ISSN 2463-9281

Izzivi prihodnosti

Challenges of the Future

Letnik 10, številka 2, maj 2025

Volume 10, Issue 2, May 2025

FOS
Fakulteta za organizacijske študije
Faculty of organisation studies

ISSN 2463-9281

Izid publikacije je finančno podprla ARIS iz naslova razpisa za sofinanciranje domačih znanstvenih periodičnih publikacij.
The journal is subsidised by the Slovenian Research and Innovation Agency.

Naslov uredništva / Editorial address:
Fakulteta za organizacijske študije v Novem mestu
Ulica talcev 3
8000 Novo mesto, Slovenija

KAZALO VSEBINE
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DOI: 10.37886/ip.2025.003

Assessment of the Internal Efficiency of Slovenia's Tertiary Education System

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Abstract:

Research Question (RQ): In this article, we address the question of how efficient Slovenia's tertiary education system is compared to the systems of other Organisation for Economic Co-Operation and Development (OECD) member countries and identify elements within the Slovenian system that could be further improved to achieve optimal relative efficiency.

Purpose: The research aims to shed light on the internal efficiency of Slovenia's tertiary education system and compare it with those of other OECD member countries, with the goal of analyzing areas where the Slovenian system falls short of achieving optimal performance.

Method: Using theoretical foundations to identify relevant inputs and outputs, along with secondary data from international databases, we applied the Data Envelopment Analysis (DEA) method to examine the internal efficiency of tertiary education systems in 29 OECD member countries with complete data available for the study period.

Results: Results show that Slovenia's tertiary education system did not achieve optimal relative efficiency in any of the four models applied. In terms of relative efficiency, Slovenia ranked between 20th and 25th among the 29 OECD countries examined. To achieve optimal relative efficiency, improvements in output measures for both pedagogical and research activities should be made.

Organization: The research results can serve as a valuable tool for decision-makers at the national level, as well as for managers of individual tertiary education institutions, in achieving greater efficiency.

Society: Achieving efficiency in tertiary education is crucial for a broader society, not only for individuals participating in the educational process but also due to the wider impact that tertiary education has on the economy and society.

Originality: This is the first research to provide an overview of past studies on the efficiency of tertiary education systems, with a focus on evaluating the outcomes of Slovenia's tertiary education system. The study also delves into a detailed assessment of its efficiency achievements.

Limitations / further research: The research is based on secondary data obtained from international databases. The sample studied is not randomly selected but consists of 29 out of 38 OECD member countries for which complete data were available for the entire period, as the analysis was constrained by the absence of data for the remaining countries. It would

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Prejeto: 10. december 2024; revidirano: 6. januar 2025; sprejeto: 9. marec 2025. /
Received: 10th December 2024; revised: 6th January 2025; accepted: 9th March 2025.

be appropriate to enhance the research with a broader sample of countries and by using other or additional inputs and outputs, especially those that reflect the qualitative component of the utilized inputs and outputs.

Keywords: efficiency, tertiary education systems, DEA method, OECD countries, education funding, graduates.

1 Introduction

One of the defining characteristics of the modern global economy is the dominance of the knowledge economy, which has gradually replaced earlier economic models where growth and wealth were based on ownership of natural and productive resources, such as raw materials, land, and manufacturing facilities (Olssen & Peters, 2005, p. 331; Sum & Jessop, 2013, p. 30). The knowledge economy is an economic model in which knowledge is the most critical capital, driving continued growth and development (OECD, 1996, p. 9; Drucker, 1993, pp. 2-3). This era is generally considered to have begun in the post-World War II period (Sinuany-Stern & Hirsch, 2021, p. 482).

In today's developed nations, tertiary education is viewed as a vital instrument for fostering prosperity and competitiveness (Bloom et al., 2006, p. 1; Lane, 2012, p. 1). Consequently, the knowledge economy has spurred the massification of tertiary education. This trend stems from the increasing demand in industries for a skilled workforce and from individuals' aspirations to achieve higher education levels that provide better socio-economic opportunities (Kaneko, 2006, p. 4; Bonaccorsi et al., 2014, p. 1; Ghaffarzadegan et al., 2017, p. 1085; Calderon, 2018, pp. 6-8). With a growing awareness of the role of knowledge and education in economic and social progress, academic and policy circles alike emphasize the need to expand, improve, and increase access to tertiary education (Sum & Jessop, 2013, pp. 25-27; Choong & Leung, 2021, pp. 1577-1578).

A key challenge faced by many countries worldwide is ensuring a high-quality, accessible, and fiscally sustainable tertiary education system that produces a highly skilled workforce while also generating new knowledge through research activities. As the expansion of tertiary education systems is inherently linked to rising costs, countries are increasingly striving to achieve efficiency in publicly funded areas (Hanushek, 2005, p. 69; Giménez et al., 2007, pp. 996-997; Mihaljević Kosor, 2013, p. 1032; Agasisti, 2014, p. 543; Liu & Xu, 2017, p. 82).

Research on efficiency in education spans a wide field, attracting the interest of many scholars. Economic efficiency in education can be assessed at multiple levels, from smaller units (such as departments, faculties, and branches) to the international level,

where the focus is on national education systems. This article specifically addresses efficiency at the international level: a topic that, until recently, received limited attention. This gap is largely attributed not to a lack of academic interest but to insufficient data for meaningful analysis and comparison across countries' tertiary education systems.

One of the most extensive reviews on this subject was conducted by De Witte and López-Torres (2017), who examined 223 studies on educational efficiency, finding only nine that focus on the international level. Agasisti (2009, p. 201), who authored the first study on tertiary education system efficiency, highlights that the rapid advancement of internationally comparable databases e.g., United Nations Educational, Scientific and Cultural Organisation (UNESCO), Organisation for Economic Co-Operation and Development (OECD), International Labour Organisation (ILO), World Bank has recently made it possible to conduct more detailed and objective efficiency studies at the international level.

This article examines the efficiency of Slovenia's tertiary education system, comparing it with those in other OECD countries. According to OECD data, Slovenia allocated 1,19% of its Gross Domestic product (GDP) to tertiary education (including public and private funding) in 2021, below the OECD average of 1,48%. Meanwhile, in 2023, 33,51% of Slovenians aged 25 to 64 held tertiary qualifications, compared to an OECD average of 40,74%. For those aged 25 to 34, the proportion in Slovenia was 41,10%, versus an OECD average of 47,40% (OECD, n.d.). According to the Education and Training Monitor (European commission, 2024), the share of tertiary-educated individuals aged 25-34 has shown a slight upward trend over the years but experienced a decline in 2023, reaching 40,7%, which falls below the European Union (EU) average of 43,1%. Between 2015 and 2022, the share of public expenditure allocated to tertiary education consistently exceeded the EU average, accounting for 1% of GDP or 2,1% to 2,2% of total government expenditure. Simultaneously, annual spending per full-time equivalent student in higher education institutions increased significantly, rising by 34,8% between 2015 and 2021. This article explores whether Slovenia's tertiary education system delivers efficiency considering its funding levels and other relevant inputs.

This work makes a significant contribution to understanding the relative efficiency of Slovenia’s tertiary education system, as a detailed comparison between Slovenia and other OECD countries has not yet been conducted. The aim of the research is to assess how successful Slovenia is in ensuring the efficient operation of its tertiary education system relative to other countries and to identify areas where improvements can still be made. The findings of this research are valuable for shaping policies for the development of tertiary education in Slovenia, helping to enhance both the efficiency and quality of the system.

The article is structured into six chapters. In addition to the introductory (first) chapter, the second chapter outlines the theoretical foundations used to construct an appropriate model for studying efficiency. It also provides a review and analysis of previous international studies on efficiency in tertiary education, including those involving Slovenia. The third chapter describes the methodology for data collection, the development of inputs and outputs, and the protocol for creating an appropriate model for DEA analysis. In the fourth chapter, we conduct our own analysis of the efficiency of tertiary education systems in OECD countries and present the results. These results are then further explained and analyzed in the fifth chapter. The final (sixth) chapter presents key findings and concluding thoughts.

2 Theoretical framework

2.1 Measuring efficiency in tertiary education

Efficiency measurement, which relies on Pareto allocation principles (Bevc, 1999, p. 59; Tajnikar, 2006, p. 17; Mihaljević Kosor, 2013, p. 1032), proves more difficult in tertiary education than in economic fields, due to the inherent complexities and unique features of educational systems (Estermann & Kupriyanova, 2019, p. 10).

The literature uses various, sometimes inconsistent, terms to describe types of efficiency in tertiary education (Johnes, 2006, p. 274; Mihaljević Kosor, 2013, pp. 1032-1034). Generally, efficiency is examined from two perspectives: the production process, often termed technical, cost, or internal efficiency, and a broader perspective encompassing both graduate and research outputs. This broader concept, known as allocative or external efficiency, considers the alignment between the system's outputs and the needs of society and the economy (Bevc & Uršič, 2008, p. 234). For instance, internal efficiency focuses on the ratio of enrolled students to graduates, while external efficiency evaluates whether the number and profile of graduates meet societal and economic demands, as indicated by employment rates and levels of over- or under-education (Bevc, 1999, pp. 60-61; Miningou & Tapsoba, 2020, p. 587; Salas-Velasco, 2019, p. 162).

This article centers on efficiency within the framework of the production function (internal efficiency), focusing on the relationship between input resources and produced outputs. Due to the clear limitation that this study examines only the production aspect and does not address the appropriate allocation of outputs, it is essential to clarify that the term "efficiency," as used in this research, pertains solely to the concept of internal efficiency in tertiary education systems. This premise also forms the theoretical basis for selecting the inputs and outputs in our models.

Moreover, internal efficiency in education can be examined from two distinct analytical perspectives: one may focus on maximizing outputs given a set level of inputs, or

alternatively, on achieving a targeted level of outputs with the minimum possible inputs. In both approaches, the relationship between inputs and outputs remains a fundamental aspect of efficiency analysis (Coelli et al., 2005, pp. 180-181; Estermann & Kupriyanova, 2019, pp. 10-11).

