**Izboljšanje obstoječega tehnološkega procesa oz. tehnologije**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.11	**Razvoj nove storitve**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.12	**Izboljšanje obstoječe storitve**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.13	**Razvoj novih proizvodnih metod in instrumentov oz. proizvodnih procesov**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.14	**Izboljšanje obstoječih proizvodnih metod in instrumentov oz. proizvodnih procesov**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.15	**Razvoj novega informacijskega sistema/podatkovnih baz**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.16	**Izboljšanje obstoječega informacijskega sistema/podatkovnih baz**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.17	**Prenos obstoječih tehnologij, znanj, metod in postopkov v prakso**	
	Zastavljen cilj	○ DA ○ NE
	Rezultat	
	Uporaba rezultatov	
F.18	**Posredovanje novih znanj neposrednim uporabnikom (seminarji, forumi, konference)**	
	Zastavljen cilj	○ DA ○ NE

	Rezultat	
	Uporaba rezultatov	
F.19	**Znanje, ki vodi k ustanovitvi novega podjetja ("spin off")**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.20	**Ustanovitev novega podjetja ("spin off")**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.21	**Razvoj novih zdravstvenih/diagnostičnih metod/postopkov**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.22	**Izboljšanje obstoječih zdravstvenih/diagnostičnih metod/postopkov**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.23	**Razvoj novih sistemskih, normativnih, programskih in metodoloških rešitev**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.24	**Izboljšanje obstoječih sistemskih, normativnih, programskih in metodoloških rešitev**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.25	**Razvoj novih organizacijskih in upravljavskih rešitev**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.26	**Izboljšanje obstoječih organizacijskih in upravljavskih rešitev**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.27	**Prispevek k ohranjanju/varovanje naravne in kulturne dediščine**	
	Zastavljen cilj	DA NE
	Rezultat	

	Uporaba rezultatov	
F.28	**Priprava/organizacija razstave**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.29	**Prispevek k razvoju nacionalne kulturne identitete**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.30	**Strokovna ocena stanja**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.31	**Razvoj standardov**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.32	**Mednarodni patent**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.33	**Patent v Sloveniji**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.34	**Svetovalna dejavnost**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	
F.35	**Drugo**	
	Zastavljen cilj	DA NE
	Rezultat	
	Uporaba rezultatov	

Komentar

11. Samo za aplikativne projekte in podoktorske projekte iz gospodarstva!
Označite potencialne vplive oziroma učinke vaših rezultatov na navedena področja

	Vpliv	Ni vpliva	Majhen vpliv	Srednji vpliv	Velik vpliv	
G.01	**Razvoj visokošolskega izobraževanja**					
G.01.01.	Razvoj dodiplomskega izobraževanja	○	○	○	○	
G.01.02.	Razvoj podiplomskega izobraževanja	○	○	○	○	
G.01.03.	Drugo:	○	○	○	○	
G.02	**Gospodarski razvoj**					
G.02.01	Razširitev ponudbe novih izdelkov/storitev na trgu	○	○	○	○	
G.02.02.	Širitev obstoječih trgov	○	○	○	○	
G.02.03.	Znižanje stroškov proizvodnje	○	○	○	○	
G.02.04.	Zmanjšanje porabe materialov in energije	○	○	○	○	
G.02.05.	Razširitev področja dejavnosti	○	○	○	○	
G.02.06.	Večja konkurenčna sposobnost	○	○	○	○	
G.02.07.	Večji delež izvoza	○	○	○	○	
G.02.08.	Povečanje dobička	○	○	○	○	
G.02.09.	Nova delovna mesta	○	○	○	○	
G.02.10.	Dvig izobrazbene strukture zaposlenih	○	○	○	○	
G.02.11.	Nov investicijski zagon	○	○	○	○	
G.02.12.	Drugo:	○	○	○	○	
G.03	**Tehnološki razvoj**					
G.03.01.	Tehnološka razširitev/posodobitev dejavnosti	○	○	○	○	
G.03.02.	Tehnološko prestrukturiranje dejavnosti	○	○	○	○	
G.03.03.	Uvajanje novih tehnologij	○	○	○	○	
G.03.04.	Drugo:	○	○	○	○	
G.04	**Družbeni razvoj**					
G.04.01	Dvig kvalitete življenja	○	○	○	○	
G.04.02.	Izboljšanje vodenja in upravljanja	○	○	○	○	
G.04.03.	Izboljšanje delovanja administracije in javne uprave	○	○	○	○	
G.04.04.	Razvoj socialnih dejavnosti	○	○	○	○	
G.04.05.	Razvoj civilne družbe	○	○	○	○	
G.04.06.	Drugo:	○	○	○	○	
G.05.	**Ohranjanje in razvoj nacionalne naravne in kulturne dediščine in identitete**	○	○	○	○	
G.06.	**Varovanje okolja in trajnostni razvoj**	○	○	○	○	
G.07	**Razvoj družbene infrastrukture**					
G.07.01.	Informacijsko-komunikacijska infrastruktura	○	○	○	○	
G.07.02.	Prometna infrastruktura	○	○	○	○	

G.07.03.	Energetska infrastruktura	○	○	○	○	
G.07.04.	Drugo:	○	○	○	○	
G.08.	**Varovanje zdravja in razvoj zdravstvenega varstva**	○	○	○	○	
G.09.	**Drugo:**	○	○	○	○	

