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Price Dynamics in Slovak Dairy Supply Chain

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Abstract

Paper's objective and research background

Milk plays a crucial role in the Slovak food consumption. This article focusses on a thorough investigation of the price fluctuations within the dairy supply chain of Slovakia, with a particular emphasis on the pricing mechanisms that govern the sale of milk. Through the analysis of both producer and consumer prices, we aim to unravel the complex relationship between these crucial elements of the milk supply chain. Furthermore, it is our aim to unravel the causal relationships between producer and consumer milk prices.

Data/Methods

To support our analysis, we have gathered data on producer prices from the Agricultural and Trade Information System (ATIS), while consumer price information has been sourced from the Slovak Statistical Office. Data was gathered from January 2006 to August 2023, to have a comprehensive view over the milk supply chain. This dataset serves as the foundation upon which we build our analysis, enabling us to find long term relationship as well as cause-and-effect linkages between the milk supply chain. To unravel the causal relationships, we employ the rigorous Engle-Granger causality test. This statistical methodology offers a robust framework for examining potential cause-and-effect linkages between these consumer and producer prices. To unravel long-term relationships, we employ Johansen cointegration test.

Results/Conclusions/Value added

The results gained from our study hold significant implications for stakeholders and policymakers within the dairy industry. Our study outcomes provide understanding behind the dynamics of milk prices shaping. Our research equips industry stakeholders with valuable information to navigate market fluctuations, optimize pricing strategies, and make informed decisions. Additionally, policymakers stand to benefit from our findings, as they seek to formulate policies that foster a fair and sustainable pricing environment within the dairy sector. In conclusion, our investigation represents an effort to unravel the intricate price dynamics within Slovakia's dairy supply chain, with milk as its focal point. Through analysis and proper methodologies, we aim to provide valuable insights that contribute to a deeper understanding of the factors driving price fluctuations in the Slovak dairy market, thereby empowering stakeholders, and policymakers alike to navigate the complexities of this industry.

Key words

agriculture, supply chain, cointegration, milk, price dynamics

JEL Classification (Times New Roman, 12 pt., Bold)

Q11, Q13, Q18

1. Introduction

Analysing the price dynamics in the Slovak dairy supply chain reveals a variety of new challenges and policy considerations, emphasizing the need for a comprehensive perspective

on the entire dairy supply chain. This perspective should take into account the interactions and interdependencies among producers and consumers. In recent decades, researchers have focused on the issue of price transmission because it is one of the critical indicators for promoting fairness, efficiency, and economic results in the food industry (Vavra & Goodwin, 2005). In his work, Fousekis (2016) found asymmetry in price transmission in the US beef sector. The aim of this work was to investigate the vertical transmission of prices in the US beef sector. Wu et al. (2019) found asymmetric price transmission in the Nigerian fresh bean market, identifying differences in market structure as contributing factors to the observed asymmetry. In a study by Harshan & Ratnasiri (2023), the authors focus on capturing asymmetric price transmission in the Sri Lankan fruit and vegetable market. The results indicate that the speed of price transmission from wholesale to retail is higher for price increases and lower for price decreases, indicating a possible problem in price dynamics within the supply chain. Price transmission in the milk sector was investigated in Finland by Rezitis (2019). Short- and long-term asymmetries in price transmission were captured in the analysis. A study by Kamaruddin et al. (2021) provides comprehensive insights into the nature of asymmetric price transmission with respect to magnitude, speed and direction. The study focuses on the Indonesian coffee market and provides evidence that the producer market price response of Indonesian coffee is higher and faster when global coffee prices decline. Ridha et al. (2022) focused their study on price transmission in the cocoa supply chain in Indonesia and their results show evidence of price asymmetry between the global cocoa market and cocoa mass prices and farm cocoa prices in Indonesia. Richter & Richterova (2020) dealt with the distribution of added value in the dairy sector in Slovakia and using error correction models revealed the existence of long-term relationships and changes in the distribution of added value. Hillen (2021) investigated vertical price transmission in milk and cheese value chains in Switzerland and found minimal long-run relationships between different levels and products in the value chains. Jurkenaite (2019) examined vertical price transmission in the potato sector in Lithuania and identified long-term relationships between producer and consumer prices. Onegin et al. (2022) analyzed price transmission in the dairy supply chain in Ukraine and the results demonstrate price asymmetry as well as highlight the weaknesses of this supply chain.

1.1 Milk sector of Slovak Republic

According to the Slovak Dairy Association, Slovakia has become part of a pan-European trend, when cow's milk reached a record consumer price of 1.19 € in 2022 (Figure 1). Based on official statistics, it can be concluded that 2023 was historically the year of the most expensive raw cow's milk in Slovakia (Bugyíková, 2024). The reason for the increase in prices is primarily a decrease in the number of dairy cows of over four thousand from 2022 to 2023. Milk supplies decreased by 16.5 million kilograms, which is the average consumption for 90 thousand people. Farmers' costs are rising, and Teluchová (2024) cites a farm in Žemberovce as an example, where costs rose by 5 cents per liter when producing over 3 million liters of milk. In addition to increased costs, farms cannot face a competitive foreign environment in which milk producers are often supported by higher national subsidies. For this reason, farmers who raise dairy cows as well as dairy enterprises ask the government to focus on the support of animal production, the development of dairy farms and investments in processing facilities in the future agricultural policy (TA3, 2023).

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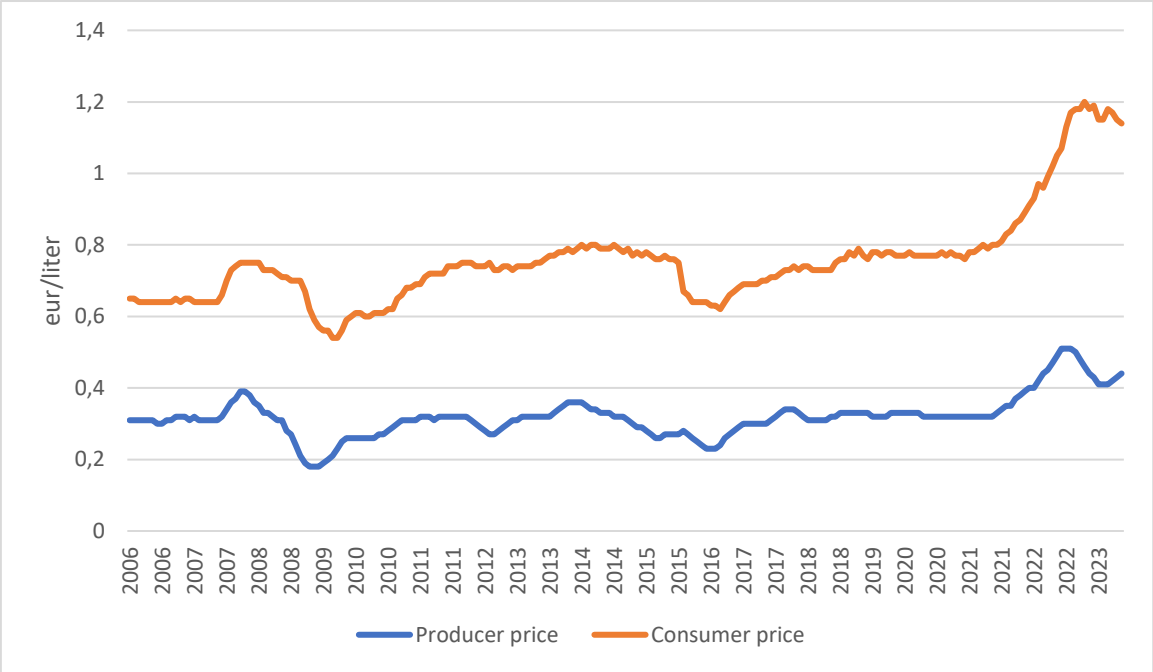

Figure 1: Development of consumer and producer prices of milk in the Slovak Republic

Source: own processing, Slovak Statistical Office, ATIS 2024

2. Data and Methods

Through the analysis of both producer and consumer prices, we aim to unravel the complex relationship between these crucial elements of the milk supply chain in Slovakia. For this purpose, time series of consumer and producer prices for milk were collected from the Agricultural Market Information System of Slovakia (ATIS), and the Slovak Statistical Office. The analysis will focus on price transmission between producer and consumer prices. The data were gathered monthly in the time range from January 2006 to December 2023. The proposed methodology is original and based on the most modern econometric models. The effectiveness of these methods has been confirmed in various case studies in other countries.

Before estimating the Engle-Granger Causality Test and Johansen cointegration test, it is necessary to verify the stationarity of the time series used in the analysis. To verify it, we use the augmented Dickey-Fuller (ADF) test. Following step is to employ a VAR model to identify the appropriate lag length.

To explore the potential causal relationship between two variables, we employ the Engle-Granger causality test (Engle & Granger, 1991). The hypotheses are outlined as follows:

(H0): There is no Granger causal relationship between the two variables.

(H1): There is a Granger causal relationship between the two variables.

The basic formula for the Granger causality test is:

$$Y_t = a_0 + \sum_{i=1}^{n} a_i Y_{t-i} + \sum_{j=1}^{n} \beta_j X_{t-j} + \varepsilon_{1t} \quad (1)$$

$$X_t = x_0 + \sum_{i=1}^{n} x_i X_{t-i} + \sum_{j=1}^{n} \delta_j Y_{t-j} + v_{1t} \quad (2)$$

Where:

Y_t = vector

X_t = variables

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β and α = coefficients

α and x = constant

n = optimal number of delays

ε and v = are vectors of error terms

In order to identify the long-run relationship between variables, it is necessary to conduct a cointegration test. To achieve this goal, we will use the Johansen cointegration test. Its methodology begins with vector autoregression (VAR) of order p, as defined by the formula:

$$y_t = \mu + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t \quad (3)$$

Where:

yt = is an nx1 vector of variables that are integrated to the first order

εt = is an nx1 vector of innovations

For this purpose, we established the following hypothesis:

(H0): there is no cointegrating relationship

(H1): there is a cointegrating relationship

3. Results and Discussion

Visual analysis of price volatility shows that prices show time-varying volatility, volatilities are large in one period but small in another period. In addition, volatility tends to exhibit cluster behavior, i.e. periods of high (low) volatility tend to be followed by periods of high (low) volatility. To initiate the testing process for time series data, it's essential to assess stationarity. According to our results both prices (consumer and producer) are stationary at 1st difference. In the next step we wanted to test empirically if the data is characterized by time-varying volatility. For this purpose, it was necessary to evaluate the ARCH model, which tests the heteroskedasticity of time series. Table 1 provides the results of the heteroskedasticity test. In the case of milk, heteroscedasticity was only present for producer prices, and no signs of heteroskedasticity were found for consumer prices.

Table 1: ARCH – heteroscedasticity results

Variables	Obs*R-squared	Prob. Chi-Square
The producer price of milk	4,950	0,0261**
The consumer price of milk	0,801	0,371

Source: own data processing, 2024

To select the best lag length, we utilized a VAR model and, within this framework, determined the optimal number of lags using the Akaike Information Criterion (AIC), which recommended a model with 1 lag. Table 2 shows the results of the Engle-Granger causality test of producer and consumer prices with the following findings: Based on the calculations, the alternative hypothesis (H1) that there is long-run causality in a Granger sense from producer to consumer price can be confirmed. However, the alternative hypothesis in the case of the effect of the consumer price on the producer price of milk cannot be confirmed. Results suggest that changes in producer prices have a significant influence on consumer prices over time. In terms of the dynamics of the Slovak dairy supply chain, it is indicating degree of pricing power within the industry.

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Table 2: Engle-Granger causality results

The consumer price of milk does not affect the producer price of milk in the sense of Granger causality	0.372	0.542
The producer price of milk does not affect the consumer price of milk in the sense of Granger causality	40.464	1.E-09***

Source: own data processing, 2024

Given that in 2023 Slovakia experienced historically highest milk prices and production is for past years slowing down, this relationship between producer and consumer prices could have significant implications for the milk market. The relationship suggests that consumers are likely to bear the brunt of increasing producer prices through higher retail prices for milk. This could potentially strain household budgets and affect consumer behaviour, leading to changes in consumption patterns or preferences. The increasing reliance on imports suggests that domestic producers may face challenges in meeting domestic demand or maintaining competitiveness against imported products. This trend could have implications for domestic producers' profitability and market share.

To check the long-run relationship between different price series, a Johansen cointegration test should be performed, utilizing maximum likelihood estimation within a VAR model. The test results, presented in Table 3, indicate a long-run relationship between producer and consumer prices of milk. The p-value of these variables is less than the 0.5 significance level, which means that we can accept the alternative that there is a long-run relationship between the given prices.

Table 3: Johansen cointegration test

Variables	Degree	Johansen tracking statistics
Milk	0	28.770***
	1	1.263

Source: own data processing, 2024

The existence of a long-run relationship between producer and consumer prices implies that changes in one price series can influence the other over time. This suggests a degree of interdependence and mutual influence between producers and consumers in milk prices. Stakeholders involved in the Slovak dairy supply chain, such as producers, processors, retailers, and policymakers, can use this information to better manage their operations. For instance, producers can anticipate the impact of changes in consumer demand on their pricing decisions, while retailers can adjust their pricing strategies based on producer price movements.

4. Conclusion

In conclusion, the analysis of price dynamics within the Slovak dairy supply chain provides valuable insights into the interactions between producer and consumer prices of milk. Through rigorous econometric methods, including the Engle-Granger causality test and Johansen cointegration test, we have uncovered significant findings regarding the long-run relationship between these crucial elements of the milk market. Our research has confirmed the existence of a long-term causal relationship from producer to consumer prices of milk in Slovakia. This indicates that fluctuations in producer prices significantly impact consumer prices over time, revealing a level of pricing authority within the sector. However, our analysis does not support the notion that consumer prices influence producer prices within the dairy supply chain.

Given the historical context of high milk prices and declining production in Slovakia, these findings hold significant implications for the milk market. Consumers may experience the repercussions of rising producer prices through increased retail costs, potentially altering

consumption trends and preferences. Furthermore, the growing dependence on imports could present challenges for local producers in maintaining their competitiveness.
The identification of a long-run relationship between producer and consumer prices underscores the interdependence and mutual influence between stakeholders in the dairy supply chain. Producers, processors, retailers, and policymakers can utilize this insight to navigate market dynamics, optimize pricing strategies, and devise policies that promote an equitable and sustainable pricing environment within the dairy industry.
In summary, our investigation contributes to a deeper understanding of the factors driving price fluctuations in the Slovak dairy market, empowering stakeholders, and policymakers alike to make to make well-informed decisions and effectively manage the intricacies of this sector. However, it must be noted that there are also other risks or factors contributing to the determination of the price calculation not included in the paper and further research may shed more light on other aspects of price determination in dairy supply chain.

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e-AgriMBA - Learning System for Tackling the Sustainability in Agricultural Education

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Abstract

Agribusiness and farm management in Europe, as well as in neighboring regions, are undergoing substantial changes to address the upcoming sustainability transitions. The concept of sustainability in food production requires the continuous improvement of entrepreneurial competencies, lifelong learning, and the ongoing enhancement of education quality. The EU, UNESCO, and ILO emphasize that one of the major shortcomings of the agricultural sector is the persistent lack of trained and skilled labor.

AgriMBA is a university network that provides academic input for MBA programs in agribusiness and accredits MBA programs in this field. It is a standing committee of the ICA - Association for European Life Science Universities. Since its inception in the 1990s, more than 8,000 graduates have successfully completed the program.

The proposed project is a response to the key challenges of MBA education recently identified by the AgriMBA board. The network's partners have proposed an ERASMUS+ project aimed at implementing a pan-European electronic learning system for sustainable MBA education in agribusiness. The project will also expand the course portfolio of existing MBA programs by creating online learning and teaching tools. Additionally, the project will extend the AgriMBA network beyond Europe by establishing a new MBA program at the Technical University of Moldova.

Paper's objective(s) and research background

The structure and specialization of primary agricultural production and of food processing and trade in value chains is very heterogeneous across EU member states in comparison with neighboring countries due to complex historical, climatic and socio-economic reasons. Overall scope of electronic learning platform and developed course materials makes it possible to facilitate knowledge transfer beyond Europe through its accessibility and unique structure. Based on the overall objective of project, „to develop and implement the Electronic Pan-European Learning System for Sustainable Agribusiness MBA Education in Europe" , the main objective of proposed manuscript is to identify and evaluate the potential of created e-learning platform within the e-AgriMBA Project for tackling sustainability in agricultural education.

Data/Methods

We use aggregate data from available sources to demonstrate level of education in partnering countries (World Bank) within the e-AgriMBA Project . Furthermore, for evaluation of potential of e-learning platform we develop a „sustainability framework" based on some strategies and examples of how to do so, in the case of e-AgriMBA Project, which belongs to the Programme Erasmus +. This framework is applied in order to analyze potential for building the teaching/learning capacity employing the e-learning platform.

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Results/Conclusions/Value added
Project activities carried out in only one country of the seven project members would reflect a single national agribusiness context, therefore, inevitably remain incomplete. e-AgriMBA creates specific and unique value added at European level both concerning the inputs it uses for creating the online AgriMBA Learning System as well as regarding its outputs and results. Results of proposed paper serve as a practical tool for evaluation of progress in projected objectives. It also identifies the factors influencing the success of transferring the knowledge using electronic learning platforms.

Key words
lifelong learning, electronic learning system, agribusiness, sustainability, knowledge transfer,

JEL classification
I21, O13, Q01

1. Introduction

People very much appreciate education since it enables them to behave decently and respond wisely to uncertain economic and social incidents. Consequently, the role that education plays in economic and agricultural growth has been allured a due attention in the literature. Researchers have inclined to include education attainment as an explicit determinant of agricultural output (Wouterse and Badian, 2019). As popularly agreed, education has a positive impact on agricultural output. A number of mechanisms through which education influences agricultural output have been explored by researchers. Education boosts farmers' ability to obtain, decode and understand information, thus enabling them to make better use of available information to come up with pertinent solutions to production, market and financing challenges. In other words, farmers with good education possess improved decision-making skills and hence better manage resources to exploit farms of various sizes (Asadullah and Rahman, 2009). Agricultural knowledge systems play a central role in developing and disseminating knowledge, information and technologies relevant to improving global food security and environmental sustainability. Formal agricultural education is one component of agricultural knowledge systems (David G. Acker, 1999).

The development of Industry 4.0 has almost brought with it developments in other areas as well, such as agriculture. The development and application of digital technologies in the early 2010s also brought significant advances in agriculture (Bronson and Knezevic, 2016). Examples include low-cost sensors and microprocessors, cloud-based ICT systems, and Big Data analytics (Gacar, Aktas, & Ozdogan, 2017). These technologies have led to the emergence of two new phenomena. On the one hand, the emergence of agricultural ecosystems with platforms that combine data from sensors or other equipment in the field (FAO, 2017) immediately allows the farmer to be provided with real-time information and thus be able to make immediate decisions to increase productivity (Janssen et al., 2017; Shepherd et al., 2018).

Agricultural education means the teaching of different skills and knowledge related to the agriculture aimed to educate students for entry level jobs and later more education for advanced agricultural jobs (A. Abbas, 2017). The agricultural higher educational institutions and the big universities with agricultural faculties has a very important role in teaching specialists for the agricultural labour market and in training entrepreneurs with farming skills and knowledge A. F. Fieldsend and J. Nagy, 2006). This way the degree holder bachelors or masters can easily find a job as an employee or start their own businesses. Nowadays the agricultural education on every level has to give the skills for the students which are making them able to detect the interconnectedness of different information regarding to the parts of the agriculture. That means

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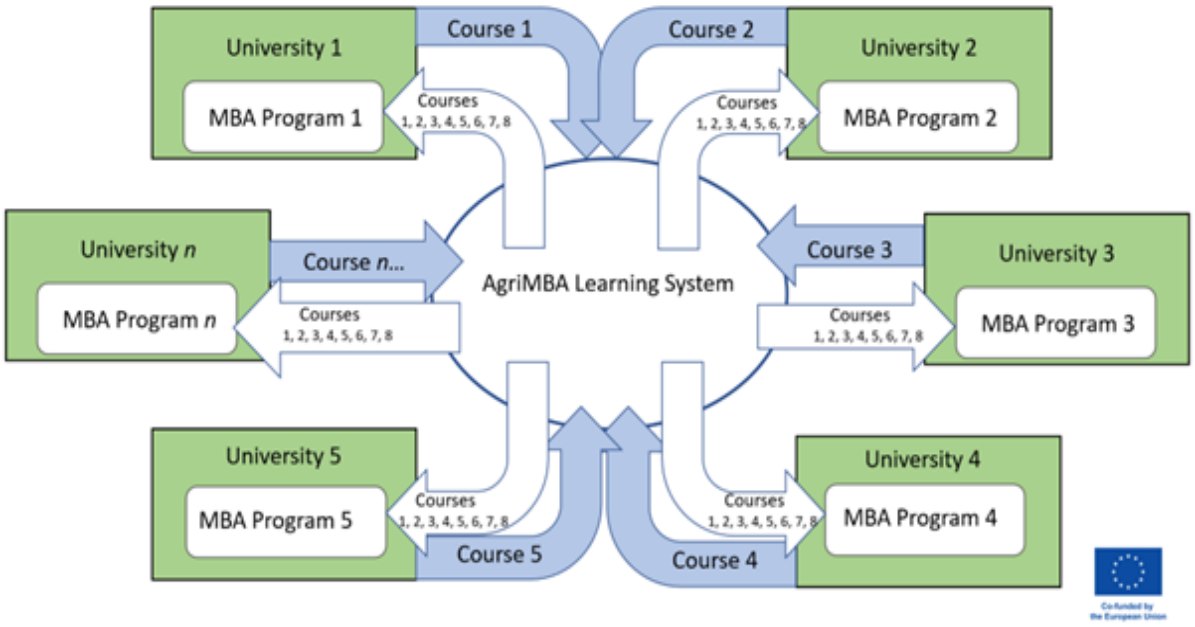
information is coming from different sources and the agricultural professionals have to be able to analyse and evaluate the relevant information during their work wherever they are working (J. W. Jones et al., 2016).

The agriculture needs the help of higher education worldwide. In the less developed countries the adaption of the actual technologies can serve the needs of the local agriculture. In developed countries the agricultural workforce needs to be educated continuously in order to keep their knowledge fresh. New knowledge, new skills and new competencies: these are the things a modern famer need continuously during her or his career in the agriculture. The agricultural higher educational system have to be reformed in order to keep it updated. Without the needed reform the higher education will not be able to serve the needs of the agricultural labour market. Lifelong learning activities can help to complete these needs but the pedagogical knowledge of the teachers and academic staff members are also very important (P.M. Kőmíves et al., 2019).

The e-AgriMBA project implements an electronic pan-European Learning System for Sustainable MBA Education in Agribusiness. It will also expand the course portfolio of existing MBA programs by creating online learning and teaching tools. The project is implemented by six universities representing the AgriMBA network, that creates, monitors and accredits MBA programs in the field of agribusiness and commerce since 1990. The project will create benefits for all network members and stakeholders beyond the network including students with fewer opportunities. The project also extends the AgriMBA network beyond Europe by establishing a new MBA program at Technical University of Moldova. The Learning System created as part of the project will support the development of digital and language competences and promote the sustainable transformation of higher education towards environmentally friendly education. (AgriMBA, 2022)



Source : e-AgriMba

Agricultural education is designed such that the other disciplines like natural and social sciences are blended. This brings lot of strengths to the overall agricultural education curriculum and makes the higher educational institutes to build the capacity to respond to any complex issues like sustainable rural development (Chittoor and Mishra, 2012), food and energy security (Engler and Kretzer, 2014), natural resource management, environmental safety etc.

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2. Data and Methods

This paper aims to analyze the e-AgriMBA Project as a learning system for promoting sustainability in agricultural education. Specifically, it focuses on investigating how the project addresses sustainability by examining key economic indicators across partnering countries (Slovakia, Czech Republic, Poland, Hungary, Netherlands, Croatia, and Moldova). The quantitative research involves analyzing a sample of economic data, including indicators such as GNI per capita, GDP per capita, and inflation, over a selected period (with the exact period unspecified due to missing data). The data for this analysis is sourced from the World Bank and the content of the e-AgriMBA Project. The period 2012-2022 was chosen for this study to capture a decade of significant economic changes relevant to sustainability in agricultural education. This time frame aligns with several key developments, including the increasing global emphasis on sustainability, economic transformation in the partnering countries, and the evolving role of educational initiatives such as the e-AgriMBA Project. Additionally, the selected period allows for a comprehensive analysis of trends in key economic indicators—such as GNI per capita, GDP per capita, and inflation—during a time when many of these countries were navigating post-financial crisis recovery, addressing sustainability challenges, and adapting to the global digital economy. Data from the World Bank and other reliable sources were consistently available throughout this period, ensuring the robustness of the analysis. In summary, the 2012-2022 period provides an appropriate window to examine both the impacts of sustainability-focused educational initiatives and the broader economic and social shifts in the partner countries, making it an ideal timeframe for this research.

The GNI per capita is the dollar value of a country's final income in a year, divided by its population. It is intended to reflect the average before-tax income of a country's citizens. The Global Knowledge Index (GKI) represents an important addition to the global repository of knowledge on development, providing updated, comprehensive, and reliable data that enable countries and decision-makers to better understand and respond to the transformations and challenges related to knowledge-based development. The GKI consists of seven sub-indices: pre-university education, technical and vocational education and training, higher education, research, development and innovation (RDI), information and communications technology (ICT), economy, and enabling environment. Each sub-index is constructed in accordance with standard international methodologies for designing composite indicators. The structure of the Index features a hierarchy comprising sectoral indices (referred to as sub-indices), pillars, sub-pillars and variables. Each of the sub-indices has a weight of 15 percent, except for enabling environment, which is assigned a weight of 10 percent. (United Nations Development Programme - Regional Bureau for Arab States and the Mohammed bin Rashid Al Maktoum Knowledge Foundation, 2023). At the end, the analysis of e-AgriMBA Project based on few strategies and examples, in the context of sustainable agriculture education was provided.

3. Results and Discussion

3.1 Basic economic indicators of partner countries

Some basic economic indicators help provide an overview of the economic health of partner countries. Knowing a country's GNI per capita is a good first step toward understanding its economic strengths and needs, as well as the general standard of living enjoyed by the average citizen. A country's GNI per capita tends to be closely linked with other indicators that measure the social, economic, and environmental well-being of the country and its people. When comparing the GNI per capita (Gross National Income) of each country, it is clear that the Netherlands holds a leading position, with the highest value of 60,230 USD in 2022. The lowest position is held by Moldova, with a GNI of only about 5,500 USD in 2022.

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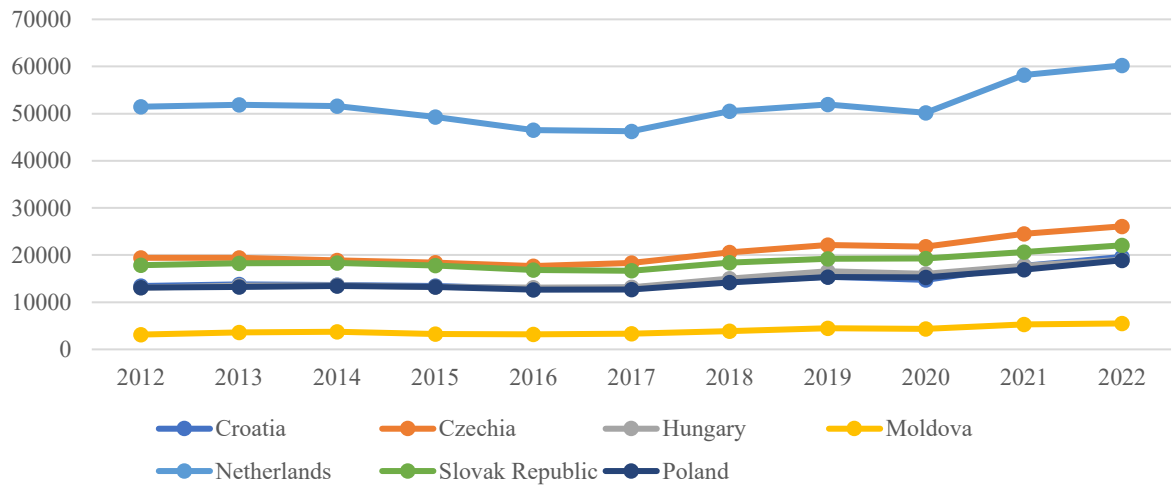

Figure 1: GNI per capita, Atlas method (current US$)

Source: Own processing based on World Bank data

When real GDP is growing strongly, employment is likely to increase as companies hire more workers for their factories and people have more money in their pockets. The largest decrease in GDP was recorded in 2020, primarily due to the Covid-19 pandemic. Among all partner countries, Moldova experienced the most significant decrease, with GDP falling by almost 8.3% in 2020 compared to 2019. Afterward, Moldova saw a rapid increase of almost 14% in 2021.

In 2022, Moldova was the only country where GDP decreased. Based on Fig. 2, it can be concluded that the Netherlands had the highest GDP per capita (57,025 USD) in 2022, while Moldova's GDP per capita was only 5,714 USD.

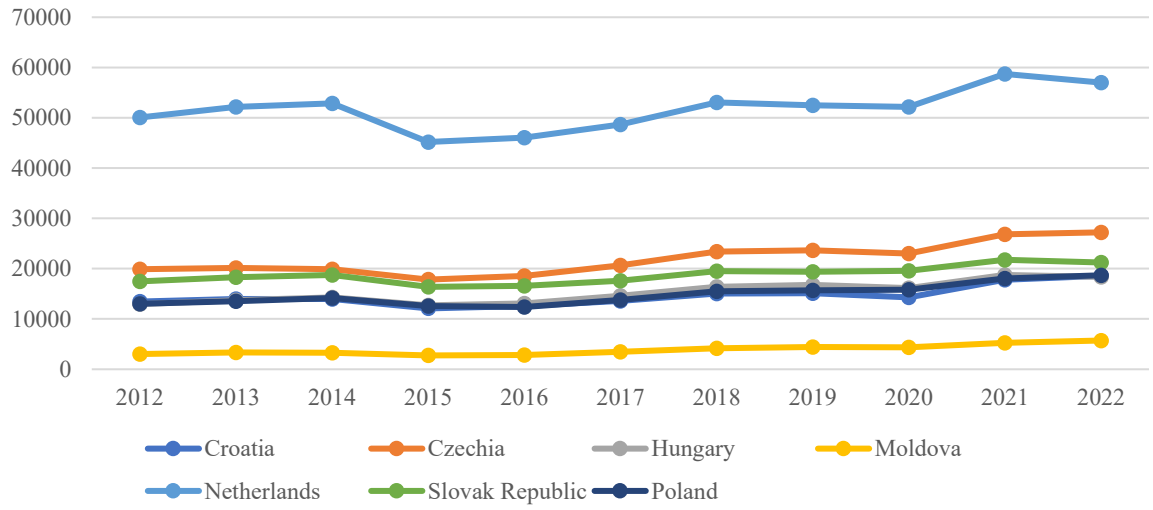

Figure 2: GDP per capita (current US$)

Source: Own processing based on World Bank data

Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.

Based on the data presented in Fig. 3, the country with highest recorded inflation is Moldova, when an increase in the cost to average consumer of acquiring a basket goods was at the level

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27,8% in 2022. During the whole monitored period there is a fluctuating trend in the development of inflation rate in all countries under analysis.

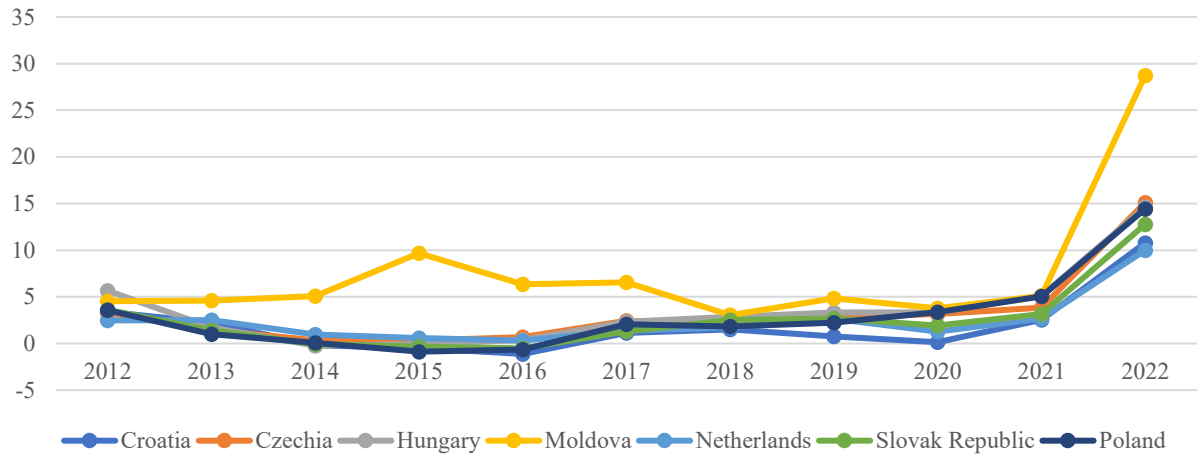

Figure 3: Inflation, consumer prices (annual %)

Source: Own processing based on World Bank data

3.2 Education indicators of partner countries

The educational system has a fundamental role in sustainable development and building a society based on knowledge. One of the priority objectives of the higher education system is the formation of the skills and abilities required on the labor market and the achievement of a professional career.

The Global Knowledge Index (GKI) is a vital tool to monitor the knowledge status of countries in key areas including education, innovation and information and communications technology (ICT). Based on the data presented in the table below can be concluded, that from all partnering countries, Moldova has the worst values in all areas of GKI, that´s why there is a place to pay attention to education, on the contrary, Netherland is on the first place.