Salerno (2003, p. 16) outlines the progression of efficiency measurement techniques from simple regression analysis to more advanced methods that allow for constructing an efficiency boundary, commonly termed the "envelope." These approaches enable the assessment of relative efficiency by examining how far each unit is from this efficiency envelope. In this study, we employ Data Envelopment Analysis (DEA) to evaluate the efficiency of tertiary education systems, as DEA is frequently used as a synonym for all non-parametric efficiency measurement techniques in the field (Salerno, 2003, p. 18; De Witte & López-Torres, 2017, p. 341).

A key advantage of DEA is its ability to handle multiple inputs and outputs, making it particularly suitable for tertiary education systems, which use a variety of inputs to generate a diverse set of outputs. As a non-parametric technique, DEA does not require a predefined production function to construct the efficiency envelope - a requirement that is often challenging in educational research. Instead, DEA forms this envelope based on empirical data from all observed units, referred to as Decision Making Units (DMUs), identifying the most efficient units that define the maximum efficiency boundary. Each DMU is then assigned a relative efficiency score ranging from 0 to 1, with a score of 1 representing full efficiency, indicating that the DMU is located on the efficiency envelope. It is important to emphasize that the data obtained through the DEA method represents relative efficiency. Therefore, when evaluating a unit as efficient or inefficient, it must be understood that this classification pertains to relative efficiency, not absolute efficiency.

A detailed description of the DEA method is provided in Chapter 3, while the rest of this chapter focuses on reviewing previous studies that have analyzed the efficiency of tertiary education systems, including those that have examined Slovenia.

2.2 Review of Previous Studies on Tertiary Education Efficiency

Upon reviewing the available literature, we identified nine studies that assess the efficiency of tertiary education at the system (country) level, each of which includes an analysis of the Slovenian tertiary education system. These studies encompass a variety of models and examine different time periods. In total, 37 distinct models were analyzed, differing in terms of the number of DMUs, selection of inputs and outputs, model orientation (input- or output-oriented) and returns to scale (constant or variable), as well as the time frames under consideration. A comprehensive overview of all models and the efficiency scores of the Slovenian tertiary education system across these models is presented in table1.

Table 1
Review of previous studies on tertiary education efficiency

No.	Study	Model type				DMU	Slovenia's results	
		Model no.	CRS or VRS	OO or IO	Time		Efficiency score	Ranking
1	Aubyn et al. (2009)	model 1	VRS	IO	1998-2001	28	0,909	9.
2			VRS	IO	2002-2005	28	0,664	14.
3			VRS	OO	1998-2001	28	0,593	15.
4			VRS	OO	2002-2005	28	0,414	18.
5		model 2	VRS	IO	1998-2001	28	0,317	25.
6			VRS	IO	2002-2005	28	0,394	25.
7			VRS	OO	1998-2001	28	0,273	25.
8			VRS	OO	2002-2005	28	0,315	20.
9	Aristovnik & Obadić (2011)	model 1	VRS	OO	1999-2007	37	1,000	1.
10		model 2	VRS	OO	1999-2007	37	1,256*	13.
11		model 3	VRS	OO	1999-2007	37	1,029*	12.
12	Yotova & Stefanova (2017)	model 1	VRS	IO	2012-2014	9	0,850	4.
13		model 2	VRS	IO	2012-2014	9	0,828	4.
14		model 3	VRS	IO	2012-2014	9	0,828	3.
15	Jelić & Kedžo (2018)	model 1	VRS	OO	2004-2006	24	0,811	21.
16			VRS	OO	2007-2009	24	0,735	23.
17			VRS	OO	2010-2012	24	0,741	23.
18			VRS	OO	2013-2015	24	0,768	22.
19		model 2	VRS	OO	2004-2006	24	0,810	19.
20			VRS	OO	2007-2009	24	0,763	23.
21			VRS	OO	2010-2012	24	0,789	22.
22			VRS	OO	2013-2015	24	0,752	21.
23		model 3	VRS	OO	2004-2006	24	0,824	20.
24			VRS	OO	2007-2009	24	0,763	23.
25			VRS	OO	2010-2012	24	0,789	23.
26			VRS	OO	2013-2015	24	0,833	21.

»continued«

»continued«

No.	Study	Model type				DMU	Slovenia's results	
		Model no.	CRS or VRS	OO or IO	Time		Efficiency score	Ranking
27	Ahec Šonje et al. (2018)	model 1	VRS	IO	2005-2013	11	0,800	9.
28		model 2	VRS	IO	2005-2013	11	0,750	8.
29	Stefanova (2019)	model 1	VRS	IO	2013-2018	7	0,610	6.
30	Mihaljević Kosor et al. (2019)	model 1	VRS	IO	2012-2016	28	0,883	2.
31	Stefanova & Velichkov (2020)	model 1	VRS	IO	2013-2018	10	1	1.
32		model 2	VRS	IO	2013-2018	10	0,893	4.
33		model 3	VRS	IO	2013-2018	10	0,893	3.
34	Sinuany-Stern & Hirsh (2021)	model 1	CRS	OO	2019	29	0,831	19.
35		model 2	CRS	OO	2019	29	0,663	15.
36		model 3	VRS	OO	2019	29	1	1.
37		model 4	VRS	OO	2019	29	1	1.

Note. IO denotes an input-oriented model, while OO represents an output-oriented model. The CRS model refers to a DEA model with constant returns to scale, whereas the VRS model indicates a DEA model that accounts for variable returns to scale. The time label specifies the period during which the data was collected. *In this study, values above 1,000 indicate a projection of increased outputs necessary to achieve full efficiency, rather than relative efficiency.

Table 1 provides an overview of the studies analyzed, with the second and third columns listing each study along with the specific models employed. The fourth and fifth columns detail the model subtypes (IO or OO, and CRS or VRS), while the "DMU" column indicates the total number of countries analyzed within each model. The final two columns present the DEA analysis outcomes, including the relative efficiency coefficient and Slovenia's ranking among all countries (DMUs) assessed.

The data in table 1 yields several critical insights: DEA was consistently employed as the methodology for assessing efficiency across all 37 models, with the VRS model utilized in 35 cases, while the basic CRS model appeared in only two. The CRS model is generally considered less suitable for comparative analysis due to its greater variability in assigning weights to individual DMUs (Sinuany-Stern & Hirsch, 2021, p. 488). Additionally, notable heterogeneity is evident in the choice of model orientation, with the OO model applied in 23 cases and the IO model in 14, indicating diverse methodological approaches across the studies.

The findings from various studies suggest that the Slovenian tertiary education system does not function at the efficiency frontier, as it was identified as fully efficient (relative efficiency = 1) in only four models. Unfortunately, the studies offer limited insight into the

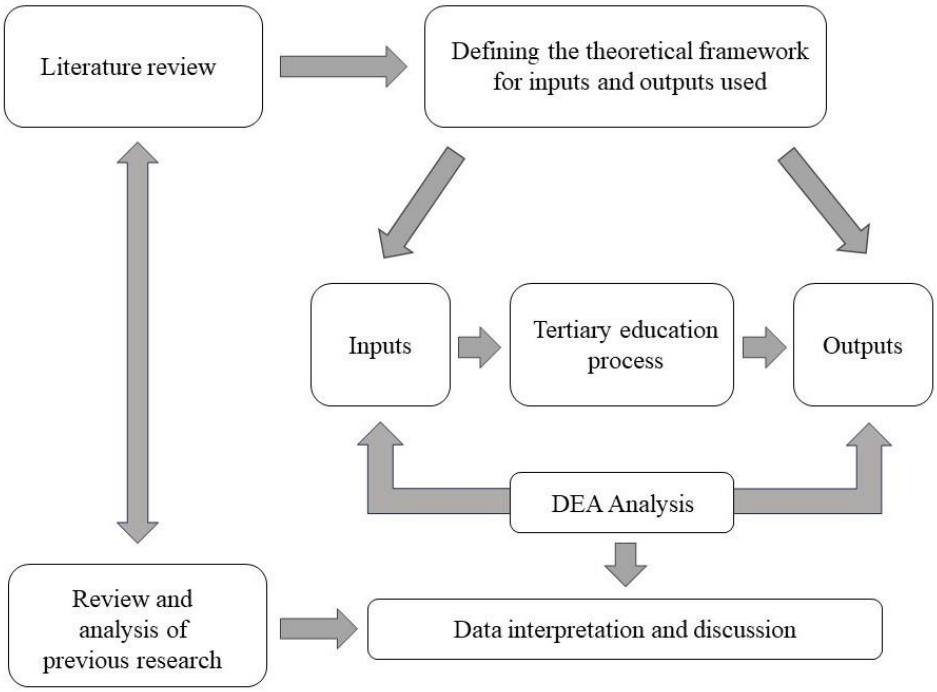
underlying causes of inefficiency within the Slovenian system. Mihaljević Kosor et al. (2019, pp. 404-405) posit that, given the financial resources allocated to tertiary education, Slovenia should increase both its graduate output and the employment rate among individuals with tertiary qualifications. From an input minimization perspective, Ahec Šonje et al. (2018, p. 10) observe that Slovenia's GDP expenditure per student could be reduced by 4,1% to achieve full efficiency.

In this study, we aim to reinforce previous findings that suggest potential for improving the efficiency of the Slovenian tertiary education system by employing carefully selected inputs and outputs focused exclusively on internal efficiency (with the justification for these choices detailed in the next section). This article seeks to address the following research questions: Does the Slovenian tertiary education system operate at the efficiency frontier relative to other OECD member countries, and which specific elements should be improved within the Slovenian system to enhance its efficiency, should it be found to be operating not efficiently. The following sections discuss the methods for data collection, the formulation of relevant indicators, and the data processing methodology.

3 Method

Figure 1 presents a visual representation of the research model. First, we conducted a literature review to establish the theoretical foundation, which allowed us to define the appropriate inputs and outputs for the model. Additionally, the reviewed studies helped us compare our research findings with those of previous studies.