Komentar

12.Pomen raziskovanja za sofinancerje[11]

	Sofinancer			
1.	Naziv			
	Naslov			
	Vrednost sofinanciranja za celotno obdobje trajanja projekta je znašala:			EUR
	Odstotek od utemeljenih stroškov projekta:			%
	Najpomembnejši rezultati raziskovanja za sofinancerja			Šifra
		1.		
		2.		
		3.		
		4.		
		5.		
	Komentar			
	Ocena			

13.Izjemni dosežek v letu 2014[12]

13.1. Izjemni znanstveni dosežek

V letu 2014 smo dosegli dva enakovredna znanstvena dosežka (A"):

1.)
V objavo v TEDE je bil sprejet članek "Net Present Value evaluation of energy production and consumption in repeated reverse logistics". Delo na simulatorju pa je potekalo v 4.in 5. semestru, po programu za delo na VENSIM ali kakšnem novejšem simulatorju. Že v letu 2011 in 2012, ko smo izvajali simulacije z VENSIM [ID 2259299], smo ugotovili, da za naše študije VENSIM ni najprimernejši in da je smiselno razviti lastni simulator, kar nam je uspelo.

2.)
Leta 2014 smo bili tudi obveščeni, da je "A fuzzy approach to forecasting the attractiveness of regions for human resources" [ID 6624865], med 25 % najbolj branih vsebin v Springer eBooks Collection 2013.

Za omenjeno monografijo [ID 2259299] smo sklenili pogodbo s Sringerjevo založbo leta 2011, napovedali izdajo leta 2014, a jo izdali že leta 2012.

(Več glej prilogo: Izjemni znanstveno-raziskovalni učinki).

13.2. Izjemni družbeno-ekonomski dosežek

Prof. M. Bogataj je bila že ob ustanovitvi International Society for Inventory Research (ISIR, 1982) pod predsedstvom Nobelovca Kennetha Arrowa, povabljena v ISIR in dvakrat izvoljena v Izvršni komite. V letu 2014 je bila ponovno izvoljena. Leta 2014 je v ISIRu odprla novo znanstveno temo: Inventory of housing kot temo, ki je v 21. stoletju deležna največ izzivov glede na globalno krizo, ki so jo povzročile slabo upravljane zaloge nepremičnin, in glede na naglo staranje prebivalstva, ki zahteva drugačno strukturo namenske rabe prostora. (Glej: http://isir.hu/about/bodies-and-officials-2)

V imenu ISIR bo v jeseni vodila sekcijo na SOR'15, kjer je MEDIFAS soorganizator. (Glej: http://isir.hu). Tu bo obravnavana tudi skupina člankov o vplivu lokacije in transporta na zaloge nepremičnin. Z otvoritvijo ISIR sekcije v okviru SOR pričakujemo, da bomo simpozij bolj približali mednarodnim krogom in pritegnili tuje raziskovalce, da približajo svetovne dosežke slovenskim.

C. IZJAVE

Podpisani izjavljam/o, da:

- so vsi podatki, ki jih navajamo v poročilu, resnični in točni
- se strinjamo z obdelavo podatkov v skladu z zakonodajo o varstvu osebnih podatkov za potrebe ocenjevanja ter obdelavo teh podatkov za evidence ARRS
- so vsi podatki v obrazcu v elektronski obliki identični podatkom v obrazcu v pisni obliki
- so z vsebino zaključnega poročila seznanjeni in se strinjajo vsi soizvajalci projekta

Podpisi:

zastopnik oz. pooblaščena oseba raziskovalne organizacije:	in	*vodja raziskovalnega projekta:*
MEDIFAS Mediteranski inštitut za sodobne študije		Marija Bogataj

ŽIG

Kraj in datum:	Šempeter pri Gorici	16.3.2015

Oznaka poročila: ARRS-RPROJ-ZP-2015/47

[1] Napišite povzetek raziskovalnega projekta (največ 3.000 znakov v slovenskem in angleškem jeziku) Nazaj

[2] Napišite kratko vsebinsko poročilo, kjer boste predstavili raziskovalno hipotezo in opis raziskovanja. Navedite ključne ugotovitve, znanstvena spoznanja, rezultate in učinke raziskovalnega projekta in njihovo uporabo ter sodelovanje s tujimi partnerji. Največ 12.000 znakov vključno s presledki (približno dve strani, velikost pisave 11). Nazaj

[3] Realizacija raziskovalne hipoteze. Največ 3.000 znakov vključno s presledki (približno pol strani, velikost pisave 11) Nazaj

[4] V primeru bistvenih odstopanj in sprememb od predvidenega programa raziskovalnega projekta, kot je bil zapisan v predlogu raziskovalnega projekta oziroma v primeru sprememb, povečanja ali zmanjšanja sestave projektne skupine v zadnjem letu izvajanja projekta, napišite obrazložitev. V primeru, da sprememb ni bilo, to navedite. Največ 6.000 znakov vključno s presledki (približno ena stran, velikost pisave 11). Nazaj

[5] Navedite znanstvene dosežke, ki so nastali v okviru tega projekta. Raziskovalni dosežek iz obdobja izvajanja projekta (do oddaje zaključnega poročila) vpišete tako, da izpolnite COBISS kodo dosežka – sistem nato sam izpolni naslov objave, naziv, IF in srednjo vrednost revije, naziv FOS področja ter podatek, ali je dosežek uvrščen v A'' ali A'. Nazaj

[6] Navedite družbeno-ekonomske dosežke, ki so nastali v okviru tega projekta. Družbeno-ekonomski rezultat iz obdobja izvajanja projekta (do oddaje zaključnega poročila) vpišete tako, da izpolnite COBISS kodo dosežka – sistem nato sam izpolni naslov objave, naziv, IF in srednjo vrednost revije, naziv FOS področja ter podatek, ali je dosežek uvrščen v A'' ali

A'.