Table 1: Global knowledge index 2023

	GKI	PREUNIVERSITY EDUCATION	TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING	HIGHER EDUCATION	RESEARCH, DEVELOPMENT AND INNOVATION	INFORMATION AND COMMUNICATIONS TECHNOLOGY	ECONOMY	ENABLING ENVIRONMENT
Poland	56	83,4	55,3	54,8	31,6	57,9	57,8	69,3
Hungary	56,5	70,6	67,1	47,8	34,9	56,7	66,2	67
Czech Republic	60,9	83,1	63,4	59,1	39,1	55,8	65,7	73,9
Netherland	67,3	83,8	68,1	63	48,8	71,6	65,6	80,6
Slovakia	57	80,1	69,1	58,3	30,5	54,2	56,6	69
Croatia	56,5	74	60,7	59,5	32,1	57,6	58,3	68,4
Moldova	47,4	75	51,5	42	25,4	51,1	50,7	54,9

Source: Own processing based on United Nations Development Programme Regional Bureau for Arab States (RBAS) data

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The pre-university education sub-index, covering the stage from pre-primary education through to the end of secondary education, reached the highest value in the Netherlands, followed by Poland and the Czech Republic. Technical and Vocational Education and Training (TVET), which is an essential sector combining training and qualifications of human capital at the professional level and is one of the most critical sectors linked to the labour market, has the best value in Slovakia, followed by the Netherlands.

Higher education plays a key role in driving knowledge and innovation by producing human capital with the qualifications and skills necessary to meet the needs of industries that drive the global knowledge economy. The leading position is held by the Netherlands, followed by Croatia and the Czech Republic.

Research and development (R&D) "comprises creative and systematic work undertaken to increase the stock of knowledge—including knowledge of humankind, culture, and society—and to devise new applications of available knowledge." In this field, the Netherlands holds an unrivaled position with a rank of 48.8.

As the digital economy grows to constitute an increasingly significant portion of the broader global economy, industries in all sectors are striving to meet the requirements of the Fourth Industrial Revolution, and its demands on information and communications technology (ICT) and other knowledge sectors. Among all partner countries, the Netherlands is best positioned to meet these criteria, with a value of 71.6 in this sub-index, followed by Poland and Croatia.

Within the GKI, the components of the knowledge economy related to economic competitiveness, economic openness, and financing and domestic value-added represent important indicators of the ability and resilience of economies to face global transformations and developments. Among all countries, the Netherlands, Czech Republic, and Slovakia are expected to have the highest ability to adapt to global transformations and developments.

The enabling environment represents the necessary conditions for the incubation and support of the production, development, and utilization of knowledge to achieve sustainable development.

Table 2: Government expenditure on education as % of GDP

	2012	2013	2014	2015	2016	2017	2018
Czechia	4,25086	4,09089	3,99462	5,78885	5,58738	3,85402	..
Hungary	4,16386	4,19773	4,61743	4,51866	4,65539	4,6671	..
Moldova	6,98339	..	6,26602	..	5,60845	5,61844	5,43973
Croatia	..	4,56487	..	..	..	3,91713	..
Poland	4,81181	4,94011	4,90918	4,81226	4,63922	4,55957	..
Slovakia	3,8677	4,07649	4,22136	4,59954	3,91171	3,93913	..
Netherland	5,41022	5,52656	5,4589	5,34816	5,4796	5,1751	..

Source: Own processing based on World Bank data

Table 2 provides information on government expenditure on education as a percentage of GDP in each of the project partner countries. Government expenditure on education, total (% of GDP), is calculated by dividing total government expenditure for all levels of education by GDP. Based on this data, we can conclude that during the monitored period, the highest share was recorded in Moldova and the Netherlands. The values show a fluctuating pattern in each country.

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3.3 How can agriculture sustainable education leverage existing networks and partnerships to scale up impact? Case of "Electronic Pan-European Learning System for Sustainable Agribusiness MBA Education"

Collaborate with stakeholders	*One of the key aspects of sustainable agriculture education is to engage with different stakeholders, such as farmers, consumers, policymakers, researchers, educators, and civil society. By collaborating with them, you can identify their needs, interests, and challenges, and tailor your educational programs accordingly. You can also benefit from their knowledge, experience, and resources, and create synergies and opportunities for mutual learning and action.*	Four transnational meetings (in person) will be organised during the lifetime of the project in order to ensure an efficient communication between the partners and to make an annual assessment of the progresses of the overall project, planning next steps, its dissemination as well as to check the compliance in terms of administration and finances. AgriMBA partners are active network members and have already shown a high degree of effectiveness to build MBA programs in Europe. Activities of the project involve both members from the management board of local AgriMBA programs, as well as teachers and current and future students of the universities involved in the project. It promotes inclusion of all target groups expected for this type of education as students from the poorest country of Europe (Moldova) are getting access to high-quality PanEuropean agribusiness education.
Use diverse and innovative methods	*Another way to leverage existing networks and partnerships is to use diverse and innovative methods to deliver sustainable agriculture education. These can include online courses, webinars, podcasts, videos, blogs, social media, newsletters, and e-books. You can also use participatory and experiential approaches, such as field trips, workshops, demonstrations, case studies, role plays, and simulations. These methods can help you reach a wider and more diverse audience, increase engagement and retention, and foster critical thinking and problem-solving skills.*	The central outputs of the e-AgriMBA project are the creation of a digital learning system and the development of digital learning tools to be integrated into it to be permanently offered to all project partners and the entire AgriMBA networkThe project offers AgriMBA programs in a very accessible and inclusive way - through the online AgriMBA Learning System - which will provide access to education in the fields of agribusiness, commerce and rural studies not only to students from rich EU countries, but also to any other MBA network programs in countries beyond the EU. In addition, the distance learning tool created by e-AgriMBA will enable equal access for students with fewer opportunities, e.g., living in remote rural or poor urban areas including students with various degrees of disability or health problems. The main result of project will be creation and implementation of the common and unified online learning system available to all educational institutions in the AgriMBA network. The system will support the teaching and learning processes for local agribusiness MBA education. Educational content that can be shared through the system will include videos, online self-study modules, literature, presentations and student networking options.
Build capacity and leadership	*A next way to leverage existing networks and partnerships is to build capacity and leadership among your target groups. This means providing them with the skills, knowledge, tools, and resources to implement sustainable agriculture practices, to advocate for policy change, to influence*	The system will support the teaching and learning processes for local agribusiness MBA education. The system will ensure the harmonization of the delivery and quality of local MBA programs within the network. The functionalities of the system will facilitate the implementation of online classes, the development and exchange of educational materials, and communication, collaboration and networking between students

	consumer behavior, and to inspire others. You can also create platforms and spaces for dialogue, exchange, and networking, and support the formation and strengthening of communities of practice and learning.	and faculty throughout Europe. The development of the AgriMBA Learning System will begin with a review of cutting-edge resources and best practices implemented in e-learning systems at leading universities in Europe. Additionally, one course will be delivered by external experts – teachers of AgriMBA programs, being representatives of East European countries (EEC, i.e., Ukraine or others). The added value of this solution is bringing EEC specificity into the AgriMBA network teaching. Easter European universities are members of the AgriMBA network, however, due to political reasons, not involved in the current proposal as official partners. Even so, their experiences are valuable for teaching and developing e-AgriMBA courses, as there are many beneficiaries of MBA programs in these countries. The important issues needed to be covered within the courses delivered by these external experts are specifics of doing business in former Soviet Union countries, with the regard to large scale farming (agriholdings) with specific supply and distribution chains, high vertical integration, cooperative ties with smaller land-owners and farmers, exporting and importing rules from and to EU countries.
Integrate with formal and informal curricula	*Strategy to scale up impact is to integrate sustainable agriculture education with formal and informal curricula. This means aligning your educational objectives and outcomes with the national and local standards and frameworks for education, as well as with the existing programs and courses offered by schools, colleges, universities, and vocational institutions. You can also collaborate with teachers, trainers, and educators to develop and deliver relevant and quality content and materials, and to assess and evaluate the learning outcomes.*	Current students and staff from existing local MBA programs are involved into the design of the AgriMBA Learning System by having their say in the questionnaire which will be distributed to them to indicate their preferences about the design of this innovative education tool. The one goal of this project, is "broadening of the course portfolio of local MBA programs by creating and sharing online courses via the novel online AgriMBA Learning System". Doing so the internationalization of the AgriMBA teaching will be strengthened just as the access to these resources by students from agricultural areas in all AgriMBA network countries. Each of the AgriMBA national programs consists of six thematic modules. Each of these modules contains six to eight courses. The project will develop 8 complete courses, which will be prepared by project partners (7 courses) and external Eastern-European experts (1 course). Thus at least one of the courses in each module is to be replaced by an online course developed by e-AgriMBA. The contents of the courses will be digitalized and teaching will become blended, which will yield a wide range of benefits from virtual cooperation, most importantly, cost reduction for teaching as well as improvement of the quality of teaching materials.

Monitor and evaluate impact	*A fifth strategy to scale up impact is to monitor and evaluate the impact of your sustainable agriculture education programs. This means collecting and analyzing data and feedback from your participants, partners, and stakeholders, and using them to measure the effectiveness, efficiency, relevance, and sustainability of your programs. You can also use the data and feedback to identify the best practices, lessons learned, challenges, and gaps, and to improve and adapt your programs accordingly.*	**Objective 1.** Establishment of the online AgriMBA Learning System. The indicator of the degree of achievement of specific objective will be the existence of the document "Report on the best e-learning practises in agribusiness MBA education: AgriMBA and beyond". The success indicator will be the report analysing stakeholder needs and expectations for the AgriMBA Learning System based on a survey of future users (members of the AgriMBA network). The implementation and functioning of the AgriMBA Learning System. Three indicators will be used to measure the degree of achievement of this objective, namely: (1) written instructions and (2) video instructions for students and teachers on using the AgriMBA Learning System; and (3) conduced trainings for trainers on the use of the AgriMBA Learning System with a count of the number of participating institutions and participants. **Objective 2.** Broadening of the course portfolio of local MBA programs by creating and sharing online course material in the AgriMBA Learning System.The level of achievement will be measured by whether the new online learning materials for eight courses will have been developed and positively reviewed by the Consortium Committee and the External Advisory Board. Objecrive will be measured by the completeness of the course content available in the Pan-European AgriMBA Learning System . **Objective 3**. Integration of one new partner institution into the AgriMBA System. The level of achievement of the objective will be measured by whether the new program and its enabling infrastructure have been successfully established. Will be measured by the extent the new MBA program is making use of the AgriMBA Learning System in its educational activities. The degree of achievement of Objective will be quantified by the number of courses and teaching material the new program is using for its educational activities from AgriMBA network members from other countries. Finally, the level of reaching objective will be evaluated based on the amount of academic expertise in terms of teaching staff which actively contributed to the implementation of the new program.
Share and disseminate results	*A sixth way to leverage existing networks and partnerships is to share and disseminate the results of your sustainable agriculture education programs. This means communicating and showcasing the achievements, outcomes, and impacts of your programs to your target groups, partners, stakeholders, and the wider public. You can also use various media and channels, such as reports, publications, presentations, webinars, podcasts, videos, blogs,*	The core objective is to establish a English-language AgriMBA program at the State Agrarian University of Moldova (SAUM) which meets EU quality standards in education. The target is educating agribusiness professionals and junior state officials with up-to-date knowledge and know-how in seven areas essential for business success such as economics, finance and accounting, marketing, operational methods and management. This will foster the internationalization of SAUM and deliver a meaningful contribution to the development of the curriculum in life-long learning and part-time education in agriculture, food supply chains and

	social media, newsletters, and e-books. By sharing and disseminating your results, you can increase awareness, recognition, and support for sustainable agriculture education, and encourage replication and scaling up of your programs.	rural development in Moldova. The expansion of the existing AgriMBA network to Moldova by establishing one new MBA program will result in the development of seven new modules at SAUM such as economics, finance and accounting, marketing, operational methods or management, the establishment of the necessary material equipment , the training of local teachers for using this AgriMBA Learning System and contributing to it as well as the graduation the first MBA cohort and starting up the second and third cohort. Another main result will be the envisaged international accreditation. When the program has started its educational activities, they will prepare and submit the necessary material to achieve national and international accreditation to ensure high-quality program design. e-AgriMBA will take concrete and effective steps to ensure good dissemination of its results. Will organize a set of multiplier events and other dissemination activities performed by all project partners. The project coordinator, with a strong support from all e-AgriMBA partners, will manage the dissemination actions for the general public which are needed to increase the impact of the project. such as: Website of the project linked to the existing AgriMBA website, Multiplier events - national dissemination MBA info-day in each country organized by each country project partner in the 3rd project year, Participation in AgriMBA Board meetings and conferences in 2023-2025, Testing of the AgriMBA Learning System in sessions with students, Newsletters and (social media) dissemination and events for various target groups, State Agricultural University in Moldova – SAUM will perform additional dissemination activities in Romanian and, Russian: launch of the program webpage and social media in Moldova, design of promo material, sending out leaflets & brochures, student recruitment .

Source: Own processing

4. Conclusion

When integrating sustainability in higher agricultural education it makes sense to focus on the development of somewhat fashionable for good reasons post-modern ideas related to things like empowerment, respect for pluralism and diversity of thought, action competence, contextual or local knowledge, grassroots decision making, collaborative and issue-based learning, systemic, and so on. Indeed, a focus on these components is useful and may eventually launch a new generation of higher education programs and curricula: ones that are more sensitive to emancipatory learning goals and the contextual, openended and uncertainly-linked nature of the creation of pathways towards sustainability. The current challenge modern agriculture is facing makes clear traditional approaches to higher agricultural education fall short in dealing with uncertainty, in coping with the normative aspects of decision making and in understanding the importance of learning that is, that learning is at the crossroad of conflicting world views rooted in varying traditions, norms and values. The agriculture needs the help of higher education

worldwide. In the less developed countries the adaption of the actual technologies can serve the needs of the local agriculture. One of the key aspects of sustainable agricultural education is the development of curricula that emphasize sustainability principles. Zamban highlights the importance of integrating sustainability into the curriculum of Agricultural Technical Vocational Education and Training (TVET), which is crucial for shaping the perspectives and actions of future professionals in agrarian sectors (Zamban, 2024). This aligns with the findings of Sørensen et al., who argue that educational institutions must adapt their programs to reflect the evolving needs of sustainable agriculture, ensuring that students are prepared to meet the challenges of a changing environment (Sørensen et al., 2021). Furthermore, the establishment of online educational repositories, as discussed by Costopouloul et al., can facilitate the sharing of agricultural knowledge and resources, thereby enhancing the learning experience and promoting sustainable practices among students (Costopouloul et al., 2011). In developed countries the agricultural workforce needs to be educated continuously in order to keep their knowledge fresh. New knowledge, new skills and new competencies: these are the things a modern famer need continuously during her or his career in the agriculture.Therefore, the six sectoral sub-indices that make up the GKI are open and dynamic systems that constantly interact with each other on the one hand, and with their surroundings within the general context on the other. They are linked to a number of contextual variables that have been proven to influence the functioning of sectors and their outputs, based on a holistic view of development and its components, placing them in the context of an integrated synthetic system that is dynamically active and interactive, without being closed or confined to one factor or component. Collaboration between academia and industry is another critical component for fostering sustainability in agricultural education. Soam emphasizes the need for strong linkages between universities and industries to enhance the relevance of educational programs and ensure that students acquire practical skills that are in demand in the agricultural sector (Soam, 2023). This collaboration can also facilitate the dissemination of innovative practices and technologies that support sustainable agriculture, as highlighted by Adu et al., who advocate for agricultural extension education as a means to promote sustainability (Adu et al., 2022). By bridging the gap between theoretical knowledge and practical application, the e-AgriMBA learning system can prepare students to become effective agents of change in their communities. e-AgriMBA will establish an electronic Pan-European Learning System for sustainable agribusiness MBA education. It will broaden the course portfolios of existing MBA programs by creating online learning and teaching tools. It will extend the AgriMBA network by establishing a new MBA program at the State Agrarian University of Moldova based on the novel system. It addresses stakeholders' specific needs which mirror the priorities of EU's Digital Educational Action Plan. e-AgriMBA will improve, innovate and digitalize agribusiness MBA education and foster lifelong learning in and beyond Europe. Its online tools will train digital and language competences and promote the sustainability transformation of higher education. e-AgriMBA will foster inclusion by profiting from and integrating the diversity of its partners and make its digital tools equally accessible to universities & students with fewer opportunities to educate highly skilled agribusiness specialists. In conclusion, the e-AgriMBA learning system has the potential to significantly enhance agricultural education by integrating sustainability principles, fostering collaboration between academia and industry, and emphasizing the importance of agricultural extension services. By doing so, it can prepare future agricultural professionals to tackle the challenges of sustainability and contribute to the development of resilient and sustainable agricultural systems.

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Assessment of the Financial Health of Farms: A Case Study from Slovakia

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Abstract
Prompt identification of critical aspects of business, as well as the assessment of crucial financial indicators of company's performance, are basic assumptions for decreasing the risks and maintaining the competitiveness of companies. One of the essential ways, how to evaluate the financial health of companies, is the use of existing bankruptcy models (Altman's model, Creditworthiness index, Index IN 05, Taffler's model, G-index, CH-index and others). However, companies operating in the agricultural sector are specific due to the biological nature of production, higher exposure to risks, dependence on climatic conditions, financing abilities or policy regulations affecting the primary sector. Therefore, the question arises, which models are the most suitable to be used for the evaluation of the financial health of farms, and which ratios have the best classification ability in order to determine the financial distress of farms.
Paper's objective and research background
The main objective of the paper is to evaluate the financial health of Slovak farms using selected prediction techniques, with the focus on the ability of financial ratios to identify differences between a group of financially healthy farms and farms in financial distress.
Data/Methods
The data set used for the analysis consists of the information from the financial statements of 1680 farms operating in the Slovak republic in period of years 2017 - 2019. The research sample is divided into a group of financially healthy companies and companies in financial distress. The models are evaluated according to their sensitivity, specificity, I Error type, II Error type and prediction ability. The prediction ability of the selected models is verified using the ROC curve and AUC area.
Results/Conclusions/Value added
The results of a comprehensive comparison of selected prediction models show, that the most suitable model for the Slovak agricultural sector is the G-index, whose AUC value reached up to 89.17%. The model is followed by the Creditworthiness Index, Index IN 05, Taffler's model and Altman's model, that achieved lower classification ability. One of the positive outcomes of the analysis is the finding, that all prediction models achieved at least an acceptable classification ability for the farms. The added value of the research is not only in its practical use for the evaluation of the performance of farms, but also in its potential for the construction of new models and usage of new evaluation techniques in the future.

Key words
Financial health, prediction models, financial distress, farms, financial ratios.

JEL Classification
Q10, Q14, G17

1. Introduction

Agriculture represents a very specific sector within the national economy, where the economic outcome is largely influenced by number of exogenous factors. The financial and economic

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performance of companies in general, as well as the agricultural businesses ought to be evaluated from the point of financial stability, health or distress. The necessity of appropriate evaluation of companies comes from the assumption, that prompt diagnosis of financial health of company can lead to the application of preventive tools by the management.

It is necessary to emphasize, that the construction of prediction models is based on financial data and therefore it does not include many exogenous factors and non-financial data, which can be essential for the agricultural company in terms of financial health. In the case of an agricultural company, these are indicators such as the quality of management, employee loyalty, a permanent circle of suppliers and customers, diversification of agricultural production between sectors and between crops, the quality of agricultural land, climatic factors, financing of the enterprise from subsidies intended for the agricultural sector, the riskiness of agricultural production with a fundamental impact on farmers' incomes and many others.

A company that is in financial distress, as opposed to a financially healthy company, is most often defined in the context of insufficient liquidity. To correctly identify a company that may run into financial difficulties in the near future, it is necessary to know the answer to the basic premise of all prediction models: *„How to define a financially healthy company and correctly differentiate it from a company in financial distress?"* In order to correctly identify a company with financial difficulties, it is necessary to know the possible causes of the deterioration of the financial health of companies stemming from various primary symptoms.

Diagnosing the financial health of companies requires the application of methods that can satisfactorily evaluate the company's situation in time. Altman (1968) constructed a discriminant function consisting of five financial ratios. The main advantage of linear discriminant analysis is that it can solve a problem that has a multivariate nature by reducing it to one numerical criterion with a relatively high accuracy of the resulting model.

On the other hand, it requires to meet the theoretical assumptions, such as multivariate normality of independent variables, equality of covariance matrices and the assumption of linear relationships between independent variables. Other prediction models, which are based on multivariate discriminant analysis, are e.g. Taffler's model (1984), Beerman's discrimination function (1982), Springate's model (1978) and others.

The main objective of the paper is to evaluate the financial health of Slovak farms using selected prediction techniques, with the focus on the ability of financial ratios to identify differences between a group of financially healthy farms and farms in financial distress.

1.1. Literary review of prediction studies in the agricultural sector

The intention of the literature review is not to characterize the individual prediction models, rather to bring their application summary in the agricultural sector. Despite the increase of prediction studies in recent years and their constant innovation in the form of the application of innovative techniques for assessing the financial health of enterprises, it is necessary to note only a very low number of scientific studies devoted to the agricultural sector and, to a greater extent, the limitation to the use of multivariate discrimination analysis.

Table 1 summarizes the prediction studies applied in the agricultural sector. All studies characterized in the Table used already existing prediction models, which they applied to a selected group of agricultural enterprises. These studies verify already created prediction models, mostly the Altman's Z-coefficient (1968), Sprigate's model (1978), Taffler's model (1984), Zmijevsky model (1984) and other constructed prediction techniques on new financial data of agricultural enterprises.

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The Table 1 also shows the use of discriminatory models created specifically for Slovak agricultural enterprises, namely CH-index (1998) and G-index (2002). The verification of both models (CH-index, G-index) created for the prediction of financial health in Slovak agriculture in comparison with Altman's Z-coefficient on a set of new data on agricultural enterprises is offered by the studies of Valášková et al. (2017) and Boďa & Úradníček (2019). In the studies, the authors argue about the appropriateness of their use for new financial data on agricultural enterprises, which have changed significantly in recent years due to transformational changes in the agricultural sector and the rules of the Common Agricultural Policy.

The usability of existing prediction models can differ according to the time conditions, specific industry and changing environment, therefore it is necessary to constantly update the existing bankruptcy formulas as stated in the study of authors Harumová & Janisová (2014).

Recently, several authors of scientific studies from different countries have paid attention to the evaluation of financial distress models under conditions of nowadays businesses, specifically their accuracy, discriminant ability or predictability, for example Karas et al. (2017) for the Czech Republic; Rajin et al. (2016) and Stojanović & Drinić (2017) for Serbia; Purves et al. (2015) for Australia companies and others.

The Table 1 points out the field of application on the data from specific country and summarizes the key results of the scientific studies.

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Table 1: Literature overview for the bankruptcy prediction techniques in the agricultural sector

Author (s)	*Applied prediction technique*	*Application field*	*Results of the study*
Kopta (2009)	Altman's Z score, CH-index, G-index, Indexes IN, Taffler's model	Agribusiness entities in Czech republic	The study presented the possibilities of developing the future state of agricultural enterprises, as well as predictions of threats. The author stated that businesses are threatened by sudden fluctuations in the economic results. The G-index (2002) and Index IN (1999) showed the best usability for predicting financial health. However, the author stated that the value of the G-index is too high for Czech agricultural enterprises.
Vavřina et al. (2013)	Altman's Z score (1983), Logit model, DEA with bankruptcy frontier, Production function approach	Agribusiness companies from Visegrad Group	Authors presented the validation results for each of the four applied prediction methods, outline the strengths and weaknesses of each approach and discuss the valid suggestions for the effective detection of financial problems in the specific branch of agribusiness.
Grushniene (2016)	Altman's Z score (1968, 1990)	Agribusiness entities in Lithuania	The purpose was to apply Altman's Z score on the traded Lithuanian agricultural enterprises. Study showed that Altman's Z score model is a practical tool and can be used in assessing the risk of insolvency in agricultural companies, as well as risk management actions of management.
Rajin et al. (2016)	Altman's Z score (1983), Kralicek's DF model, Quick test	Serbian agricultural sector	Results suggest that Kralicek's DF model indicates better financial state of the company than Altman's Z score, considering the characteristics of the market in which the model is formed. Authors conclude that each of the applied method gave different answers. Therefore, they recommend that in analysing the probability of bankruptcy always take into account indicators of different methods.
Srebro et al. (2021)	Altman's Z score (1968, 1988)	Agribusiness entities in Serbia	The results of the study showed that there are differences between the models. It was mainly about classification into "zones", when the original Altman's Z coefficient (1968) classified agricultural enterprises in the red area, but the Altman's Z coefficient (1988) already had significantly better results.
Matejić et al. (2023)	Altman's Z score, Sprigate's model (S-score), Taffler model	Agribusiness entities in Serbia	The study performs an evaluation of the financial distress of agricultural enterprises, in order to choose an adequate model. Authors conclude that the adapted Springate's model gives the best results in the context of differentiating the enterprises from the sample not only in terms of their bankruptcy risk, but also in terms of their profitability indicators.
Stoyancheva & Angelova (2023)	Altman's Z score, Sprigate's model (S-score), Index IN05, Zmijevski's model (X-score)	Agribusiness entities in Bulgaria	Crop and livestock farms have been analysed as separate subsectors in order to determine whether the applied methods for analysis of the financial sustainability show their specifics depending on the character of their particular activity. Authors conclude that the most sensitive to deterioration of financial sustainability is the S-score, while the model with the lowest levels of sensitivity is X-score.

Source: own processing

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2. Data and Methods

Data used for the analysis are obtained from the financial statements of Slovak farms recorded in the FINSTAT dataset. The sample includes 1680 agricultural companies operating in the period of years 2017-2019. After the outlier detection, 1000 farms remained in the dataset. These farms are divided into the group of financially healthy companies and companies in financial distress, using the criteria of Slovak legislation. A farm is classified as the company in financial distress in the case that the Equity value is negative and also the ratio Equity/Liabilities is lower than 0.8. With the application of selected criteria, 902 farms created the group of financially healthy farms, and 98 the group of farms in financial distress. The results of classification are in next step compared with the analysis of prediction models.

All selected prediction models, which are summarized in Table 2 are constructed based on the multivariate discriminant analysis. The models have been selected according to the availability of data and appropriateness of research results of other authors mentioned in the literature review. Table 2 shows the sector of the economy on which the discriminatory financial health prediction model was constructed, its mathematical formulation and cut-off values that classify enterprises that predict possible financial difficulties of the enterprise. The specification of financial variables of selected prediction models is shown in Table 3.

Janoušková et al. (2015) classify enterprises into prosperous and bankrupt, taking into account four situations:

- truly positive (TP) – is the number of prosperous businesses that the model correctly classified as prosperous,
- true negative (TN) – is the number of bankrupt enterprises that the model correctly classified as bankrupt,
- false positive (FP) – is the number of bankrupt businesses that the model incorrectly classified as prosperous. This is a Type I error,
- false negatives (FN) – is the number of successful businesses that the model incorrectly classified as bankrupt. This is an error Type II.

Type I error indicates false positive results. Type Error II tells about false negative results. Authors stated that if the error Type I. and II. is higher, so the prediction ability of the model is lower. According to the authors Klepáč & Hampel (2017), classification accuracy can be described as the proportion of correctly classified subjects to all subjects. Sensitivity expresses the percentage of correctly classified prosperous enterprises. It is given by the ratio of true positive cases to all positive cases. Specificity expresses the percentage of correctly classified bankrupt enterprises. It is given by the ratio of true negative cases to all negative cases. Error I. and II. is represented by False Negative Rate (FNR) and False Positive Rate (FPR), which are conditioned by the actual situation of the enterprise.

According to Klepáč & Hampel (2017), it is appropriate to measure the discriminatory power through the ROC curve, known as the Receiver Operating Characteristic (ROC) and especially the area under this curve, called the Area under the Curve (AUC), to compare the predictive ability of selected models. Based on the calculated values of sensitivity and specificity, it is possible to construct an ROC curve, and subsequently to evaluate the accuracy through the area under this AUC curve as follows:

- values from 0.5 to 0.75 – acceptable classification ability,
- values from 0.75 to 0.92 – good classification ability,
- values from 0.92 to 0.97 – very good classification ability,
- values from 0.97 to 1.0 – perfect classification ability.

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Table 2: Prediction models and their evaluation criteria

Predictive Model	*Author/Year of study*	*Sector*	*Formula*	*Cut-off points*
CH-index	Chrastinová (1998)	agribusiness companies in Slovakia	$CH = 0{,}37x_1 + 0{,}25x_2 + 0{,}21x_3 - 0{,}10x_4 - 0{,}07x_5$	CH≤-5 failure CH≥2,5 non failure CH=-5 to 2,5 grey area
G-index	Gurčík (2002)	agribusiness companies in Slovakia	$G = 3{,}412x_1 + 2{,}226x_2 + 3{,}277x_3 + 3{,}149x_4 - 2{,}063x_5$	G≤-0,6 failure G≥1,8 non failure G=-0,6 to 1,8 grey area
Index 05	Neumaierová, Neumaier (2005)	medium and large industrial companies in the Czech Republic	$IN_{05} = 0{,}13y_1 + 0{,}04y_2 + 3{,}97y_3 + 0{,}21y_4 + 0{,}09y_5$	IN05<0,9 failure IN05>1,6 non failure IN05=1,6 to 0,9 grey area
Altman's Z score model	Altman I. Edward/ 1983 (revised 1968)	companies which do not issue shares traded on a regulated market	$Z' = 0{,}717x_1 + 0{,}847x_2 + 3{,}107x_3 + 0{,}42x_4 + 0{,}998x_5$	Z'<1,2 failure Z'>2,9 non failure Z'=1,2 to 2,9 grey area
Taffler's Z score model	Taffler R.J.(1983)	industrial companies	$Z = 0{,}53T_1 + 0{,}13T_2 + 0{,}18T_3 + 0{,}16T_4$	Z<0,2 failure Z>0,3 non failure Z=0,2 to 0,3 grey area
Creditworthiness index	Maczynska E. model II (1994)	industrial companies in Poland	$Creditworthiness\ index = 1{,}5I_1 + 0{,}08I_2 + 10I_3 + 5I_4 + 0{,}1I_6$	IB<-1 failure IB>1 non failure IB=-1 to 1 grey area

Source: own processing

Table 3: Prediction models and their evaluation criteria

Predictive Analytics Model	*Financial variables in the formula*
CH-index	*x1=EAT/total assets, x2=EAT/total revenues, x3=cash flow/liabilities, x4=liabilities/total revenues, x5=liabilities/total assets*
G-index	*x1=retained earnings/total liabilities, x2=EBT/total liabilities, x3=EBT/total revenues, x4=cash flow/total liabilities, x5=stocks/total revenues*
Index 05	*y1=total assets/liabilities, y2=EBIT/interest paid, y3=EBIT/total assets, y4=total revenues/total assets, y5=current assets/current liabilities*
Altman's Z score model	*x1=net working capital/total assets, x2=retained earnings/total assets, x3=EBIT/total assets, x4=equity/total liabilities, x5=sales/total assets*
Taffler's Z score model	*T1=EBT/short-term liabilities, T2=current assets/total liabilities, T3=short-term liabilities/total assets, T4=sales/assets*
Creditworthiness index	*I1=(gross profit+ amortization)/total liabilities, I2=total assets/total liabilities, I3=operating profit/total assets, I4=operating profit/sales revenue, I5=stocks/sales revenue, I6=total revenues/sales revenues*

Source: own processing

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3. Results and Discussion

All 6 models are firstly used to classify 1000 Slovak farms into the group of financially healthy companies and companies in financial distress. The results of models are compared with the classification according to the selected criteria of Slovak legislation about financial health of companies. The models have the ability to include the farm into so called "grey zone", neither prosperous nor unprosperous company. However, for the purpose of the analysis the option of grey zone has been removed, using the modified scores of models determined be the mean values of scoring intervals. The results in their absolute and relative values are presented in the matrix of change (Table 4).

Table 4: Results of classification of Slovak farms

Model	Real sample	Prediction sample		Relatively (%)	
		Financial distress	Financial health	Financial distress	Financial health
CH-index	Financial distress	2	96	0,20%	9,60%
	Financial health	0	902	0%	90,20%
	SUM	**2**	**998**	**0,20%**	**99,80%**
G-INDEX	Financial distress	86	12	8,60%	1,20%
	Financial health	85	817	8,50%	81,70%
	SUM	**171**	**829**	**17,10%**	**82,90%**
INDEX IN 05	Financial distress	90	8	9%	0,80%
	Financial health	517	385	51,70%	38,50%
	SUM	**607**	**393**	**60,70%**	**39,30%**
ALTMAN'S Z SCORE MODEL	Financial distress	93	5	9,30%	0,50%
	Financial health	556	346	55,60%	34,60%
	SUM	**649**	**351**	**64,90%**	**35,10%**
TAFFLER'S Z SCORE MODEL	Financial distress	48	50	4,80%	5%
	Financial health	133	769	13,30%	76,90%
	SUM	**181**	**818**	**18,10%**	**81,90%**
Creditworthiness index	Financial distress	66	32	6,60%	3,20%
	Financial health	70	832	7,00%	83,20%
	SUM	**136**	**864**	**13,60%**	**86,40%**

Source: own processing

Chrastinová (1998) is the author of ***CH-index***, the first evaluated prediction model created for agriculture sector based on a discriminant function. According to the results of our case study, CH-index correctly classified all 902 prosperous farms and 2 unprosperous farms (Table 2). The remaining, misclassified companies are determined as prosperous by this model, but in the reality these businesses are in financial distress (96 farms). Prediction accuracy of CH-index reached up to 90.4% and 100% sensitivity, however Type I error reached 97.96%, due to the inability of the model to recognize the companies in financial distress.

Figure 1 shows the ROC curve, the relationship between true and false positivity, it means the interconnection between sensitivity and specificity of model. The area under the curve refers to the AUC and for CH-index represents 51.02% (Figure 1). It is obvious that the AUC value is lower than the classification accuracy of the model, 90.4%. The reason for the difference between the AUC value and the accuracy could also be the construction of the ROC curve, which works on a different calculation than the classification accuracy. The main disadvantage of the CH-index remains in the incorrect classification of farms in financial distress.