Figure 1.
Model of research



The DEA method was originally developed by Charnes, Cooper, and Rhodes (1978), with their model based on the principle of constant returns to scale (CRS). This implies the assumption that an increase in the quantity of inputs leads to a proportional, linear increase in outputs. Subsequently, Banker, Charnes, and Cooper (1984) extended the CRS model to develop a version that operates under variable returns to scale (VRS). The main distinction between the two models is that the VRS model yields a higher number of fully efficient units compared to the CRS model, which consequently reduces its discriminative power (Sinuany-Stern & Hirsch, 2021, p. 488).

As with any method, DEA has its limitations and potential challenges, making it essential to follow established protocols for accurate application. According to Golany & Roll (1989, p. 238) and Dyson et al. (2001, p. 247), the initial step is to define the DMUs being observed, ensuring they are sufficiently comparable (possessing a substantial number of shared characteristics) to make efficiency comparisons meaningful. In this study, we evaluate the efficiency of tertiary education systems across OECD member countries. The primary reasons for this choice include the relative homogeneity of the sample, as these are economically advanced nations that adhere to democratic and free-market principles (Sinuany-Stern & Hirsch, 2021, p. 482), as well as the availability of robust data (the OECD maintains a comprehensive dataset of high-quality information from its member countries, supporting objective and unbiased international comparisons). As outlined by Golany & Roll (1989, pp. 239-241) and Dyson et al. (2001, pp. 248-253), the next step is to define the inputs and outputs to be included in the model, considering the following constraints:

- The ratio between the number of DMUs and the total number of inputs and outputs should ideally be greater than 1:3 to ensure sufficient discriminative power in the DEA method. As the number of inputs and outputs increases, so does the number of efficient units (with a relative efficiency score of 1) in DEA models. This rise in efficient units complicates result interpretation and the ranking of DMUs.
- The selected inputs and outputs must satisfy the criteria of exhaustiveness and exclusivity, meaning that each system input is represented by only one indicator, and the entire set of indicators encompasses all inputs and outputs of the system (Mihaljević Kosor et al., 2019, p. 399).
- Inputs and outputs must be expressed in consistent units (either absolute or relative) and designed to meet the isotonicity condition. This means that an increase in input values should contribute to a decrease in overall efficiency, while an increase in output values should lead to higher relative efficiency of the DMUs.
- Consideration must also be given to the time required for the production process that converts inputs into outputs, which necessitates defining appropriate time periods for recording inputs and outputs.

- It is advisable to use the average value over a multi-year period rather than focusing on a single year, as this approach mitigates the impact of potential extremes in any given year.
- When selecting appropriate indicators, it is also necessary to consider the qualitative component of each input or output (Bevc, 1999, p. 64; Jelić & Kedžo, 2018, p. 382).

In the subsequent section, we provide a rationale for the selection of secondary data used in our models and clarify the formulation of inputs and outputs. Accordingly, the models incorporate six distinct inputs (I) and four outputs (O).

In selecting inputs, we draw on foundational economic theory, which, even in the context of educational systems, considers labor and capital as the primary production factors (Scheerens, 2011, p. 49; Salas-Velasco, 2019, p. 162). Thus, our model includes inputs from both categories, with additional structuring. A review of inputs and outputs used in previous studies on the efficiency of tertiary education systems indicates that financial resources are consistently included as an input, although different studies employ various indicators for this input (such as the proportion of GDP allocated to tertiary education, the share of government budget for tertiary education, funding per student, and so forth).
Since the amount of financial resources does not directly indicate quality, we contend that a more comprehensive understanding of system performance requires examining the structure of individual factors that influence efficiency. An essential consideration in constructing an efficiency model is that objective and impartial analysis of efficiency in tertiary education systems should encompass both teaching and research activities. This aspect has largely been overlooked in prior research, as only two of the 12 reviewed studies (Aubyn et al., 2009; Sinuany-Stern & Hirsch, 2021) included indicators for research activity in their models. Data on education resources was retrieved from the OECD database (OECD, n.d.), specifically from the Education and Skills section. Drawing on available data, our study incorporates two financial indicators that provide deeper insights into the funding structure of tertiary education systems. Both indicators reflect relative values, showing financial resources (public and private) as a percentage of each country's GDP. They differ in that input I1 represents financial resources allocated to the entire tertiary education system, excluding research and development (R&D) funds, which are captured separately in input I2:

- **I1:** Financial resources for tertiary education (excluding R&D funding),
- **I2:** Financial resources allocated for research and development within the tertiary education system.

Despite the general neglect of labor-related inputs in previous studies on education and research efficiency (with exceptions like Aubyn et al., 2009 and Aristovnik & Obadić, 2011, who included labor as an input), we contend that including labor as a production factor in efficiency models is essential for achieving unbiased results. In this context, we consider both students (participants) and employees (providers) as key labor inputs. Aubyn et al. (2009, p. 10) argue that students are a fundamental production input, necessary for tertiary education systems to produce graduates as outputs, and that each student who fails to graduate contributes to the system's inefficiency.

Inputs I3 and I4 reflect the proportion of the population actively engaged in tertiary education. Input I3 represents the number of students in International Standard Classification of Education (ISCED) levels 5, 6, and 7 programs, while Input I4 captures students enrolled in ISCED level 8 (doctoral programs). There are two main reasons for this structuring: ISCED levels 5, 6, and 7 focus primarily on knowledge acquisition and later successful entry into the labor market, whereas ISCED level 8 programs are designed for those intending to pursue research careers. Since some OECD member states (e.g., Estonia, Finland, Greece, Lithuania) do not include ISCED level 5 programs in their national frameworks, we use an aggregate indicator. Data on students was retrieved from the OECD database (OECD, n.d.), specifically from the Education and Skills section. Both indicators are expressed in relative terms, showing the number of enrolled students as a share of the total population:

- **I3:** Students enrolled in ISCED levels 5, 6, and 7 programs,
- **I4:** Students enrolled in ISCED levels 8 programs.

In our model, we also include the number of employees as an input. The student-to-staff ratio, as used by Jelić & Kedžo (2018, p. 388), might indicate cost efficiency; however, it could also suggest a decline in teaching quality as instructors manage a larger number of students (Johnson, 2010, pp. 701-702). Consequently, similar to the approach of Aubyn et al. (2009), we include the number of academic staff as a proportion of the total population, defining this as input I5:

- **I5:** Employed academic staff.

Data on academic staff was retrieved from the OECD database (OECD, n.d.), specifically from the Education and Skills section.

In the context of including indicators that reflect the quality of each production factor, Rothschild & White (1995, pp. 574-576) emphasize the significance of students, particularly their prior knowledge and intellectual abilities. Consequently, in our model, we focus on developing indicator I6 to capture the quality of students' knowledge, using data from the 2009 (OECD 2010) and 2012 (OECD 2014) Programme for International Student Assessment (PISA) study. While Jelić & Kedžo (2018, p. 385) also draw on PISA

data, our approach differs in that we do not rely on the national average score. Instead, we consider only the top third of the population, acknowledging that only a portion of the population advances to tertiary education. We argue that, in studying tertiary education, it is relevant to focus solely on the segment likely to enter higher education, as analyzing the full sample of 15-year-olds could produce misleading results. This approach defines the sixth input (I6):

- **I6:** The average PISA score of the top third of the population.

On the output side, we follow the previously established premise that both educational and research outputs must be equally considered when evaluating the efficiency of tertiary education systems, as both are fundamental activities within these institutions. Accordingly, we define two groups of outputs: O1 and O2, representing educational outputs, and O3 and O4, representing research outputs.

O1 and O2 reflect the number of graduates across various levels of study. As noted by Warning (2004, pp. 398-399), Scheerens (2011, p. 49), and Salas-Velasco (2019, p. 162), the number of graduates serves as a representative indicator of educational output. Following the structure used for student numbers as inputs, we incorporate two graduate indicators into the model: graduates at ISCED levels 5, 6, and 7, and graduates at ISCED level 8. Both indicators are presented as relative values, showing the proportion of the total population, with data drawn from the OECD database (OECD, n.d.):

- **O1:** Graduates at ISCED levels 5, 6, and 7,
- **O2:** Graduates at ISCED levels 8.

O3 and O4 pertain to research activities within tertiary education systems. The number of scientific articles and other research publications produced by researchers (students and faculty) at each university is typically considered the primary output of research activities (Warning, 2004, pp. 398-399; Aubyn et al., 2009, p. 19; Saljoughian et al., 2013, p. 25). Agasisti et al. (2011, p. 277) also find that the number of published articles is a commonly used measure of research output. To develop the indicators representing research activity outputs, we utilize data from the Web of Science bibliographic database (Clarivate, n.d.), which provides comprehensive information on scientific works by country and institution, as well as citation counts.

Indicator O3 is constructed by identifying articles from each country where at least one author is affiliated with a domestic tertiary education institution (excluding foreign institutions, research institutes, hospitals, private companies, government agencies, etc.). The number of such articles is then calculated relative to the country's total population. The data on scientific publications used for indicator O3 also provide the basis for an indicator reflecting the quality component of research outputs (O4), which

can be assessed using citation indices, indirectly indicating the impact and quality of the research (Aksnes et al., 2019, pp. 1-2). For the selected articles in indicator O3, we examine the number of citations received in the publication year and in the following two years to capture the most recent citation impact.

Citation data were collected in November 2024, allowing us to include all scientific works published through 2022 and to analyze their citation counts for the publication year and the two subsequent years. The model incorporates the following indicators:

- O3: Published scientific works,
- O4: Citations.

In selecting inputs and outputs, we rigorously adhere to the principle of evaluating the efficiency of tertiary education systems strictly within the confines of the production function (i.e., technical, or internal efficiency). Consequently, indicators that assess the appropriateness of output allocation (such as the unemployment rate or earnings of tertiary-educated individuals) are excluded from our models. While most of the analyzed models incorporate unemployment as an indicator, and some even include income or poverty metrics as outputs, we argue that these reflect the interaction between production and demand, aligning more closely with the concept of external efficiency, which falls outside the scope of this study. We maintain that a comprehensive and objective efficiency analysis requires that internal and external efficiency be examined separately. It is also important to note that incorporating output indicators to reflect graduate quality would enhance the model's depth. However, due to the absence of a standardized instrument to measure the quality and breadth of graduate knowledge at the OECD country level, such an indicator cannot presently be included in the model.