Družbeno-ekonomski dosežek je po svoji strukturi drugačen kot znanstveni dosežek. Povzetek znanstvenega dosežka je praviloma povzetek bibliografske enote (članka, knjige), v kateri je dosežek objavljen.

Povzetek družbeno-ekonomskega dosežka praviloma ni povzetek bibliografske enote, ki ta dosežek dokumentira, ker je dosežek sklop več rezultatov raziskovanja, ki je lahko dokumentiran v različnih bibliografskih enotah. COBISS ID zato ni enoznačen, izjemoma pa ga lahko tudi ni (npr. prehod mlajših sodelavcev v gospodarstvo na pomembnih raziskovalnih nalogah, ali ustanovitev podjetja kot rezultat projekta … - v obeh primerih ni COBISS ID). Nazaj

[7] Navedite rezultate raziskovalnega projekta iz obdobja izvajanja projekta (do oddaje zaključnega poročila) v primeru, da katerega od rezultatov ni mogoče navesti v točkah 6 in 7 (npr. ni voden v sistemu COBISS). Največ 2.000 znakov, vključno s presledki. Nazaj

[8] Pomen raziskovalnih rezultatov za razvoj znanosti in za razvoj Slovenije bo objavljen na spletni strani: http://sicris.izum.si/ za posamezen projekt, ki je predmet poročanja Nazaj

[9] Največ 4.000 znakov, vključno s presledki Nazaj

[10] Največ 4.000 znakov, vključno s presledki Nazaj

[11] Rubrike izpolnite / prepišite skladno z obrazcem "izjava sofinancerja" http://www.arrs.gov.si/sl/progproj/rproj/gradivo/, ki ga mora izpolniti sofinancer. Podpisan obrazec "Izjava sofinancerja" pridobi in hrani nosilna raziskovalna organizacija – izvajalka projekta. Nazaj

[12] Navedite en izjemni znanstveni dosežek in/ali en izjemni družbeno-ekonomski dosežek raziskovalnega projekta v letu 2014 (največ 1000 znakov, vključno s presledki). Za dosežek pripravite diapozitiv, ki vsebuje sliko ali drugo slikovno gradivo v zvezi z izjemnim dosežkom (velikost pisave najmanj 16, približno pol strani) in opis izjemnega dosežka (velikost pisave 12, približno pol strani). Diapozitiv/-a priložite kot priponko/-i k temu poročilu. Vzorec diapozitiva je objavljen na spletni strani ARRS http://www.arrs.gov.si/sl/gradivo/, predstavitve dosežkov za pretekla leta pa so objavljena na spletni strani http://www.arrs.gov.si/sl/analize/dosez/. Nazaj

Obrazec: ARRS-RPROJ-ZP/2015 v1.00a
C8-E9-EE-64-25-FD-AC-63-E5-93-B6-AC-F6-13-18-1C-9E-0B-77-A4

Priloga 1

Special Section Call for Proposal: Inventory Research

Professor Marija Bogataj, Member of ISIR Executive Committee

Mediterranean Institute for Advanced Studies – MEDIFAS

Mednarodni prehod 6, Vrtojba – Šempeter pri Gorici

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ISIR Executive Committee Members are working organizing inventory related sessions under the ISIR umbrella at main international conferences of related topics. MEDIFAS members of Faculty as the active members of ISIR are working in this Inventory Research session at SOR.

Priloga 2

Subject: Technological and Economic Development of Economy - Decision on Manuscript ID TTED-2013-0171.R2
Date: Sat, 3 Jan 2015 14:20:12 -0500 (EST)
From: tede@tede.vgtu.lt
To: marija.bogataj@guest.arnes.si

03-Jan-2015

Dear Professor Bogataj:

Ref: Net present value evaluation of energy production and consumption in repeated reverse logistics

Our reviewers have now considered your paper and have recommended publication in Technological and Economic Development of Economy. We are pleased to accept your paper in its current form which will now be forwarded to the publisher for copy editing and typesetting. The reviewer comments are included at the bottom of this letter, along with those of the editor who coordinated the review of your paper.

You will receive proofs for checking, and instructions for transfer of copyright in due course.

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Thank you for your contribution to Technological and Economic Development of Economy and we look forward to receiving further submissions from you.