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G-index is very similarly as the CH-index used for the prediction of financial situation of agricultural companies. When constructing the model, the author (Gurčík, 2002) analysed three models, namely Altman's model, CH-index and Creditworthiness Index. Results of our analysis show that according to the G-index 609 farms would be selected into the grey zone. After the modified scores, 829 farms were classified as financially healthy, and 171 as the farms in financial distress. Table 2 shows that the prediction model correctly classified 90.30% of the examined farms. Model incorrectly indicated 12.24% farms as financially healthy (Type I Error) and 9.44% as farms in distress (Type II Error). The model reached very high values of sensitivity (90.58%), as well as specificity (87.76%), what reflects also high value of AUC 89.17% (Figure 1). It can be evaluated that the model reached very positive values, has good classification ability and high accuracy.

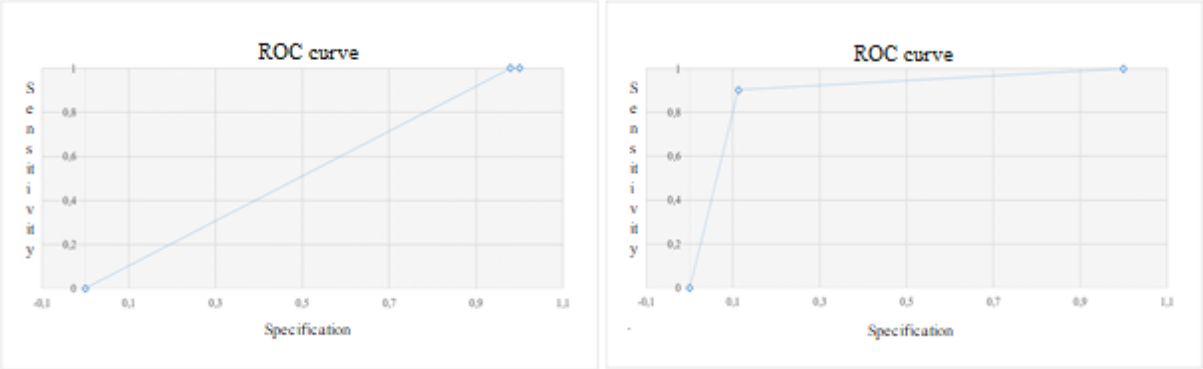

Figure 1: ROC curve for CH-index and G-index

Source: own processing

Index IN 05 was constructed by Neumaiers, a couple from the Czech Republic, who created four indices for assessing the financial health of companies. Index IN 05 correctly identified 385 prosperous farms and 90 farms in financial distress. The examined index incorrectly evaluated 517 farms, which were classified as farms in financial distress, despite the fact that they were prosperous according to the chosen criteria of Slovak legislation (Type II Error 57.32%). It also wrongly evaluated 8 businesses as prosperous, although they were actually in distress (Type I Error 8.16%). Type I and II Errors impacted the prediction accuracy of the model, which reached a value 47.50%. The area under the ROC curve represents 67.26% (Figure 2), it means acceptable classification ability. The authors themselves stated an 80% classification ability of the model, which was not confirmed based on the results of our case study. The reason could have been the fact that the model was created using data from industrial enterprises.

Altman (1968) was the first one, who used multivariate discriminant analysis for predicting the financial situation of companies. In 1983, he revised his model, when replacing the x4 indicator: the market value of equity with its accounting value. With this adjustment, the weights of the indicators were also adjusted. In the case study, the ***Altman Z-score*** classified only 43.90% of farms correctly, which means relatively low classification accuracy. Type II error reached the value 61.64%, it means 556 financially healthy farms were identified incorrectly as farms in financial distress. It represents the highest value of Type II Error when comparing all prediction models. Also the sensitivity of the model is on 38.36% and Type I error reached a value 5.10%. According to the AUC (66.36%) would be the model considered as acceptable from the point of prediction ability. However, in the literature it is stated that the model achieves a prediction ability 80-90%.

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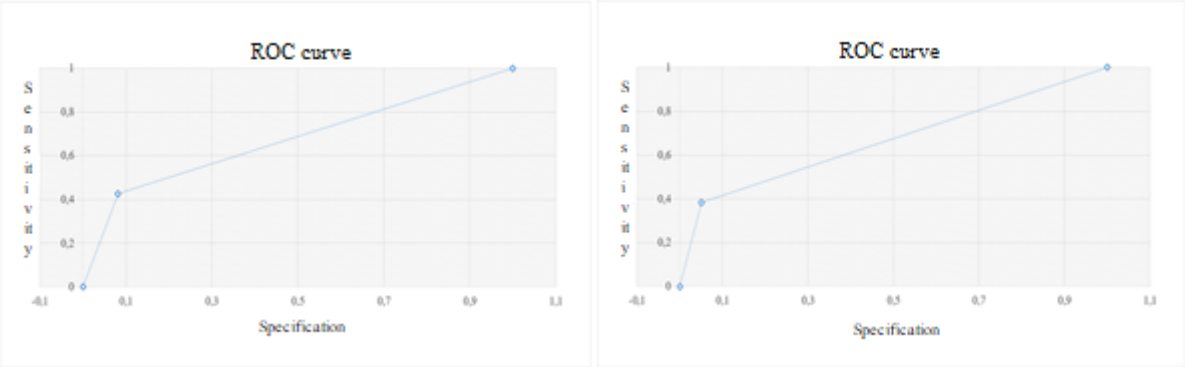

Figure 2: ROC curve for Index IN 05 and Altman's model

Source: own processing

R. J. Taffler (1997) created so called ***Taffler's bankruptcy model***. Originally, the model included five ratios, but after its improvement, only four of them remained in the function. In the case study, the model correctly identified 769 prosperous farms and 48 farms in financial distress. Prediction accuracy of the model represents 81.7%, which is considered as a very positive result, however the Type I Error is very high, 51.02%. It reflects also the value of specificity of model, 48.98%. The AUC area shows 67.12% dependence between sensitivity and specificity, and the result reflects acceptable classification ability (Figure 3). Although, the Type I Error shows that the model classified a large number of farms in financial distress as prosperous (50 out of 98 cases), it did not cause a large decrease in the classification accuracy of the model and the AUC area.

The Creditworthiness index consists of six ratios and their weights, and it is very often used in German-speaking countries. The results of our analysis show that the index correctly identified 832 financially healthy farms and 66 farms in financial distress. The overall classification accuracy of the model is at the very high level, 89.80%. Both Type I and II errors occurred, with the values 32.65% and 7.76%. Mainly the incorrect classification of bankrupt companies to the group of financially healthy companies affected the prediction ability of the model. Sensitivity 92.24% and specificity 67.35% reflect the AUC value almost 80%, what also confirms the positive evaluation of Creditworthiness index.

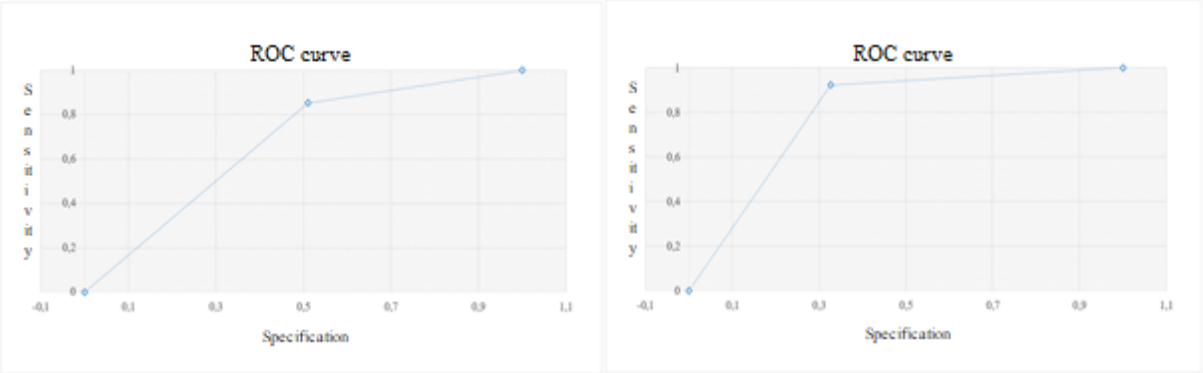

Figure 3: ROC curve for Taffler's model and Creditworthiness index

Source: own processing

Table 5 shows the values of Type I Error, Type II Error, Specificity, Sensitivity, Prediction ability (accuracy) and AUC for each evaluated model. The comparison and evaluation of prediction models shows that the most suitable prediction model for Slovak agricultural sector is the G-index, which AUC value reached up to 89.17% and prediction accuracy 90.30%. G-index was created using the sample of Slovak farms, what could have impact in our analysis. From the models that did not use agricultural companies by their construction achieved the best

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ranking the Creditworthiness index, with an AUC value of 79.79%, prediction ability 89.90% and sensitivity 92.24%. The model can be considered as very suitable also for agricultural companies. Index IN 05, Taffler's model and Altman's model achieved very similar results and the worst evaluation has the CH-index.

Table 5: Comparison and evaluation of prediction models

	Type I Error		Type II Error		Specificity		Sensitivity		Prediction ability (accuracy)		AUC	
CH-index	97.96%	6.	0%	1.	2.04%	6.	100%	1.	90.40%	1.	51.02%	6.
G-index	12.24%	3.	9.42%	3.	87.76%	3.	90.58%	3.	90.30%	2.	89.17%	1.
Index IN 05	8.16%	2.	57.32%	5.	91.84%	2.	42.68%	5.	47.50%	5.	67.26%	3.
Altman's Z score Model	5.10%	1.	61.64%	6.	94.90%	1.	38.36%	6.	43.90%	6.	66.63%	5.
Taffler's Z score model	51.02%	5.	14.75%	4.	48.98%	5.	85.25%	4.	81.70%	4.	67.12%	4.
Creditworthiness index	32.65%	4.	7.76%	2.	67.35%	4.	92.24%	2.	89.90%	3.	79.79%	2.

Source: own processing

4. Conclusion

Prediction models belong to the important part of the analysis of companies, not only because they provide information about the financial health of the company, but also about the possible threat of bankruptcy and distress. From the wide range of prediction models were for the analysis the Altman's model, Creditworthiness index, Index IN 05, Taffler's model, G-index and CH-index chosen. The common characteristic of these models is, that they were created using the discriminant analysis. The attention to the G-index and CH-index is paid mainly because of their direct focus on the Slovak agricultural companies.

To be able to compare the ability of prediction models to correctly classify the financially healthy farms and farms in financial distress, the case study from Slovakia has been used. The case study included 1680 farms operating in the Slovak republic in period of years 2017 – 2019. After the outlier detection, 1000 farms were divided into the group of financially healthy companies and companies in financial distress and used for the evaluation and comparison of prediction ability of selected models. The models can classify a farm also in so called “grey zone”. However, to be able to meet the objective of the paper and compare the prediction models, we removed this possibility using the modified scores as the mean values of scoring intervals. The results of models were compared with the results of classification according to the criteria of Slovak legislation about the financial health of companies. Based on the comparison, the values of sensitivity, specificity, Type I Error, Type II Error and prediction accuracy of each model were calculated. The prediction ability (accuracy) of selected models was verified also by using the ROC curve and AUC area.

The overall evaluation and ranking of the models is very complex, because each model is specific and differs in many ways. The models were constructed in different years, economic conditions, and mainly from different samples of companies. All these facts affect not only the prediction ability of models, but also the results of individual parameters. An example of such an imbalance is the ranking of the CH-index in the classification accuracy of the model parameters on the first place and AUC on the last place.

Based on the comprehensive comparison of selected prediction models, it can be concluded that the most suitable prediction model for Slovak agricultural sector is the G-index, which AUC value reached 89.17% and prediction accuracy 90.30%. For construction of the model the author used a sample of farms operating in Slovakia, what could also have an impact on the results of our analysis.

The second place is taken by the Creditworthiness index with an AUC value 79.79%, prediction ability 89.90% and sensitivity 92.24%. The model is preferably used in German-speaking countries, whose economic and agriculture differs from the Slovak Republic, so the results can be considered positively surprising.

Index IN 05, Taffler's model and Altman's model achieved very close AUC values around the level of 67%, which indicates an acceptable classification ability of the model.

The CH-index, which was constructed on a sample of Slovak farms, reached surprisingly the lowest AUC results, only 51.07%. However, it is very important to emphasize that the model has relatively wide evaluation intervals, and in the original research sample, almost all farms were included in the grey zone. Almost all farms in the analysis were included in the prosperous group, and only 2 were classified as companies in distress, which was the most important factor that caused the unfavourable results of the AUC area, although the model achieved the highest classification accuracy, up to 90.40%.

Acknowledgements

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Nutrition Label as a Tool for Potentially Influencing the Consumer Choice of Cakes

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Abstract
The study underscores the importance of indicators, in influencing purchasing decisions within the gastronomy sector. As contemporary consumers exhibit a growing inclination towards health-conscious choices, the accuracy and transparency of nutrition labels have become pivotal factors shaping their preferences in the gastro domain. Within the gastro sector, companies that prioritize the provision of clear and reliable nutritional information are poised to experience tangible benefits, including increased sales and the cultivation of brand loyalty. The study explores how these factors play a crucial role in the gastronomic context, where consumers seek not only culinary satisfaction but also value nutritional awareness.

Paper's objective(s) and research background
The main objective of this paper is to investigate how information about the nutritional balance of cakes influences consumer preferences and emotional response.

Data/Methods
In addition to the classic Tablet Assisted Personal Interviewing (TAPI), biometric methods such as Eye Tracking and Electroencephalography (EEG) were used to obtain unaware emotional reactions. During testing, constant conditions in terms of light, acoustic conditions, and air quality were ensured.

Results/Conclusions/Value added
We found statistically significant differences in the emotional response due to different nutritional labeling of the cakes. The nutritional indicator had no effect on consumer preferences.

Key words
Nutrition Label, Consumer Behaviour, Gastronomy, Cakes, Emotion, Consumer preference

JEL Classification: M29, M31

1.Introduction

1.1 Importance of Nutritional Labelling

Food is an essential fuel for the human body and its physiological functions. The way a person selects, purchases and processes food is closely related to his/her characteristics such as social status, economic opportunities, lifestyle, the environment in which he/she lives, consumption preferences and various other factors that determine this relationship between consumer and food consumption (Martinho et al., 2022). A factor that has a significant impact on changing consumer decision-making during the food purchasing process is the nutritional indicator. One of the public policies is to label with more eye-catching and easier to interpret front-of-package nutrition facts (FoPL) to help consumers identify unhealthy foods and make more informed choices (Machín at al. 2018). In addition, this method of food labelling is recommended by the

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World Health Organization (WHO) and many other multilinear health organizations, which identify this FOPL as an effective tool to promote healthy and balanced diets (Champagne et al., 2020). The front-of-pack labelling method aims to provide more accessible and understandable information to consumers compared to more complex information panels that provide nutritional information located on the back or side of products (Pettigrew et al., 2023). The use and application of Nutri-Score on food is increasingly being introduced in the European Union, with a proliferation of studies associated with research on Nutri-Score labelling aimed at stimulating the selection of healthier food alternatives (De Bauw et al. 2021). Nutri-Score is one type of front-of-package nutritional indicator (FoPL) that originated in France and is now gaining popularity. Its aim is to motivate consumers to pay attention to this simple intuitive system, which consists of five colours and letters (Gabor at al., 2020). However, more directive labels such as Nutri-Score have been shown to force consumers to perceive and reach for healthier alternatives (Crosetto et al., 2020; Ducrot et al., 2015; Egnell et al., 2018; Hodgkins et al., 2012; Julia & Hercberg, 2017; Julia et al., 2015; Mora-García et al., 2019; Talati et al., 2017; Van Herpen et al., 2014). However, discussions on FoPL are emerging in Europe and especially in Mediterranean countries, which require further new studies focusing on NutriInform or shoppers' understanding of FoPL.

1.2 FoP Nutrition Label and Its Influence on Consumer Behaviour

The study of consumer behaviour in the context of front-of-pack nutrition labelling has received considerable attention recently. Of course, not all consumers perceive or are influenced by these labels differently, e.g., depending on gender, age, education, income, or cultural background (Priya & Alur, 2023). Consumers' interest may also vary according to their level of health motivation. Studies suggest that consumers with healthier lifestyles are more likely to use nutritional information on either the front or back of the pack and, consequently, this influences their actual purchase intentions towards healthier foods (Gassler et al., 2023). As mentioned above, front-of-pack nutrition labelling allows consumers to make informed food choices, which can lead to a healthier lifestyle. Therefore, the aim of our paper was to investigate whether the Nutri-Score can potentially influence consumers' food choices by specifically guiding them to choose a healthier dessert option. Several authors (Penzavecchia et al., 2022) report that front-of-pack nutrition labelling is seen as a useful tool to help consumers make food choices and change their behaviour towards a healthier diet. Similarly, Feteira-Santos et al. (2020) argue that front-of-pack nutrition labelling has a positive impact on the understanding of nutritional content, perception of product healthiness, selection of products with better nutritional quality, and purchase intention. Although several studies confirm that consumers have positive attitudes towards front-of-pack nutrition labels and believe that it helps them make healthier food choices and increases their purchase intention towards healthier foods, there are also conflicting studies that have found no effect on purchase intentions (Dubois et al., 2021). For example, a study (Folkvord et al., 2021) found no effect of Nutri-Score labelling on three different snack bars on consumers' attitudes, taste perception, and purchase intention. However, it is possible that respondents were not necessarily influenced solely by the Nutri-Score label on the products, or that they responded based on their prior knowledge of the brands.

There are relatively few studies focusing on similar issues in Slovak conditions. The first major study among Slovak consumers comparing two nutrition labels (Nutri-Score and Nutrinform) and their impact on consumer choice was conducted in 2022. In this study (Savov et al., 2022), consumers expressed their preference first for products without a nutrition label on the front of the packaging and then for products with a nutrition label. Both studied labels led to a change in consumer behaviour (the respondents improved their choice towards healthier products, with better results in favour of the Nutri-Score system), which was also in line with other studies

conducted on the studied issue abroad. For example, a study by Egnell et al. (2018) compared consumers' ability to understand five FoPLs (Health Star Rating system, Multiple Traffic Lights, Nutri-Score, Reference Intakes and Warning symbol) in 12 different countries. Across all countries, the Nutri-Score was again found to be the most effective system for communicating information about the nutritional quality of food. Another 18-country analysis looked at the relative effectiveness of five FoPLs currently in use around the world. The results showed that different front-of-pack food labels have different abilities to help consumers. The Nutri-Score performed best in terms of both attraction and aversion scores for understanding and simulated choice outcomes (Pettigrew et al., 2023). Dubois et al. (2021) in their study compared 4 different types of FoPLs and similarly concluded that the Nutri-Score system had the greatest ability to capture shoppers' attention and helped them rank products according to their nutritional quality. A major strength of this study was that it was conducted under real-life conditions, but as a result, the effect size was much smaller than in comparable laboratory studies. Other authors agree with this view. Many studies using a simulated shopping situation have reported that shoppers exposed to FoPLs have an increased intention to buy healthier foods, but in real-world conditions, results suggest that FoPLs are less successful in persuading shoppers to buy healthier foods (Temple, 2020). These facts suggest that it is justified to continue research on this topic and to investigate whether Nutri-Score can potentially influence consumer choice.

2. Data and Methods

The theoretical background of the problem addressed was obtained by reviewing available secondary sources from scientific articles and journals related to the impact of Nutri-Score on consumer food choice. These sources provided a comprehensive overview of the current state of research and practical applications of nutrition labels in the context of consumers' dietary preferences and purchasing behaviour.

The main objective of the study was to validate the impact of the Nutri-Score on the choice of a cake among a trio of different options. The object of investigation was three chocolate cakes, labelled with codenames with different nutritional composition (EGLO - category E, ENGA - category D, EGGC - category C). All cakes were the same size and approximately the same weight of 50g. Visually, the EGLO and ENGA cakes were identical, while EGGC contained a decorative element.

The research was conducted in cooperation with the secondary school - Hotel Academy of Ľudovít Winter in Piešťany in November 2024. 30 respondents (10 men and 20 women aged 18 to 61 years) participated in the research. The study consisted of an initial general questionnaire to obtain basic information about the respondents and an in-depth interview to explore in more detail their purchasing preferences and attitudes towards nutritional labels. In addition to traditional feedback, unconscious feedback was also collected through Eye tracking. Eye tracking glasses 2 from Tobii and the Tobii PRO Studio software interface were used in the experiment to track respondents' eye movements and attention while viewing and evaluating different cake variants.

At the same time, the emotional response of the respondents was monitored using a 14-channel mobile electroencephalograph Emotiv Epoc. Emotional engagement was calculated from the brain activity data, which was statistically verified using ANOVA.

This study focuses on two respondent tasks. The first task involves selecting a cake without a nutritional indicator, while the second task involves comparing cakes labelled with Nutri-Score to identify the impact of the indicator on consumer choice. Comparing these tasks allowed to assess whether and how the Nutri-Score influences consumers' food choice decisions.

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3. Results and Discussion

All participants who took part in the survey eat cakes/desserts, where 8 of them regularly and 22 of them saying occasionally. Similarly, all respondents reported going to catering establishments (pastry shop, café, etc.) for this kind of food, with 5 of them regularly and 25 of them occasionally. For the majority of respondents (24) healthy eating is important and for 7 of them even very important.

When asked if they like to try/consume novelties in gastronomic establishments, only 3 answered that they never do, see. Fig. 1. The other respondents said sometimes (17) and always (10).

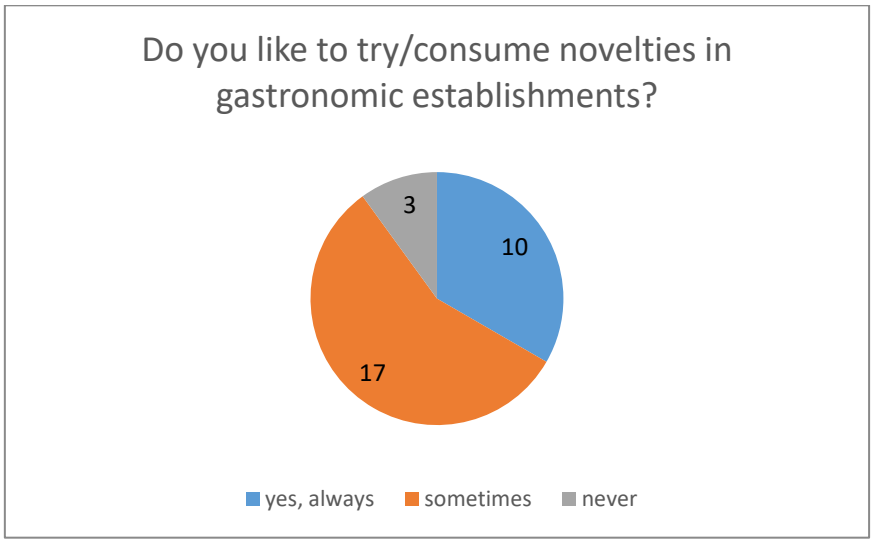

Fig. 1 Attitudes towards trying new things in catering establishments
Source: Own elaboration based on research 2024

In terms of perceptions of healthy eating in the context of taste, the majority of respondents (24) expressed the view that they did not find it less tasty with 10 of them emphasising that they definitely did not see. Figure 2. 6 respondents considered healthy food to be less tasty, with 2 responding definitely yes.

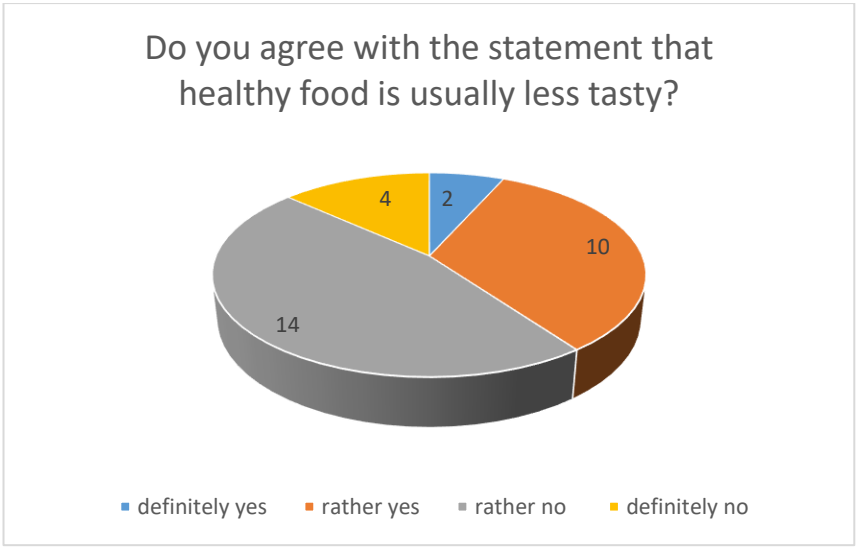

Fig. 2 Perceptions of healthy eating in the context of palatability
Source: Own elaboration based on research 2024

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At the same time, the same 24 respondents think that healthy eating is usually more expensive. Only 6 respondents answered that rather no see. Fig. 3. When asked if they agree with the statement that they do not gain weight from eating healthy, 15 respondents said rather no and 6 definitely no.



Fig. 3 Perceptions of healthy eating in the context of palatability
Source: Own elaboration based on research 2024

In terms of ordering the prepared dessert samples according to how the respondents perceive them in terms of health without a nutritional indicator, it can be stated that they consider the EGGC sample (20 respondents) to be the healthiest. On the other hand, they considered the EGLO sample (16 respondents) as the least healthy based on visual inspection, cf. Table 1. It can be assumed that they identified the healthiest sample based on the ornamentation, which consisted of nut and fruit.

Tab. 1 Rank the prepared dessert samples according to your perception of their health (1 being the healthiest; 3 being the least healthy).

	1.rank	2.rank	3.rank
EGLO	3	11	16
ENGA	7	17	6
EGGC	20	2	8

Source: own elaboration based on research 2024

When asked which of the samples they would buy based on a visual inspection without the nutritional indicator, the majority of respondents (14) would choose the EGLO sample. For the ENGA and EGGC sample, 8 respondents would choose the same, see. Tab. 2. There were changes in consumer preferences after the Nutri-Score cakes were labelled. For the sample that was least nutritionally balanced EGLO there was a 42% decrease. For the sample with the best nutritional composition, there was a 34% increase after looking at the indicator, suggesting that FoPL may influence consumer preferences.

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Tab. 2 Choosing a cake without and with a nutritional indicator

	Without Nutri-Score	With Nutri-Score	% Change
EGLO	17	10	-42%
ENGA	8	8	0%
EGGC	8	12	+34%

Source: own elaboration based on research 2024

In addition to the classical interview, visual attention recorded by a mobile eye camera was also of interest. The visual attention of the interviewees is documented by the heat map in Fig. 4. Most attention was focused on the EGGC sample, which contained the ornament and also the ENGA sample. This is an interesting finding given that the ENGA sample was visually identical to the EGLO sample. At the same time, the names of the samples themselves were also a significant first visual focus.

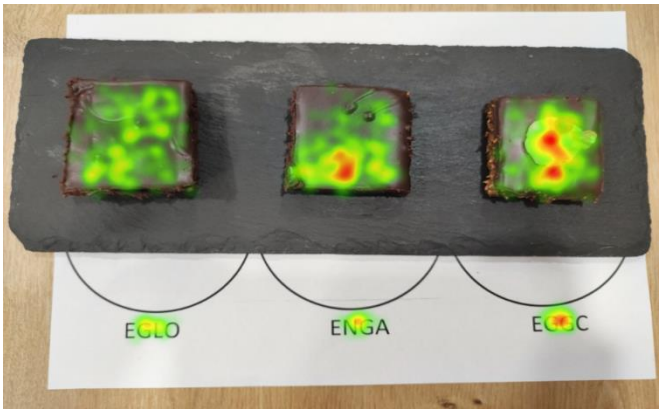

Fig. 4 Heat map of respondents' visual attention without nutritional labelling

Source: own processing based on Tobii PRO Studio 2024

After the addition of the nutritional labels as can be seen in Fig. 5, most visual attention was also focused on the cake labelled as EGGC, again most likely due to the ornamentation. The indicators themselves also attracted a high level of visual attention. An interesting finding is that most of the gaze was focused on the indicators labelled E and D, which may indicate that this was information that was minimally re-evaluated by consumers. This fact is documented by the impact on consumer choice itself in Tab. 3.

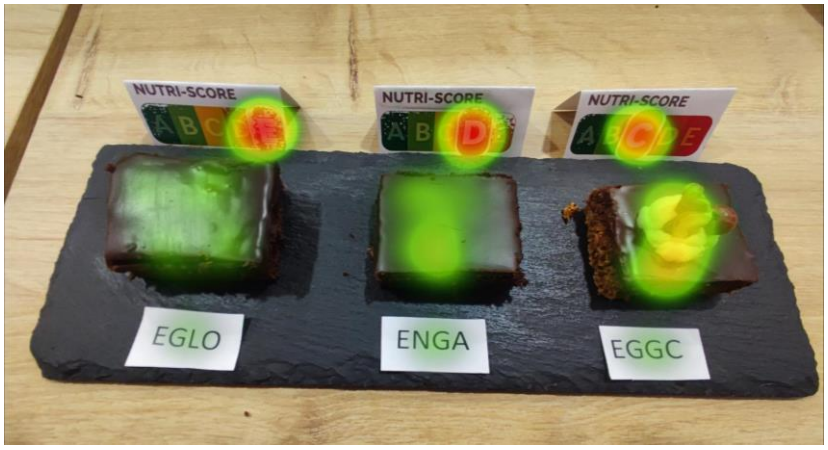

Fig. 5 Heat map of respondents' visual attention with Nutri-Score

Source: own processing based on Tobii PRO Studio 2024

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Respondents noticed the EGGC (Time to First Fixation 2.75 s) pattern first for the nutritionally labelled cakes. At the same time, they also spent the total time looking at this sample (Total Fixation Duration 3.41 s). The highest number of repeat visits was made to the ENGA sample (7). In terms of nutritional labels, the longest gaze time was spent on Nutri-Score - E (2.34 s). They noticed Nutri-Score- D (Time to First Fixation 3.51 s) first see. Tab. 3. The highest number of re-fixations was performed on the cake samples (9-11), but also on the nutritional labels (6-7).

Tab. 3 Areas of Interest (AOI) when choosing cakes with nutritional labelling

	Cake EGGC	**Cake EGLO**	**Cake ENGA**	**Name EGGC**	**Name EGLO**	**Name ENGA**	**Nutri-Score C**	**Nutri-Score D**	**Nutri-Score E**
Total Fixation Duration	3.41	2.39	2.34	0.60	0.52	0.54	1.91	1.86	2.34
Time to first Fixation	2.75	3.97	2.98	14.58	13.29	10.52	3.54	3.51	4.13
First Fixation Duration	0.41	0.36	0.22	0.22	0.19	0.20	0.44	0.38	0.39
Fixation count	11	8	9	3	3	3	6	7	7
Visit count	6	5	7	3	2	3	5	6	5

Source: Own processing based on Tobii PRO Studio 2024

Based on the measurement of electrical brain activity, processing of the recorded data, and after excluding outliers, a median score (engagement, arousal) for the selected emotions was obtained (Table 4). As can be seen, a higher emotional engagement score (0.91) was obtained when selecting cakes with a nutritional indicator, which may be related to the active involvement of the respondents in reflecting on the nutritional composition of the cakes. This difference was confirmed to be statistically significant between the cake sampling without and with FoPL.

Tab. 4 Measurement of electrical brain activity.

Samples	Engagement	Excitement
Without FoPL	0.69 ± 0.05	0.42 ± 0.25
With FoPL	0.91 ± 0.09	0.39 ± 0.18***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.00$

4. Conclusion

Based on the information gathered and its analysis, it is clear that eating cakes and desserts is a widespread practice among the participants, with most of them also visiting catering establishments where these delicacies are available. It was also found that healthy eating is important to most of the respondents. Moreover, our study revealed significant insights into consumer behaviour and preferences within the realm of food choices.

The impact of nutritional labels, specifically Nutri-Score, on consumer preferences is evident, as there have been changes in dessert choice following their introduction. Notably, respondents exhibited a keen visual attention to garnishes and nutritional indicators, indicating their

importance in consumer decision-making and preferences. Additionally, based on the measurement of electrical brain activity, processing of the recorded data, and after excluding outliers, a median score (engagement, arousal) for the selected emotions was obtained. A higher emotional engagement score (0.91) was observed when selecting cakes with a nutritional indicator, suggesting active involvement of the respondents in reflecting on the nutritional composition of the cakes. This difference was confirmed to be statistically significant between the cake sampling without and with FoPL.

These findings provide important insights about consumer behaviour in the context of foodservice product choice and can be used to formulate strategies for manufacturers and retailers in the foodservice industry. From an economic point of view, it is important for food manufacturers and retailers to understand that healthy eating and nutrition labels can influence consumer preferences and ultimately their profits. Investing in the development of healthy and nutritionally balanced products, as well as in their labelling, could help to expand the market and gain loyal customers. In addition, understanding consumers' visual attention and preferences could help to design more attractive packaging designs and marketing strategies. Manufacturers should also pay attention to the affordability of healthy alternatives to ensure that they are accessible to a wider group of consumers and thus increase their competitiveness in the market."

Acknowledgements

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The Influence of Marketing Communication Tools on the Consumer Behaviour of Generation Y

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Abstract
The post deals with examining the impact of marketing communication tools on the consumer behaviour of Generation Y. Generation Y, also known as millennials, represents an important demographic group for many businesses, characterized by their digital awareness, technological literacy, and interest in personal experiences. In the post, we identify marketing communication tools influencing the consumer decision-making process and purchasing behaviour, as well as the extent of the impact of these marketing communication tools. We present methods used to gather and evaluate data on the preferences of Generation Y across various forms of marketing communication. The contribution of the post lies in understanding the marketing behaviour of Generation Y and providing practical guidance to businesses for effectively targeting Generation Y.