The defined set of inputs and outputs is applied across four different models, focusing on two distinct periods. For data collection, we calculated a three-year average for both inputs and outputs, maintaining a four-year gap between the input and output periods. An exception is made for I6, which relies on PISA results, as the PISA assessment occurs every three years and involves 15-year-olds who typically enter tertiary education three to four years later. For the first period, we used PISA results from 2009, and for the second, we used results from 2012. Table 2 outlines the data collection periods for each input and output in both time frames.

Table 2
Time frame for input and output collection

	Inputs		Outputs
	I6 (PISA)	I1 - I5	O1 - O4
First time period	2009	2013 - 2015	2017 - 2019
Second time period	2012	2016 - 2018	2019 - 2022

We performed a DEA analysis for both the input-oriented (IO) and output-oriented (OO) models on data from each time period, resulting in four distinct models. The VRS model was applied in all four cases. Alongside measuring relative efficiency, we also analyzed changes in efficiency between the two periods using the Malmquist index - MI (Liu & Xu, 2017, p. 82). This model is designed to address the research question of whether the Slovenian tertiary education system operates efficiently compared to other OECD member countries. Furthermore, it will provide a detailed analysis of the individual input and output values, allowing for a thorough examination of factors contributing to inefficiency, should the Slovenian system be found lacking, and facilitating the proposal of targeted improvements.

4 Results

This section presents the findings of the efficiency analysis conducted for tertiary education systems in 29 OECD member countries. Although the OECD has comprised 38 member countries since 2010, the analysis for the period 2013 to 2022 is restricted to 29 countries due to missing data for the I1, I2, and I5 variables. As DEA requires complete datasets, countries with incomplete information could not be evaluated. Table 3 displays the relative efficiency coefficients obtained through the DEA method. These results pertain to the two observed periods described in the previous section, with analyses conducted for both input-oriented (IO) and output-oriented (OO) models in each period. In addition to the relative efficiency coefficients, table 3 shows each country's ranking within the sample of 29 countries. Table 3 also includes Malmquist index (MI) values, with the penultimate column presenting the index for input-oriented models, showing the ratio of relative efficiency between the first and second periods, and the final column showing MI values for output-oriented models, indicating the changes in relative efficiency across the two periods.

Table 3
DEA analysis results

Country (DMU)	First time period				Second time period				MI IO	MI OO
	IO		OO		IO		OO			
	Score	Rank	Score	Rank	Score	Rank	Score	Rank		
Australia	1	1.	1	1.	1	1.	1	1.	1,007	1,041
Austria	0,989	20.	0,942	22.	0,988	24.	0,885	26.	1,004	1,032
Belgium	1	1.	1	1.	0,986	25.	0,975	16.	1,301	1,072
Czech Republic	0,996	17.	0,966	20.	0,997	17.	0,857	27.	0,965	0,779
Denmark	1	1.	1	1.	1	1.	1	1.	0,812	0,882
Estonia	1	1.	1	1.	1	1.	1	1.	1,411	1,212
Finland	0,979	24.	0,978	17.	1	1.	1	1.	1,321	1,113
France	1	1.	1	1.	1	1.	1	1.	1,239	1,080
Germany	1	1.	1	1.	1	1.	1	1.	0,896	0,966
Hungary	1	1.	1	1.	1	1.	1	1.	1,241	1,560
Ireland	1	1.	1	1.	1	1.	1	1.	1,655	1,029
Italy	1	1.	1	1.	1	1.	1	1.	1,288	1,121
South Korea	0,970	28.	0,858	25.	0,978	28.	0,957	18.	1,054	1,111
Latvia	0,986	22.	0,754	29.	0,990	22.	0,764	29.	1,003	1,112
Lithuania	0,979	25.	0,799	27.	0,992	21.	0,927	20.	1,019	1,233
Luxembourg	1	1.	1	1.	1	1.	1	1.	1,876	1,057
Mexico	1	1.	1	1.	1	1.	1	1.	0,896	1,078
Netherlands	1	1.	1	1.	1	1.	1	1.	1,325	1,003
New Zealand	0,967	29.	0,968	19.	0,979	26.	0,912	21.	1,138	1,026
Norway	0,996	18.	0,975	18.	0,988	23.	0,906	23.	0,996	0,974
Poland	0,977	26.	0,948	21.	0,971	29.	0,784	28.	0,991	0,924
Portugal	0,990	19.	0,768	28.	1	1.	1	1.	1,008	1,239
Slovakia	0,987	21.	0,813	26.	0,994	18.	0,904	24.	1,000	1,016
Slovenia	**0,981**	**23.**	**0,874**	**24.**	**0,993**	**20.**	**0,887**	**25.**	**1,009**	**1,115**
Spain	1	1.	1	1.	0,993	19.	0,910	22.	0,682	0,692
Sweden	1	1.	1	1.	0,998	16.	0,972	17.	1,028	0,994
Turkey	1	1.	1	1.	1	1.	1	1.	1,019	0,824
United Kingdom	1	1.	1	1.	1	1.	1	1.	1,351	0,954
USA	0,974	27.	0,940	23.	0,979	27.	0,939	19.	1,038	1,073

The next section examines the results for the Slovenian tertiary education system within the broader analysis. Table 4 shows the countries whose tertiary education systems were deemed efficient and share the most similarities with the Slovenian system in terms of characteristics and structure. For each of the four models analysed, table 4 presents three benchmark countries for Slovenia. Lambda values are also included in the table 4, indicating the degree of similarity between the Slovenian tertiary education system and these foreign systems.

Table 4
Benchmark countries

Time period	Model used	Benchmark countries (lambdas)		
		Benchmark 1	Benchmark 2	Benchmark 3
First time period	Input oriented	Luxembourg 32,28%	Ireland 28,80%	Mexico 26,15%
	Output oriented	Luxembourg 52,58%	Ireland 34,60%	Belgium 12,83%
Second time period	Input oriented	Luxembourg 43,39%	Ireland 36,46%	Mexico 20,16%
	Output oriented	Luxembourg 54,97%	Ireland 33,95%	Italy 7,86%

Table 5 presents the values of all inputs and outputs for the second time period for Slovenia, alongside Luxembourg and Ireland, which were previously identified as benchmark models for achieving efficiency. The last row of table 5 provides the average values of all inputs and outputs across the 29 OECD countries analyzed in this study, offering a comparative perspective on Slovenia's performance relative to the broader sample.

Table 5
Input and output values for Slovenia, Ireland, Luxembourg and OECD averages (second time period)

Country	I1	I2	I3	I4	I5	I6	O1	O2	O3	O4
Slovenia	0,821	0,211	3,696	0,124	0,342	595,864	0,758	0,021	2,550	8,244
Ireland	0,631	0,240	4,512	0,176	0,201	596,464	1,930	0,031	3,881	9,581
Luxembourg	0,275	0,180	1,069	0,109	0,170	597,743	0,317	0,027	2,537	10,138
OECD average	0,989	0,407	4,310	0,145	0,338	594,710	1,034	0,024	2,477	8,854

Table 6 presents the results of the indicator values for the four outputs in both output-oriented models, along with the projected ideal value for each indicator that the Slovenian system should meet in order to achieve optimal efficiency. Additionally, Table 6 shows the percentage increase in output values needed for Slovenia to attain full efficiency.

Table 6
Output targets for Slovenia

	First time period (OO)				Second time period (OO)			
	O1	O2	O3	O4	O1	O2	O3	O4
Result	0,773	0,023	1,985	7,463	0,758	0,021	2,550	8,244
Target	0,884	0,027	2,687	8,539	0,912	0,027	2,875	9,730
Change	14,42%	14,94%	35,34%	14,42%	20,31%	30,34%	12,77%	18,03%

5 Discussion

The results shown in table 3 validate prior research, confirming that the Slovenian tertiary education system does not operate at the efficiency frontier. While a significant number of DMUs are classified as efficient (due to the relatively large number of inputs and outputs) Slovenia is not among them. In none of the four models tested does the Slovenian system reach full relative efficiency, consistently placing near the bottom of the rankings among the 29 countries analyzed. Slovenia's relative efficiency and ranking

are marginally higher in both input-oriented models than in the output-oriented models. Despite the poorer performance in the output-oriented models, an improvement in relative efficiency is observed between the two periods. The MI exceeds 1,000 in both cases suggesting that the Slovenian system is gradually moving closer to the efficiency frontier.

As evidenced by the data in table 4, Slovenia should primarily look to Luxembourg and Ireland as benchmarks for improving efficiency. Similar conclusions were drawn by Mihaljević Kosor et al. (2019, p. 403), who identified Luxembourg, Ireland, and Hungary as benchmark models for Slovenia. While Hungary was also recognized as fully efficient in our study, it was not classified as a benchmark model for Slovenia. It is crucial, however, to approach the interpretation of benchmark results and derived lambda values with caution and a critical perspective, particularly regarding their applicability to Slovenia.

Luxembourg and Ireland stand out as OECD countries with the highest GDP per capita, exceeding Slovenia's GDP per capita by more than twofold (OECD, 2025). This economic advantage allows these countries to sustain effective tertiary education systems even while allocating a lower proportion of GDP to this sector. As detailed in table 5, Luxembourg dedicates a smaller share of its GDP to research activities (I2) and broader tertiary education efforts (I1). However, it is important to account for Luxembourg's unique circumstances, where the majority of its population pursues tertiary education in neighboring countries (OECD, 2023, p. 39). This factor may distort the reported data on the number of students and graduates for Luxembourg.

The comparison with Ireland is particularly insightful. Although Ireland allocates a smaller percentage of its GDP to the overall functioning of the tertiary education system (I1 + I2) than Slovenia, table 5 reveals that Ireland directs a higher percentage of its GDP toward research activities (I2), compared to Slovenia. This higher investment is probably reflected in Ireland's superior performance in research-related outputs (O3 and O4). The data show that Slovenia lags significantly behind Ireland in the production of scientific outputs (O3), with a somewhat smaller gap in citation rates (O4). These trends, also confirmed by values in table 6, underscore the necessity for Slovenia to enhance its research outputs, particularly O3 and O4.