Sincerely,
Dr Saparauskas
Associate Editor, Technological and Economic Development of Economy
tede@tede.vgtu.lt

Net Present Value evaluation of energy production and consumption in repeated reverse logistics

Dr. Danijel Kovačić (doktorand MB), prof.dr. Marija Bogataj

Abstract

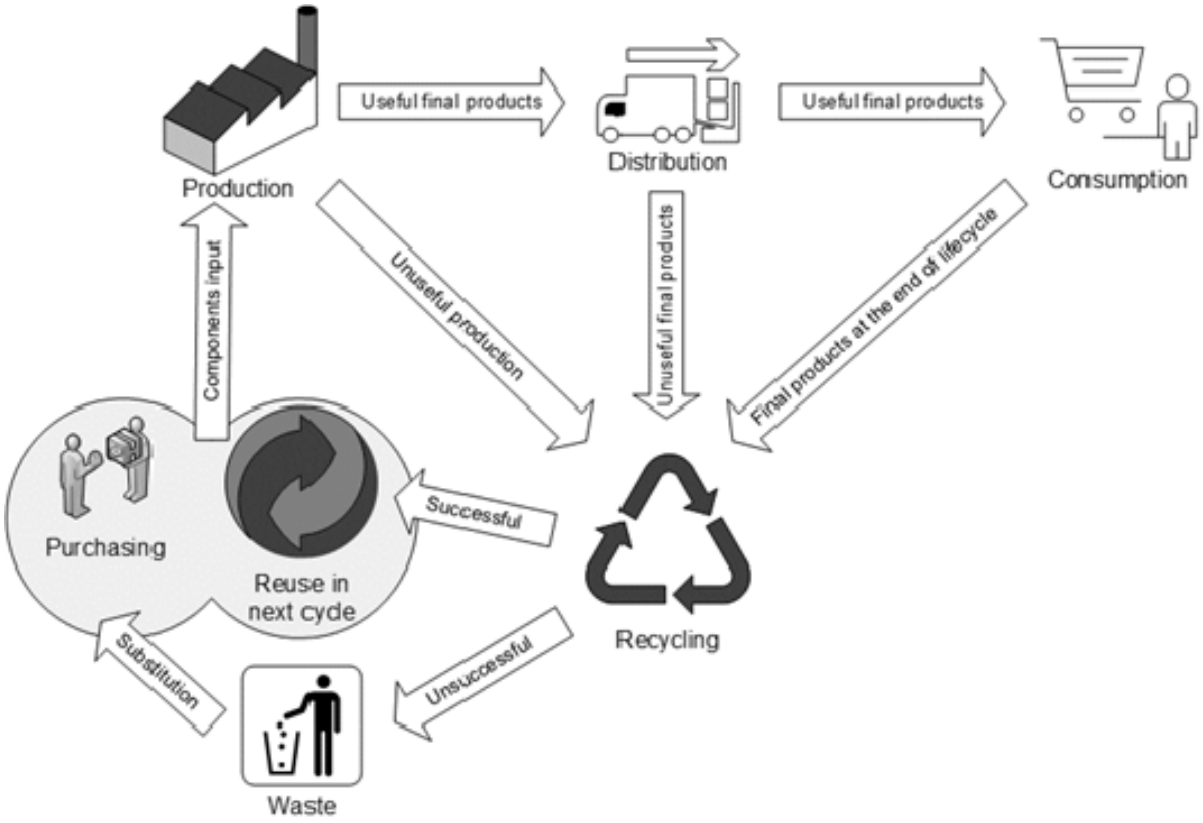
•The paper is based on Grubbström's MRP theory previously used in analysis of production processes "under one roof". This theory has recently been extended to model global supply chains by Bogataj and Grubbström, both scientists from the MEDIFAS faculty. Every production cycle is followed by distribution, consumption and recycling activities. In broad supply chains, transportation costs between pairs of activity cells have a significant impact on the overall net present value of the system. Possible flows inside or between subsystems can all be described with input-output matrices **H** and **G**. Recently published papers of the above mentioned authors describe the presentation of supply chains in a generalized form. Generalized input and output matrices and hold technical coefficients and lead times. Lead times are split into 2 parts: production and transportation. As presented in the publication of R.W. Grubbström, L. Bogataj and M. Bogataj, and further research of these authors, the results of recycling activities in the extended MRP model are the recovered and the waste items, but in their model the recycling of the items is not repeated.

•Recovered items could be reused several times in future production cycles, reducing the need to purchase new items on the market as considered here. The waste items must be disposed of, requiring environmental taxes which vary among regions, depending on local environmental policy. If recovered, items must be delivered from the recycling facility back to production, and waste items must be sent to landfills. This process requires an expenditure of human resources, and energy at each activity cell plays an important role. In this article we show how the location of recycling facilities, the prices and quantity of energy needed and the environmental taxes can drastically influence the net present value for the entire system. We also present the method for evaluating cases where energy can be recovered during recycling or decomposition processes at landfills. It is also assumed that energy recovery can be stimulated with subsidized purchase prices, but generally, lower quality energy can be expected as an output of these processes. This paper introduces generalized input and output energy matrices, which describe these energy flows and their impact on environmental sustainability through the net present value of the system, which is the novelty in the extended MRP theory.

•

•*Keywords:* Location theory, Energy, Extended MRP , Reverse Logistics, Supply Chain, Net Present Value.

Fig. 1. Presentation of the cyclical extended MRP theory model with 4 subsystems.



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Leta 2014 smo bili tudi obveščeni, da je bilo poglavje z naslovom : **"A fuzzy approach to forecasting the attractiveness of regions for human resources"** avtorjev : BOGATAJ, M. in njenih doktorandov: DROBNE, S., TULJAK SUBAN, D. [COBISS.SI-ID 6624865], v Springerjevi monografiji: SETHI, S. P. (ed.), BOGATAJ, Marija (ed.), ROS MCDONNELL, Lorenzo (ed.), Industrial engineering: Innovative Networks , London: Springer, cop. 2012. [COBISS.SI-ID 2258787] , **med 25 % najbolj branih vsebin v Springer eBooks Collection 2013.**

Abstract

Thinking flexibility and security on labour markets together is a new paradigm because business as well as labour is in need of security as well as flexibility. The flexibility will increase with accessibility of individual regions in Europe. A study of migration may show us not only how these aims can be achieved, but also may highlight other policies needed for inducing growth. Accessibility is especially increased by investments in European transportation corridors and by removing barriers on the borders (Schengen Agreement). ESPON ATTREG project aims to investigate also the motivation and behaviour of migration flows and daily commuting of human resources in gross migrations and commuting between regions.