Key words
marketing communication tools, consumer behavior, generation Y

JEL Classification: M31

1. Introduction

Generation Y, also known as millennials, represents a significant segment in the Slovak market. As of December 31, 2022, there were 1 583 011 Generation Y consumers living in Slovakia, accounting for 29.01% of the total population (Datacube, 2024). These are individuals aged 29 to 43, constituting a segment of society with substantial purchasing power. Besides being an important market segment, it is crucial to recognize that their consumer behaviour significantly differs from previous generations. Their preferences, purchasing habits, and loyalty are shaped not only by the quality of products and services but also by the way these products and services are presented and promoted. This post examines the impact of various marketing communication tools on the consumer behaviour of Generation Y. In the context of an ever-changing environment and increasing competition, understanding this impact is crucial for successful consumer relationship building and management. With advancements in technology and the dynamically expanding digital environment, marketing communication tools play a significant role in communicating with consumers. In the post, we formulate four research questions, which are subsequently verified through a questionnaire survey. The aim of the post is to provide practical guidance to businesses for effectively targeting Generation Y.

1.1 Marketing communication

Just as with the concept of marketing, there isn't a single definition for marketing communication. When examining marketing communication, various theories and perspectives are drawn upon, creating different ways of interpretation. Marketing communication stems from the basic philosophy of marketing, which involves understanding the market, customer needs, providing optimal solutions for their satisfaction, and conveying value (Kotler, Armstrong, 2019). In marketing communication, it's important to recognize that it comprises a

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collection of different tools, not just a single means. The ideal approach is when a company can coordinate these tools to create a clear, cohesive, and persuasive message about its activities and products (Hanuláková, 2021). There are several variations on how and what marketing communication can communicate with consumers. Through marketing communication, consumers can be informed about the place, time, manner, and reasons for using a particular product. It can also provide them with information about the manufacturer, company, and brand and can motivate or reward them for trying and regularly using the product (Berg, Behrer, 2012). Marketing communication represents a key element in the strategy of every company seeking to effectively address and engage its customers. It is a process through which organizations communicate with their target groups with the aim of creating, maintaining, and improving their relationships with the brand and products (Kusa, Zauskova, Cabyova, 2020). Authors such as Kotler and Armstrong (2019) point out that marketing communication consists of certain communication tools, such as advertising, sales promotion, and others. We agree with this assertion, therefore, we list these and other tools in Table 1.

Table 1: Marketing communication tools

Advertising	Newspapers and Magazines	Television and radio commercials	Promotional materials, Flyers, Billboards
Sales Promotion	Discounts, Bonuses, Gifts	Samples, Contests	Coupons and multipacks
Public Relations	Annual Reports	Press conferences and seminars	Charitable activities
Personal Selling	Product Presentations and Business Meetings	Participation in exhibitions and trade shows	Customer service after product purchase
Direct Marketing	Teleshopping, Telemarketing	Newsletters	Product catalogues
Event Marketing	Cultural and Sports Events	Product and service presentations	Festivals, Excursions, Corporate parties
Digital marketing	Company product websites	Email marketing	Video and photo sharing platforms (YouTube)
Social media marketing	Facebook, Instagram, Tik Tok, Twitter	Influencers, blogs	Viral marketing
Mobile marketing	Mobile phone search and online shopping	QR codes	Mobile app stores
Product placement	Product placement in movies or TV series,	Product placement in video games	Product placement in TV shows, cinema, theatre, music videos
Guerrilla marketing	Public space product or service images	Promoting a product or brand on car bodies	Graffiti

Source: Kotler, Keller, Hanuláková,

Marketing communication tools are various means and techniques that organizations utilize to achieve their marketing objectives and effectively interact with their target audiences. These tools are designed to engage and inform customers about a product, brand, or service and encourage them to take desired actions, such as making a purchase, registering, participating in an event, and more (Civelek, 2021). These marketing communication tools can be combined and customized according to the needs and objectives of a specific organization to achieve the best results in communicating with their customers (Kovanovienė, 2021).

1.1.1 Generation Y

In this case, customers from Generation Y are individuals born between 1981 and 1995 and belong to a generation known for their frequent use of modern communication tools,

considering internet communication as a natural part of life (Smolka, 2019). Generation Y differs from its predecessor by preferring a wide range of media, not just the internet. They regularly watch television, read newspapers, and listen to the radio. This diversity of preferences can be explained by their ability to multitask, as members of Generation Y can, for example, listen to the radio while simultaneously browsing the internet. As a result, they are not limited to a single media preference, as was the case with the previous generation (Lissitsa, 2021). Generation Y shows a strong preference for online shopping. The internet has become part of their daily lives, and they use it to seek information as well as to purchase goods and services. This generation prefers to shop from small independent retailers and brands that have strong social and environmental values (Seemiler, Grace, 2018). Some key characteristics of Marketing communication and consumer behaviour are inherently interconnected areas. With the emergence of Generation Y, or millennials, these relationships have evolved as this generation has brought new values, preferences, and ways of interacting with brands (Kopřivová, 2023). Generation Y has a significant influence on how brands communicate with their customers. To successfully engage this generation, businesses must understand the consumer behaviour of Generation Y and adapt their marketing strategies to reflect their values, preferences, and ways of interacting with advertising and brands (Luger, 2022).

2. Data and Methods

This post focuses on the consumer behaviour of Generation Y and its overall impact on this generation. The aim is to provide practical guidance to businesses for effectively targeting Generation Y. Generation Y represents approximately 30% of the population in the Slovak market. In this post, we initially established theoretical foundations by defining the most important concepts in this area. Subsequently, we conducted a questionnaire survey aimed at examining the consumer behaviour of Generation Y. We used the website vyplnto.cz for this survey. MS Excel was used for processing the results. The questionnaire consisted of 14 questions, which were dichotomous, closed, and semi-closed. The survey took place from July 9, 2023, to August 16, 2023. During this period, we approached 298 respondents. These respondents had different economic and social statuses, primarily including employed individuals, unemployed individuals, entrepreneurs, and students. The response rate of the questionnaire was 41.61%, representing 124 correctly completed questionnaires. Within the research, we established the following research questions:

- Are online communication tools more preferred than traditional tools by Generation Y?
- Which social network is preferred by Generation Y?
- What activities do individuals from Generation Y most frequently engage in on the internet?

Given the small number of respondents, we decided to primarily use graphical interpretation of our results to address the research questions, supported by the Chi-squared test. As part of the research, we formulated one hypothesis, which, like the research questions, was interpreted using a combination of graphical interpretation and the Chi-squared test. The hypothesis was as follows:

- **H_0**: There is a statistically significant difference between price and other factors in Generation Y's purchasing decisions.

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3. Results and Discussion

The following section of the article is dedicated to the results and analysis of responses from the questionnaire survey. A total of 124 questionnaires were processed and evaluated. The research sample consisted of respondents from Generation Y, individuals born between 1981 and 1995.

Research Question 1: Are online communication tools more preferred than traditional tools?
The main focus of our study was to examine the impact of marketing communication tools on the consumer behavior of Generation Y. Our findings are presented in Figure 1 and Table 2.

Table 2: Chi-square test marketing communication tools

Factor	Observed values	Expected values	Differences
Advertising	12	13.77	-1.77
Social media marketing	32	13.77	18.22
Digital marketing	17	13.77	3.22
Sales support	37	13.77	23.22
Mobile marketing	8	13.77	-5.77
Personal marketing	6	13.77	-7.77
Direct marketing	4	13.77	-9.77
Event marketing	4	13.77	-9.77
Public relations	4	13.77	-9.77

Source: own processing

- **Chi-square value (x^2):** 91.85
- **p-value:** 1.95×10^{-16}
- **Degrees of freedom (df):** 8

The research results confirm that Generation Y clearly prefers modern communication tools over traditional ones. The analysis of preferences revealed statistically significant differences among the various tools, as confirmed by the results of the Chi-squared test (x^2=91.85, $p=1.95\times10^{-16}$, df=8). The low p-value indicates that these differences in preferences are not random. The most preferred marketing tool was sales promotion, selected by 30% of respondents. This result is logical, as this tool offers financial and non-financial benefits, which can be attractive to consumers in the context of current product prices. The second most preferred tool was social media marketing (25.80%), reflecting the digital literacy and habits of Generation Y, for whom social networks are a natural part of life. In third place was digital marketing, chosen by 14% of respondents. Traditional marketing tools, such as advertising (9.67%), personal marketing (4.45%), direct marketing (3.19%), event marketing (3.22%), and PR (3.22%), achieved significantly lower values. These tools are less relevant for Generation Y, although they still play a certain role in reaching customers.

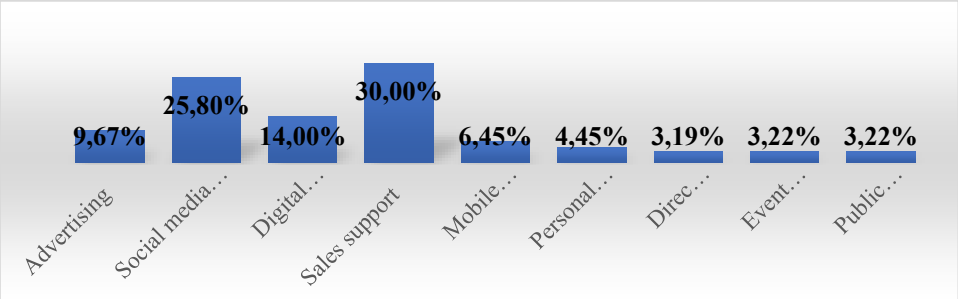

Figure 1: Preferred marketing communication tools

Source: own processing

Research Question 2: Which social network is preferred by Generation Y?

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The second research question was formulated based on the finding that Generation Y identified social media marketing as the second most preferred tool. As seen in Figure 2 and Table 3, Generation Y utilizes several social networks.

Table 3: Chi-square test social networks

Factor	Observed values	Expected values	Differences
Facebook	60	17.71	42.28
Instagram	36	17.71	18.28
LinkedIn	12	17.71	-5.71
Telegram	4	17.71	-13.71
Tik Tok	2	17.71	-15.71
Twitter	2	17.71	-15.71
Žiadnu	8	17.71	-9.71

Source: own processing

- **Chi-square value (x^2):** 91.85
- **p-value:** 1.95×10^{-16}
- **Degrees of freedom (df):** 8

The obtained research results reveal significant differences in social network preferences among Generation Y. The results of the Chi-squared test (x^2=91.85, p=1.95×10^{-16}, df=8) confirmed that these differences are statistically significant. Generation Y has clearly defined preferences, with some platforms being much more popular than others. The most preferred social network is **Facebook**, chosen by 60 respondents, representing 48.38% of responses. Compared to the expected value (17.71), Facebook has the largest positive difference (+42.28). This result clearly indicates that Facebook plays a key role in the online activities of Generation Y. The second most popular platform is **Instagram**, chosen by 36 respondents (29.03%), which is +18.28 above the expected value. In third place is **LinkedIn**, with 12 respondents (9.67%), although its share was below the expected value (-5.71). Conversely, platforms such as **Telegram** (4 responses, -13.71), **TikTok** (2 responses, -15.71), and **Twitter** (2 responses, -15.71) showed very low popularity, with negative differences compared to the expected value (17.71). Interestingly, 8 respondents (6.45%) stated that they do not use any social networks, which is -9.71 below the expected value. These findings indicate that social networks such as **Facebook** and **Instagram** are dominant platforms for Generation Y, together accounting for over 75% of preferences.

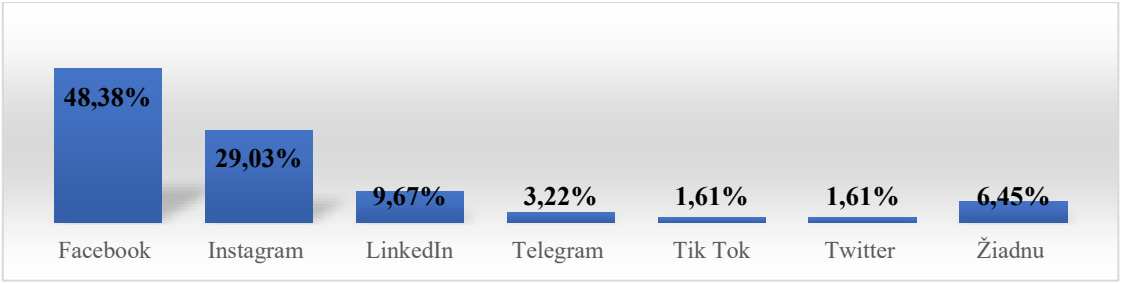

Figure 2: Preferred social network
Source: own processing

Research Question 3: What activities do individuals from Generation Y most frequently engage in on the internet?

In the following part of the research, we focused on the most common activities that Generation Y engages in on the internet. The following findings are presented in Figure 3 and Table 4.

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Table 4: Chi square test internet activities

Factor	Observed values	Expected values	Differences
Searching for information	40	15.5	24.5
Chatting with friends	36	15.5	20.5
Browsing social networks	10	15.5	-5.5
Watching movies and videos	3	15.5	-12.5
Work	5	15.5	-10.5
Shopping	24	15.5	8.5
Education	5	15.5	-10.5
Education	1	15.5	-14.5

Source: own processing

- **Chi-square value (x^2):**110.32
- **p-value:** 7.87×10^{-21}
- **Degrees of freedom (df):** 7

The obtained results revealed significant differences in the preferences for various online activities among Generation Y. The statistical analysis using the Chi-squared test (x^2=110.32, p=7.87×10^{-21}, df=7) confirms that these differences are not random but highly structured. The extremely low p-value indicates that Generation Y has clear preferences in how they use the internet. The most frequently performed online activities are searching for information, chatting with friends, and shopping, which together account for 80.63% of all responses. Searching for information was mentioned by 32.25% of respondents, exceeding the expected value by +24.5. This highlights the internet's crucial role as a tool for acquiring knowledge and solving everyday problems. Chatting with friends, the second most popular activity (29.03%), showed a difference of +20.5 compared to the expected value, reflecting the social nature of Generation Y and their reliance on online communication platforms. Shopping, chosen by 19.35% of respondents, had a positive difference of +8.5, underscoring the importance of the internet as a primary tool for making purchases. On the other hand, less popular activities include browsing social networks (8.06%, difference -5.5), education, work, and watching videos, all showing differences compared to expected values ranging from -10.5 to -12.5. While these activities are present, they are not priorities for Generation Y. The least preferred activity was listening to podcasts (0.80%), significantly below the expected value (-14.5), indicating that podcasts are not yet widely embraced by this demographic group. Based on these findings, it is evident that Generation Y primarily uses the internet for practical purposes such as searching for information, social interaction, and shopping.

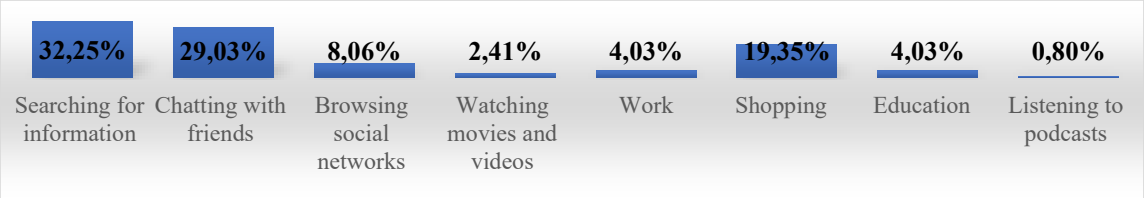

Figure 3: Activities on internet
Source: own processing

Hypothesis: There is a statistically significant difference between price and other factors in Generation Y's purchasing decisions.

In the final section, we focused on the factors influencing purchasing decisions. Specifically, we examined whether price is the most important factor in the purchasing decisions of Generation Y. The following values are shown in Figure 4 and Table 5.

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Table 5: Chi-square test purchase decision factors

Factor	Observed values	Expected values	Differences
Quality of the product or service	52	20.67	31.33
Reviews and recommendations	48	20.67	27.33
Price	16	20.67	-4.67
Personal experience	4	20.67	-16.67
Availability	0	20.67	-20.67
Brand	4	20.67	-16.67

Source: own processing

- **Chi-square value (x^2):** 132.26
- **p-value:** 7.89×10^{-27}
- **Degrees of freedom (df):** 5

The research focused on factors influencing the purchasing decisions of Generation Y, testing the hypothesis H_0: "Price is the most important factor influencing the purchasing decisions of Generation Y." The results of the Chi-squared test clearly showed statistically significant differences among the factors (x^2=132.26, p=7.89×10^{-27}, df=5). These differences indicate that not all factors are equally important to respondents, as the observed values deviate significantly from the expected even distribution. The most important factor influencing decision-making was found to be product or service quality, identified as the main factor by 41.93% of respondents, significantly exceeding the expected value (difference +31.33). The second most important factor was reviews and recommendations, preferred by 38.70% of respondents, with a difference of +27.33. These two categories clearly dominate the decision-making process. Price, which was examined as a potentially most important factor, was identified by only 12.90% of respondents, falling below the expected value (difference -4.67). This result proves the hypothesis and confirms that price is not the primary factor for Generation Y when making purchasing decisions. Less important factors included personal experience (3.22%), brand (3.22%), and availability (0%), with observed values significantly lower than expected. For instance, availability showed a difference of -20.67. Based on these findings, we conclude that Generation Y places a strong emphasis on product quality and trustworthiness, as reflected in reviews from other consumers. While price has some importance, it is not a key criterion for this generation. Therefore, we accept the hypothesis here is a statistically significant difference between price and other factors in Generation Y's purchasing decisions.

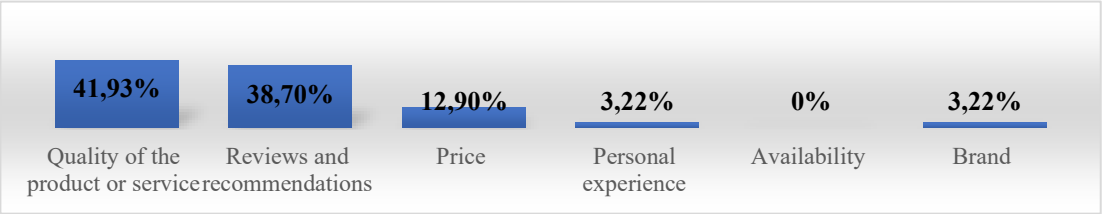

Figure 4: Factors purchasing decisions
Source: own processing

4. Conclusion

The impact of marketing communication tools on the consumer behavior of Generation Y represents a significant and dynamic phenomenon in today's digital age. Based on the analysis, we identified three key factors essential for a successful marketing strategy. The first factor is the importance of digital media and social networks. The second important factor is an integrated marketing approach. While digital channels dominate, traditional media cannot be overlooked. Generation Y still uses television, radio, and print media, so it is necessary to adopt an integrated approach encompassing multiple communication channels. The third key factor includes aspects influencing Generation Y's purchasing decisions. These include product or service quality, reviews and recommendations from other consumers, and price. These factors

significantly affect whether Generation Y will choose a particular product or service. When interpreting the results, several limitations of the study need to be considered. The research was geographically limited to Slovakia, making generalization to other markets challenging. The relatively low number of respondents reduces the statistical power of the findings, and seasonal factors during the summer of 2023 might also have affected the results. The study focused exclusively on Generation Y and did not compare their behavior with other generations. In the future, it would be interesting to compare the consumer behavior of Generation Y with other generations, such as Generation Z or X, and expand the research to an international level to examine cultural and geographical differences. Future studies could explore the long-term impact of personalized marketing on customer loyalty and analyse emotional and psychological factors influencing decision-making. Incorporating qualitative methods such as interviews or focus groups could provide a deeper insight into respondents' motivations. Understanding the preferences, values, and behavior of Generation Y is the key to the success of brands and companies looking to effectively engage and gain the loyalty of this target group. Marketing communication must be flexible, dynamic, and adaptable to successfully address challenges and seize opportunities in today's digital environment.

Acknowledgements

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New Standards in Sustainable Business and their Impact on EU Markets

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Abstract
After 20 years, the concept of corporate social responsibility (CSR) reached a qualitatively new level in the ESG (Environment, Social, Governance), emphasising sustainable development through environmental protection, social responsibility and business management. The new EU Corporate Sustainability Reporting Directive (CSRD) contains European standards for reporting sustainability information (European Sustainability Reporting Standards) and for their publication. This mandatory non-financial reporting for large companies will affect smaller companies shortly because, for example, banks already assess ESG factors when deciding on operating and investment loans and adjust interest rates accordingly. Also, large companies already require ESG information from their supply chains for reporting. The paper presents the CSRD legislation and its impact on the enterprise's sustainability.

Paper's objective(s) and research background
The background of a research paper brings the context about new standards in sustainable business and their impact on EU markets and the relevant literature to understand the research problem. The goal of the research is to bring new information to the solved issue of sustainable business in the EU and to point out the state of the issue in the packaging industry with the introduction of Regulatory rules for packaging.

Data/Methods
In the presented article, the authors analyze the EU directives that determine companies' obligations for ESG reporting using a uniform methodology according to the CSRD directive.

Results/Conclusions/Value added
The European Commission, aware of the shortcomings in the existing rules for disclosing non-financial information about organizations in the NFRD (Non-financial Reporting Directive), proposed their amendment through the new CSRD (Corporate Sustainability Reporting Directive). The article provides a comparison of both directives. The results show a case study of ESG application in a packaging company and simultaneously bring structured information about Regulatory rules for packaging.

Key words
CSR, CSRD, EST, sustainable business, packaging industry

JEL Classification
L10, L52, L60, O25, Q53

1. Introduction

Integrating the latest principles into business strategies and investment decisions allows companies and investors to consider their long-term impact on the environment, society and economy (Tsang et al., 2023) while achieving sustainable and responsible development (Nirino et al., 2021). The European Green Deal represents the European Commission's plan for the ecological transformation of the European Union's economy in the interests of a sustainable

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future. The world, including Europe, will have to deal with increasingly frequent and difficult challenges in the field of environment and climate change. The European Green Agreement should represent a tool for facing the given challenges and turning them into opportunities (Šebejová, 2024).

New standards and obligations of organizations for environmental, social and governance (ESG) reporting using uniform ESG criteria and a uniform methodology are set by the new CSRD (Corporate Sustainability Reporting Directive). ESG criteria are becoming an increasingly important part of investment decisions and business strategies, becoming an integral part of discussions on sustainability and responsible business (Al-Hiyari et al., 2022) and, at the same time, a key indicator of management competence, risk management and non-financial performance (Cucari et al., 2017). For investors, ESG factors represent a way to evaluate not only financial performance but also companies' social and environmental responsibility (Huang, 2019). Over the past two decades, many firms, especially large multinationals, have intensified their efforts to report on ESG matters to legitimize their behaviour and improve their reputation (Fatemi et al., 2018). For businesses, ESG criteria challenge adapting to the growing demand for transparency, accountability and sustainable growth (Nirino et al., 2021). Despite this widespread recognition of the importance of ESG practices and the many positive initiatives around the world that have been about social and environmental practices, the world still suffers from social inequalities, violence and deprivation. The basic requirements of life and the state of the environment in general are getting worse (Eliwa et al., 2021). Current contributions consider ESG activities to have the potential to increase firm value (Fatemi et al., 2018). At the same time, ESG performance is an important aspect of corporate strategy, which reflects a company's ability to maintain good relations with various stakeholders (Nekhili et al., 2019).

1.1 ESG aspects

ESG is an acronym that indicates environmental, social and governance aspects (Environmental, Social, Governance) of sustainable investment and business (Al-Hiyari et al., 2022). These three factors have become key to evaluating sustainable, responsible investment and business practices. The basic principle is the integration of environmental, social and governance factors into investment and business decisions to achieve sustainable and responsible development (Li et al., 2017). This approach emphasizes that companies and investors should consider financial performance and their impact on the environment, society and governance (Nirino et al., 2021). A closer look at each of these aspects is processed in Table 1.

Table 1: ESG Aspects

	Aspects
Environmental	It concerns the environmental impact of business and investments. It includes issues such as greenhouse gas emissions, energy and resource use, biodiversity conservation, waste management and climate impact. Companies and investment funds are increasingly evaluated based on environmental policies and initiatives to reduce their ecological footprint. The goal is to minimize companies' negative impact on the environment and contribute to the protection and sustainable use of natural resources.
Social	This aspect concerns social factors such as human rights, working conditions, diversity and inclusion, employee safety and health, and customer and community relations. The goal is to support a fair, inclusive, ethical working environment and contribute to social stability and

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Governance	development. In recent years, investor demand for companies with a significant commitment to social responsibility has increased. This aspect focuses on companies' management and organizational structures, such as transparency, ethics, quality of leadership, independence, accountability, and compliance with legal and regulatory requirements. The aim is to ensure efficient and transparent company management and the protection of interested parties' interests.

Source: Modified by Christensen et al., 2019, Broadstock et al., 2020, Al-Hiyari et al., 2022

1.2 Application of ESG standards

The ESG report is a report on activities in the fields of environment, fair approach to employees, and ethical way of doing business that large companies will be obliged to publish from 2025. This step is based on the essence of the EU as a community of values, which in all areas of activity tries to harmonize economic development with the conditions for a quality life of its inhabitants (Eurostat, 2022).

This legislation covers only a few companies and, therefore, does not something in this area. Moreover, this may be a fatal flaw shortly. However, the relationships and needs in the supply-customer chain are an even stronger influence than legislation. Ignoring ESG can lead the company to lose business partners, as they will require it not because of legislation but because of their convictions (European Sustainability Reporting Standards in a nutshell, 2023).

The RepTrak 2020 study shows that companies with an excellent reputation motivate 78% of consumers to buy their products, and vice versa; with a bad reputation, less than 10% of people are open to buying products from such companies. This is how brands also stand out in the market. Moreover, it also concerns the labour market. An excellent reputation is why three-quarters of people work for such a company (European Sustainability Reporting Standards in a nutshell, 2023).

The main features of CSRD are:

- mandatory inclusion of information on sustainability in reports on business management,
- mandatory external assurance of their correctness and truthfulness,
- introduction of mandatory European standards for reporting information on sustainability (ESRS, from the English European Sustainability Reporting Standards),
- subsidiaries are not required to report this information if it is included in a consolidated report that meets CSRD requirements,
- digital marking of messages for automated machine reading.

According to CSRD, the European Sustainability Reporting Standards are the upcoming standards for the disclosure of sustainability information. Similar to financial reporting, they represent a summary of indicators and fixed rules for their calculation and publication. As of August 2023, twelve ESRS standards are already in place, marking a significant step forward. Furthermore, specific standards for various sectors and SME organizations are in the pipeline, with the first proposals expected in 2024. The application of sector standards is anticipated to commence in 2026, keeping you well-informed and engaged in the process. Technical guidelines for introducing machine readability of ESRS reports (XBRL taxonomy) and special guidelines for supply chain activities and for performing significance analysis (European et al. in a nutshell, 2023) are also being prepared.

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ESRS 1 and ESRS 2 - general requirements and disclosures

ESRS 1 contains mandatory principles for preparing and disclosing sustainability reports by the CSRD. The standard covers reporting areas and specifications regarding due diligence obligations, value chain, and time specifications. It also defines how sustainability information must be collected and presented. ESRS 1 also requires that individual standards undergo a materiality assessment. According to ESRS 1 the materiality assessment is based on the double materiality principle. It represents the main CSRD tool for identifying and reporting impacts, risks, and opportunities by individual ESRS. Materiality assessment is a specific tool for creating targeted reporting content. If some aspects are classified as insignificant, a detailed explanation is required.

ESRS 2 specifies the general characteristics and information, such as policies, measures and objectives, that must be reported regardless of the outcome of the materiality assessment. In addition, ESRS 2 specifies the structure and content of ESRS thematic standards. It defines a total of four areas of information disclosure:

- Administration and management (Governance, GOV)
- Strategy (Strategy, SBM)
- Management of impacts, risks and opportunities (Management of impacts, risks and opportunities, IRO)
- Metrics and targets (Metrics and targets, MT)

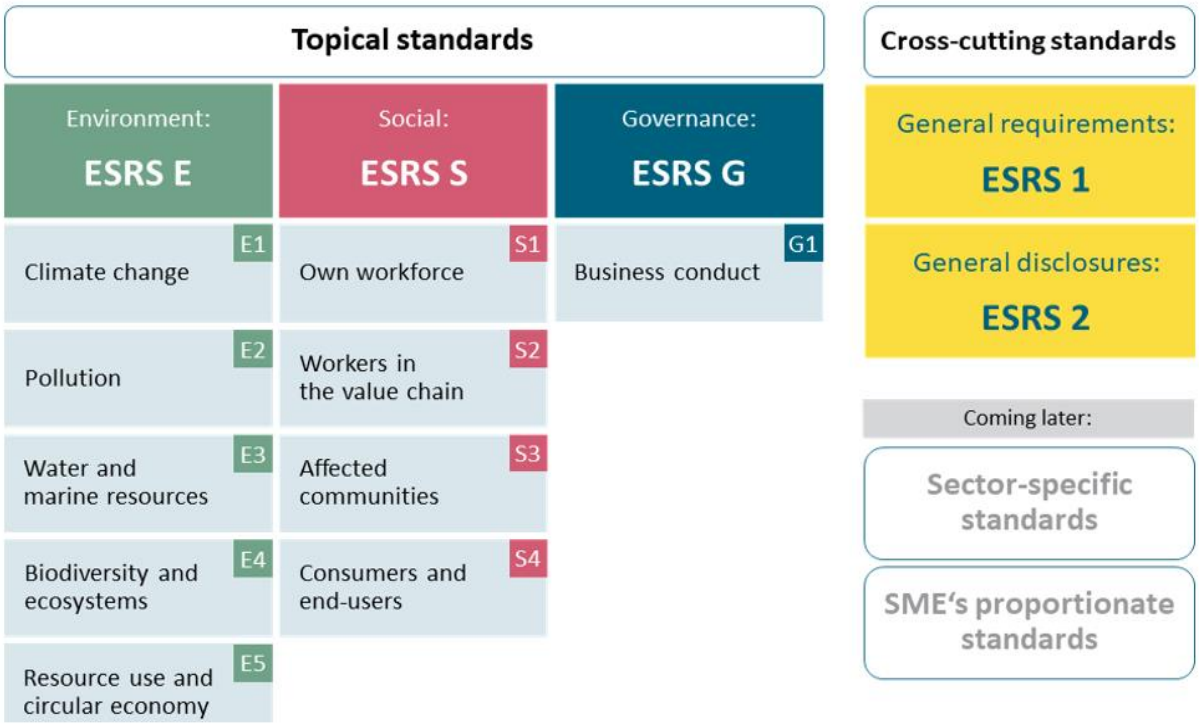

Figure 1: ESRS standards
Source: European Sustainability Reporting Standards in a nutshell, (2023)

2. Data and Methods

In the presented article, its authors use a unified methodology to analyze the EU directives that determine companies' obligations for ESG reporting. At the same time, we point out a case study for ESG applications in packaging company.

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The **CSRD** (*Corporate Sustainability Reporting Directive)* sets new standards and obligations for companies for environmental, social and governance reporting using a unified methodology. It is focused on performance disclosure and modelling future strategies and scenarios for effective ESG risk management. For the first time, this will effectively facilitate the publication of information on sustainability. The information will thus be consistent, comparable, and reliable and will also be included in the decision-making process for investors. On the one hand, this will significantly impact the organizations concerned with how they monitor, measure and report their sustainability. However, these requirements for accountability and transparency will be reflected in the organization's advantages in the competitive environment and increase its business efficiency.

CSRD is the first regulatory tool to focus on sustainability and ensure prosperity for future generations by bringing a holistic approach across ESG at such a broad and deep level of detail. It changes the way organizations must disclose and report ESG data. It replaces the Non-Financial Reporting Directive NFRD (Non-Financial Reporting Directive, Directive 2014/95/EU of the European Parliament and the Council of October 22, 2014).

The new rules will come into effect on the following dates:

- from January 1 2024, for companies that are already obliged to publish non-financial information,
- from January 1, 2025, for all large companies and
- from January 1, 2026, small and medium-sized enterprises listed on the stock exchange, small and uncomplicated credit institutions and captive insurance companies
- from January 1, 2028, for companies outside the EU, as long as they have substantial operations in the EU (turnover of min. EUR 150 million in the EU).

2.1 Comparison of the CSRD Directive with the NFRD Directive

The European Commission, aware of the shortcomings in the existing rules for publishing non-financial information regulated by the NFRD, proposed their amendment through a new directive. The NFRD needed to meet the expectations that investors would be provided with comprehensible, sufficient, and comparable information on its basis. The CSRD introduces more detailed reporting requirements and expands the range of companies covered. From now on, all large companies will have to publish information related to the sustainability of their economic activity (e.g. information on environmental rights, social rights, human rights or factors affecting corporate governance).

This new directive will apply to:

- large companies, i.e., j. companies meeting at least two of the following three criteria:
  - at least 250 employees,
  - total amount of property (assets) at least 20 million EUR,
  - net turnover of at least 40 million EUR,
- all companies on the stock exchange on regulated markets, including small and medium-sized enterprises (10-250 employees). CSRD does not apply to micro-enterprises (up to 10 employees).
- companies not based in the EU have at least one subsidiary or branch here, and their net turnover in the EU exceeds 150 million EUR.