An even greater disparity is observed in the educational outputs (O1 and O2) between Slovenia and Ireland during the second period. As shown in Table 5, Ireland significantly outperforms Slovenia in the share of graduates at ISCED levels 5, 6, and 7. It is important to note also that Slovenia's values of O1 and O2 are below the average of the analysed countries. Given the intrinsic link between the number of students enrolled (I3) and the number of graduates (O1), the analysis shows that the gap in O1 is significantly wider than

in I3. This finding suggests that Ireland achieves substantially higher completion rates, which is a key factor in Slovenia's inability to attain full relative efficiency.

A similar discrepancy is evident in the comparison of students (I4) and graduates (O2) at ISCED level 8. Once again, the gap in outputs is more pronounced than in inputs. These observations, corroborated by table 6, highlight the urgent need for Slovenia to improve its educational outputs, particularly O1 and O2, to achieve a higher level of efficiency within its tertiary education system.

The data in table 5 indicates that, based on PISA results, Slovenian students begin secondary education with solid foundational knowledge and sufficient intellectual capacity. Additionally, the number of academic staff in Slovenia is comparable to the average across the analysed OECD sample.

6 Conclusion

The results of our research show that the Slovenian higher education system is not operating at the boundary of optimal efficiency, which confirms the findings of previous studies. To achieve optimal and efficient performance, it would be necessary to either reduce the volume of inputs or increase the volume of outputs. Given that the proportion of financial resources allocated to the Slovenian higher education system is below the average of OECD member countries, and that Slovenia also lags behind the OECD average in terms of the share of the population with tertiary education, a strategy focused on reducing inputs would be quite risky in terms of maintaining both the scale and the quality of higher education. This presents a significant challenge, particularly in the context of the knowledge-based economy.

As established in the discussion, Slovenia's efficiency is particularly constrained by low graduation rates at all ISCED levels. A relatively small proportion of students enrolled in tertiary education successfully complete their studies, which negatively impacts output values. Addressing this issue requires a thorough analysis of systemic factors contributing to low completion rates. However, efforts to improve graduation rates must not compromise educational quality.

Beyond educational outputs, research activities remain a crucial area for improvement. While Slovenia's scientific output volume is above average, enhancing both the quantity and quality of high-impact academic publications is essential for achieving efficiency. A deeper evaluation of research processes and targeted policy measures would be beneficial.

To improve efficiency, a multifaceted approach is necessary. Providing stronger academic and financial support, such as mentoring, tutoring, and targeted scholarships,

could help students complete their studies more successfully. Additionally, institutional reforms aimed at optimizing resource allocation and enhancing research productivity should be considered.

It is crucial to address the limitations of this research and delineate directions for future studies, particularly those focusing on the efficiency of tertiary education systems. As outlined in the introduction, this study is centered exclusively on the concept of internal efficiency within tertiary education systems. The selection of inputs and, more notably, outputs reflect this specific focus. However, this emphasis on internal efficiency should not be interpreted as a diminishment of the importance of external efficiency. On the contrary, external efficiency provides a deeper understanding of the applicability and societal relevance of the outputs produced by tertiary education systems. It also addresses critical questions about whether these outputs are coherent and appropriately allocated to meet the evolving needs of society and the economy. Accordingly, future research should integrate the concept of external efficiency to offer a more holistic evaluation of tertiary education systems. Future research should also prioritize expanding the analysis to include a larger and more diverse set of countries, including non-OECD members, once comprehensive and reliable data become available. Another significant limitation of this research is the restricted range of inputs and outputs available to capture qualitative dimensions of the indicators used, due to the lack of suitable data. Indicators that better reflect the quality of graduates' knowledge, evaluations of academic staff performance, and assessments of research output quality would be particularly beneficial.

Finally, we emphasize that future research should also examine external factors influencing efficiency that may not be directly controlled by individual countries, particularly in the short term. These external variables, such as global economic trends, international mobility of students and researchers, and cross-border collaboration, could provide valuable insights into the broader context affecting tertiary education systems. Including such variables would shed additional light on this complex and multifaceted topic, enabling a more comprehensive understanding of the determinants of efficiency in tertiary education.

We believe that this study will contribute to a deeper understanding of the challenges in ensuring the effective functioning of the higher education system in Slovenia and will encourage both academic and political stakeholders to seek solutions that could improve efficiency. These solutions are likely to be found within the higher education process itself, which, however, was not the primary focus of this study.

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Povzetek:
Vrednotenje notranje učinkovitosti slovenskega Sistema terciarnega izobraževanja

Raziskovalno vprašanje (RV): v članku podajamo odgovor na vprašanje koliko je je slovenski sistem terciarnega izobraževanj učinkovit v primerjavi z drugimi sistemi terciarnega izobraževanja v državah članicah Organizacije za gospodarsko sodelovanje in razvoj (OECD) ter kateri so tisti elementi, ki jih je mogoče v slovenskem sistemu še izboljšati oz. optimizirati za doseganje optimalne relativne učinkovitosti.
Namen: raziskava poskuša osvetliti slovenski sistem terciarnega izobraževanja z vidika učinkovitega delovanja ter ga primerjati s sistemi ostalih držav članic OECD s ciljem, da se identificira tista področja, v katerih slovenski sistem ne dosega ustreznih rezultatov, ki bi omogočali popolnoma učinkovito delovanje.
Metoda: Z uporabo teoretičnih osnov za identificiranje ključnih inputov in outputov ter sekundarnih podatkov iz mednarodnih virov smo izvedli analizo relativne učinkovitosti z uporabo metode DEA, da bi proučili notranjo učinkovitost sistemov terciarnega izobraževanja v 29 državah OECD, za katere so bili na voljo celoviti podatki v obdobju študije.
Rezultati: Rezultati kažejo, da slovenski sistem terciarnega izobraževanja ni dosegel popolne učinkovitosti v nobenem od štirih uporabljenih modelov. Po stopnji relativne učinkovitosti se je Slovenija uvrstila med 20. in 25. mesto med 29 proučevanimi državami članicami OECD. Za doseganje popolne učinkovitosti bi bilo potrebno izboljšati rezultate outputov tako na področju pedagoške kot raziskovalne dejavnosti.
Organizacija: Rezultati raziskave lahko predstavljajo uporabno orodje za doseganje relativne učinkovitosti odločevalcem na državni ravni kot tudi managerjem posameznih inštitucij terciarnega izobraževanja
Družba: Doseganje učinkovitosti na področju terciarnega izobraževanja je pomembno za širšo družbo predvsem z vidika oseb, ki se vključujejo v proces kot tudi z vidika širšega vpliva, ki ga ima terciarno izobraževanje na gospodarstvo in družbo
Originalnost: To je prva raziskava, ki opravi pregled dosedanjih študij, ki obravnavajo učinkovitost sistemov terciarnega izobraževanja z vidika analize rezultatov slovenskega sistema terciarnega izobraževanja ter podrobneje ugotavlja doseganje učinkovitosti slovenskega sistema terciarnega izobraževanja.
Omejitve/nadaljnje raziskovanje: Raziskava temelji na sekundarnih podatkih, pridobljenih iz mednarodnih baz podatkov. Raziskovani vzorec ni naključno izbran, temveč vključuje 29 od 38 držav članic OECD, za katere so bila na voljo popolna podatki za celotno obdobje, saj je bila analiza omejena z odsotnostjo podatkov za preostale države. Vključene so tiste države, za katere so bili podatki na voljo za celotno obdobje. Primeren bi bil širši vzorec držav in uporaba drugih ali dodatnih vhodov in izhodov, še posebej tistih, ki odražajo kvalitativno komponento uporabljenih inputov in outputov.

Ključne besede: učinkovitost, sistemi terciarnega izobraževanja, metoda DEA, države članice OECD, financiranje izobraževanja, diplomanti.

Izzivi prihodnosti / Challenges of the Future, Članek / Article
Maj / May 2025, leto / year 10, številka / number 2, str. / pp. 77–93.

DOI: 10.37886/ip.2025.004

Tools of Visual Merchandising in Slovenian Grocery Stores in Practice

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Abstract:
Research Question (RQ): Distribution of products in stores should contribute to better selling. In the article we want to test if such methods are used in the case of selected Slovenian grocery stores.
Purpose: The article tries to demonstrate on two case studies presence of merchandising in Slovenian grocery stores.
Method: Based on literature review experiment with observation is carried out in two grocery stores.
Results: Merchandising methods are psychological trick that count on individuals' impulsiveness to increase the selling. Testing them on selected cases in Slovenia shows existence of such "tricks" also in Slovenian grocery stores, despite merchandising tactics are not consistently applied.
Organization: The research results can contribute to organisational awareness of potential sloppiness in execution of merchandising.
Society: The article potentially raises awareness of selling strategies implemented by stores and consequently should lead to more conscious buying.
Originality: Article contributes to observational study in the field and can serve as a pilot study for further development of methodology for more systemic approach.
Limitations / further research: Empirical research was conducted only on two cases which makes results demonstrative but not conclusive, the approach should be implemented on bigger sample.

Keywords: merchandising, store layout, arrangement of goods, purchase management, impulse purchase.

1 Introduction

Nowadays, number of small stores is getting reduced, and people are more and more often forced to buy in large shopping malls and "super-stores", which are offering all from freshly baked bread to clothing and electric appliances. One the one hand, it is very convenient to buy everything at one location at the same time, but at the same time

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Prejeto: 30. avgust 2024; revidirano: 20.september 2024; sprejeto: 10. marec 2025. /
Received: 30th August 2024; revised: 20th September 2024; accepted: 10th March 2025.

people often return from the store with everything, but not with what they originally wanted to buy. Impulsive purchases can, in principle, be prevented by writing a shopping list in advance and strictly following it. However, not all people come to the store with a list, and even if, they can still see, for example, seasonal cherries, and impulsively buy them. And the Hollandaise sauce standing next to the asparagus, one wants to say “thank you” to the workers of this store, because there was no need to search for it all around the store, even if there was no initial intention to buy it.