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Priloga 3

Optimal Allocation of Public Service Centres in the Central Places of Functional Regions

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Abstract: In the European Union, Member States and their regions are responsible for planning, funding and administration of public services, which should be based also on smart city tools. How smart is a city could be evaluated also by its ability to produce favorable conditions to get urban operators actively involved into spatial innovation dynamics, also to develop the innovative public logistics networks. The method presented supports local authorities and state government's decision on optimal allocation of regionally based public services. The article is presenting the method for optimal coverage of the state territory with functional regions, where smart city is a center of the activities, and optimal allocation of services influence city growth. Sets of functional regions were modelled using the *Intramax* method. An optimal regionalization on number of functional regions is presented where the optimal number is chosen according to the cost of services. The case study for Slovenian regionalization for eldercare is presented.

Keywords: region, functional region, central place, optimal allocation, service, smart city

1. INTRODUCTION

1.1 Formal political region and functional region

How smart is a city could be evaluated also by its ability to produce favourable conditions to get urban operators actively involved into spatial innovation dynamics, also to evaluate which public services are best to be located in the city and what is the optimal functional region which will be covered by these services. Different services in a city as a central place of a region have different optimal size of the territory covered by them. While a formal region is understand as an area having the same characteristics (at least one) and also well-defined border, a functional region is based around something (local labour market (LLM) areas, around their central places, utilities around sources or destination point, even pizza delivery area can be understood as a functional area) and its borders could be fuzzy and changing in a time horizon. Therefore, functional region is an area that is made up of different elementary spatial units (ESUs, e.g. communities, municipalities) that are linked and function as a unit. The participating ESUs could change in a time horizon. Functional region is organized around one or few central places. Dependent on number of functions, which are concentrated in central places, such central places create a highly stratified network of cities. Regarding economic and social cohesion of European Union (EU) regions, which are the main goal of European Spatial Development Perspective (ESDP 1999), the regional state-of-art and especially future development, must be studied as the base for further economic and political decisions. Here, the regions became a subject of complex, open, dynamic nonlinear system of transparent functional connections between smaller and larger territorial areas.

Many researchers (e.g. Ball, 1980; Casado-Diaz, 2000; Tomaney and Ward, 2000; Laan and Schalke, 2001; Andersen, 2002) showed already that the standard administrative regions covering territory of European Member States used as basic entities for policy making, resource allocation, and research do not provide meaningful information on actual conditions of a particular areas. As such, there has been a move towards functional regions. A functional region is defined as a region characterised by its agglomeration of activities and by its intra-regional transport, information and communication infrastructure, facilitating production and services, therefore a large mobility of people, items in production processes and final products, but also enabling services within its interaction borders, which is rarely well defined.

In industrial society, the basic characteristic of a functional region is the integrated labour market, in which intra-regional commuting as well as intra-regional job search and search for labour demand is much more intensive than the inter-regional counterparts. Consequently, the identification and delineation of functional regions are commonly based on the conditions of local labour market. Based on this perception, Smart (1974) delineated functional regions and this "industrial" approach is accepted in the recent literature (OECD, 2002; Cörvers et al., 2009; Casado-Diaz and Coombes, 2011), while the economic shocks like the nowadays' economic crises require reconsider the labour market perception. In the post-industrial society, intensity of flows of workers and flows of items decline and intensity of services in a functional region is progressing.

A number of regionalisation procedures for delineation of functional regions have been suggested in the literature. A recent review of different approaches and methods is in Casado-Diaz and Coombes (2011). Methods for delineation of functional regions can be divided into rule-based (Coombes et al., 1986; Coombes and Bond, 2008) and hierarchical methods (Smart, 1974; Masser and Brown, 1975, 1977; Masser and Scheurwater, 1980; Slater and Winchester 1978; Slater, 1981). There were developed several methods to determine functional areas/regions, that can be used for statistical purposes to analyse different aspects of labour market performance (Smart, 1974; Combes et al. 1986; Casado-Diaz, 2000; Van der Lann and Schalke, 2001; Newell and Papps, 2001; Karlsson and Olsson, 2006; Mitchell and Stimson, 2010; Landréa and Håkansson, 2013) and other socio-economic aspects (Green et al., 1986; Tomaney and Ward, 2000; Baum et al., 2008; Karlsson et al., 2008), to evaluate the administrative regions (Slater, 1976; Anderseen, 2002; Nel et al., 2008; Cörves et al., 2009), to analyse functional urban regions (Shimizu, 1975; Sykora and Muliček, 2009; Drobne et al., 2010; Manley, 2014), for analyses and applications of transport policy (Krygsman et al., 2009), to analyse housing market areas for housing policy (Goetgeluk and de Jong, 2007; Brown and Hincks, 2007), to analyse commodity market areas (Brown and Pitfield, 1990), to analyse telephone communication patterns (Fischer et al., 1993), to enhance economic development (Freshwater et al., 2013) – but only some of them have been developed for study the location problems and opportunities of services (Shortt et al., 2005; Drobne and Bogataj, 2014). The optimal delineation of functional regions for individual services or group of services has not been subject of scientific investigation.