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Table 2: Comparison of the CSRD Directive with the NFRD Directive

Scope and requirements of the directive	NDRD	CSRD
Affected organizations	Large "public interest" entities with more than 500 employees (listed companies, banks and insurance companies	Large companies meeting 2 of 3 criteria: more than 250 employees; turnover higher than 40 mill. EUR; total assets higher than 20 mill. EUR Listed companies on regulated EU markets except for micro-enterprises
Number of organizations affected	11,600	49,000 – covering 75% of the total turnover of companies in the EU
Content of reported reports	Companies report on 5 dimensions: - Environmental Protection - Social responsibility and treatment of employees - Observance of human rights - Fight against corruption - Diversity in company boards Companies must report in each dimension: - Politics - Policy results - Risks - KPIs It focuses on its own employees	New European standards will be adopted. Other requirements include: - The principle of double materiality - Sustainability risks, including climate change, that affect the organization - The impact of organizations on society and the environment - The process of selecting important topics for stakeholders - Includes a value string - More forward-looking information, including goals, progress and strategy - Disclosure of information related to intangible assets (social, human and intellectual capital) Reporting in line with the Sustainable Finance Disclosure Regulation (SFRD) and the EU Taxonomy
Legislative obligation	Optional	Mandatory and subject to external certification with limited validity for the first three years and periodically after that
Reporting location	Part of the annual report. Sustainability report	Part of management. Single report in "digital machine readable format".
Reporting format	online PDF	In electronic form

Source: Bureau Veritas, 2023

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3. Results and Discussion

3.1 Case study in packaging company

Slovak company Chemosvit Folie, s.r.o., Svit is the largest company of CHEMOSVIT GROUP and focuses on the production, converting and sale of packaging plastic films. Tradition, decades of experience and high-end technologies predispose us to being a reliable partner for their customers in all industries where its products are used. The company is one of the European leaders in packaging solutions and has been systematically dedicated to protecting the environment for a long time, which results in its activities in the field of CSR and subsequently also in the field of ESG. In 2023, the company and external consulting organizations, suppliers, and customers organized several workshops for the entire Chemosvit group to prepare for adopting the new legislation. They agreed on mutual benefit for all business partners. Everyone has to start from themselves, and together, they will be stronger, inspiring others because an individual will not change the planet's fate, but together, it will succeed.

Results from the familiarization of the whole group:

- explanation of trends and legislation related to sustainability, the opening of questions, mutual recognition of ESG requirements of business partners in the supply chain (company SUSTO-Sustainability Tools),
- a sophisticated energy consumption management system for the entire Chemosvit group (Chemosvit company),
- staying updated on trends and new sustainable material structures, as well as current mechanical and chemical methods of plastic recycling (company Chemosvit Folie), is essential for making informed decisions for sustainable practices.
- sustainability at the world's top manufacturer of lines for the production of packaging films and its view on the future of plastics (company Brueckner),
- sustainability in waste sorting, with an emphasis on plastic waste, producer responsibility, and the formation of new legislation in the field of packaging waste management (NATUR-PACK company).

The adoption process of the CSRD directive was designed in three key areas:

Analysis of the current state of ESG

The goal is to determine the current state of non-financial reporting and to what extent current and expected future requirements are being met. It focuses on the availability of the necessary data sets, as well as processes and systems for collecting, aggregating, analyzing, calculating, and reporting non-financial information and indicators. Assessment of materiality. Application of GAP analysis.

Recommendations

Elimination of identified deficiencies and improvement of processes and systems.

Transformation strategy in the field of ESG

CSRD makes sustainability reporting much more comprehensive. ESRS deals with virtually every known and new topic of sustainability, such as biodiversity, climate strategies, and circular economy. In particular, the ESRS standard on climate change (ESRS E1) defines high requirements for measures to mitigate and manage climate risks. In addition, reporting must comply with the EU Taxonomy Regulation. According to the CSRD, all organizations will be publicly accountable for their impact on people and the environment. The quality, consistency and credibility of ESG data will improve, allowing capital to flow into sustainable projects.

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3.2 Regulatory rules for packaging

The following table shows the new regulations for packaging within the **Packaging and packaging waste regulation** (PPWR), which companies operating in the packaging industry are obliged to follow and fulfil.

Table 3: Regulatory rules for packaging

Regulations	Description
All packaging recyclable	From 2025 fulfil 3 criteria – sorting, substitution, collection From 2030 designed as recyclable From 2035 recyclable at scale License fees to be paid by producers of packaging based on the recyclability grades of the products Plastic packaging producers will have to consider also recycled content
Be-use and refill	Targets for a proportion of packaging to in reusable/ refillable form First to come into force in 2030 ranging from 5% to 30% based on product type Restriction of certain single-use transport packaging and 100% reuse quotas in these cases (e.g. bulk containers) De facto ban of straps and wrappings Increase in closed loop cycles
Deposit return schemes	Mandatory deposit and return system from 2029 for plastic and metal beverage bottles/ containers Exception for wine, spirits and milk Steep decrease of demand for virgin plastic bottles and metal cans especially in countries where is no deposit system at all Rise of collection systems
Waste recycling targets	In 2025 65% of all packaging waste shall be recycled, 70% in 2023 Targets for plastic waste recycling to reach 50% in 2025 and 55% in 2030 Re-design of products into monomaterials Significant investments needed into collection, sorting and recycling Overall rise in R&D spending
Minimum recycled content targets	In 2030 non-PET food contact-sensitive packaging should contain at least 10% of recycled material and other non-PET food packaging should contain at least 35% These should increase to 50% in 2040 Higher prices of contact-sensitive packaging (higher need of recycling, chemical for flexible packaging) Rise of compostable and possibly bio-based plastics
Bans on single-use products	Plastics carrier bags reduction from 2025 – not to exceed 40 bags per person yearly Additional restrictions on single-use packaging, e.g. shrink wraps for multipacks Lower or no production of carrier bags, shrink wraps for group packaging, bags used to package fresh fruit, miniature packaging for hotels and many others

Source: Authors own processing

3.3 ESG standards for other industries and SMEs

Although the presented contribution discusses the application of ESG standards for the packaging industry, a detailed analysis of the ESG issue allows for transferring generally valid principles to other industry sectors, emphasising SMEs. The specificities of SMEs and the need to implement ESG into a key part of corporate reporting are highlighted, for example, by (Gjergji et al., 2020), (Papademetriou et al., 2023). They agree that most studies focus on large

companies, but the effects of ESG on SMEs have not been sufficiently investigated. SMEs represent 90% to 99% of all companies worldwide and in the EU; therefore, it is important to understand their specificities. The studies are based on analyses of SMEs from dozens of countries (Gangi et al., 2018), specifically Italian SMEs (Gjergji et al., 2020), or companies outside the EU, specifically from South Africa (Epoh, L. R., & Mafini, C., 2018).

They also agree on the benefits that ESG brings, regardless of the geographical location of the companies. It is not only philanthropy but also a strategic tool to improve enterprises' financial stability and long-term survival, increase investor confidence in obtaining better access to finance, and increase overall competitiveness. They recommend introducing financial support so that ESG reporting is not a financial burden for them. In (Papademetriou et al., 2023), an important aspect of people orientation in SMEs is emphasised: how enterprises can integrate environmental strategies into HR practices to create a sustainable and motivating work environment. Enterprises need a new business management model that will help them move from traditional HR strategies to environmentally oriented *Green Human Resource Management* (GHRM).

4. Conclusion

By introducing the ambitious European Green Deal, the ultimate goal is to achieve carbon neutrality (i.e. zero total positive and negative carbon emissions) by 2050; the EU is committed to transforming the European economy and promoting sustainable business models. To achieve this, it is necessary to define which activity is sustainable clearly, and this is where the EU taxonomy comes into play. The EU taxonomy is a system of classification of economic activities that establishes a list of those that are sustainable from the point of view of environmental protection. It gives companies, investors, and politicians proper definitions of activities that can be considered environmentally sustainable. This way, it should create a sense of security for investors, protect private investors from greenwashing, help companies behave more environmentally and climate-friendly, and direct investment flows where they are most needed. The taxonomy regulation was issued in June 2020. It sets the basis for the EU taxonomy by defining six environmental objectives and clarifying in detail the four conditions for economic activity to be considered environmentally sustainable.

Six environmental goals: mitigation of climate change, adaptation to climate change, sustainable use and protection of water and marine resources, transition to a circular economy, prevention and control of pollution, protection and restoration of biodiversity and ecosystems.

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Towards Improving Business Relationship Management from AI Perspective

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Abstract

Paper's objective and research background

In today's competitive business landscape, effective business relationship management (BRM) is essential for organizational success. This paper explores the integration of artificial intelligence (AI) methods to enhance BRM practices. Key concepts such as relationship management, key account management, and customer focus underscore the importance of BRM in modern management strategies. Leveraging a data-driven approach, the research investigates the potential of AI for data analysis and communication within BRM systems.

Data/Methods

Through a comprehensive literature review spanning a decade (2014-2024), this study elucidates the significance of strong relationships in achieving organizational objectives efficiently. Traditional decision-making processes often suffer from knowledge silos and information gaps among stakeholders. To address these challenges, the paper introduces the concept of Collaborative Business Intelligence (CBI). CBI fosters collaboration, knowledge sharing, and improved communication among stakeholders.

Results

The study proposes a BRM framework that integrates AI techniques and CBI principles. By synthesizing insights from the literature review, the framework emphasizes data-driven performance management, informed decision-making, and continuous improvement in BRM practices. The contributions of this research are translated into actionable recommendations for practical implementation, enhancing the effectiveness and efficiency of BRM strategies in contemporary business environments.

Key words

Business Relationship Management, Artificial Intelligence, Framework, Collaborative Business Intelligence

JEL Classification

M30, M19, O31

1. Introduction

In the contemporary world of fiercely competitive markets, adept management of business relationships stands as a cornerstone for organizational triumph. The business relationship management (BRM) is essential for organizational success. Recognizing the imperative of harnessing data-driven methodologies, we delve into the potential of Artificial Intelligence (AI) in augmenting both data analysis and communication facets within BRM frameworks. Leveraging AI-driven analytics, organizations can glean actionable insights from vast troves of data, unraveling hidden patterns and trends to inform strategic decision-making processes. By harnessing AI-powered communication tools, such as chatbots and virtual assistants, businesses can streamline interactions with stakeholders, ensuring timely and personalized responses to inquiries and concerns.

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BRM entails the systematic cultivation and nurturing of relationships with various stakeholders, including customers, partners, suppliers, and internal teams (Jain, 2015). Central to BRM are concepts such as relationship management, key account management, and a relentless focus on customer satisfaction (Malaviarachchi, 2021). Traditionally, businesses relied on manual methods and subjective assessments to manage relationships with stakeholders. However, with the advent of technology, particularly Artificial Intelligence, new avenues have opened up for transforming BRM practices (Kraus, Durst Ferreira, Veiga, Kailer, & Weinmann, 2022).

AI holds immense potential for enhancing communication within BRM systems. Through natural language processing (NLP) and sentiment analysis, AI-powered tools can decipher the tone and intent behind communications, enabling organizations to respond proactively to emerging issues and opportunities (Cherednichenko, Ivashchenko, Lincényi, and Kováč, 2023). Additionally, AI-driven chatbots and virtual assistants can streamline communication channels, providing stakeholders with timely assistance and support (Masche & Le, 2017).

This research aims to explore the potential of AI for data analysis and communication within BRM systems. The main goal of AI information technology development is to continually enhance and innovate the capabilities, efficiency, and utility of digital tools and systems to meet evolving technological, business, and societal needs. The main objective of our research is to propose AI-based BRM framework, which enhancing user experiences in BRM practices and related applications. To delineate the scope and direction of our inquiry, we formulate the following research question: *How might artificial intelligence techniques be effectively harnessed to amplify the efficiency and effectiveness of business relationships?*

The rest of the paper is structured as follows. The next section depicts the concept of business relationship management and reasons to use Artificial Intelligence for it. The state-of-the-art is presented. Then Collaborative business intelligence issues are highlighted. The third section describes a brief summary of the AI methods and BI tools and represents the AI-based BRM framework as well as our findings derived from a case study. And finally, we conclude our results.

2. Data and Methods

At the heart of organizational dynamics lies business relationship management, a vital function governing every facet of an organization's engagement with both current and prospective customers. This practice is indispensable for nurturing enduring and robust alliances between service providers and customers, grounded in a comprehensive comprehension of customer requirements. Functioning as a conduit, it not only facilitates the fulfillment of these needs but also discerns avenues for necessary adaptation and enhancement. Business relationship management epitomizes a strategic approach wherein an organization cultivates continuous, mutual relationships with various stakeholders.

To systematically organize existing research on business relationship management, we adhere to the methodological framework delineated by Kraus, Breier, and Dasí-Rodríguez (2020). This entails the development of a literature review protocol that defines the selection criteria for the study. Subsequently, relevant articles were gathered from the online Mendeley database. Established in 2007, the Mendeley database serves as a free reference management tool, offering functionalities to store, organize, annotate, share, and cite references and research data. It aggregates a vast array of scholarly content from diverse sources such as Web of Science, Scopus, Google Scholar, among others, providing a comprehensive overview of global research endeavors.

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The analytical process unfolded through the following steps: Firstly, a comprehensive search was conducted encompassing publication titles, keywords, and abstracts, targeting research literature published between 2014 and 2024. This initial inquiry yielded 9,479 open accessed research papers (see fig. 1).

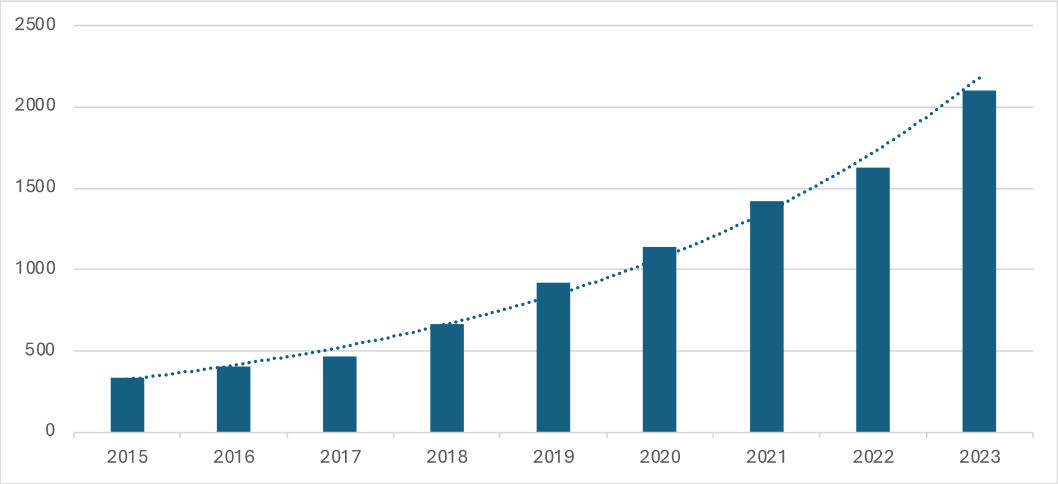

Figure 1: The trend of publications related to BRM
Source: author's calculations

Further refinement ensued in the next step, wherein the search was narrowed down to encompass only those contributions featuring the term "business relationship management" within their titles (see fig. 2). This meticulous curation reduced the corpus of research papers to a final tally of 64.

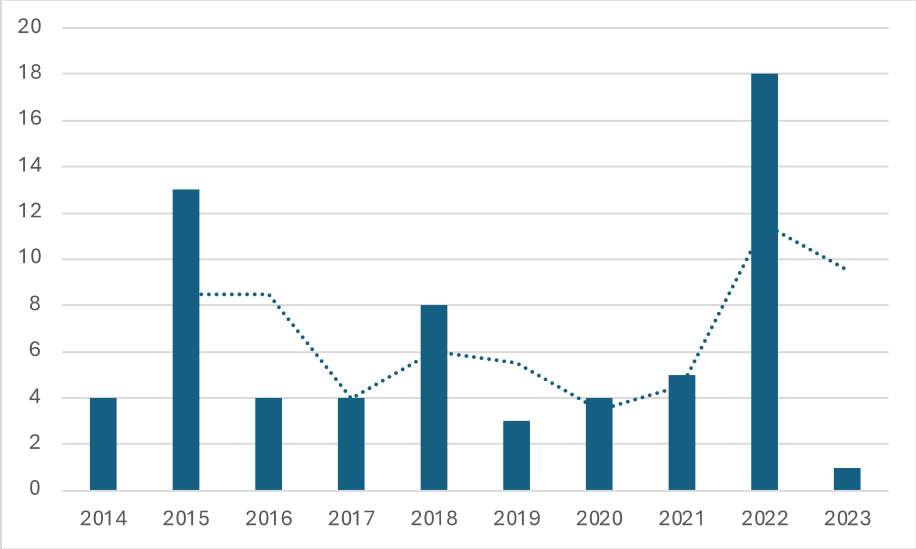

Figure 2: The number of publications with the "business relationship management" term in the title
Source: author's calculations

Companies engage in business activities to fulfill their objectives, which may involve developing products, creating markets, and manufacturing goods (Jain, 2015). In the scope of business-to-business transactions, it is customary for suppliers to serve multiple customers for the products and services they offer, just as purchasers typically engage with multiple suppliers for their procurement needs. Consequently, a specific relationship between a supplier and a purchaser represents only a fraction of the broader network of business relationships shared by the two parties (Suneetha, 2021). Business relationship management embodies a strategic

approach centered around fostering enduring exchange relationships between a supplying company and its customers. This approach hinges on recognizing and capitalizing on the enduring nature and significance of these relationships. Furthermore, it directs marketing efforts towards cultivating and sustaining customer loyalty, with a particular emphasis on encouraging repeat purchases.

Business Relationship Management constitutes a strategic methodology aimed at cultivating and nurturing business relationships between a service provider and a client. Central to BRM is a comprehensive understanding of the client's needs and requirements, serving as the foundation for building enduring partnerships. BRM shares commonalities with Customer Relationship Management (CRM), leveraging similar concepts and principles. CRM encompasses all facets of an organization's interactions with its customers, focusing on fostering positive relationships across various touchpoints.

The initial query was changed into “customer relationship management”. We found out 6,437 papers restricted by the same criteria. Then we reduce the corpus of research papers by featuring the term "customer relationship management" within their titles and receive 2,681 results. However, BRM diverges from CRM and Enterprise Relationship Management (ERM) in its distinct emphasis on the broader spectrum of business relationships beyond customer interactions. While CRM predominantly concentrates on managing customer relationships, BRM encompasses a wider scope, extending beyond mere client-vendor interactions. It encompasses a holistic approach to managing relationships across multiple stakeholders, encompassing vendors, partners, and internal teams. Moreover, BRM transcends the role of a liaison aligning business objectives with IT deliverables, embracing a strategic perspective that integrates business objectives with IT strategies to drive organizational success.

In the past decade, the landscape of digitization has undergone significant advancements (Secundo, Rippa, & Cerchione, 2020). According to findings by Hofacker, Golgeci, Pillai, & Gligor (2020), several key areas are pivotal in comprehending forthcoming trends in digital marketing and business-to-business (B2B) relationships. These include coopetition, value co-creation, B2B branding, innovation networks, relationship dynamics, and aspects of power and trust. The decision-making process in contemporary business environments is intricately intertwined, often reliant on critical information possessed by decision-makers. The management of vast datasets frequently falls under the purview of data analysts, highlighting the indispensability of Business Intelligence (BI). However, a notable challenge persists in bridging the communication gap between technical specialists, decision-makers, and business process analysts. Addressing this challenge underscores the significance of Collaborative Business Intelligence (CBI) (Rizzi, 2012).

Efficient communication is essential for organizational success across various domains, including product development, customer relations, personnel management, and virtually every operational facet (Rashi, Rao, Kamuni, & Patil, 2024). Conversely, Hazée, Zwienenberg, Van Vaerenbergh, Faseur, Vandenberghe, & Keutgens (2020) contend that customers and peer service providers may exhibit reluctance towards collaborative consumption due to a complex array of multidimensional functional and psychological barriers. These barriers encompass perceptions related to complexity, value, risk, compatibility, contamination, image, and responsibility, which may impede participation in collaborative processes.

AI algorithms can leverage predictive analytics to forecast customer behavior, such as purchasing patterns, churn risk, and future needs. By anticipating customer needs and preferences, organizations can proactively engage with clients, address potential issues, and offer personalized solutions, thereby enhancing customer satisfaction and loyalty. We can conclude that 77077 research papers featuring with “artificial intelligence” in their titles from

2014 till 2024 are indexed at the Mendeley database that is the hype of artificial intelligence (AI) is pointed. AI technologies enable organizations to harness the power of big data and derive actionable insights from diverse data sources, including customer feedback, market trends, and social media interactions. But the only 61 papers are obtained after restricting the query by adding the "customer relationship management". And as a response for the combination of “artificial intelligence” and "business relationship management" we can obtain the only 2 papers.

As we can conclude, AI-powered BRM systems can analyze customer interactions, purchase history, and preferences to provide insights that help build stronger relationships with clients. By understanding customer needs and behavior patterns, organizations can tailor their offerings and communication strategies, thereby fostering more meaningful and productive relationships. The chatbots and virtual assistants can streamline communication channels and provide immediate assistance to clients, suppliers, and partners (AlGosaibi, Sait, AlOthman, & AlHamed, 2020). These AI-powered interfaces can handle routine inquiries, resolve simple issues, and escalate complex queries to human agents, ensuring prompt and efficient responses, and enhancing overall communication experiences. y leveraging AI-driven analytics tools, BRM professionals can make informed decisions, identify emerging opportunities, and mitigate potential risks, thereby optimizing business processes and enhancing stakeholder relationships.

Thus, Artificial Intelligence holds significant promise in enhancing Business Relationship Management practices through its ability to analyze vast amounts of data, identify patterns, and automate certain tasks. This article presents findings derived from a case study to better understand the factors driving the value of AI for adoption in business processes. Based on these findings, we formulate practical recommendations for improving business relationship management (BRM) by implementing a BRM framework that utilizes data-driven and collaborative approaches.

3. Results and Discussion

To create value, organizations are looking to leverage AI technologies that address major pain points. Analysis shows that AI plays a key role in solving business problems. AI as a technology can not only increase automation of business processes but also help find insights and innovative solutions. Specifically, AI can handle customer inquiries more efficiently, which reduces costs. AI algorithms can identify meaningful patterns in unstructured data, which, in addition to supporting existing workflows, benefits from reviewing and evaluating the process itself. Because AI can create content, it can transform business models and deliver new services itself. People on the other hand, complement AI by becoming learning experts who contextualize knowledge or by creating advanced use cases based on tandem.

Whether the value of using AI is automation, insight generation, decision empowerment, or business model building, organizations must define a strategy, build a set of initiatives, and develop a strategy to create the necessary supporting capabilities. Consider the example of the company Brother International Corporation and the results of AI adoption at that company.

Brother International Corporation, a leading provider of office and business equipment, was faced with the need to improve its employer brand and attract talented candidates. The company needed to: create an attractive career website, personalize job recommendations, implement a chatbot to communicate with site visitors, and optimize the application process. The company has implemented the following AI tools:

1. Personalized career site with AI job recommendations.

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2. A chatbot for interacting with candidates.

3. a CRM system for screening passive candidates.

4. AI analytics to optimize the application process.

After three weeks of working with the new AI tools, Brother has achieved impressive results. The number of completed applications increased by 140%. The total number of page views increased by 45%. The number of applicants increased by 15%. As a result, the company was able to reduce job closing times by 25%. In six months of using the new solutions, the company realized more than 250,000 interactions with candidates, 35,000 unique visits were registered. The number of calls to the HR department decreased from 50 to 1-2 per week.

Thus, the implementation of AI technologies allowed Brother International Corporation to significantly improve the hiring process, making it more efficient and attractive to candidates. The company was able to automate routine tasks, improve interaction with job seekers, and streamline the recruitment process. This case study demonstrates how AI can transform recruiting, bringing tangible results in a short period of time.

Brother International Corporation's example is not the only one. There are several examples of successful implementation of AI in international companies to improve workflows in the financial sector, logistics, manufacturing, and e-commerce. For example, JPMorgan Chase has implemented the AI assistant COiN to automate back-office operations. COiN analyzes large volumes of financial documents, automating data entry, reconciliation and compliance checks. UPS's use of the ORION (On-Road Integrated Optimization and Navigation) AI platform to optimize delivery routes has reduced the distance drivers travel by millions of miles annually, resulting in significant cost savings and environmental benefits. The AI-based ORION platform analyzes customer, traffic, and weather data to generate optimal routes in real time. The Digital Enterprise Suite platform analyzes data from sensors and equipment to provide real-time information about production processes. Siemens' implementation of this AI platform has optimized manufacturing operations, reduced downtime and improved overall efficiency. E-commerce takes advantage of AI technology to predict customer needs, automatically create product descriptions, provide customer support and organize product delivery.

Thus, the case study confirms the prospect of implementing AI technologies to improve company workflows. Let's consider which AI technologies are the most promising in terms of BRM support.

Collaborative Business Intelligence (CBI) represents a strategic endeavor employing Information and Communication Technologies (ICT) to foster intra-organizational cooperation for the acquisition, analysis, and dissemination of critical information to support decision-making processes, thereby enhancing Business Relationship Management (BRM). It constitutes an integral facet of organizational optimization methodologies, aiming at enhancing overall operational efficacy and nurturing robust relationships with stakeholders.

In contemporary management paradigms, Business Intelligence (BI) has emerged as a pivotal tool facilitating data-driven decision-making through structured data analysis juxtaposed with the contextual organizational landscape. Collaborative BI extends this functionality by enabling synchronized, real-time collaboration among organizational stakeholders for the gathering, processing, and sharing of strategic information, thereby enhancing BRM practices. It entails the deployment of specialized tools and methodologies designed to facilitate cooperative endeavors among diverse organizational constituents, including employees, managers, suppliers, and customers.

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Successful implementation of a collaborative BI framework necessitates a comprehensive delineation of organizational objectives and challenges, coupled with concerted efforts to engender participation and enthusiasm across all organizational echelons, thereby fostering robust business relationships. Identifying pertinent data sets and devising methodologies for their collection and analysis constitutes a crucial preliminary step, aligning closely with BRM strategies aimed at understanding and addressing stakeholder needs. Subsequently, the selection of collaboration tools and methodologies must be informed by a nuanced understanding of organizational requisites, catering to the distinctive needs and expectations of stakeholders, thereby enhancing BRM effectiveness.

Various tools and methodologies are commonly employed to foster collaboration within the BI milieu and support BRM endeavors. These include (fig. 3):

- *Dashboards*: These graphical interfaces facilitate the intuitive visualization of data, accentuating key performance indicators vital for informed decision-making and nurturing stakeholder relationships.
- *Project Management Software*: Such platforms enable the real-time monitoring of project progression while facilitating seamless information dissemination among team members, thereby fostering collaboration, and enhancing BRM practices.
- *Professional Social Networks*: These platforms afford the creation of thematic communities, fostering informal information exchange and the cultivation of collective expertise, thereby enriching BRM efforts.
- *Wikis*: Collaboratively authored repositories of knowledge, wikis facilitate the creation and dissemination of organizational intelligence among stakeholders, fostering a shared understanding and strengthening business relationships.

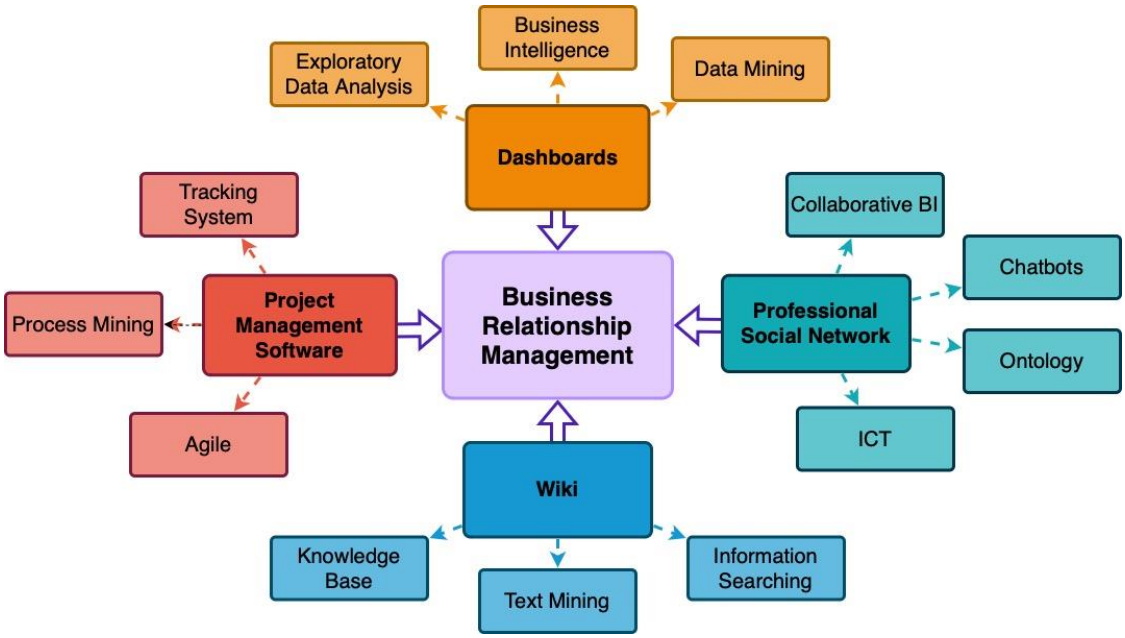

Figure 3: The proposed BRM framework
Source: author's own work

In response to the research question, we propose a 4-axis BRM framework that includes analytics visualizing (Dashboards), business process tracking and analysis (Project Management Software), collaborative decision-making and communication (Professional Social Networks), and corporate knowledge bases (Wikis). The BRM framework presented in

figure 3 highlights possible ways to apply artificial intelligence technologies along each of the proposed axes.

AI empowers organizations to proactively anticipate customer needs and preferences, enabling the delivery of tailored solutions and offerings. Through predictive analytics, AI algorithms forecast future trends and behaviors, equipping businesses with the foresight to adapt and innovate in response to shifting market dynamics. By leveraging AI-driven insights, organizations can optimize resource allocation, refine marketing strategies, and enhance service delivery, thereby fortifying their competitive edge in the marketplace. It is paramount to underscore that the efficacy of collaborative BI transcends technological infrastructures, necessitating a fundamental cultural shift within the organization towards openness and collaboration, which in turn enriches BRM practices. Consequently, initiatives aimed at fostering organizational culture conducive to collaborative endeavors, such as training programs and awareness campaigns, assume critical importance in nurturing robust business relationships.

In summary, collaborative BI embodies a transformative concept aimed at augmenting decision-making processes and enhancing BRM effectiveness through the judicious deployment of collaborative tools and methodologies for the acquisition, processing, and dissemination of strategic intelligence. As a catalyst for organizational growth and strengthened business relationships, collaborative BI underscores the imperative for enterprises to cultivate a culture of information-sharing and cooperation, thereby fostering enduring partnerships with stakeholders. Its successful implementation hinges upon a lucid articulation of organizational objectives, coupled with the discerning selection of collaboration tools and methodologies tailored to organizational imperatives and BRM strategies.

4. Conclusion

In today's dynamic business environment, characterized by rapid technological advancements and evolving consumer preferences, the adept cultivation and sustenance of robust business relationships emerge as quintessential drivers of organizational success. Integral to this pursuit are the fundamental tenets of relationship management, emphasizing the cultivation of mutually beneficial partnerships, and key account management, prioritizing strategic engagement with pivotal stakeholders. Moreover, the overarching focus on customer-centricity underscores the imperative of aligning organizational endeavors with the evolving needs and preferences of clientele, thereby fostering enduring and fruitful relationships.

AI offers diverse capabilities that can significantly enhance BRM practices by providing actionable insights, streamlining communication channels, optimizing business processes, and mitigating risks. By leveraging AI technologies effectively, organizations can cultivate stronger and more mutually beneficial relationships with customers, suppliers, partners, and other stakeholders, thereby driving business growth and fostering long-term success. However, the integration of AI into BRM systems necessitates careful consideration of ethical, legal, and privacy implications. As organizations harness AI to automate decision-making processes and personalize customer interactions, they must ensure transparency, fairness, and accountability in algorithmic decision-making. Moreover, robust data governance frameworks are imperative to safeguard sensitive information and mitigate risks associated with data breaches and misuse.

In conclusion, the convergence of AI and BRM heralds a new era of strategic partnership management, underpinned by data-driven insights and enhanced communication capabilities. By embracing AI technologies, organizations can unlock untapped potentials for innovation, efficiency, and growth in their business relationships. Yet, as they navigate this transformative

journey, organizations must remain vigilant in upholding ethical principles and safeguarding the trust and privacy of their stakeholders.

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Organic Farming and Farm Performance: the Case of Slovakia

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Abstract

The goal of this paper is to evaluate the economic efficiency of organic farms comparing them to conventional farms at the farm-level in Slovakia.

Climate change is one of the current biggest challenges. At the level of European Union (EU) it is addressed by European Green Deal which sets the organic farming as one of strategies to mitigate the global warming. The EU committed to a very concrete goal, to reach at least 25% of the EU's agricultural land practicing organic farming by 2030. Therefore, organic farming is heavily discussed across the EU. We evaluate the share of organic farming across and in individual EU Member States (MS).

From the economic perspective, the organic farms record lower yields and are less productive, therefore also the additional financial support at national and EU level is provided. On the other hand, many studies present the environmental and health benefits of organic farming and organic products. Agriculture in Slovakia is dominated by large corporate farms with 81.5 percent share in Utilised Agricultural Area (UAA). Small farms dominate in farm population and in production focus more on fruits, vegetables and animal production (mainly sheep and goats).

We use individual farm data to compare the performance of organic and conventional farms. We merge financial data of farms operating in Slovakia in 2022 with data on agricultural subsidies including organic farming support. The main method of economic efficiency evaluation is financial analysis. Specifically, we compare financial ratios for both groups of farms following the methodology of Naglova and Vlasicova (2016) and standard financial ratios. The paper is an introduction to detailed comparison of organic and conventional farms using economic modelling of the authors.

Firstly, this paper contributes to literature by a detailed analysis of organic farming system in Slovakia. Secondly, paper provides detailed results on differences in overall performance of organic and conventional farms comparable within other EU MS. Results offer an insight into effects of organic farming support in countries with high share of large farms on total UAA. Same conditions are in many CEEC like Czech Republic and former East Germany.