Such coincidences are actually premeditated rules by which stores are organised. They go under the name of merchandising. Merchandising is optimisation of the trade system related to the preparation of goods, their advertising, as well as stimulations of trade activities (price, discounts, benefits, bonuses, etc.). By applying the rules of merchandising in practice, store can make itself more interesting for buyers, stimulate impulsive purchases, and inform the buyer about a new product. Merchandising gives imaginary freedom of choice to consumers, but applies psychological tricks that guide customers purchase decisions in a way to overbuy or to buy overpriced (see Dziamski, 2011). According to merchandising principles entrance, check-outs and music are organised; one can feel certain odour and the flow of people is organised so that people, walking through the store, cover as much space with goods as possible.

Within this article, we will try to check application of merchandising principles in the case of two hypermarket stores in Slovenia and based on the results explain to which degree the merchandising practices are used.

2 Theoretical framework

2.1 Principles of merchandising – overview

There are no merchandising rules in traditional sense, comparable to punctuation in languages. Stores are very different and not every store applies the same strategy to sell its products. But at the same moment there are specific ways, which can influence buyers’ decision in a particular store.

Everything can be planned and written by buyers, and they could strictly follow their lists of goods that they need. If this statement would work correctly and absolutely, there would be most likely no space for merchandising. Merchandising performs two main large-scale tasks. The first task is to attract customers with the goal to establish that particular store their usual place for everyday purchases. Second goal is to drive customers into maximisation of unplanned purchases. The store cannot manage

customers' purchases directly, but, as we indicated before, there are certain methods to influence customers behaviour.

There are people who are going around without list of needed goods and even if buyers have shopping lists, they can make unplanned decisions, like buying products different from planned ones. Historically, there was a lot of research producing different results regarding unplanned buying. According to the Popai/Du (1977), as cited in Abratt and Goodey (1990: 113), 65% of all supermarket purchase decisions were made in store with over 50% of these being unplanned). According to the Johnson and Williams study (1984), as cited in Abratt and Goodey (1990: 113), 20% of purchasing decisions were made in the store. The Kollat and Willett (1967), as cited in Abratt, Goodey (1990: 113), study showed that 50,5% of the products on an unplanned basis. The Choudhary (2014) indicated that more than 60 per cent of purchases in an organized retail outlet are unplanned, Wood (2005) says that a majority (71 per cent) made no unplanned purchases. Of those mall shoppers who made unplanned purchases, a majority (66 per cent) could be classified as 'impulsive'. Such numbers suggest that there is significant amount of buyers who can be directed in their shopping.

The research of merchandising in clothing stores shows that the prices in clothing stores are the most influential visual merchandising element, whereas celebrity endorsements were of no significant importance. The study also revealed that gender and age factors do not have any significant influence on the preference of visual merchandising elements and consumers' buying behaviour (see Jelani et al, 2022). On the other hand, the atmosphere of the store influences the choice of purchasing location for planned purchase (e.g. Köseoğlu, 2022; Fachri & Farhan, 2023).

For the purpose of this article, we will determine some key factors of merchandising that we will further evaluate in the case study of selected Slovenian stores. Different authors (see Franjković et al., 2022) analyse different key factors as crucial. Franjković et al. (2022) define as key factors, the following: store layout, store design and cleanliness, regular promotion signage, in-store product displays, in-store price promotional labels, out-of-store price promotions, in-store colours, in-store music, store employees. All these factors are considered important, but for the purposes of the article we will concentrate on the layout of the store and logic of placing goods on the shelves in the store.

2.2. Store layout

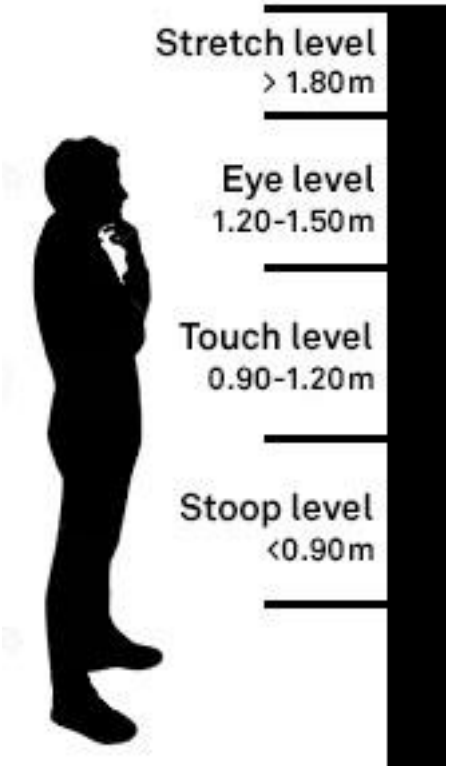
Research results imply that retailers need to create stimulating atmosphere and appealing layout in order to trigger consumer's buying decision (Štulec et al., 2018).

Buyers are pleased to enter a well-organized, spacious and bright room, where there is a large space between the shopping rows. In the future we will check whether the selected stores meet these requirements. According to the Wei and Yazdanifard (2014), store layout or arrangement of departments or groupings of merchandise has to be organized in a way to provide ease of customers' movement through the store and to provide maximum exposure and attractive display of merchandise. It would be strange if, at the entrance to the store, each customer was greeted by an employee, who would guide the customer around the store. That is one of the reasons why the store is structured in a way to guide the buyer where and how to move. The most striking example is Ikea, where, before getting to the warehouse store, the buyer ideally goes through all the departments, directed by visual signs. Of course there are also shortcuts, and direct way to the warehouse. However, it is safe to say that Ikea puts lots of effort for customers not to easily find the shortest way to requested department and to the exit. At the same time, groceries stores are also not alien to such techniques. Most shops guide customers through the store in an anti - clockwise direction. This is generally justified by the fact that costumers are for the most part right-handed (Groeppel-Klein & Bartmann, 2008). However, unlike Ikea, most of the stores have free-form layout. There can be still some layout tricks, but customers are much more independent in their movement. Customers in this situation feel less rushed and thus are more likely to make unplanned purchase. Paths are often organized by "landmarks" that will attract customer attention. Whenever customer reach a focus point, another focus point should already be in their field of vision. The most visited places in the store are the entrance, the central alley and the aisles near the cash registers (Guzelevich, 2010). At the entrance, the store often places perishable goods, which include for example vegetables and fruits. Other "necessary" products are often placed on the remote locations. The technique of separating the necessary products when planning a store is quite often used. Most people buy vegetables, fruits, bread, meat, fish, dairy products, eggs. Separating products means finding some needed products on one side of the store and others on the other. Since the number of buyers are vegans or vegetarians the fruits and vegetables section is also distant to other non-meat products. There is a theory of "Golden triangle" (see Naumova &, Sboeva, 2014) that puts the entrance and checkout of the supermarket on different sides on the same line, and any necessary goods are located in the middle at the end of the store. Thus, to purchase this product you will need to go through the entire store. In children's store the path to children's clothing leads through toys (Guzelevich, 2010). In order to reach all the "necessary goods" spots, the buyers will inevitably pass through products that are not considered essential, but have high impulsive buy potential (e.g. sweets, alcohol, etc.). Along the main shopping path, necessary goods can be interspersed with optional goods, reminding of their existence.

2.3 The arrangement of goods on the shelves

According to the research of Solovyova and Boldyreva (2017) the most recognizable brands are located in a manner to catch the most attention; individual brands are grouped in rectangular blocks and the density of product presentation should be uniform; each brand is placed with the same spacing and the so-called eye level is considered to be best-selling option.

Figure 1
Organisation of the shelf level



Adapted from SBShoppingBasket by https://sbshoppingbasket.com/en/, 2025. Copyright 2025 by SB Shopping Basket.

Figure 1 shows which heights are used for which categories of reach. Interesting part is that for kids' eye level will be a bit different, which would result in different product placement logic in sections attractive to kids (toys, sweets). Our empirical part of empirical analysis will use shelf positioning from Figure 1 as a methodological base of analysis. Manipulating the shelf positions of the products resulted in positive sales performance variation only for "eye level" shelves, keeping the other variables that may affect the sales constant (Kamaşak, 2008). According to Drèze et al. (1994) location had a large impact on sales, whereas changes in the number of spaces allocated to a brand had much less impact as long as a minimum threshold (to avoid out-of-stocks) was

maintained. According to Ebster and Graus (2011) customers primarily search for products horizontally since most of our eye muscle are made for horizontal movement.

The probability of choosing the eye level placed product over similar ones at other heights is increased (Varghese, 2021). However, there is also different perspective, according to which eye level is not “buy level” and greatest propensity to capture shoppers’ attention is approximately 14.7 inches *below* eye level (which is around chest level). (Chen et al., 2021)

Goods can be placed vertically or horizontally. Vertical merchandising refers to displaying a product, or branded range of products, from top to bottom in a vertical line. Horizontal merchandising is displaying a product, or branded range of products, left to right in a horizontal line. In both types there are pluses and minuses (see Kiselev et al., 2007)

Figure 2
Graphical representation of shelf organisation

Source: Own representation based on “Store design and visual merchandising: Creating store space that encourages buying”, by C. Ebster and M. Garaus, 2011. Copyright 2011 by by C. Ebster and M. Garaus.