The location-allocation models which try to answer the question where optimally locating a set of facilities and how to allocate resources are part of colourful and ever growing body of literature also given in the review papers of Rahman and Smith (2000), Plastria (2001), Klose and Drexl (2005), Revelle and Eiselt (2005), Sahin and Süral (2007), Revelle et al. (2008), and Farahani et al. (2010). About optima location and allocation of services have wrote Harper et al. (2005), Mestre et al. (2015) and many other researchers. Specific problems of servicing elderly has been considered in Cromley and Shannon (1986), Johnson et al. (2005) and in others. However, as far as the authors know it, there is no literature that couples both problems: location-allocation problem of facility location and the problem of optimal delineation of the functional regions. In this paper a method for delineation of functional regions servicing elderly like developed by Drobne and Bogataj (2014) is coupled by a general location-allocation model for servicing in the functional regions on the special way using *Intramax* method. Here we are looking for such allocation of activities in the potential centres of functional regions, and delineation of these functional regions, that the costs of communication between city as a central place and other areas in the functional region, and other costs of services (including investments) would be minimal, when the functional regions are covering the area of a state as tessellations.

1.2 From the classical tradition of location theory to the post-industrial smart city

Higher fix costs of public service activity A in a central place influence lower number of central places k an a broader territory of a country where A would be placed. Therefore, some "expensive" activities will find optimal location in less central places and some "cheaper" in more. Therefore, the tendencies of growth in modern city decline from the pure Tinbergen's description of spatial allocation of production activities. Tinbergen (1968) explained how the smallest towns and villages produce certain goods, let us say type TYA goods. The next largest towns produce type TYA and TYB goods. They satisfy the demands of their own population and they export goods of TYB to smaller central places and villages. Larger towns manufacture three kinds of goods, TYA, TYB and TYC for their own population, exporting TYC and so on. The market area as a functional region of the goods is a result of the competition of spatial oligopoly of central places at different levels of centrality. If some central places of a certain level are stronger than others, their market area grows and attracts customers from other central places. Models of spatial games can describe this process, like presented by Bogataj and Usenik (2005). The authors also presented that the same competition appears in the strategic logistics of supply chains. Activity cells need to find an optimal level of central place to benefit the appropriate structure of human resources, subventions and other fiscal policies, and lower production or distribution costs.

In post-industrial age among the factors influencing urban and regional growth, importance of services is growing and influence of production is declining. The answer to the question where to locate services, especially public services like schools, hospitals and eldercare is given in the next chapter, where α and β are subject of negotiation.

2. THE DELINEATION OF 21ST CENTURY LOCAL LABOUR MARKET AREAS AND FUNCTIONAL REGIONS

2.1 Intramax procedure

To follow the ideas of functional regions as a local labour market areas (Casado-Diaz and Coombes, 2011), delineation could be made as described in the first part of this chapter. Let us consider the labour commuter as a person in employment whose territorial unit (ESU, e.g. community, municipality) of workplace is not the same as territorial unit of residence. To analyse functionally delineated regions as LLM areas, the groupings have been arranged using the *Intramax* method, which belongs to the methods of hierarchical clustering.

Regionalisation procedures based on hierarchical clustering were initially developed in the 1970s and 1980s, and were introduced as alternatives to the more ad hoc methods. The methods include Markov chain techniques of Brown and Holmes (1971), as well as the strategy of Masser and Brown (1975, 1977) and Masser and Schuerwater (1980), which is

based on refinements to Ward's (1963) hierarchical aggregation procedures.

The objective of the *Intramax* procedure is to maximise the proportion within the group interaction at each stage of the grouping process, while taking account of the variations in the row and column totals of the matrix. In the grouping process, two ESUs are grouped together, for which the objective function is maximised (Breukelman et al., 2009):

$$\max I, \quad I = \frac{I_{ij}}{O_i \cdot D_j} + \frac{I_{ji}}{O_j \cdot D_i} \tag{1}$$

where I_{ij} is the flow from home i to working area j, I_{ji} the flow from home j to working area i, $O_i = \sum_j I_{ij}$ is the total of flows originating from origin i, $D_j = \sum_i I_{ij}$ is the total of flows coming to destination j, $O_j = \sum_i I_{ji}$ is the total of flows originating from origin j, $D_i = \sum_j I_{ji}$ is the total of flows coming to destination i, and $O_i, O_j, D_i, D_j > 0$.

The *Intramax* analysis is a stepwise analysis. In each step two ESUs are grouped together and the interaction between them becomes the internal interaction for the new resulting spatial unit (SU). This new SU takes the place of the two parent (E)SUs at the next step of the analyses. So, after $N-k$ steps we get k functional regions in which inner flows together have maximal intensity $I_{ij}^{*k} + I_{ji}^{*k}$.

2.2 The optimal allocation of the public service centres to the central places

When regionalization regarding flow of workers ($*w$) has been achieved, the transportation costs of workers to the regional central places $c_{ij}^{*w} = c_{ji}^{*w}$ have been calculated for each potential functional region. The costs of services needed for the population or part of their members in household in region have been calculated and added to the travel costs.