Key words

European Green Deal, organic farming, economic efficiency, financial ratios

JEL Classification

Q12, O16, Q5

1. Introduction

Organic farming combines traditional farming methods with modern farming technologies. Organic management practices include mainly crop and livestock rotation and diversification,

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managing pests and diseases naturally, and improving the soil with compost additions and animal and green manures (Reganold & Wachter, 2016).

There are various benefits of organic farming:

1. **Biodiversity conservation.** Loss of biodiversity due to intensive agriculture is often at the centre of debate about sustainability of conventional farming methods. Comparison studies show that organic farming has more positive effects on biodiversity conservation. Organic farming identifies a wide range of soil microbial community that benefits from organic management through increases in abundance and/or species richness. Organic management practices are particularly beneficial for farmland wildlife (Saha, 2010).
2. **Healthier food products.** A growing number of important findings are being reported from observational research linking demonstrable health benefits with organic food consumption. Significant positive outcomes were seen in studies where increased organic intake was associated with reduced incidence of e.g. infertility, birth defects, allergic sensitisation and others (Vigar et al., 2019).
3. **Rural development**. Organic farming presents several benefits for rural development, including increased employment, potential for stronger local economies, and reestablishing connections between consumers and producers. Organic farms are shown to employ more people than conventional. The increase in employment opportunities contributes to rural development by providing jobs for local residents, thereby reducing rural unemployment (Lobley at el., 2009).

On the other hand, several benefits and concerns are attributed to organic farming as well:

1. **Lower yields**. Organic farming often yields lower quantities compared to conventional farming methods. Ponisio et al. (2015) researched the organic to conventional yield gap and found out that one of the factors that decreased the grap and increased the organic yields was the implementation of diversification practices, such as multi-cropping and crop rotations.
2. **Lower productivity and efficiency**. Lakner and Breustadt (2017) researched 29 studies comparing productivity and efficiency of organic and conventional farms and organic farms were on overage less efficient than conventional farms.
3. **Land Use Inefficiency.** Organic farming typically requires more land to produce the same amount of crops as conventional farming. This could lead to increased deforestation or conversion of other natural habitats such as wetlands or grasslands to agricultural land to meet the growing demand for organic products (Trewavas, A., 2001).

1.1 Organic Farming and European Green Deal

The European Union introduced European Green Deal (EGD) in 2019 including the ambition to become first climate neutral continent by 2050. EGD outlines a new, sustainable and inclusive growth strategy to boost the economy, improve people's health and quality of life, care for nature. Within EGD two strategies focus on agriculture: i) Farm to fork strategy and ii) Biodiversity strategy.

Farm to Fork Strategy[1] adopted in 2020 expects the demand for organic food to grow. To satisfy the demand for organic food it is necessary to promote and support organic farming. Organic

[1] The Farm to Fork Strategy thoroughly tackles the challenges associated with sustainable food systems and acknowledges the inseparable connections among healthy people, healthy societies and a healthy planet. It aims to make food systems fair, healthy and environmentally-friendly.

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farming positively impacts biodiversity, generates employment opportunities, and attracts young farmers. Furthermore, consumers are increasingly recognizing its value. While the existing legal framework supports the transition to organic farming, more efforts are required, extending beyond land-based initiatives to include oceans and inland waters (EC, Farm to Fork Strategy, 2021). Several EU policies promote and financially support sustainable farming. Within the EU Common Agricultural Policy (CAP) eco-schemes, organic farming, integrated pest management are an example.

Farm to Fork Strategy sets a goal for each Member State to increase the area under organic farming to 25% by 2030. In 2021, the European Commission has adopted a comprehensive action plan specifically focused on organic farming called Action Plan for the Development of Organic Production. This plan aims to assist Member States in stimulating both the supply and demand for organic production and organic food. It seeks to build consumer trust, boost demand through promotional campaigns, and encourage green public procurement (EC, Farm to Fork Strategy, 2021).

Motivation of farms to change from conventional production to organic farming depends also on income and profitability of organic farming compared to conventional production. The goal of this paper is to evaluate the economic efficiency of organic farms compared to conventional farms using farm-level data in Slovakia.

2. Data and Methods

We use data from two datasets. Individual farm data of conventional and organic farms from Agricultural Paying Agency were used to identify type of farming. Financial statements of farms were used to apply the ratio analysis focused on differences in income and profitability of organic and conventional farms.

The total number of agricultural entities in Slovakia in 2023 is 17 217 (Table 1), of which over 95% are conventional and almost 5% organic farms. The natural persons form the biggest group regarding the number of entities (almost 79%), namely almost 77% given by conventional farms and almost 2% by organic farms. However, within the organic farming group, the number of natural persons is smaller than number of legal persons.

Regarding the size of Utilized Agricultural Area (UAA), the legal persons occupy almost 82% of area, namely 68% is occupied by conventional legal persons and almost 14% by organic legal persons. The study´s main focus is on legal persons as they manage the vast majority of agricultural land and in case of organic farming, they prevail also in the number of farms.

Table 1: All farms with CAP support in Slovakia (2023)

	Share of UAA in %	Number of farms	Share on farms in %
Conventional farms	**84,39%**	**16372**	**95,09%**
Natural persons	16,39%	13232	76,85%
Legal persons	68,00%	3140	18,24%
Organic farms	**15,61%**	**845**	**4,91%**
Natural persons	1,69%	326	1,89%
Legal persons	13,92%	519	3,01%
TOTAL	**100%**	**17217**	**100%**

Source: APA, own elaboration

The final sample of organic and conventional farms having the form of legal persons was selected based on the completeness of data necessary for analysis. Furthermore, the database

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was narrowed to farms classified under agricultural sector in order to avoid other sectors interfering into financial results. The final sample is formed by 1 222 farms (Table 2), of which 1016 are conventional (over 30% of conventional legal persons in Slovakia) and 206 are organic (almost 40% of organic legal persons in Slovakia).

Table 2: Number of farms with financial statements data

	Number of farms
Conventional farming	1016
Organic farming	206
TOTAL	**1222**

Source: Financial statememts, own elaboration

We use the methodology of Naglova and Vlasicova (2016) to compare the performance of conventional and organic farms. According to Naglova and Vlasicova (2016) following financial ratios were chosen:

Table 3: Observed ratios

$ROE = \frac{EAT}{Equity}$ (1)	ROE is a measure of the efficiency with which a company employs owners' capital. It is a measure of earnings per dollar of invested equity capital or, equivalently, of the percentage return to owners on their investment.
$ROA = \frac{EBIT}{Total\ Assets}$ (2)	ROA is a basic measure of the efficiency with which a company allocates and manages its resources. It differs from ROE, in that it measures profit as a percentage of the money provided by owners and creditors as opposed to only the money provided by owners.
$Asset\ Turnover = \frac{Sales}{Assets}$ (3)	The Asset Turnover ratio measures the sales generated per dollar of assets. This ratio measures asset intensity, with a low asset turnover signifying an asset-intensive business and a high turnover the reverse.

Source for description: Higgins, R. C., & Koski, J. L., Mitton, T. (2023). *Analysis for Financial Management* (13th ed.). New York, McGraw Hill LLC. Own elaboration

All of the abovementioned financial ratios were calculated for each of the farming group for given year 2022. With regards to descriptive statistics, we use an average value (mean), standard deviation, minimum and maximum value, median, 1st and 3rd quartile for indicators interpretation and the main graphical method was the boxplot analysis.

The normality of the data was tested by Shapiro-Wilk and Kolmogorov-Smirnov test. For the assessment of differences between the groups, Mann-Whitney non-parametric test at 5% statistical significance was used as normality tests showed not normal distribution of data. The financial analysis was undertaken in Excel and the statistical tests and boxplots were created in IBM SPSS.

2. Results

At EU Member States level, there is a large diversity with regards to the share of organic farming (Fig. 1). Only Austria reached in 2021 already the EU-wide goal of 25% share of organic farming in, followed by Estonia, Sweden and Portugal with shares around 20%. Countries with the lowest share of organic farming are Malta, Bulgaria and Ireland, with the shares below 2%. Slovakia´s share of organic farming on UAA increased from 10.3% in 2019 to 13,5% in 2021. Slovakia therefore belongs to 10 EU countries with the highest share of organic farming in 2021.

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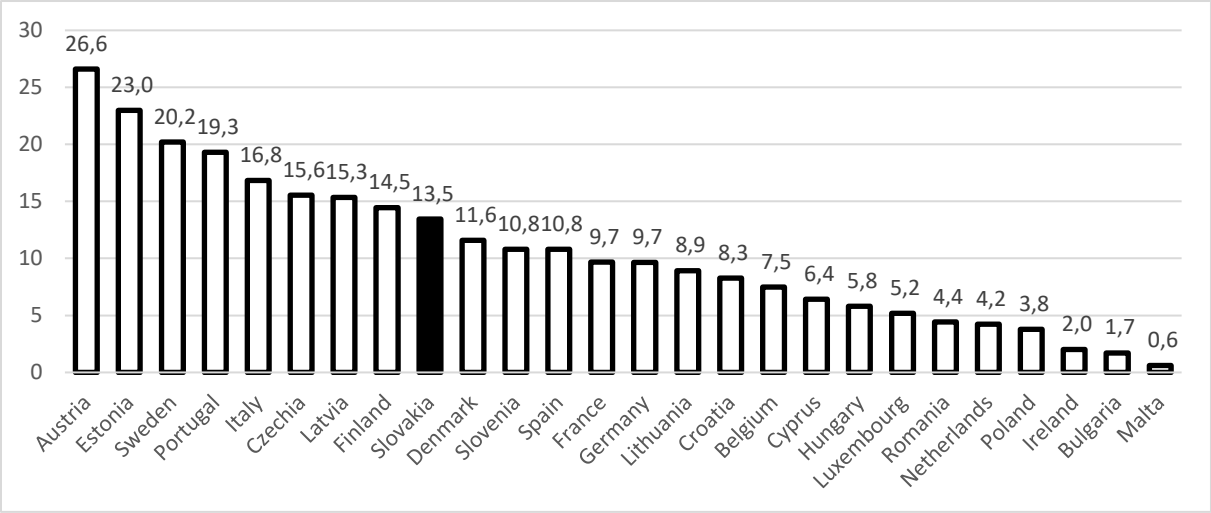

Figure 1: Share of UAA under Organic Farming in EU MS in 2021
Source: European Commission - CAP Context Indicators, own elaboration

In Slovakia, the organic farming includes crop and animal production. 65% of area under organic farming is permanent grassland, 34% arable land, and less than 2% are orchards and vineyards. In animal production sheep (51%) and cattle (42%) dominate. Other animals have a share of 7% and include poultry, goats, pigs and other.

Ratio analysis of organic and conventional farms

Following table show the descriptive statistics for two groups of farms and three ratios: i) ROA, ii) ROE and iii) Asset Turnover

Table 4: Descriptive Statistics results and Mann-Whitney U test

		ROA		ROE		Asset Turnover	
		O	C	O	C	O	C
Number of observations		206	1016	206	1016	206	1016
Mean		0,06	0,07	0,10	0,12	0,47	0,56
Std. Deviation		0,08	0,08	0,17	0,17	0,36	0,40
Minimum		-0,17	-0,25	-0,45	-0,46	0,00	0,00
Maximum		0,35	0,40	0,63	0,69	1,93	2,23
Percentiles	10	-0,01	0,00	-0,02	-0,03	0,08	0,10
	25	0,01	0,01	0,01	0,02	0,21	0,26
	50	0,03	0,04	0,06	0,08	0,41	0,50
	75	0,10	0,10	0,17	0,19	0,66	0,77
	90	0,18	0,18	0,33	0,35	0,96	1,11
Mann-Whitney U		Not significant		*		***	

Note: O-Organic, C- Conventional,
****highly significant, *lowly significant*
Source: own calculations and elaboration

Two of the ratios we used focus on profitability: ROE and ROA. Return of equity (ROE) measures the benefit of equity holder. Results show higher profitability (2% on average) of conventional farms when measured by ROE. The differences are also confirmed by Mann-

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Whitney U test. Return on assets (ROA) measures the overall profitability of assets. Results show a 1% difference between the profitability of organic and conventional farms. Also, in this case the profitability of conventional farms is higher but the Mann-Whitney U test shows no statistical difference. Results of our analysis show that CAP compensations for organic farms do not fully cover the increased cost and lower yields of organic farms. This might hinder the future increase in share of organic farming in Slovakia. On the other hand, the difference in ROE is 2% only and the difference in ROA is only 1%.

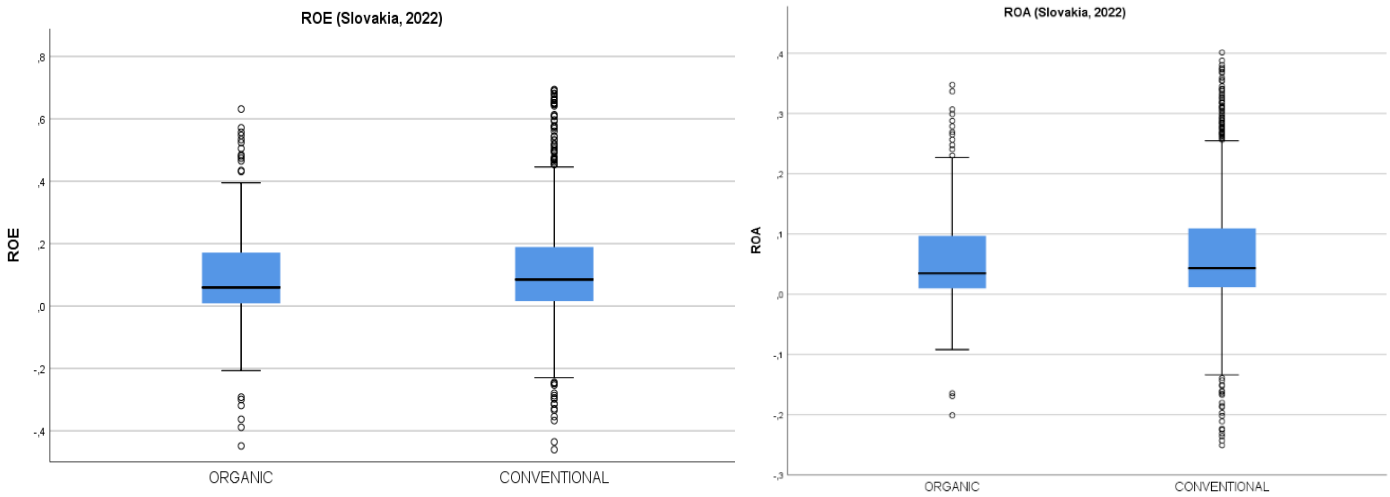

Figure 2: Boxplot analysis ROE and ROA of organic and conventional farms
Source: own calculations and elaboration

Our results show a significant difference in asset turnover also confirmed by Mann-Whitney U test. Asset turnover of organic farms is 0,47 on average. Asset turnover of conventional farms is 0,56 on average. Higher asset turnover ratio generally indicates higher sales. Higher sales of conventional farms are caused by lower yields of organic farming.

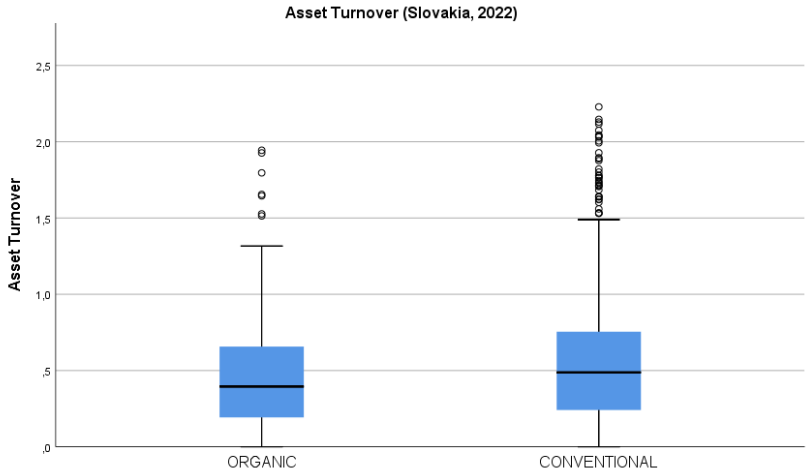

Figure 3: Boxplot analysis Asset turnover of organic and conventional farms
Source: own calculations and elaboration

4. Conclusion

European Green Deal and Farm to Fork Strategy react to the climate change, higher demand for organic food and biodiversity loss in Europe. Farm to Fork Strategy sets a goal for each EU Member State to increase the area under organic farming to 25% of UAA.

Organic farming is one of the measures that can help reduce the biodiversity loss but for farmers generates lower yields and higher cost. EU therefore compensates organic farms. Interventions within EU Common Agricultural Policy can reduce the negative effects of organic farming on profitability of farms. If the profitability of organic farms will be equal compared to conventional farms, the share of UAA under organic farming will increase.

The aim of this paper was to evaluate the economic efficiency of organic farms compared to conventional farms with farm-level data in Slovakia. Using ratio analysis we analyse the differences in profitability and asset turnover of organic and conventional farms in Slovakia.

Our results show that CAP compensations for organic farms do not fully cover the increased cost and lower yields of organic farms. This might hinder the future increase in share of organic farming in Slovakia. On the other hand, the difference in ROE is 2% only and the difference in ROA is only 1%. Our results also show a significant difference in asset turnover. Asset turnover of organic farms is 0,47 on average while asset turnover of conventional farms is 0,56 on average. Lower asset turnover ratio of organic farms is a result of lower yields of organic farming.

Our analysis has several limitations. First, we will further extend the period and perform profitability analysis of organic farms for several years. Second, we will extend the methodology to eliminate selection bias with the aim to analyse the profitability of organic farms by type of agricultural production.

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Factors of Influence on Agricultural Employment in Slovakia and Ukraine

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Abstract

Paper's objective(s) and research background

In recent years, there has been a noticeable decline in the number of workers employed in the agricultural sector across Europe. Both the European Union (EU) as a whole and individual member states, including Slovakia, have experienced this trend. Additionally, Ukraine, a candidate for EU membership, faces similar challenges. Researchers have been closely studying this change in employment patterns. In our study, we aim to investigate the factors that might influence agricultural employment in both Slovakia and Ukraine.

Data/Methods

Our research combines secondary data analysis with primary data collection. We focus on specific economic indicators, including the number of agricultural enterprises, gross industry value added, and expenditures on innovation. These indicators serve as proxies for understanding the dynamics of employment in the agricultural sector. Additionally, we delve into the subjective aspect of job satisfaction among workers in agricultural enterprises. Our primary data is derived from a survey conducted for the study.

Results/Conclusions/Value added

Agricultural employment is a multifaceted phenomenon influenced by a complex interplay of economic, social, and cultural factors. Our findings suggest that economic indicators may play a significant role in shaping employment patterns. However, job satisfaction also emerges as a crucial factor to consider. Further investigation of correlations, causations, and anomalies should be performed for profound understanding of the issue. Understanding the intricate dynamics of agricultural employment is essential for informed policy decisions and sustainable development in both Slovakia and Ukraine.

Key words

Agricultural employment, job satisfaction, subjective factors, objective factors

JEL Classification

Q00, Q1, Q2, Q19, E24, J2

1. Introduction

In an era marked by dynamic global transformations, the agricultural sector stands as a crucial nexus intertwining economic, social, and environmental dimensions. Amidst the complexities of contemporary agricultural landscapes, the dimensions of farming employment and food security emerge as pivotal concerns shaping the socio-economic fabric of nations.

Employment in EU farming has been in long-term decline, as rising agricultural productivity due to mechanization has reduced the need for labor and because of older farmer's progressive retirement. At the same time, in the recent years the matter of the restoration of the food security

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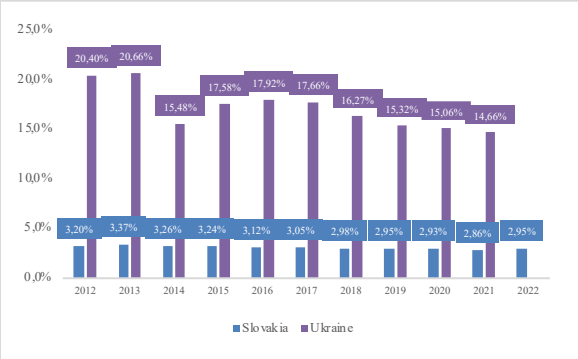
of the EU and the world has been prevailing. Such factors as coronavirus pandemic and war in Ukraine only weakened global food security and sharpened this issue.

Given the latest trends, EU agricultural outlook of the European Commission (2021) forecasts further labor outflow from agriculture until 2030, albeit at a slower pace. Agricultural labor was forecasted to decrease by 1.3% yearly in 2021-2031, which was a slowing down in comparison to 1.9% decrease in 2011-2021. The EU agricultural outlook of the European Commission (2019) suggests that the number of workers in agriculture across the EU will reach 7.9 million workers in 2030.

1.1 Overview of employment in agriculture in Slovak Republic and Ukraine

Agriculture as a sector of economy is prone both to general labor market trends and industry-specific characteristics as well. European Commission (2022) mentions such factors as low attractiveness of the agricultural sector, boosting mechanization and automation, which results in increased productivity, profit variability as a result of market volatility and higher exposure to climate change as those that can explain downward trends for the labor outflow.

If we observe how employment in Agriculture, forestry, and fishing in Slovak Republic and Ukraine as a share of total employment changed over the last 10 years, we can see that there has been a gradual decline for both countries. For instance, in 2013, the share was 3.37%, which decreased to 3.05% in 2017, and further down to 2.95% by 2022, which suggests a shift away from employment. The minimum was reached in 2021, with 2.86% of employment in Agriculture in Slovakia. (OECD) If we refer to Ukraine, share of agricultural employment out of total employment in Ukraine has been significantly higher over the last decade and has experienced significant changes. Starting at approximately 20.4% in 2012, the percentage of people employed in agriculture gradually declined. The first sharp decrease is observed in 2014, which can be explained by annexation of Crimea and occupation of territories in Donetsk and Luhansk regions. By 2021, the share of agricultural employment had decreased to around 14.66%. (State Statistics Office of Ukraine)



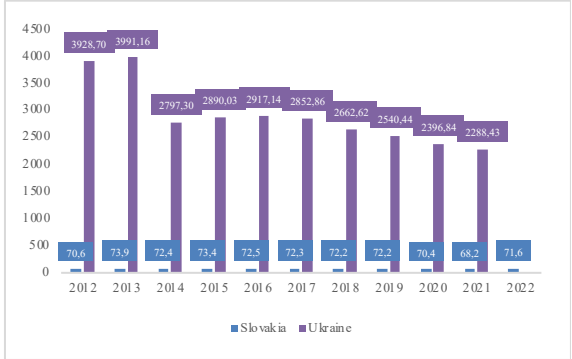


Fig. 1: Share of Agriculture, forestry and fishing in total employment in Slovakia and Ukraine
Fig. 2: Number of employees in Agriculture, forestry and fishing in Slovak Republic and Ukraine, thousand people
Source: own elaboration based on OECD and State Statistics Office of Ukraine data, 2023.[2]

However, while the percentage share of agricultural employment in Slovakia declined, the actual employee count experienced fluctuations. We observe the increase of number of people

[2] Data for Ukraine for 2014-2021 exclude the temporarily occupied territories of the Autonomous Republic of Crimea, the city of Sevastopol, from 2015 – also exclude temporarily occupied territories in the Donetsk and Luhansk regions

employed in Agriculture, forestry and fishing, with 70.6 thousand workers in 2012 and 71.6 thousand workers in 2022. The employee count reached a peak of 73.9 thousand in 2013, and the lowest minimum occurred in 2021 at 68.2 thousand employees. As for the employee count in Ukraine, number of people employed gradually declined, starting at 3928.70 thousand employees in 2012. By 2021, the number of agricultural employees had dropped significantly to 2,288.43 thousand employees.

1.2 Factors influencing changes in agricultural employment

Researchers highlight different factors that can influence the level of employment in agriculture, such as technological progress, accession to the EU (for EU member states and candidates), income gap between alternative economic sectors.

Factors such as intensification, mechanization, and automation have been pivotal in driving the increase in agricultural productivity in recent years. This encompasses the deployment of automated farming equipment for field operations, animal systems, and growing systems, such as greenhouse climate control and irrigation systems. However, technological progress in agriculture not only enhances agricultural productivity but also influences the agricultural labor market dynamics. This implies that while better results and increased productivity can be achieved with a reduced labor input, there is a simultaneous rise in demand for highly specialized labor. This paradoxical effect of technological progress leads to a decreased overall demand for labor while simultaneously creating a heightened demand for individuals possessing advanced expertise in agricultural technologies (Pesce et al., 2019, Edan et al., 2009, Gallardo and Sauer, 2018, Marinoudi et al., 2019, Decker et al., 2017).

Accession to the EU can shape agricultural labor dynamics across member states via such domains, as increased opportunities and challenges, structural changes, labor mobility and migration, and environmental and regulatory factors. Integration into the EU also fosters the widespread adoption of modern agricultural technologies, enhancing not only efficiency but also alters traditional employment patterns. At the same time alignment with EU quality standards also introduces an additional dimension to the labor landscape. (Espon, 2019, Tocco et al., 2013, Bocean, 2024).

Salary and income gap between agriculture and other sectors, combined with low agricultural education, can become factors influencing labor flow from agriculture to other sectors. Also, people seek for better infrastructure and services, which are usually more advanced in the urban areas compared to rural ones. (Gullstrand and Tezic, 2008, Tocco et al., 2013).

1.3 Job satisfaction and motivation and its impact on employment in agriculture

One strategy to tackle the labor shortage in the agricultural sector involves addressing it through enhancing the job satisfaction of current workers, thereby improving retention rates.

High level of job satisfaction, which is defined by Locke (1976) as a “pleasurable or positive emotional state resulting from one’s … job experience”, has been demonstrated to yield advantageous outcomes for both individuals and organizations, supported by evidence indicating a causal relationship (Erdogan et al. 2012). These benefits encompass reduced employee turnover (Tnay et al. 2013), heightened work performance, decreased absenteeism, and the promotion of overall worker well-being (Wegge et al. 2007).

Job satisfaction and motivation in agriculture are significantly shaped by the unique characteristics of agricultural production. The seasonal nature of production, marked by annual cycles in crop cultivation and interactions with living organisms in animal husbandry, plays a primary role in driving this motivation. Furthermore, the distinct features of agricultural infrastructure also contribute to shaping job satisfaction. Additionally, individuals who choose

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agriculture as their profession are essentially opting for a specific lifestyle, characterized by rural living, which may be perceived as less appealing in terms of social benefits compared to urban life. This aspect holds particular importance for the younger generation as they navigate decisions regarding their career paths (Mentey, 2017).

Compensation plays a crucial role in motivating agricultural workers and boosting productivity, but it should not be the only factor considered for employee motivation. Employing a variety of motivators is essential, necessitating a comprehensive approach to different forms of labor motivation within agricultural enterprises as part of their corresponding motivational systems (Andryushchenko, 2014).

2. Data and Methods

For this article we estimated the parameters of the trend component using regression analysis, to review how selected indicators influence farming employment in Ukraine and Slovak Republic. In our analysis independent variables are X1 – number of enterprises (NACE A), X2 – gross value added of agricultural sector, X3 – expenditures on innovation; and dependent variable Y – number of workers employed in agriculture.

The general linear regression model has the form:

$$y=\beta 0 + \beta 1 x1 + \ldots + \beta k x k + u \quad (1)$$

where y – dependent variable;

$x1,\ldots\ xk$ – independent variables;

u – a random error which distribution generally depends on independent variables but expected value equals zero.

The null hypothesis stated that there is no significant relationship between the independent variables and the dependent variable, which is number of workers employed in agriculture. The alternative hypothesis stated that there exists a significant relationship between at least one of the independent variables and the dependent variable:

$$H_0: \beta_1 = \beta_2 = \beta_3 = 0 \quad (2)$$

$$H_1: \text{at least one } \beta_i \neq 0, \text{ where i = 1, 2, 3.}$$

Additionally, a random judgmental survey on job satisfaction in agricultural sector was conducted to obtain primary data from agricultural entities in Ukraine and Slovakia. The main purpose of the survey was to collect additional insights on how much employment in the agricultural sector can be influenced by the employees' job satisfaction. The survey consisted of 30 questions, covering such areas as portrait of the respondent, pay and benefits, professional growth and/or promotional opportunities, communications, and overall working environment. Mann-Whitney U test and Goodman and Kruskal's gamma analysis were employed to analyse the outcomes. 243 responses were obtained and processed. IBM SPSS Statistics and Gretl software was used for the analyses in the given article.

3. Results and Discussion

3.1 Relation between selected indicators and employment in agriculture

By investigation of the impact of selected indicators on agricultural employment in Ukraine and Slovakia, we can see if the number of employees in the agricultural sector canbe influenced by overall number of agricultural enterprises, gross industry value added and expenditures on innovation and technology in the country. The variables were defined as follows: dependent

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variable Y – number of workers employed in agriculture, and three independent variables: X1 – number of enterprises (NACE A), X2 – gross value added, and X3 – expenditures on innovation.

The outcomes suggested that the number of enterprises (X1) does not have an impact on employment, while gross value added (X2) and expenditures on innovation (X3) can be significantly affecting employment levels.

Table 1: Outcomes of regression analysis of employment in agriculture in Ukraine

Model: OLS, using observations 2010-2021 (T = 12), Dependent variable: Y

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	4504.20	1819.14	2.476	0.0384	**
x1	−0.0212412	0.0195556	−1.086	0.3090	
x2	−111.560	34.7707	−3.208	0.0125	**
x3	2.16224	0.432193	5.003	0.0010	***

Source: own processing.

R-squared is approximately 88,7%, which means that about 88% of the variability in the number of workers employed in agriculture in Ukraine can be explained by the number of enterprises, gross value added, and expenditures on innovation.

For each additional enterprise, the number of workers employed in agriculture decreases by 0,02 thousand persons, but this result is not statistically significant given the p-value of 0,3090.

The outcomes suggest that for each additional EUR billion of gross value added, the number of workers employed in agriculture decreases by 111,56. The p-value of 0,0125 suggests that gross value added can significantly impact agricultural employment in this model.

As for the expenses on R&D, for each additional unit of expenditure on innovation (EUR million), the number of workers employed in agriculture increases by 2,16. The p-value of 0,0010 suggests that this coefficient is statistically significant.

Based on the regression, we can state that the number of agricultural enterprises does significantly affect agricultural employment in Ukraine, unlike gross value added of the agriculture and investment in research and development in Ukraine – these variables can be significantly affecting employment levels.

As for Slovakia, given the fact that all coefficients were not statistically significant, we could not confirm the hypothesis that mentioned factors are significantly affecting agricultural employment in the country..

Table 2: Outcomes of regression analysis of employment in agriculture in Ukraine

Model: OLS, using observations 2010-2021 (T = 12), Dependent variable: Y

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	78.8395	2.88500	27.33	<0.0001	***
X1	−0.00043599	0.000671616	−0.6492	0.5344	
X2	−0.00679946	0.00570433	−1.192	0.2674	
X3	−1.75660e-06	0.00461160	−0.0003809	0.9997	

Source: own processing.

3.2 Analysis of survey on job satisfaction in Ukraine and Slovakia

Assessment of significant differences in overall job satisfaction scores among male and females employees of the industry showed that there isn't a statistically significant difference in job satisfaction levels between males and females, as well as there's no statistically significant difference in job satisfaction scores between Slovakia and Ukraine.

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To better understand what exactly influenced job satisfaction in Slovak and Ukrainian agriculture we conducted cross-sectional analysis and Goodman and Kruskal's gamma analysis to identify what influence on job satisfaction the such satisfaction aspects, as remuneration, benefits, career growth opportunity, satisfaction with the colleagues and supervisor, and job safety have.

Outcomes of analysis suggest a weak positive correlation ($\gamma = 0.180$) between job satisfaction and perceived fair pay. As individuals' feeling that they are being paid fairly increases, there is a tendency for individuals to also feel increased job satisfaction, although this association is not strong. However, given the level of approximate significance associated with the gamma value (0.021), we conclude that there is a statistically significant relationship between job satisfaction and perceived fair pay.

As for the additional benefits, we observe that as individuals' satisfaction with additional benefits they obtain increases, there is a tendency for individuals to also feel increased job satisfaction ($\gamma = 0.255$). The approximate significance associated with the gamma value is <0.001. So we can say that there is a statistically significant relationship between job satisfaction and satisfaction with received benefits.

However, we do not observe relationship between job satisfaction and perception of promotion opportunities or satisfaction with supervisor's competence.

Outcomes suggest a weak positive association ($\gamma = 0.201$) between job satisfaction and enjoying coworkers. As individuals' establish positive relationship with colleagues, there is a tendency for job satisfaction to increase. However, it is essential to consider that this is a moderate association and not a strong one. The approximate significance (0.004) associated with the gamma coefficient confirms that such association is statistically significant.

Also we do not observe strong association between job satisfaction and perceptions of workplace safety provided by the employer, which is also not statistically significant, indicating that the observed trend could be due to chance. However, assessing separately the perception of safety among Ukrainian respondents, we observe a moderate positive association ($\gamma = 0.301$) between job satisfaction and perceptions of workplace safety provided by the employer, which is also statistically significant.

3.3 War-related challenges to agricultural employment in Ukraine

Currently all challenges Ukrainian agriculture may encounter due to the full-scale war can be divided among such domains as limited export opportunities, loss of cultivated areas, machinery and infrastructure, decrease in the marginality of farms and high risk of bankruptcy, and limited resources for the agricultural industry. Referring to the agricultural resources, we mean deficiency of fertilizers, shortage and increase of cost of fuel and lubricants and other energy resources, and finally lack of human resources.

Lack of human resources in agricultural industry may be occurred due to the following identified risks:

1. Physical destruction of human capital (murder, maiming during hostilities): it directly reduces the available labor force, impacting agricultural operations and productivity.
2. Mobilization of workers: the existing State program of "employee reservation" does not contain effective mechanisms and algorithms for implementation in practice. On top of that, forced mobilization of workers with narrow agricultural specialties without military experience negatively contributes to the employment trends.
3. Violation of the training process of agronomists and mechanizers due to the suspension of the work of educational institutions: educational institutions had at first suspended

and later introduced significant changes to usual educational processes. As a result, the training and development of agronomists and mechanizers have been compromised. The lack of skilled professionals affects agricultural practices and innovation.