3 Method

For the purposes of analysis, we will use two Slovenian shopping mall size grocery stores of different brands in medium-sized urban centre with about 13.000 inhabitants and potential to attract about additional 50.000 people from the gravitational area. Initially, we will present the basic the layout of stores and will try to compare them to the general rules of store path navigation as described in theoretical part. Attention will be paid to the existence any special paths that buyers are encouraged to take through these stores, in which direction the movement takes place in the store, how are distributed the departments, whether the most important goods are divided between locations, are the necessary or most needed goods interspersed with those that can

easily be dispensed with, whether the goods, that are presumably purchased together, are located next to each other. We will also evaluate the arrangement of sets of goods on the shelves. For our research we will take shelves with tomato paste and analogies, dry red wine, dish-washing liquid and olive oil. These products were selected in the perspective that there is relatively big amount of same kind of product available on a concentrated space. This allows fair possibility of amassment of the principles implemented in practice. Similar could be achieved in the cosmetics department but the products in this field often vary already too much in the size of the shelf. Due to the small sample of the stores, we cannot generalize, but we can indicate potential existence of the merchandizing principles in selected stores, further assuming the existence of merchandizing principles in selected store chains. Selection of sets of products ensure also validity and reliability of the test. Results can be under same conditions reproduced, not only in selected stores but in all stores of given store chains at the same level (mall size grocery store of selected chain in Slovenia). Reliability of the test is derived from the principals of merchandizing and its implication in practice, while we are monitoring the practice and compare it to the established theoretical principles. In this manner, we understand the method and results as valid.

4 Results

4.1 Layout of the selected stores

During analysis of the store A, as well as for the store B, it was established that there are no specially noted paths for buyers. Entrance to the store A is situated on the right side of the store and there is vegetables and seasonable products next to it. Given the fact of where is the entrance, it is possible to assume that people would predominantly move around the store anticlockwise. On the other hand, store B has two entrances into the area, where main entrance (more exposed and broader one) is on the left side, indicating less movement control approach.

In the store A, after vegetables and bread there are departments with meat, cheese, fish continuing towards oil. Then there are aisles of preprepared food and frozen meat and fish, then starts long shelves deep in store with meat products (sausages, salami, prosciutto), pasta, rice, sweets, coffee, tea, corn flakes, honey, canned vegetables, fish and pate, alcohol production, healthy food, snacks. On the main path it is oil and snacks. After snacks there is big department with soft drinks and on the side opposite of entrance it is milk products, eggs, closer to the cashiers there are technic and toys. On the aisles closer to the exit are clothes, diapers, products for children, hygiene items, shampoos and shower gels, toothbrushes and pastes, deodorants and shaving products. There is also stand with toilet paper, washing powders and liquids, laundry

softeners and dishwashing liquids. Seasonal entertainment products are located closer to the toys, such as sea slippers and water pistols. Gift bags and candles, and on the next line - goods for office and school. Vegetables, bread and meat are separated from milk products and eggs with whole store. And if you need milk, eggs, kefir or vegan products (which are also on the opposite side from entrance) you will need to walk through whole store (potentially taking interest in the products). In some cases, they use approach of related products proximity, for example, next to the pasta there was tomato and pesto sauce for pasta. The store is light, cool and spacious. Based on the aforementioned theories of store layout, this store uses the logic of merchandising behind.

Concerning arrangement of goods on the shelves, the density of product presentation was uniform with most of products. Detailed analysis of shelves organisation will be provided in the next part.

As it was pointed out earlier, in the store B the main entrance to the store is located on the left side which suggest predominant clockwise circulation of customers. No special markings were found for the route of movement of customers in the store. Some of the product shelves, such as a shelve with corn flakes, are much lower than in store A. Also, in terms of fullness of shelves and neatness of product placement, store B is visually inferior to store A (e.g. there is less light, some shelves seem to be unorganized and untidy). As you enter, there are vegetables and fruits on the right side and prepared food and backed bread on the left, then bread product, eggs, corn flakes, muesli and snacks continue on the left, but in between there are pallets of non-alcoholic beer. Dairy products begin along the left wall of the store and then occupying big part of wall which is opposite of the entrance. On the right side of main alley there are floor refrigerators with cheese, meat product and sausages. On the left wall then it is fresh meat and fish. On the right side there are going long lines of products (perpendicular to the wall on which the main entrance is located) which start with dry meat and salami, then there are alcoholic drinks. Then there is long line with pasta and different sauces for it. On the corner of shelf (possible to see it from the main alley) there are farmer’s dairy products and next corner has farmer’s meat products. Next perpendicular to wall with main entrance line has flavour and everything what is needed for backing sweet products. On the corner of it is small island with action goods and behind on the corner are sweet water and champagne. This is followed by horizontal shelves with different types of oil, salt, vinegar. On the left wall (right from the main alley) when meat and fish are finished, there are glass jars with cucumbers, ajvar and different other canned vegetables. In front of the canned vegetables there is again an isle with summer light alcoholic drinks such as beer. There are also several stands around the store with white wine common in

summer. It is followed horizontal line with coffee and tea. On the corner there are common cookies, jam and porridge. Then there are small isles with chocolate, cacao, cookies. The main alley is further going to the right, and on the left side there is huge amount of space which all full of different type of non-alcoholic drinks. On the left side there are electric devices, different staff for cooking. On the corners of horizontal shelf, we can see equipment for summer grill on the first one and on the second one there are different types of glass jar to make canned vegetables at home. Then there are shelves with dishes and various cutlery, and further, closer to the exit, there is a department with school supplies and toys. The main alley turns right again and further on there are also long shelves located perpendicular to the wall with the entrance. They contain cutting boards, flowerpots, and then products related to body care and cleaning products. These floors end with a refrigerator with frozen vegetables and semi-finished products. With this store layout, we see that the main products such as milk, bread, meat, fruits, vegetables, and cereals are located on one side of the store. This rather hectic organisation has however certain logic that requires buyer to go all around while searching for products.

To analyse the arrangement of products on shelves, the following products were selected in stores A and B. It is wines, tomato pastes and analogues, dishwashing liquids and olive oils. As mentioned before, this selection is chosen due to comparability between store A and B and because of significant amount of products that they can be compared. Below, we tried to convey through the tables what the shelves selected for analysis look like in the stores.

4.2 Organisation of selected shelves: representation of data with analysis

This subsection presents the organisation of selected shelves in both analysed stores, not only by price ranges on different levels, but also as graphical representation of diversity and product placement. “Ac” marks product in action with action price written.

Figure 3
Wine shelf, store A

9,39€	13.89€	18,78€	35,49€	34.49€	16.69€	15.99€	14.79€	14.59€	28,79€	28.79€	22,59€	22.38€	13,69€	13.69€
13.98€	12,98€	12,98€	17,98€	18,19€	16,25€	16,29€	14,68€	37,19€	28,28€	17,59€	4,99€ Ac	4,79€ Ac	4,79€ Ac	5,59€ Ac
4,39€ Ac	21,45€	6,29€	13,99€	16,49€	17,58€	17,38€	15,38€	12,88€	12,04€	14,45€	14,88€	15,19€	16,99€	
4,39€ Ac	3,89€ Ac	4,99€ Ac	6,49€	13,99€	7,49€	17,19€	17,19€	8,98€	11,15€	10,88€	11,89€	13,43€	22,05€	16,85€	28,08€
5,88€	5,88€	6,29€	7,29€	5,98€	8,79€	5,69€	5,99€	10,28€	9,43€	12,78€	10,99€ Ac			

Figure 4
Wine shelf, store B

24,99€	37,38€	13,28€	13,49€	12,99€	11,15€ Ac	20,99€	14,69€	14,99€	14,69€	28,29€	15,49€	17,39€	17,59€	4,99€	7,49€	8,59€
14,69€	12,69€	12,99€	4,98€ Ac	13,69€	15,59€	18,19€	10,89€	11,49€	12,99€ Ac	15,39€	13,39€ Ac	5,39€ Ac	10,29€	3.99€Ac	
7,39€	9,99€	7,99€	14,09€	6,49€	7,59€	12,59€	8,49€	9,99€	15,99€	7,99€	4,99€	6,29€	13,39€	12,49€Ac	4,58€ Ac
7,99€	4,79€ Ac	6,29€	11,29€ Ac	5,49€	4,99€ Ac	5,39€ Ac	4,49€	5,89€ Ac	5,39€	3,77€ Ac	3,99€	6,99€	6,29€	3,39€	3,49€
	3,78€	4,59€	3,29€	2,39€	4,13€ Ac	5,39€	4,99€	7,99€	5,19€ Ac						

The wine shelves in store A and B look fully stocked. We did not indicate the names of the brands, because, in our opinion, none of the brands distinguished from the other in terms of popularity. Singling out any brand for analysis will require an explanation of the selection criteria, of something that does not contribute to the purpose of this work. As already mentioned above, product that stand on the shelf at eye-level and at touch level are popular with buyers (or are pushed forward by the store). According to merchandising rules, in this case, stores should have placed the most expensive bottles at eye level. In order to confirm that we analysed the averages of shelves.

Store A: 18,59€; 14,43€; 14,24€; 12.4€; 7,94€
Store B: 16,38€; 11,78€; 9,40€; 5,62€; 6,20€.

In general, wine in store B is cheaper than in store A. In both cases we see that prices of wine on the top level are the most expensive. And bottles on the bottom shelves in both cases are the cheapest. This calculation shows that on the bottom shelf still staying

bottles which are much cheaper then bottles on the eye-level or on the top. Putting the most expensive goods on the top slightly deviates from the perspective of rules of merchandising.