Notations:

a_j … fix costs of daily activity for activity (service) A in the central place area j;

k … potential number of central places j where activities (services) A will be located or from where they will originate;

c_{ij}^h, c_{ij}^s … the transportation costs regarding daily servicing a person living at the ESU i if A is located at the central place j or on her/his home (h), c_{ij}^h, or in the central place (s), c_{ij}^s;

c_j … in place costs of service A servicing a person from the area i if A is located at the central place j on her/his home or in the central place these costs do not depend on location i;

n_i … the number of potential users of A in the ESU i;

p_{ij}^h, p_{ij}^s … the percentage of potential users of A living in the ESU i needing the service A per day, or at their home_ p_{ij}^h, or at the central place area j_ p_{ij}^s.

To the criteria of optimal regionalisation on the bases of number of daily commuters to work (1) we shall add the criterion function

$$F = \alpha \sum_{i \in \Gamma_j} c_{ij} (I_{ij}^{*k} + I_{ji}^{*k}) + \\ + \beta \left[\sum_{j=1}^{k} a_j + \sum_{i \in \Gamma_j} ((c_{ij}^s + c_j) p_{ij}^s + (c_{ij}^h + c_j) p_{ij}^h) n_i \right] \tag{2}$$

In general, when we plan public services in a region, α and β are subject of budget availability and negotiation in the process of governance of regions. Therefore we are looking for such allocation of activities A in k functional regions, that costs of communication and services between city as a central place and other areas in the region would be minimal

$$\min_k F = \\ = \min_k \left(\begin{array}{l} \alpha \sum_{i \in \Gamma_j} c_{ij} (I_{ij}^{*k} + I_{ji}^{*k}) + \\ + \beta \left[\sum_{j=1}^{k} a_j + \sum_{i \in \Gamma_j} ((c_{ij}^s + c_j) p_{ij}^s + (c_{ij}^h + c_j) p_{ij}^h) n_i \right] \end{array} \right), \tag{3}$$

where often the constraints appear like: $\beta \sum_{j=1}^{k} a_j \le a$ and other costs could be shared with the beneficiaries as co-financing.

3. NUMERICAL EXAMPLE: THE CASE STUDY OF SLOVENIAN FUNCTIONAL REGIONS

In our numerical example, we considered inter-municipal labour commuters in Slovenia in 2010. There were 210 municipalities in Slovenia, therefore 43,890 inter-municipal interactions were included in the analysis. The Flowmap software (Breukelman et al., 2009), with implemented Intramax method, was used to delineate functional regions. Analysed territory of Slovenia has been divided into k sets of functional regions stepwise, where $k = 1, 2, ..., 20$, from 20 to 2 (respectively 1) functional region(s) in the state. For each set of functional regions the value of the criterion function (2) has been calculated for the case of servicing elderly. Here we used: $\alpha = \beta = 1$, $p_{ij}^s = 0$, $p_{ij}^h = 0.001$, $c_j = 25€$, n_i had been calculated as 16.5% of the population in ESU (there were living 16.5% seniors of total population), the transportation costs have been calculated as the shortest road distance by car multiplied by 0.26 EUR, using ArcGIS software, but a_j was assumed as an variable taking value between 2,000 EUR, and 2,000,000 EUR (by 1,000 EUR), to test how fix costs of daily activity of A in the central place area j influence the optimal regionalization of Slovenia into (1)2-20 functional regions. Fig. 1 shows the optimal numbers of functional regions in dependence of fix costs of daily activity for services in the region. We can see that at higher

a_j the optimal k is lower. At fix costs between 303,000 EUR and 1,585,000 EUR per day, the optimal number of regions having services in their central place is two and services would be optimally allocated in two the biggest central places, in Ljubljana and Maribor. When fix costs are between 155,600 EUR and 302,000 EUR, the optimal number of service centres would be three. Between 58,000 EUR and 154,000 EUR of fix costs per service centre, the optimal number of services would be five. Fig. 5 shows their optimal allocation, while Figs. 2, 3 and 4 show values of function (2) for $a_j = 100,000$ EUR (optimal number of functional regions is five), $a_j = 200,000$ EUR (optimal number of functional regions is three), respectively $a_j = 500,000$ EUR (optimal number of functional regions is two) according to the regionalization into one to twenty functional regions. When the fix costs are lower, the services took place at higher number of smaller functional regions, therefore small fix costs of daily activity for services in a functional region allow higher number of centres, also in small functional regions in the state, when k is increasing.

The concept of Slovenia's central places is defined in the Spatial Development Strategy of Slovenia (SDSS, 2004). There are fifteen regional centres (Fig. 6). We compared fifteen centres of functional regions delineated by *Intramax* method with administratively defined regional centres. It is obvious that three administratively defined regional centres are in the same functional region with other functionally more important central place. Consequently, there are three additional functional regions derived around three additional central places (the names are underlined in Fig. 6). Therefore, if fifteen centres of functional regions would be chosen as optimal set of k central places for servicing elderly people, the fix costs of daily activity for services in the functional region should be between 28,000 EUR and 44,000 EUR; in Fig. 7 for $a_j = 30,000$ EUR optimal $k = 15$. But, from Fig. 1 it is obvious that when fix costs fall under 58,000 € per day, the optimal number of central places with located services is rapidly increasing from 6 to 20.