4. Internal and external migration of labor resources: insecurity and displacement have led to internal and external migration of labor. Workers seek safety elsewhere, leaving behind gaps in the agricultural workforce. This migration further strains the sector.
5. The risk of not returning labor resources to Ukraine due to the destruction of housing and infrastructure: destruction of housing and infrastructure during the war poses a risk that displaced workers may not return to their regions or to Ukraine at all. The absence of labor resources hinders post-war recovery efforts.
6. Long-term restoration of human capital in the post-war period: rebuilding human capital – both in terms of skills and physical well-being – will be a prolonged process after the conflict ends. Training, education, and rehabilitation are essential for restoring the workforce.

4. Conclusion

Employment in agriculture in the European Union has been in a long-term decline with numerous factors that could have influenced it. Such factors as globalization, climate change and automatization get most concerns in regard to the agricultural employment.

Agriculture is one of the main employment sectors of the European Union. Agriculture, forestry and fishing overall employed 9.2 million people in 2021, which was 4,4% of total EU employment. The number of workers in agriculture across the European Union decreased by approximately 20% since 2012, with more than 2.3 million workers having left agricultural industry. With more than 11.5 million workers in agriculture 2012, there were left approximately 9.2 million agriculture workers in 2021.

Such labor outflow can be explained by significant structural changes in agriculture. Structural change would mean a decline in number of farms, combined with increasing attempts to achieve economies of scale through bigger farms and investments in machinery and technology. Thus, EU agriculture is moving towards a concentration of activity in a decreasing number of larger capital-intensive farms. There are certain drivers of such structural changes in the EU agriculture, such as technological progress, accession to the EU, income gap between alternative economic sectors, and other factors.

Additionally, the of job satisfaction could also have its impact at the employment level has been studied.

Research suggests that gross value added of the agriculture and investment in technology can significantly affect employment levels in Ukraine. This can be reflected in a creation of new jobs in areas such as software development for agricultural technologies, technical support and, data analysis for production improvement, improvement of working conditions through automation and using robots, enhancement of safe working conditions and production efficiency. Additionally, the digital transformation of agriculture contributes to developing associated industries, such as agricultural technology production, agro-technology consulting, engineering, and programming of farming needs.

Digitalisation in agriculture in Ukraine and Slovakia has excellent potential to improve the rural population's production efficiency and quality of life. However, adopting digital technologies requires investment, training and a regulatory approach to ensure equal access and beneficial use of these opportunities.

As for the job satisfaction in agriculture, from 243 responses obtained and processed, we have observed that satisfaction with salary, benefits and colleagues, and also feeling safety for Ukrainian agricultural workers can influence the job satisfaction significantly, which consequently is reflected on the level of agricultural employments.

Therefore we would suggest that strategic approach to engagement, retention and motivation of personnel in agriculture should be used, bringing such benefits, as extended decision-making time-horizon, emphasis that motivation should shape and support the overall strategy of the enterprise and the human resources management strategy, highlighting that that incentive tools should be integrated with other elements of the human resources management system, and linkage of motivational strategy to the organizational culture of the enterprise.

Referring to the current situation in Ukraine and its potential impact on the agricultural employment, we can outline the following initiatives for private businesses and policymakers to mitigate the outstanding challenges:

1. Provision of an efficient and transparent procedure for reservation of agricultural employees – to ensure a sufficient number of workers for harvesting.
2. Restoration and development of human capital potential of the agriculture – to ensure smooth and efficient training and education within agricultural study programs.
3. Provision of favorable conditions and sufficient resources to stimulate return of people who fled Ukraine (refugees) due to the russian aggression – to ensure a sufficient number of labor resources for the agricultural sector in the short- and long term.

The listed initiatives should be driven and implemented both by State authorities (for example, Ministry of Education and Science of Ukraine, Ministry of Agrarian Policy etc), international organizations and private enterprises (for example, agricultural holdings, business associations etc). However, such initiatives may encounter such risks, as lack of state support and funding, lack of support from businesses and international organizations, corruption and favouritism risks, as well as long implementation of proposed actions and lack of coordination between government institutions and other stakeholders.

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Assessing Top Universities in Slovakia and Neighboring Countries: A Study on University Social Responsibility Excellence

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Abstract

Corporate social responsibility is one of the topics that both lay and especially professional public have been focusing on for quite some time. Several scientific publications have been written on this topic, bringing valuable information and, above all, clarity and coherence to the issue. Despite this, new findings continue to emerge, and one of the newer approaches is university social responsibility. It is an analogy to corporate social responsibility but at the level of universities. We chose this topic because there is a lack of scientific outputs in this very interesting, stimulating, but above all important area of sustainability and responsibility in Slovakia. After all, universities are places where responsibility plays a key role not only in science, research, and education but also in social, environmental, and ecological matters.

Paper's objective(s) and research background: The aim of the submitted article is to assess university social responsibility in Slovakia and neighboring countries.

Data/Methods: In the submitted article, we analyze selected countries: Slovakia, the Czech Republic, Austria, Hungary, Ukraine, and Poland. We compare scores from two rankings: UI Greenmetric World University Rankings and the Center for World University Rankings. The analyzed year was 2023. For a better understanding, we also provide information on how the monitored countries rank in the rankings compared to the top universities in Europe, the European Union, and the world. We assessed the normality of the data for the top 200 universities in Europe in the UI GreenMetric ranking using Q-Q plots, and then performed a Kruskal-Wallis test for 17 countries (represented among the top 200 universities in the UI GreenMetric ranking) across six areas measured by the UI GreenMetric.

Results/Conclusions/Value added: The best university in Slovakia in the field of university social responsibility is the Slovak University of Agriculture in Nitra. It achieved the highest scores in all six analyzed subcategories of the ranking. According to CWUR, there are four universities in Slovakia that belong to the Top 2000 best universities in the world, with only one of them also ranking in the university social responsibility assessment.

Key words: responsibility, best universities, social, ranking, Slovakia

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1. Introduction

Over the past twenty years, socially responsible business has emerged as a pivotal tool in both corporate and public policy across EU countries. A vast body of literature has delved into the nature, role, and dynamics of Corporate Social Responsibility (CSR). The modern history of socially responsible business began to take shape in the 1950s when the concept of responsible business practices gained traction in professional literature for managers. The initial definitions were rooted in a managerial model of socially responsible business, which emphasized that companies should not only prioritize profit maximization but also contribute to societal well-being through voluntary efforts.

Nowadays, social responsibility plays a significant role as a competitive advantage, as **Fatima & Elbanna (2023)** suggest. They argue that when CSR is viewed from a strategic perspective, it stems from top management's vision and values. Rather than being seen as an expense, it is regarded as a strategic initiative readily adopted by organizations to differentiate themselves from their competition. In their publication, **Islam et al. (2021)** demonstrate that initiatives in the field of social responsibility are significantly and positively associated with a company's reputation, customer satisfaction, and trust. **Rjiba et al. (2020)** found that social capital investments through CSR activities limit the negative effect of economic policy uncertainty on financial performance. **Velte (2022)** adds that, in line with its increased relevance in business practice, CSR has become a key topic in empirical-quantitative research. Over the last decade, firm valuation has become dependent not only on financial performance but also on environmental and social strategies, as well as successful management of these issues.

More recently, an emerging body of literature has been examining the need for regulating CSR and the role of law. For example, **Tamvada (2020)** looks for an answer to a question in an article: Should CSR be within the realm of voluntarism or does it consist of mandatory obligations? The author states, that responsibility is both an obligation and a duty, and it is important in the context of law and accountability. A lot of moral obligations arise concurrently with the legal obligations.

The notion of social responsibility extends beyond the realm of large corporations to encompass a diverse array of entities, including universities. As emphasized by **Ali et al. (2021)**, integrating social responsibility initiatives into universities' administrative structures is crucial for achieving meaningful impact. Stakeholder engagement is paramount in adopting a sustainable approach and driving significant societal change. Globally, universities must embrace social responsibility as an intrinsic aspect of their organizational ethos, tailoring their educational endeavours accordingly. This idea is supported by the findings of **Kappo-Abidemi & Ogujiuba (2020)**. In their publication, they elaborated precisely and in depth on the concept of social responsibility at universities. The authors state, that the economic, social and environmental development hinges on education. It is the means to create a knowledge-based society and to achieve sustainable conditions. Therefore, universities play a fundamental role in all dimensions of social responsibility (environmental, economic and social). **Hernández et al. (2020)** highlight the innovative endeavour of expanding organizational social responsibility to universities. However, the implementation of large-scale projects faces hurdles, particularly given universities' pivotal role in shaping individuals' education. Progress in designing effective management systems has lagged behind traditional organizational social responsibility initiatives. Additionally, **Moghadam et al. (2021)** delve into the concept of university social responsibility, portraying it as an ethical administration model fostering mutual benefits for both institutions and societies. Concept of University Social Responsibility (USR) derives from and is directly connected with the concepts of social responsibility, CSR, sustainable development and education for sustainability. Despite recognition of its importance, the lack of consensus on evaluation criteria and the absence of a standardized framework pose challenges

in measuring University Social Responsibilities impact. Similarly, to businesses operating in various industries and markets, universities also compete for their customers, who in this case are students. As **Latif et al. (2021)** state, student loyalty is crucial for universities to remain competitive by recruiting and retaining satisfied students who provide positive evaluations of their university to others.

We can confidently assert that social responsibility is a critical area that institutions providing university education, science, and research should prioritize. Experts in the field unanimously agree that it is an issue that universities cannot afford to overlook. However, despite this consensus, professional literature reveals several instances where universities do not allocate adequate attention to social responsibility across various domains. For instance, **Nardo et al. (2020)** argue that universities in most cases still pay little attention in their planning documents to objectives regarding the different dimensions of social responsibility.

In addition to the business environment, the university education sector must also consider another important aspect: internationalization. Nowadays, study abroad opportunities are more accessible than ever before, and students are increasingly taking advantage of them. Internationalization also has a significant impact on the academic side of universities. Therefore, it is imperative to address USR within the context of internationalization**. Jones et al. (2021)** emphasize the urgent need to align internationalization and university social responsibility agendas through the construct of internationalization of higher education for society. **ChenYu (2023)** suggests that due to the stable and gradual development of the global economy, people are experiencing an improved quality of life compared to the previous decade. To provide children with better educational opportunities, studying abroad has become an increasingly popular choice for students. The significant rise in the number of international students also underscores the importance of research into the evaluation methods used by universities worldwide. Regarding the evaluation of universities, it is proven that university rankings significantly influence the choices of prospective students. For example, **Wut et al. (2022)** state that the results suggest that eWOM, i.e., electronic word of mouth, is the most influential factor, followed by peer influence and university reputation.

The issue of university social responsibility in Slovakia is quite challenging. Currently, there is no comprehensive study addressing this topic. Existing professional articles and publications focus solely on the concept of USR, and a comprehensive comparison of universities operating in Slovakia is lacking. We can find some information in the work of **Jirásková (2014).**

2. Data and Methods

For the analysis, we selected five Central European countries: Slovakia, the Czech Republic, Poland, Hungary, Ukraine and Austria. For the evaluation of the university, we have selected two types of ranking systems, that are publicly available.

THE CENTER FOR WORLD UNIVERSITY RANKINGS 2023 (CWUR)

This ranking publication stands out as the sole academic assessment of global universities, evaluating educational quality, alumni employment, faculty expertise, and research impact without relying on surveys or university data submissions. Utilizing seven objective and rigorous indicators grouped into four key areas, it ranks universities worldwide.

- **Education**: based on the academic success of a university’s alumni, and measured by the number of a university's alumni who have won prestigious academic distinctions relative to the university's size (25%)

- **Employability**: based on the professional success of a university's alumni, and measured by the number of a university's alumni who have held top positions at major companies relative to the university's size (25%)
- **Faculty**: measured by the number of faculty members who have won prestigious academic distinctions (10%)
- **Research**:
    - **Research Output**: measured by the total number of research papers (10%)
    - **High-Quality Publications**: measured by the number of research papers appearing in top-tier journals (10%)
    - **Influence**: measured by the number of research papers appearing in highly-influential journals (10%)
    - **Citations**: measured by the number of highly-cited research papers (10%)

For the purposes of this article, we decided to analyze the 2023 CWUR due to its unique approach to evaluating higher education institutions on a global level. CWUR is known for its comprehensive methodological framework, which covers key aspects of academic and research performance, focusing on criteria that directly reflect the quality of education, graduate employability, faculty quality, and research productivity. Unlike other rankings that emphasize the opinions of academics and employers or include subjective assessments, CWUR uses exclusively objective indicators based on publicly available data, minimizing biases in the evaluation. This approach enhances the transparency and credibility of the ranking, which is important for a thorough analysis. Another reason for choosing CWUR is its global reach. The ranking includes over 20,000 universities worldwide, evaluating and publishing results for the top 2,000 institutions. Such a broad selection provides a relevant comparison between universities from different geographic, economic, and cultural backgrounds, enabling the identification of differences and similarities in their performance.

UI GREENMETRIC WORLD UNIVERSITY RANKINGS 2023 (UI GreenMetric)

The global university ranking system is dedicated to assessing the sustainability performance of institutions and it includes 1 183 institutions across 84 countries. This system is designed to evaluate the sustainability performance of institutions. These rankings provide the outcomes of an online survey assessing the current status and policies pertaining to campus greening and sustainability initiatives in universities worldwide. In the current performance evaluation tool there are 39 indicators and 6 criteria i.e.:

- **SI - Setting and Infrastructure (15%),**
- **EC - Energy and Climate Change (21%),**
- **WS - Waste (18%),**
- **WR - Water (10%),**
- **TR - Transportation (18%), and**
- **ED - Education (18%).**

We are aware of other rankings that focus on the environmental and sustainability aspects of universities worldwide (e.g., the QS World University Rankings, which analyze academic outputs and the opinions of academics and employers while emphasizing employability and sustainability, or U-Multirank, which compares the performance of higher education institutions across five dimensions of activity, including regional engagement, which may also encompass environmental aspects, among others). For the purposes of this article, we chose to analyze the aforementioned ranking due to its unique focus solely on the environmental aspects

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of university operations. Unlike other rankings that evaluate academic excellence, graduate employability, or research activity, this ranking assesses the ecological footprint of universities, their sustainable practices, and their commitment to environmental protection. It is a globally recognized ranking that includes universities from all continents, enabling comparisons of diverse institutions in various geographic, cultural, and economic conditions. This global perspective enhances the relevance of the analysis results.

STATISTICS ANALYSIS

To verify the normality of the data for the top 200 universities ranked in the UI GreenMetric ranking, we used visualization through Q-Q plots. Using the Kruskal-Wallis test, we verified:

H0: The medians of the scores in all six areas (SI, EC, WS, WR, TR, and ED) are equal.

H1: The medians of the scores in at least one area (SI, EC, WS, WR, TR, or ED) differ from the others.

3. Results and Discussion

For clarity and comprehensibility, we have decided to analyze European countries together with the top universities (according to CWUR and UI GreenMetric) from around the world, and then we will analyze universities in the monitored countries.

WORLD AND EUROPEAN COUNTRIES

The total number of recognized higher education institutions in Europe is two thousand seven hundred six. Among the first two hundred best universities in CWUR, there are 73 from Europe and 48 from European Union countries. The number of universities in the CWUR (top 200) for each country is indicated in Figure 1. (countries outside the EU are highlighted in red color). According to CWUR, the best European university is the University of Cambridge with a score of 94.1, followed by the University of Oxford with a score of 93.3. Looking at the global ranking, only universities in the USA and the aforementioned universities from the United Kingdom made it to the top ten best universities in the world. The first university outside the USA and Europe is the University of Tokyo in Japan, ranking 13th with a score of 89.8. Also among the top twenty best universities in the world according to CWUR is University College London, ranking 19th with a score of 88.4. The best university in the European Union is PSL University based in Paris, France, which ranked 21st with a score of 88.0. Among the top ten universities in Europe are: four universities from the United Kingdom, four universities from France, and one university each from Denmark and Sweden. It's interesting to note that Germany had the second-highest number of universities in the top 200 among all European countries, but not a single German university made it to the top 10 European universities.

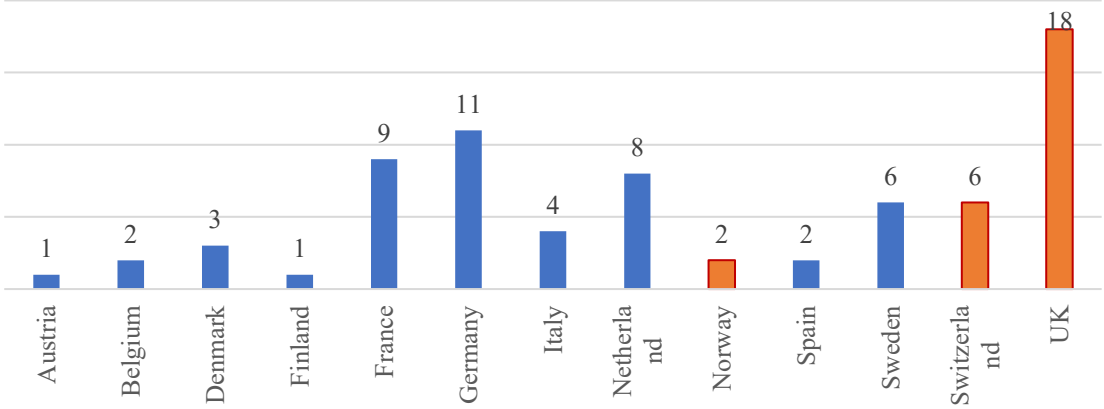

Figure 1: The total number of universities in the CWUR (top 200) operating in Europe
Source: data - CWUR, authors

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When comparing Figures 1. and 2., we can see that more countries made it into the top 200 in the UI GreenMetric than in the CWUR. The best university according to the UI Green Metric is Wageningen University and Research in the Netherlands with a score of 9 500. This university achieved 181st place in the CWUR with a score of 79.2. In the top ten universities according to the UI GreenMetric, there are 2 universities from the United Kingdom, 2 universities from Germany, 2 Dutch universities (including the one mentioned earlier), and 1 university from Ireland; the remaining 3 universities operated outside Europe (2 from the USA, 1 from Brazil). Among the best universities in Asia were Universitas Indonesia in 24th place and University Putra Malaysia in 25th place.

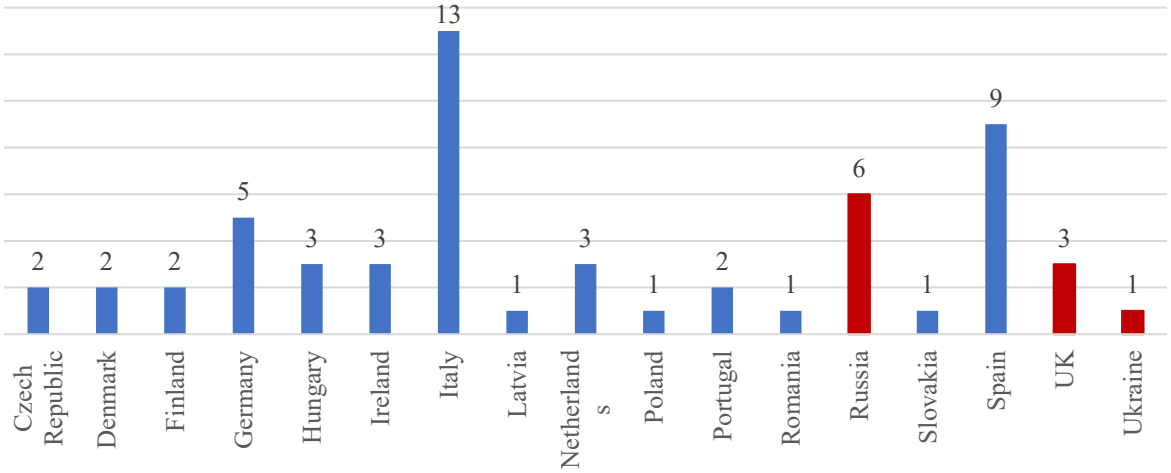
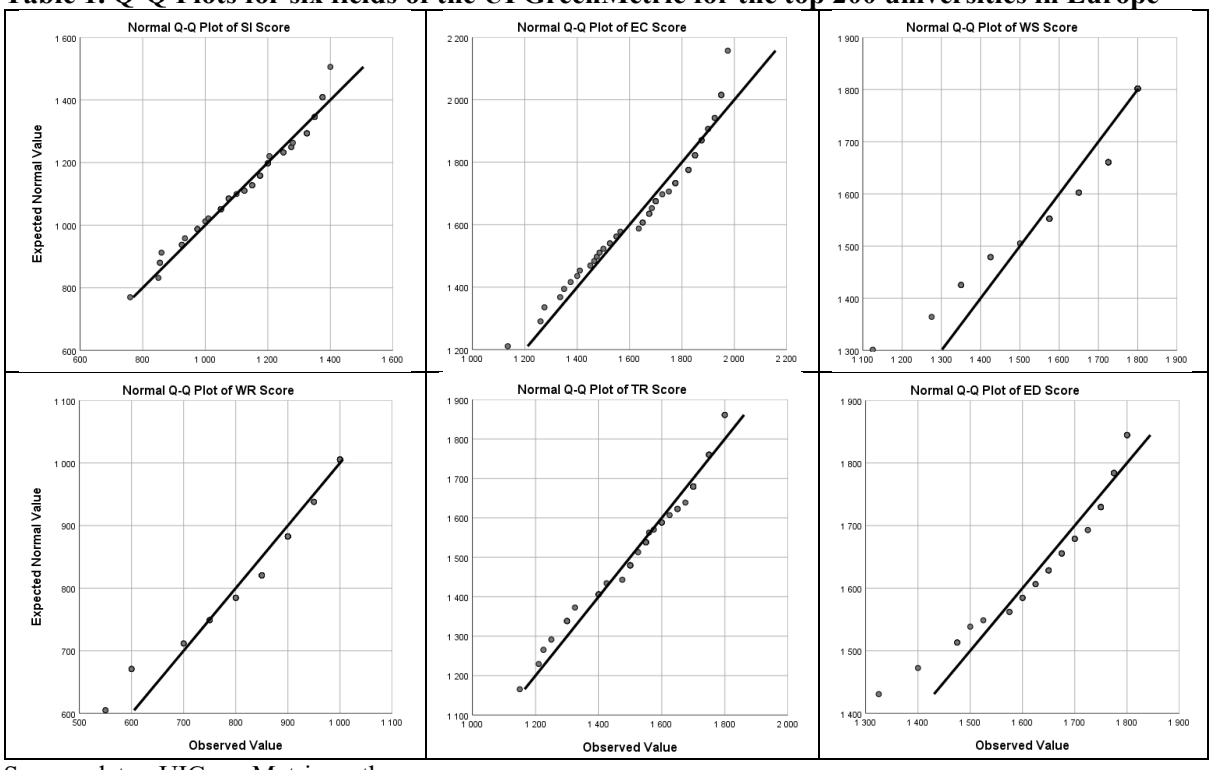


Figure 2: The total number of universities in the UI Green Metric (top 200) operating in Europe
Source: data – UI GreenMetric, authors

From Table 1, it can be seen that the data in the individual areas of UI GreenMetric do not follow a normal distribution; therefore, it is necessary to use the non-parametric Kruskal-Wallis test.

Table 1. Q-Q Plots for six fields of the UI GreenMetric for the top 200 universities in Europe



Source: data - UIGreenMetric, authors

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In Table 2, we can see the results of the Kruskal-Wallis test for the top 200 universities in the UI GreenMetric ranking across the six areas of study, namely SI, EC, WS, WR, TR, and ED.

From Table 2, it is evident that, at a significance level of 0.05, we can state that in the areas of WS, WR, and TR, we reject the null hypothesis, meaning there are statistically significant differences between the medians of the areas WS, WR, and TR.

Table 2. Kruskal-Wallis test for six fields of the UI GreenMetric for the top 200 universities in Europe

			SI	EC	WS	WR	TR	ED
Kruskal-Wallis H			18,816	22,054	27,196	27,030	28,166	16,073
Asymp. Sig.			,278	,141	,039	,041	,030	,448
Monte Carlo Sig.	Sig.		,239[c]	,081[c]	,008[c]	,008[c]	,005[c]	,465[c]
	99% Confidence Interval	Lower Bound	,228	,074	,006	,006	,003	,452
		Upper Bound	,250	,088	,011	,011	,006	,478

Based on 10000 sampled tables with starting seed 2000000.
Source: data - UIGreenMetric, authors

The highest score among European universities in the SI category was achieved by Siberian Federal University in Russia with a score of 1,400. Wageningen University and Research achieved a score of 1,350 in this category. In the WS category, the highest score was 1,800, achieved by 25 universities, including Wageningen University and Research. A similar situation can be observed in the WR category, with the highest score being 1,000 and achieved by 14 universities, again including Wageningen University and Research. In the TR category, the highest score was 1,800, achieved by only 3 universities, 2 from the Netherlands and one from Italy. Wageningen University and Research achieved a slightly lower score of 1,750. The last analysed category is ED. Again, the highest score was 1,800, achieved by 7 universities, 4 from Italy, and one each from Germany, Ireland, and the United Kingdom. In this case as well, Wageningen University and Research did not achieve the highest score but "only" 1,775.

The overall highest score of 9,500 was achieved by Wageningen University and Research. This university has consistently ranked at the top of the UI GreenMetric World University Ranking, largely due to its comprehensive and impactful sustainability initiatives. The university has implemented various solutions that significantly contribute to its high position in the ranking. Notably, Wageningen University and Research has made substantial investments in renewable energy, energy-efficient buildings, and waste reduction strategies. Furthermore, the university promotes sustainable food systems, biodiversity conservation, and eco-friendly practices in its research and education programs. Wageningen University and Research's commitment to sustainability is deeply embedded in its institutional strategy, which includes a university-wide sustainability management system and continuous engagement with local and global environmental challenges. These efforts not only contribute to a sustainable campus but also support the development of practical, research-based solutions for pressing global issues related to climate change and resource depletion.

SLOVAKIA AND NEIGHBORING COUNTRIES

Only one university from the monitored universities made it into the top 200 best universities in the world, namely the University of Vienna, which ranked 198th with a score of 78.8. Two more universities made it into the top 300: Charles University of Vienna ranked 238th with a

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score of 78.0, and Medical University of Vienna ranked 289th with a score of 77.0. In Table 3., we can see the best universities for the monitored countries.

Table 3: List of the top universities in the CWUR in the surveyed countries

Number of CWER	University's name	CWER Score	State
198.	University of Vienna	78.8	Austria
238.	Charles University in Prague	78.0	Czech
409.	University of Warsaw	75.3	Poland
517.	Eötvös Loránd University	74.1	Hungary
661.	Comenius University in Bratislava	72.8	Slovakia
1170.	Institute of Mathematics of the National Academy of Sciences of Ukraine	69.5	Ukraine

Source: data - CWER, authors

Table 4: List of the top universities in the UI GreenMetric in the surveyed countries

Number of GreenMetric	University's name	CWER Score	State
23.	University of Pécs	8,950	Hungary
36.	Czech University of Life Sciences Prague	8,800	Czech
178.	Slovak University of Agriculture in Nitra	7,950	Slovakia
179.	Ukrainian National Forestry University	7,935	Ukraine
197.	Gdańsk University of Technology	7,835	Poland

Source: data - UI GreenMetric, authors

Encouragingly, each of the monitored countries is represented in the CWUR. From Tables 3. and 4., we can see that there are significant differences among the top universities for each analyzed country in the rankings. The best university is the University of Pécs from Hungary, which achieved the overall 23rd place with a score of 8,950. Furthermore, from Table 4., we see that in the UI GreenMetric ranking, the best universities from all monitored countries, except Austria, were ranked in the top 200. Not a single university operating in Austria made it into the UI GreenMetric ranking.

Table 5: Information about higher education institutions in the surveyed countries

Country	Population (1.January 2023)	Number of Universities		Number of Universities in CUWR		Number of Universities in UI GreenMetric	
		Number	per million inhabitants	Number	%	Number	%
Poland	36 753 736	359	9.77	39	10.86	15	4.18
Czech	10 827 529	61	5.63	11	18.03	6	9.84
Hungary	9 597 085	70	7.29	7	10	12	17.14
Slovakia	5 428 792	32	5.89	4	12.5	4	12.5
Ukraine	41 167 336*	132	3.21	5	3.79	19	14.39
Austria	9 104 772	76	8.35	16	21.05	0	0

* 1. January 2022

Source: EuroStat, studentnews.eu, CWUR, UI GreenMetric, Federal Ministry Republic of Austria – Education, Science and Research, authors

Out of the total of 82 universities that made it to the CWUR, the most are from Poland and the least from Ukraine. This figure is somewhat misleading because, as we can see in Table 5., the

highest percentage of placed universities out of all universities operating in a given country is Austria with 21.05%, followed by the Czech Republic with 18.03%. Slovakia is just above the average achieved by the monitored countries together.

Also interesting is the data on the number of universities in a given country and the number of universities per one million inhabitants. This data can also be seen in Table 5. Poland has the most universities in terms of both the total number and the number of universities per one million inhabitants. The Czech Republic and Slovakia have approximately the same share of universities per one million inhabitants. This fact is likely due to the historical unification of these two states in the past. Ukraine has the smallest share per one million inhabitants, and its best university in the CWUR is the worst among all the monitored countries.

In Table 5., we find the percentage representation of universities found in both CWUR and UI GreenMetric compared to the total number of universities in each country. We can see that Ukraine has the most universities, 19 in UI GreenMetric, but in proportion to the total number of universities in the country, Hungary achieved the highest percentage at 17.14%.

There are a total of 20 public universities in Slovakia. These institutions are public and self-governing, established and abolished by law. There are also 3 state universities and 10 private universities operating in Slovakia. Currently, there are a total of 6 foreign universities operating in Slovakia.

Table 6: The best universities in Slovakia according to the CWUR

World Rank	Institution	Score
661.	Comenius University in Bratislava	72.8
1 435.	Pavol Jozef Šafárik University in Košice	68.2
1 637.	Slovak University of Technology in Bratislava	67.3
1 993.	Technical University of Košice	66.0

Source: CWUR

Table 7: The best universities in Slovakia according to the UI GreenMetric

World Rank	Institution	Score
178.	Slovak University of Agriculture in Nitra	7 950
749.	Technical University of Košice	5 240
1 043.	Catholic University of Ružomberok	3 230
1 067.	University of Žilina	3 040

Source: GreenMetric

In Tables 6. and 7., all universities operating in Slovakia that ranked in both CWUR and UI GreenMetric are listed. The only university in Slovakia, Technical University of Košice, can be found in both rankings. The best university in CWUR is Comenius University in Bratislava, and in UI GreenMetric, it is the Slovak University of Agriculture in Nitra. The Slovak University of Agriculture in Nitra had the highest score in all six sub-categories of UI GreenMetric compared to other universities in Slovakia. Moreover, in the WS category, it achieved the second-highest score among all universities in the ranking.

University Social Responsibility has become an integral part of the vision and mission frameworks of universities. The presented article demonstrates that universities worldwide are deeply engaged with this issue and show significant interest in incorporating this area into their daily operations. As in many other fields, shortcomings can be identified in this domain as well.

Nevertheless, it must be unequivocally acknowledged, as evidenced by the presented article, that universities are making concerted efforts not to neglect USR. According to **Chen, Nasongkhla, and Donaldson (2015)**, strategic planning is a multifaceted and demanding process that requires significant time and effort. It is essential to ensure that this process involves stakeholders at all levels within the higher education system. For strategic planning to be truly effective, it must result in a robust and feasible plan that outlines a clear vision for the future. This plan should provide detailed guidance on implementing reforms and emphasize the broader impacts of USR, not just on the university itself but also on the surrounding community and the global society. As highlighted by **Rad et al. (2020)**, USR encompasses a wide range of both local and international expectations. These include fostering a culture of respect and environmental responsibility, promoting peace on national and global levels, alleviating poverty, and striving for social and economic equity. Addressing these responsibilities requires organizational adjustments, such as revising the structure of curriculum development, rethinking the university's core missions, and reshaping its organizational culture to align with its social obligations.

When compared to other countries in the region, it is interesting that Comenius University in Bratislava, the highest-ranked Slovak university in CWUR, was not included in the UI GreenMetric ranking, suggesting discrepancies between academic performance and university social responsibility. This phenomenon is consistent with previous studies, which show that universities excelling in traditional academic rankings may not necessarily perform equally well in sustainability and responsibility assessments.

4. Conclusion

USR is a vital pillar of the university environment, influencing not only the institutions themselves but also their communities and the broader societal context. The findings of this study suggest that there is significant potential in the field of USR, both in Slovakia and in neighboring countries, with universities showing varying degrees of performance. While Slovakia’s universities have demonstrated notable achievements, there are still substantial opportunities for improvement to enhance the overall quality of the university climate and their contributions to sustainability and social responsibility.

Interestingly, the best university in Slovakia according to CWUR, Comenius University in Bratislava, was not ranked in the UI GreenMetric ranking, highlighting a potential gap between global academic performance and university responsibility in environmental and social matters. The comparison of rankings in Slovakia shows that the Slovak University of Agriculture in Nitra has excelled in the UI GreenMetric ranking, illustrating its leadership in USR at a national level. This success mirrors Comenius University’s lead in the CWUR rankings, suggesting that universities that perform well in one ranking may not necessarily reflect the same strengths in another, indicating the multidimensional nature of university social responsibility.

Beyond Slovakia, these findings emphasize the diverse ways universities in Central and Eastern Europe approach USR, with opportunities for cross-border learning and cooperation in improving sustainability, social responsibility, and environmental impact. The results also invite further exploration of how USR can be measured and integrated into rankings globally, providing valuable insights for policymakers and higher education institutions worldwide.