Figure 5
Tomato paste shelf, store A

1,29€ SP	0,99€ SP	1,79€ SP	1,35€ SP	3,39€ SP	3,56€ BIO	5,49€ SP	2,99€ SP	1,99€ S	1,49€ Natureta	3,88€ Natureta	1,30€ Victoria	0,98 Fructal	Podravka
2,15€ DS				0,99€ SP					Mutti 1,59€	Mutti 2,48€	Mutti 3,88€		DS 0,79€
2,43€ DS	SB 0,55€	SP 0,75€		SB 0,59€	DS 1,29€	1,48€/ 1,38€ Vapore			1,99€ Muti				
Mutti 1,68€/2,58€/2,18€/4,69€						Natureta 1,59€			Mutti 2,98€				
Mutti 1,78€/1,79€/2,34€/2,58€/5,98€						Podravka, 1,28€	Podravka, 1,58€	Victoria 1,62€/1,30€		Victoria 1,79€/2,89€		Natureta 2,19€	
SB 0,99€		SB 0,99€	Natureta 1,95€	Podravka 1,38€/1,88€					Mutti 1,89€/2,78€				

Figure 6
Tomato paste shelf, store B

Garden good 0,79€		Podravka 1,29€	Natureta 1,69€	Vapore 1,49€/4,19€		2,99€ SP	Mutti 2,59€/1,49€ Ac/2,19€					
Garden good 0,69€		Natureta 1,59€			Vapore 1,39€	Mutti 1,89€/2,69€						
Rosso 1,45€		Rosso 1,29€			Mutti 4,69€				Vapore 2,49€		Natureta Ac	2,49€
Garden good 1,39€		Garden good 1,39€		Podravka 1,39€/1,99€		Natureta 20,19€ (price for whole box)			Mutti, 189€	Pomi, 2,49€	Star 1,99€	Mutti 3,69€
Garden goods, 1,19€	Podravka 2,39€	BIO 3,49€	Natureta 2,19€		Vapore, 3,49€/1,39€		Mutti 2,14€/2,89€/2,99€/2,39€					
		Garden good, 0,84€		Podravka 1,44€	Pomi 2,19€	Fractal 0,99€	Mutti 1,99€					
Golden good 1,39€		Golden good 1,39€		Podravka 2,29€	Valfrutta 1,19€/1,59€					Mutti 4,49€ Ac		

The shelves with tomato paste and analogues differed in both cases in a large number of different brand options, volume and shapes of the products. When examining these shelves, there was not a big difference in price depending on the location on the

shelves, however in store A it is clearly visible that at eye level and stretch there are slightly more expensive products, and at touch level there are products branded by the store. Also, in the store A shelves are fully stocked and in the store B there is lots of free space. Checking average price (the highest shelf goes first) gives some additional insight.

Store A: 2,35€; 1,98€; 1,3€; 2,61€; 2,26€; 1,69€
Store B: 2,07€; 1,65€; 2,03€; 2,46€; 2,45€; 1,49€; 2,05€

This confirms the rules of merchandising. The store, wanting to sell its own products, places it on the most popular shelves and provides significant quantity of shelves covered with it.

Figure 7
Olive oil shelf, store A

	Gea 5,99€/10,97€/18,89€/20,74€			Bio Gea 7,67€/14,89€
Zvezda 19,98€	Zvezda 19,98€	Gea 12,07€	Belica 14,89€/14,79€	Greg lisjak 16,99€/18,99€
SP 7,98€	SP 13,65€			Olium 17,98€/17.89€
SB 6,67€	SB 6.67€			Cekin 9,98€

Figure 8
Olive oil shelf, store B

Zvijezda 15,99€	Zvijezda 19,99€	Monini 14,99€/17,99€	Borges 15,44€	Action/17,84€	Kalamata 18,99€
Kmetija Metlika 18,39€	Monini 17,99€/17,99€	Filippo Berio, 10,79€	Epulon, 18,99€		Farchioni, 15,49€

Shelves with olive oil repeating this logic. In the store A on the stretch level are most expensive products, and on the same time on touch level there are products from their own store brand. In the case of store B, olive oil is staying only on the two top shelves, touch level and shelves below occupied with sunflower oil of the same brand.

Store A: 13,19€; 16,80€; 14,38€; 7,73€,
Store B: 17,03€; 16,61€.

We see in the store A products on the eye - level are the most expensive, which again follows the principles of merchandising.

In the case of shelves with dishwashing liquid, the logic of both stores is quite similar. On the top shelf, both stores place quite specific brands, and the most of the shelves are given to wee-known brands.

Figure 9
Dishwashing liquid shelf, store A

Nana 3,49€	Frosh 2,29€/2,99€		Dual 3,99€
Splend0,95€/1,50€	Jar 4,79€/7,29€		Dual 3,99€
Spend 1,48€	Vio 1,69€/2,79€	Jar 1,99€/ 4,79€/7,29€/8,99€	Pril 1,99€ Ac/3,99€
Spend 0,95€/1,49€	Vio 1,69€/2,79€	Jar 1,99€/ 4,79€/8,99€	Pril 1,99€ Ac/3,99€
Spend 0,95€/1,49€	Vio 1,69€/2,79€	Jar 1,99€/ 4,79€/8,99€	Carli 0.92€

Figure 10
Dishwashing liquid shelf, store B

Dax 0.89€	Carli, 1,11€	Nana, 2,79€ Ac	Frosch 1,61€ Ac	Dax 1,79€ Ac
	Pril 2,99€ Ac /2,59€/2,99€ Ac		Jar 3,99€ Ac/2,40€ Ac	
Dax 0.89€	Pril 2,99€ Ac /2,59€/3,99€ Ac		Jar 4,79€/4,79€/5,49€ Ac	
Dax 0,89€	Pril 3,29€/2,99€ Ac /3,99€ Ac		Jar 4,79€/4,79€/5,49€ Ac	
Daisy 1,35€	Pril 2,59€/2,99€ Ac /2,99€ Ac /2,99€ Ac		Jar 1,99€ Ac/5,49€ Ac	

In the case of store A, we were analysing the part of the shelves one meter long, next to them there were also shelves with dishwashing liquid and the same volume of shelves was occupied exclusively by one very known brand. Both store places recognisable purchased at eye and level of touch. They occupy most of it. However, there are other brands, their products are located vertically bellow each other, but compared to well-known brands, their quantity is so small that the eye does not catch it unless buyer has interest in that specific product.

Average price store A: 3,19€; 3,7€; 3,89€; 3,19€; 2,95€
Average price store B: 1,64€; 2,99€; 3,65€; 3,75€; 2,91€

In the case of the store A we see that on eye–level and touch level are the most expensive products. In the case of store B, top level is the most expensive, but on the same moment the emptiest. Store A again very strictly follows the merchandising principles.

5 Discussion and conclusions

By correctly applying merchandising methods, principles and tools, a company can attract the attention of consumers to its products and encourage them to purchase the product, regardless of whether this purchase was planned or not (Brineva et al., 2021). The main task of every company is to sell their own goods, and merchandising principles can help a lot with this. According to research, there are different principles that apply to different customers. Some methods are only of limited use and highly depending on various preconditions. We tried to establish if major grocery stores in Slovenia use merchandising principles, we selected two different hypermarkets. We assessed such criteria as store layout, which includes also customer movement patterns in the store, and the logic of placing goods on shelves. During practical analysis in stores, we found that in Slovenia stores do not necessarily follow the principles of merchandising. In one store the movement of customers is clockwise, while in another counterclockwise. The arrangement the products on the shelves according to their price usually occurs from top to bottom, with the most expensive products on the top. Top level is stretch level, which means that people will less likely buy these products unless moved to the reach or eye levels. In one case, at the reach level there are products branded by the store. Which follows the principles merchandising.

Merchandising is important set of psychological “trickery” that counts on gullibility of the people and their impulsive nature when it comes to daily shopping decisions. Empirical cases from Slovenian cases show that stores do apply some of it, despite rather non-systematically. We can say that analysed store A uses the merchandising principle more intensively and to greater extent than analysed store B. They are following the ambient principles more visibly, the rule of golden triangle as well as more systematic placement of preferred products on the level, that, according to studies, sell better. However, merchandising is set of various approaches, and that some of them are actually mutually excluding, so they cannot be used together. This study is, according to our knowledge, first empirical study of the type in the case of Slovenia, that gives deeper insight into the question.

Sellers can maximize their profits using merchandizing principles. Additionally, some of those principles can also help them to improve the actual organisation of the store, which can be considered positive side-effect of the desire for profit. Our case (despite not presented here as part of the analysis) indicates that the store which uses principles of merchandizing more effectively gives the impression of better organisation. From the perspective of customers, raising the awareness of merchandizing is important in the perspective of financial literacy in order to limit psychological effect of the merchandizing principles. These principles should be explained already in youth as well as in school within the household management course.

Further research should be directed towards improving the data collection method and especially to gathering bigger sample of observations, which would enable us to more confidently describe practices of merchandising in the case of Slovenian grocery shops. Additionally, this would enable us also to see the patterns clearer. At the same time, it would be interesting to connect the use of merchandising principles with the financial result of the individual stores to see potential financial effectiveness of the measure.

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Povzetek:
Orodja vizualnega trženja v živilskih trgovinah v Sloveniji v praksi

Raziskovalno vprašanje (RV): Razporeditev produktov v trgovinah naj bi doprinašala k boljši prodaji. V članku želimo preveriti ali so tovrstne metode spodbujanja prodaje uporabljene v izbranih slovenskih živilskih trgovinah.
Namen: Članek poskuša prikazati na dveh primerih prisotnost vizualnega trženja v slovenskih živilskih trgovinah.
Metoda: Na osnovi pregleda literature je bil izveden eksperiment z opazovanjem v dveh izbranih živilskih trgovinah.
Rezultati: Vizualno trženje kot metoda je psihološki trik, ki računa na impulzivnost posameznikov z namenom povečanja obsega profita. Testiranje prisotnosti tovrstnih trikov v izbranih primerih kaže na prisotnost tovrstnih praks tudi v Slovenskih živilskih trgovinah, čeprav se ne izvajajo konsistentno.
Organizacija: Raziskovalni rezultati lahko doprinašajo k organizacijski ozaveščenosti o potencialni nedoslednosti pri izvajanju trženjskih strategij.
Družba: Članek potencialno dviguje zavest o prodajnih strategijah, ki jih uporabljajo trgovine kar naj bi posledično pripeljalo do bolj ozaveščenega kupovanja.
Originalnost: Članek doprinaša na področju študij z opazovanjem na opredeljenem področju in lahko služi kot pilotna študija za potrebe nadaljnjega raziskovanja.
Omejitve/nadaljnje raziskovanje: Empirični del je bil izveden zgolj v dveh primerih, kar dela rezultate zgolj demonstrativne ne pa definitivne. Pristop bi bilo v nadaljevanju potrebno testirati na večjem vzorcu.

Ključne besede: vizualno trženje, postavitev trgovine, razporejanje produktov, upravljanje nakupovanja, impulzivno nakupovanje.