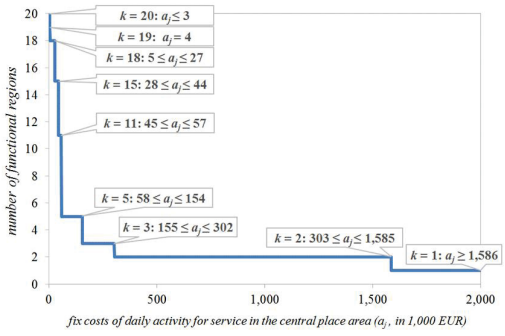

Fig. 1. Optimal numbers of functional regions in dependence of the fix costs of daily activity for services in the central places as centres of functional regions of Slovenia, 2010.

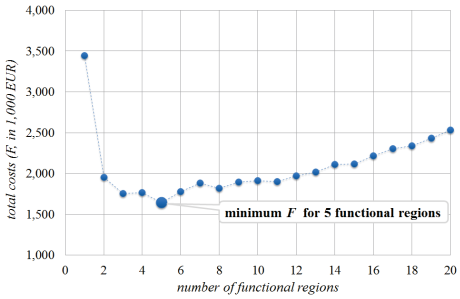

Fig. 2. Total costs F for $a_j = 100,000$ EUR according to the regionalization into one to twenty functional regions.

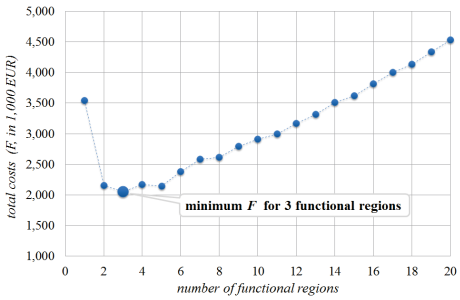

Fig. 3. Total costs F for $a_j = 200,000$ EUR according to the regionalization into one to twenty functional regions.

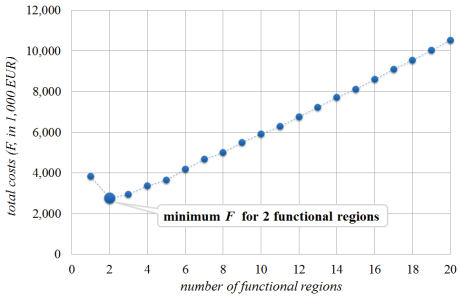

Fig. 4. Total costs F for $a_j = 500,000$ EUR according to the regionalization into one to twenty functional regions.

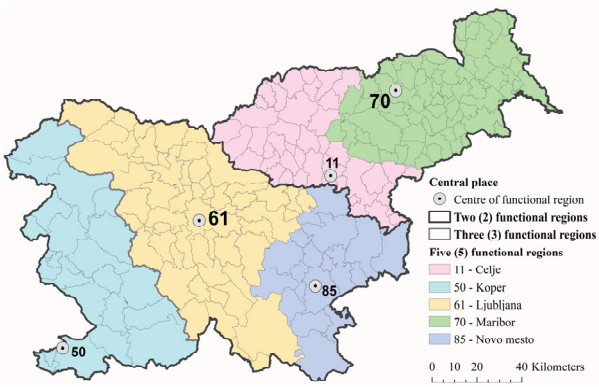

Fig. 5. Five, three and two functional regions in Slovenia.

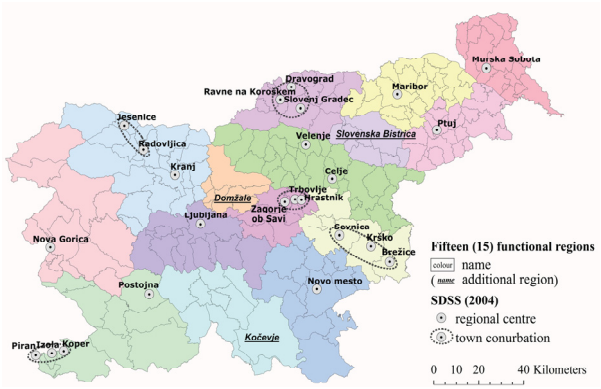

Fig. 6. Fifteen functional regions in Slovenia.

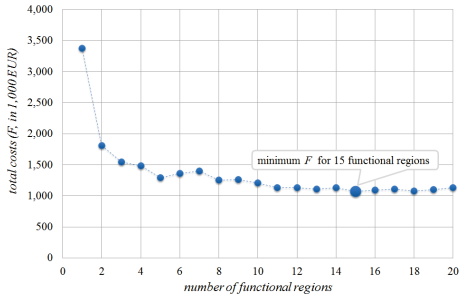

Fig. 7. Total costs F for $a_j = 30{,}000$ EUR according to the regionalization into one to twenty functional regions.

4. CONCLUSION

Various spatial models, which explain the systematic arrangement of central places, have been developed based on Christaller's and Lösch's seminal works. When a socioeconomic systems dynamic is present due to technological innovations the static hierarchy of Christaller's approach needs to be replaced by dynamic perspectives. Therefore, the static idea about fixed regionalisation was upgraded to a theory of functional regions. The improved size rule and the hierarchical system of settlements has been explained by answering the question where to locate services, especially public services like schools, hospitals and elder-care which will significantly influence urban growth in the 21st century. The answer has been found by looking for such allocation of activities in their functional regions, that costs of communication and services between cities as the central places of each activity and other areas in the functional region of the individual activities, when they cover the complete national territory, would be minimal. More activities are allocated to the central place, higher is the rank of the central place.

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