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Exploring the Nexus: Company Size and Primary Area of Operation in Slovakian Commerce Strategic Management

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Abstract

In the field of commerce, there is a need to explore the factors that influence decision-making processes and strategic management. However, limited research has focused specifically on the Slovakian business environment, warranting further investigation. This article aims to examine the relationships between primary area of operation (production, services, combination) and company size in relation to aspects of implementation and control of strategies in a select group of companies in Slovakia. The aim is to highlight the importance of the commercial strategic management problem. Using Voswiever, a bibliographic analysis of scopus articles on the given issue was prepared, which laid the foundation for the correct direction of the issue. The researchers employed statistical methods to analyse the data, including the nonparametric Kruskal–Wallis test and post hoc analysis using the pairwise comparison post hoc test. These tests were applied to identify statistically significant differences between the chosen factors and individual variables relating to commercial strategic management. The findings indicate that the company size significantly influences commerce strategic decisions in areas such as Efficiency and Perfection, Quality and Deliberation, Formality and Collaboration and Alignment and Stability. Primary area of operation was also found to significantly influence commercial strategic management with regard to the Efficiency and Perfection, Quality and Deliberation, Formality and Collaboration and Alignment and Stability. Similarly, company size seems to play a role in strategic management and Efficiency and Perfection, Quality and Deliberation, Formality and Collaboration and Alignment and Stability decisions. This study contributes to the existing body of knowledge by offering insights into the specific context of strategic management in terms of commerce in the Slovakian business environment. The use of statistical analysis methods enhances the rigor of the findings. The findings provide practical implications for decision-making processes, resource allocation strategies and organizational design. This research fills a gap in the literature by focusing on the relationships between factors and mainly adds new point of view using bibliographic analysis in this problematic. This study serves as a foundation for future research in this field, guiding further exploration and understanding of the factors affecting commerce strategic management in Slovakia.

Key words

commerce; strategy; management; business.

JEL Classification

L1, L8, M1

1. Introduction

In the realm of commerce, understanding decision-making processes and strategic management is crucial. However, there's a lack of research, especially regarding the Slovakian business environment. This study fills this gap by examining the relationship between primary operation area and company size concerning strategy implementation and control in Slovakian

companies. Using rigorous methods, including bibliographic analysis and statistical tests like the Kruskal–Wallis test, significant differences were identified. The findings reveal that company size and primary operation area significantly influence strategic decisions in areas such as efficiency, quality, formality, and alignment. This study contributes to the understanding of strategic management in Slovakia and offers practical implications for decision-making and organizational design. By addressing this gap, it provides valuable insights for future research in commerce strategic management dynamics in Slovakia.

1.1 Strategic management

Strategic management in commerce, as emphasized by Afsharian et al. (2021), is crucial for steering businesses toward success in a globalized and ever-changing environment. Within Slovakia's unique business landscape, Amdam and Benito (2022) stress the importance of aligning strategic initiatives with local dynamics. A comprehensive literature review underscores how effective strategic management, as noted by Amin and Viganola (2023), enhances decision-making and sustains competitiveness. BadewI (2016) highlights the need to adapt global frameworks to Slovakia's context, considering cultural and regulatory nuances. Examining strategy implementation and control, as emphasized by Bahoo et al. (2020), is pivotal for translating goals into actions and evaluating outcomes, per Bena (2017). Pradip et al. (2023) assert that understanding and controlling strategy execution are essential for achieving organizational goals and adapting to change. Identifying a research gap, as noted by Ben-Daya et al. (2019), presents an opportunity to delve into nuanced areas of strategic management, considering factors like company size and primary areas of operation. Closing this gap, highlighted by Bondarenko et al. (2017), Cachón-rodríguez et al. (2022), and Chang et al. (2010), is crucial for advancing both academic understanding and practical applications in strategic management, guiding businesses toward adaptability and resilience in the commerce landscape.

1.1.1 Factors of strategic management

The role of company size and primary area of operation in strategic commerce is a complex field requiring thorough exploration (Anini et al., 2015). In Slovakia, understanding how these factors influence strategic decision-making is crucial for business success (Kormaníková and Šenková, 2023). However, there's a noticeable gap in literature regarding these dynamics (Maylor and Turner, 2017). Filling this void is essential for tailored strategies that promote growth and competitiveness (Ďaďo et al., 2015). Moreover, considering other contextual factors is imperative for a holistic understanding (Dwivedi et al., 2021). This research not only enriches strategic management theory but also provides practical insights for businesses and policymakers (Dyck et al., 2019).

Hypothesis

As the literature states, there are many factors that influence the process of strategic management in commerce. However, since this is a very broad field in the field of commerce and management, we decided to examine the very implementation and control of commercial strategies and through the factors of the size of the company and the primary area of operation of the company.

Considering the size of a company as a factor in strategic commerce is crucial also according to Teece, (2018). The scale of a business significantly influences strategic decision-making processes. Larger enterprises, with more resources, often engage in sophisticated planning, while smaller companies may adopt more agile approaches. Understanding the impact of company size is essential, especially in Slovakia's diverse business landscape. Analyzing this

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factor provides valuable insights for practitioners aiming to optimize strategic management practices in varying business environments.

Analysing the primary area of operation is vital in strategic commerce, influencing how organizations tailor their strategies. Whether in production, services, or a combination, this factor shapes strategic decisions. Understanding its impact is crucial for adapting strategies to the unique dynamics of each sector, Weilu et al. (2022). In Slovakia's diverse business landscape, exploring this influence provides practical insights for businesses seeking strategic alignment with their operational domains.

- Hypothesis 1 (H1): Variations in strategic management practices will be evident among companies of different sizes – small, medium, and large. Specifically, it is anticipated that larger enterprises will exhibit a higher likelihood of employing more extensive and sophisticated strategic management processes compared to their smaller counterparts. This hypothesis posits that the scale of operations and available resources influences the depth and complexity of strategic management efforts.

2. Data and Methods

This paper assesses strategic management processes in commerce companies in Slovakia, identifying strengths, weaknesses, and proposing improvement measures. The research involved interviews and a questionnaire survey, with pilot verification conducted beforehand. Out of 400 companies approached, 352 participated, representing an 87.50% response rate. After data adjustment (Teunissen, 2003), 350 companies remained in the sample set, selected through stratified randomization based on registration in the Slovak Commercial Register. Respondents, typically directors or top management, answered questions related to company size and primary area of operation. The questionnaire covered various aspects of strategic management, focusing on strategy implementation and control. Likert scale responses (1-5) were used for analysis. For the purpose of this study variable optimization was applied for a better understanding of the individual factors (see Table 1 below).

Table 1: Operationalisation of variables

Variable	Operationalisation	Method of measurement
Size of the company	Determinate your company size according to number of employees.	Micro enterprise; small business; medium enterprise; big business
Primary are of operation	Select the primary are of business operations	Production; services; a combination of the above
Implementation and Control questions (Implementation; Quality; Formalization; Alignment; Reserves; Growth; Motivation; Monitoring; Check; Review)	Items G1 - G10	Likert scale 1–5: 5 – completely agree; 3 – neutral; 1 – completely disagree

Source: own processing

3. Results and Discussion

The first goal of the work was to make a basic overview of scopus articles using bibliographic analysis, while the articles should focus on the implementation and control of strategic commercial processes. This analysis offers a basic overview of the main relevant terms, followed by an overview of the number of words, connected to the cluster distribution of the issue using graphic maps showing the classification of clusters and the temporal development of publications. The last step enables the preview of the heat map for the deep field cluster of

the graphic representation of the intensity of the relevant terms. The analysis of Scopus articles using Voswiever software reveals a strong emphasis on key terms that drive strategic decision-making in commerce. Terms like "supply chain," "price," "profit," "production," and "adoption" highlight core elements crucial for strategic management. The recurrence of these terms underscores the importance of logistical efficiency, financial strategies, operational processes, and innovation in commerce. Additionally, terms like "condition," "interaction," "supplier," and "manufacturer" emphasize the influence of external factors, collaborative relationships, and supply chain dynamics on strategic management discussions. Overall, this analysis reflects a comprehensive exploration of essential factors shaping strategic decision-making in commerce.

Table 2: Relevance score model

Term	Relevance
Trading enterprise	6.53
Strategic sustainability	6.12
Post digital world	5.32
Busy executive	4.75
Latest management development	4.67
Practical thinking	4.60
Briefing	4.54
Technology roadmapping	4.20
Virtural water	3.43

Source: own processing

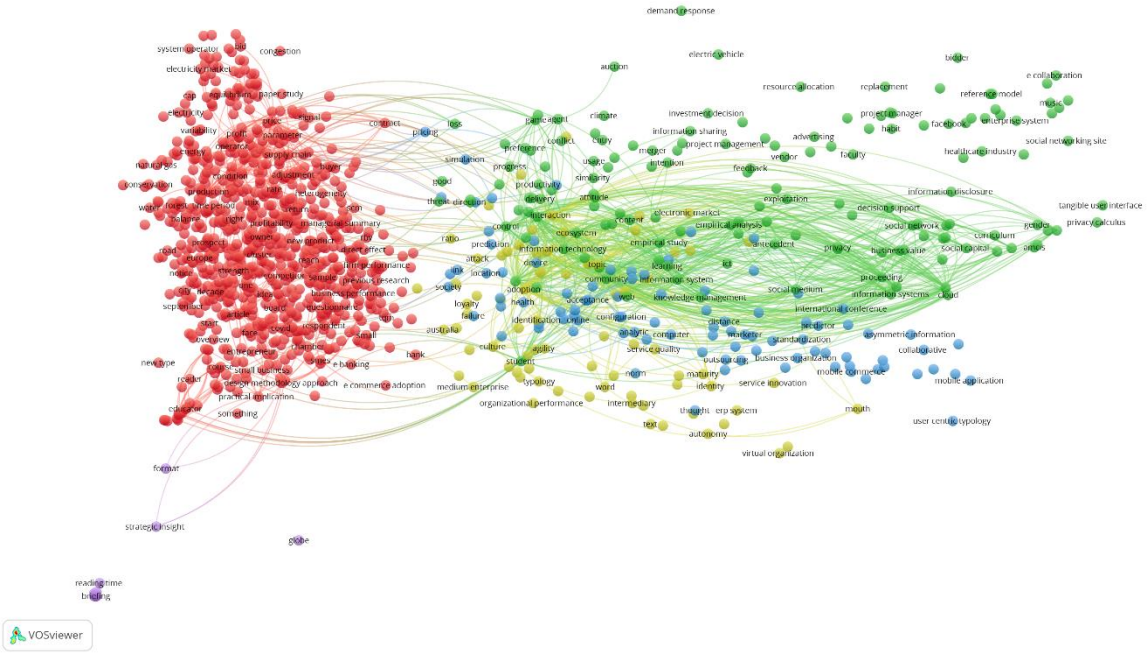

Figure 1: Bibliographic analysis
Source: Own processing

The analysis highlights several key terms with high relevance scores, indicating a forward-looking focus on strategic management in commerce. Terms such as "Trading enterprise," "Strategic sustainability," and "Post digital world" reflect a focus on global market dynamics, sustainability, and technological advancements. Additionally, terms like "Busy executive," "Latest management development," and "Practical thinking" underscore considerations of leadership and practical application in strategic decision-making. "Briefing" suggests an emphasis on concise communication, while "Technology roadmapping" indicates attention to technology planning. Lastly, "Virtual water" points to sustainability in resource management.

These findings paint a comprehensive picture of strategic management, encompassing various dimensions such as technology, sustainability, leadership, and communication.
The analysis of Scopus articles using Voswiever software reveals key themes in strategic management. Terms like "supply chain," "price," "condition," "production," "profit," "adoption," "interaction," "supplier," and "manufacturer" highlight factors influencing decision-making. Relevance scores for terms like "Trading enterprise," "Strategic sustainability," "Post digital world," "Busy executive," "Latest management development," "Practical thinking," "Briefing," "Technology roadmapping," and "Virtual water" suggest a future-oriented approach. These terms cover global market dynamics, sustainability, leadership, and practical application in strategic management.

Survey Results

Strategic management area Implementation and control of strategy

Strategy implementation, also known as strategic management, is vital for organizations aiming to achieve long-term objectives. This process involves meticulous planning, resource allocation, monitoring, and adaptation to ensure effective execution of strategic initiatives. Regular evaluations and the use of KPIs are crucial for tracking progress and aligning strategies with original objectives. Managing risks and adapting to changing environments are essential components. Communication and feedback from employees and stakeholders play a pivotal role in supporting success. Strategy implementation is a dynamic cycle of continuous improvement and adaptation to maintain competitive advantage. Our research focuses on specific points related to this process, as outlined in questions G1 to G10.

Size of the company

Implementation and control of the strategy according to the size of the company

Strategy implementation and control vary based on the size of the enterprise, tailored to its specific needs and characteristics. Large enterprises with complex structures rely on specialized teams and management layers, supported by technological tools for effective monitoring and coordination. Clear communication channels between management levels are essential. Conversely, SMEs often opt for a more flexible approach, fostering creativity and quick adaptation to changes. Constant monitoring and evaluation of strategy are crucial for long-term success across all business sizes. See the table below for average company size factor values.

Table 3:Test Statistics

	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Kruskal-Wallis H	20,181	9,455	12,663	5,959	2,758	5,735	5,963	25,642	14,154	16,482
Asymp. Sig.	**,000**	**,024**	**,005**	,114	,430	,125	,113	**,000**	**,003**	**,001**
Post hoc	3-4	3-4	1-4					1-4	1-2	1-4
	1-4							3-4	1-4	3-4

Source: Own processing

The analysis reveals significant differences in strategy implementation and control among enterprises of varying sizes. Medium-sized and large enterprises exhibit more pronounced disparities in decision implementation and strategy monitoring, potentially due to resource availability and business process complexity. Variances in quality versus speed of implementation are notable between medium and large enterprises, suggesting differing

priorities based on size. Micro-enterprises differ from large enterprises in sharing best practices and pre-strategy control, indicating varied management approaches and the need for experience exchange. Monitoring post-implementation shows differences across size categories, likely linked to complexity. These insights can guide managers in adapting strategies to enhance implementation efficiency and success.

Implementation and control of the strategy according to the primary area of operation

The implementation and control of strategy can be influenced by the company's primary area of operation, whether it is manufacturing, service provision, or a combination of both. Each of these areas has its own characteristics and specifics that can affect the way an organization formulates, implements and monitors its strategies.

The manufacturing, service, and combination sectors exhibit distinct approaches to strategy implementation and control. Manufacturing businesses face challenges in decision implementation due to technological and logistical complexities, while the service sector excels in quick and efficient execution. Combined businesses demonstrate adaptability across industries. Manufacturing and service industries prioritize quality over speed, whereas combined businesses strike a balance. Services excel in sharing best practices, while manufacturing struggles with alignment between strategy and structure. Services allocate reserve resources effectively, while combined businesses require a balanced strategy. Services outperform manufacturing in strategic planning's impact on sales and profit growth. Employee motivation is key in services, while combined businesses value both motivation and compensation. Monitoring and evaluation strategies require improvement in services. Each sector prioritizes different aspects of strategy implementation and control, reflecting their unique characteristics.

Table 4: Test Statistics

	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Kruskal-Wallis H	6,977	5,734	2,920	4,752	,915	2,871	,430	2,501	2,315	1,297
Asymp. Sig.	**,031**	,057	,232	,093	,633	,238	,806	,286	,314	,523
Post hoc	2-3									

Source : own processing

The difference in values between production and combination in question G1 on the implementation of decisions can be interpreted in the context of the characteristics of these industries. Manufacturing enterprises achieve lower values, which could be related to their probably higher complexity and the need to solve logistical and technological challenges in the process of implementing decisions. On the contrary, combined enterprises achieve the highest values, indicating their flexibility and ability to implement decisions in both sectors. These differences may reflect the different needs and challenges associated with strategy implementation in manufacturing and combined activities, where combined firms are likely to excel in adaptability and coordination of decisions for different parts of their business structure.

4. Discussion

This study evaluated strategic management processes in commerce companies in Slovakia, identifying strengths and weaknesses and proposing improvement measures. It employed interviews and a questionnaire survey, preceded by pilot verification. With an 87.50% response

rate, 350 companies formed the final sample. Stratified randomization was used based on registration in the Slovak Commercial Register, with representatives completing the questionnaire. The survey comprised 67 questions across seven sections, focusing on strategic management aspects. Analysis of Scopus articles using Voswiever software revealed key themes and contemporary focuses in strategic management. Statistical analyses, including Kruskal-Wallis tests, showed significant differences in strategy implementation and control based on company size and primary area of operation. Large enterprises excelled in decision implementation and strategy monitoring, while small and medium-sized enterprises prioritized decision quality. Manufacturing prioritized decision quality, services excelled in quick decision-making, and combined enterprises showed a balanced approach. The research offers insights for managers aiming to enhance strategic management efficiency and success, contributing to the broader discourse on strategic management in commerce. Comparisons with other countries like the Czech Republic or Poland support the findings, emphasizing the need for adaptable approaches tailored to specific organizational contexts.

5. Conclusion

In summary, this study makes a significant contribution to understanding strategic management in the Slovakian commerce context. By meticulously examining company size, primary area of operation, and strategy implementation and control, it uncovers various facets of strategic management dynamics. Focusing on Efficiency, Quality, Formality, Collaboration, Alignment, and Stability, it fills a crucial gap in the literature, offering timely insights for decision-making, resource allocation, and organizational design. Rigorous statistical analysis enhances the credibility and applicability of the findings, paving the way for future research in this field. While acknowledging limitations such as sample size and geographic scope, the study lays the foundation for deeper exploration and refinement of strategic management practices within Slovakia and beyond.

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Measuring the Level of Food Self-sufficiency: Methodological Approach

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Abstract
The ongoing military conflict in Ukraine has increased the need to monitor food security and self-sufficiency not only in the Slovakia and the European Union, but also on a global scale. For policy makers it is important to measure production and food self-sufficiency with accuracy using relevant data and methodology.
The goal of the paper is to present methodology of measuring the level of production and food self-sufficiency and international comparison between EU member states using national and international data. Methodology presented in this paper allows to determine the degree of self-sufficiency for a specific commodity or commodity group, as well as in an aggregated form for branches of economic activity, i.e. for agricultural raw materials and food products. In our paper, we present methodological aspects and sources of data needed for determining the degree of self-sufficiency of a country.
Using our approach, it is possible to compare the levels of food self-sufficiency of individual EU member states. We present methodology for measuring the degree of self-sufficiency at the i) commodity level, ii) at the level of the food industry branch as well as for, iii) the entire agricultural and food sector.

Key words
production self-sufficiency, food self-sufficiency, commodity approach, sector approach

JEL Classification
C02, C80, Q02, Q11

1. Introduction

There are several understandings of food self-sufficiency that can be applied at different levels of analysis (O'Hagan, 1976). In its most basic form, FAO defined food self-sufficiency as "the extent to which a country can satisfy its food needs from its own domestic production" (FAO, 1999). This definition can apply at the individual, regional or country level. Country food self-sufficiency has become a key indicator for food availability and is a fundamental pillar of food security. Therefore, self-sufficiency is the main goal of agri-food policies, even though this goal is often not explicitly defined (Clapp, 2017).

Currently, indicators of self-sufficiency, expressed by the rate of self-sufficiency (SSR) (FAO, 2012), are standard indicators in agricultural and economic statistics. They are measured in calories, or in physical and monetary units (Gálik et al., 2022; Beltran-Peñ, Ros & D'Odorico, 2020; Godenau et al., 2020; Puma et al., 2015; Davis, D'Odorico & Rulli, 2014).

The Ministry of Agriculture and Rural Development of the Slovak Republic distinguishes two indicators of self-sufficiency: production and food self-sufficiency (MPRV SR, 2021). Production self-sufficiency shows the extent to which agricultural primary production from its own production can satisfy the demand and food needs of domestic consumers. Food self-

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sufficiency shows the extent to which the food industry can satisfy the needs of domestic consumers from its own production (Gálik et al., 2022).

2. Data and Methods

The goal of the paper is to present detailed methodology of measuring the level of production and food self-sufficiency and international comparison between EU member states. Depending on the input data, it is possible to determine the degree of self-sufficiency for a specific commodity or commodity group, as well as in an aggregated form for entire branches of economic activity, i.e. for agricultural raw materials and food products (Gálik et al., 2022).

The paper is organized as follows: after the Introduction and Data and methods parts we present methodology for measuring self-sufficiency in the Results and Discussion of the article divided into 3 parts. Self-sufficiency at the:

i) commodity level

ii) level of individual branches of the food industry, and

iii) for the total agricultural and food sector.

All formulas of the presented methodology are in the relevant Results and Discussion section, so we do not list them here.

We use two databases in the presented methodology:

1. national: Annual report on the food industry (POTRAV), which provides except financial and HR also structured data on individual commodities of the food industry. The report uses a 4-digit numbering starting from *6674-Drinking milk* to *6980-Food packaging (rice, cocoa, powdered sugar, spices)*. Full structure of the data is available in Radela (2022)
2. international: The database on international trade in goods (ITG), also called Comext database. The database uses a 4-6-8-digit numbering of food products and full structure is available in: Eurostat (2023a).

Because of the difference in items and numbering between these two databases, we present the "data bridge" which allows the comparison and data harmonization.

3. Results and Discussion

A commodity approach of measuring self-sufficiency

Self-sufficiency rate is usually calculated for a specific commodity or group of commodities. When calculating production and food self-sufficiency, we use balance sheets of agricultural commodities, which are since 2022 published annually by the Ministry of Agriculture and Rural Development of the Slovak Republic as part of situational and outlook reports (MPRV SR, 2022). Based on data from commodity balance sheets, production self-sufficiency is expressed as follows (Matošková, Gálik & Jamborová, 2015):

Production self-sufficiency = gross domestic production x 100 / balance consumption (1)

In the case of animal commodities, it is also possible to determine the degree of food self-sufficiency from balance sheets according to formula:

Food self-sufficiency = net domestic production x 100 / balance consumption (2)

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European union in the medium-term outlook uses balance sheets of selected agricultural commodities that are published only in an aggregated form for the entire European Union (EU, 2022). For that reason, it is not possible to use the mentioned procedure to determine the degree of self-sufficiency of individual EU countries. For the purposes of international comparison, the key indicator is therefore the self-sufficiency rate (SSR) using the following equation:

SSR = production x 100 / (production + import – export) (3)

Table 1: Items of production of selected agricultural products and relevant Harmonized System Customs Statistics items

Commodity	Item HS
Cereals together (without rice)	1001, 1002, 1003, 1004, 1005, 1007, 1008
Oil products	1201, 1205, 1206
Fresh vegetables including melons	0702 - 0709, 0807
Beef	0201, 0202, 021020
Pork	0203, 020910, 021011, 021012, 021019
Poultry	0207, 020990

Source: Comext, own processing

Data on production and international trade on commodity groups in individual EU member states are published by Eurostat (Eurostat, 2023; Eurostat, 2023a). Since it is necessary to use data from two independent and incompatible databases – production of agricultural products and international trade exchange (Comext) – it is necessary to use bridge between the items of both databases (Table 1).

The rate of food self-sufficiency of Slovakia based on individual branches of the food industry

The food self-sufficiency can be assessed using data on the volume of production for the sale of own products of individual branches of the food industry in Slovakia in a detailed breakdown by individual groups of the food industry (Radela, 2022). Based on data in natural measurement units, food self-sufficiency can be determined according to the formula (Matošková et al., 2020):

Food self-sufficiency = production x 100 / (production – export + import) (4)

The application of this method depends on the bridge between the items of production of the food industry and the items of the Harmonized System of Customs Statistics (Table 2).

Table 2: Bridge between the production items of individual branches of the food industry and the items of the Harmonized System of Customs Statistics

Code Production department	Product code POTRAV	Item HS Comext
1511 Meat industry		
Abattoir-processed beef	6711	0201; 0202
Slaughter-processed veal	6713	
Slaughter processed pork meat	6712	0203
Slaughter-processed sheep, goat meat	6714	0204
Meat products	6720	0210 11 – 0210 20

Continuation of the Table 2

Code Production department	Product code POTRAV	Item HS Comext
Canned meat	6721	1601

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Meat products not heat treated	6722	1602 41 – 1602 90
Heat-treated meat products	6723	
1512 Poultry industry		
Frozen poultry	6735	
Chilled poultry	6740	0207
Portioned and divided poultry	6741	
Poultry products	6742	1602 10 – 1602 39
Poultry canned and ready meals, semi-finished products	6745	
1551 Dairy industry		
Drinking milk	6674	
Non-perishable drinking milk	6675	0401
Creams	6678	
Sour milk products (except yogurts)	6676	0403
Yoghurts	6677	
Dairy butter	6680	0405 10
Spreading butter (other milk fat products)	6681	0405 20
Dried dairy products	6684	0402
Natural cheeses (except bryndza and cottage cheese)	6690	
Processed cheeses	6695	0406
Bryndza	6696	
Cottage cheese	6697	
1533 Canning industry, additives, spices		
Sterilized compotes	6805	2008 40 – 2008 80, 2008 99
Sterilized vegetables (except cucumbers)	6806	2002; 2004; 2005 80 2005 10 – 2005 60
Sterilized cucumbers	6807	2001 10 00
Fermented cabbage	6808	2005 99 60
Dried fruits, candied fruits and dry fruits	6809	0813
Dried vegetables except paprika	6811	0712
Dried paprika	6812	0904 21 – 0904 22
Soup and meal preparations	6814	2104 10 - 2104 20
Tomato sauce	6815	2103 20 00
Ketchup	6816	
Jams, jams, marmalades, fruit purees	6817	2007 99 10 - 2007 99 50
Baby food	6818	1901 10 00
Vegetable juices	6821	
Fruit juices	6822	2009
Fruit and vegetable drinks	6823	
Edible syrups	6825	2106 90 20 – 2106 90 59
Lemonade syrups	6830	

Continuation of the Table 2

Code Production department	**Product code POTRAV**	**Item HS Comext**
Vinegar 8%	6862	2209

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Vinegar 10%	6863	
Yeast	6865	2102 10-20
Mustard	6866	2103 30 90
1541 Fat industry		
Emulsified vegetable edible fats liquid	6919	
Spreadable vegetable edible fats	6920	1517
Edible vegetable fats, including hydrogenated	6921	
Sunflower oil	6922	1512 11 91
Rapeseed oil	6924	1514 11 90
Tofu cheese	6925	
Soy products	6926	1507; 2103 10; 2106 10
Soy drink (milk)	6927	
1561 Mill industry		
Wheat flour	6762	1101
Rye flour	6763	
Flour mixtures for the production of food products	6764	1102
Flours (except wheat and rye)	6766	
Semolina	6767	1103
Other products from cereal grains	6768	1104
1593 Wine industry		
Grape wine altogether	6835	2204 21 – 2204 29
Sparkling wine	6843	2204 10
1581 Bakery and confectionery industry		
Fresh bread	6765	
Pastry fine	6769	
Fresh pastries	6770	1905 10+1905 20+1905 40+1905 90
Confectionery products except durable ones	6780	
Production of gingerbread	6781	
Other bakery products	6771	1904
Special grain products (muesli, expanded and extruded products)	6772	
Pasta	6775	1902
Preparations and mixtures for bakery and confectionery production	6776	1901 20
1584 Confectionery and bakery industry		
Packaging of natural honey	6876	0409
Chocolate production	6881	1806 90
Chocolate candies	6883	
Non-chocolate confectionery (including white chocolate)	6884	1704
Durable pastry	6885	1905 31; 1905 32
Ingredients and preparations for baking	6886	2102 30
Processing of bean and instant coffee	6887	0901

Continuation of the Table 2

Code Production department	**Product code POTRAV**	**Item HS Comext**

DOI: https://doi.org/10.15414/2024.9788055228167.115-123

Coffee products, preparations, ingredients and extracts from coffee and coffee plants	6888	2101
Extracts, essences, concentrates and preparations from tea	6890	
Processing of dried and instant tea	6889	0902
1596 Brewery and malt industry		
Alcoholic beer without mixed drinks	6790	
Non-alcoholic beer without mixed drinks	6791	2203 00
Mixed drinks such as Radler, Cider, etc. (alcoholic and non-alcoholic)	6792	
Malt	6795	1107
1598 Non-alcoholic beverage production industry		
Carbonated, sweetened soft drinks	6870	2202
Carbonated, unsweetened soft drinks	6871	
Natural mineral water	6872	2201
Spring water, bottled baby water and drinking water	6873	
1599 Freezer industry		
Frozen vegetable products	6935	0710 21 – 0710 40; 0710 90
Frozen fruit products	6936	0811 10; 0811 20
Ice cream and frozen creams	6938	2105
Frozen potatoes	6939	0710 10 00
1583 Sugar industry		
Sugar production	6932	1701
Production of molasses	6933	1703
1562 Starch industry		
Potato starch	6892	
Wheat starch	6893	1108
Maize starch	6894	
Starch derivatives except isoglucose	6905	1702
Isoglucose	6906	
1591 Distillery industry		
Raw alcohol	6850	2207
Refined alcohol	6855	
Fruit distillates	6856	2208
Spirits	6860	
1520 Fish industry		
Processing of sea fish (including fish for salads)	6951	0302, 0303, 0304, 0305
Processing of freshwater fish (including fish for salads)	6953	
Production of fish salads	6955	1604
Canned fish and fish products	6957	

Source: own processing based on the departmental report of the Ministry of Agriculture of the Slovak Republic POTRAV

The detailed data of the report POTRAV allow to determine the level of potential food self-sufficiency, which expresses the share of theoretical production of food products corresponding to the fully utilized production capacities reflecting current consumption (Matošková et al., 2020):

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Potential self-sufficiency = production capacity x 100 / (production - export + import) (5)

The degree of self-sufficiency of the agricultural and food sector

The degree of self-sufficiency can also be expressed on a global scale for all EU member states and for the entire sector of agricultural commodities or food products (Pokrivčák, Gálik & Tóth, 2022). Data on the total agricultural and food production of individual EU countries published by Eurostat are used to analyze individual indicators of self-sufficiency (Eurostat, 2023b) - Detailed breakdowns of main GDP aggregates (by industry and consumption purpose). We express production self-sufficiency by share of domestic production and consumption of agricultural commodities, which we derive from production and international trade data:

Production self-sufficiency = agricultural production*100 / (production – export + import) (6)

The food self-sufficiency rate is given by the share of food production, including non-alcoholic beverages, and food consumption, which we derive from production and data on international trade in food products:

Food self-sufficiency = food production*100 / (production – export + import) (7)

Since we derive domestic consumption from production and international trade data, the problem is to define trade in agricultural and food products from the items of customs statistics. The Ministry of Agriculture and Rural Development of the Slovak Republic (MPRV SR, 2021a) classifies agri-food trade as the sum of the first 24 chapters of the customs nomenclature (HS 01-24), while agri-food trade is further divided into agricultural raw materials and food products. Trade in agricultural raw materials includes live animals (HS 01), live fish (HS 0301), liquid milk (HS 0401), live plants and flowers (HS 06), fresh vegetables (HS 0701-0709, 0713), fresh fruit (HS 0801-0810), cereals (HS 10), oilseeds (HS 12 except HS 1208), knitting materials (HS 14), cocoa beans (HS 1801) and unprocessed tobacco (HS 2401). Trade in food products consists of other items of agri-food international trade (HS 01-24).

4. Conclusion

The ongoing military conflict in Ukraine has increased the need to monitor in detail food security and self-sufficiency not only in the Slovakia and the European Union, but also on a global scale. The military conflict between two major exporters of agricultural commodities significantly destabilized the world market, with a negative impact on the food availability in developing countries. At the same time, developed countries to pay more attention to monitoring own level of food self-sufficiency. The basic prerequisite for policy makers in taking measures to increase production and food self-sufficiency is an accurate methodology. In our paper, we focused on detailed methodology and data necessary for determining the degree of self-sufficiency of the country. It also can be used for international comparison between EU member states.

The paper summarizes all methodological approaches and procedures for measuring the level of food and production self-sufficiency of the country. The most frequently used is the commodity approach. It is based on the balance sheets of specific agri-food products. We have generalized the approach using of transfer bridges so that an international comparison of the degree of self-sufficiency between EU member states is possible.

Unique data on the volume of production of individual branches of the food industry (report POTRAV) allow to establish and evaluate the degree of food self-sufficiency of individual branches. For this purpose, based on the structure of the report POTRAV, we developed a

bridge with the items of the Harmonized System of Customs Statistics. However, this methodological procedure cannot be used for international comparison countries, as such detailed data on production are only available in Slovakia. Therefore, in the paper we also present methodology for measuring the degree of self-sufficiency of the entire agricultural and food sector, which can be used for international comparison.

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Using AI to Reduce the Economic Impact of Air Pollution

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Abstract

Paper's objective(s) and research background

The main objective of the paper is to demonstrate how Artificial Intelligence (AI) can help reduce the economic impact of air pollution, through prediction of pollution levels, optimizing countermeasures, and mitigating health-related cost associated with poor air quality. As AI is among the fastest growing technologies in human history, it can also aid in issues associated with poor air quality. More than half of the world's population lives in cities, and the majority have to deal with the same problem of poor air quality. Nitrogen oxides and fine dust, in particular, often exceed the permitted limits and residents, especially children and the elderly, suffer health consequences. It is therefore not only an environmental problem, but also an economic one, in terms of the burden on public finances in the health system, and the paper's objective is to focus on this problem.

Data/Methods

The data sources include governmental environmental monitoring agencies and own air quality monitoring stations at four locations in Slovakia. Data are presenting pollutants PM2.5 and PM10 measured hourly. The dataset was processed using AI tools, including chatGPT.

Results/Conclusions/Value added

AI can play an important role in reducing the economic impact of air pollution through various applications and solutions such as early warning systems, air quality monitoring, traffic management, control of industrial emissions, assessment of population health impacts and public information or education. The study proposes the possibilities of using AI tools in the elimination of air pollution in the conditions of Slovakia.

Key words

air pollution, artificial intelligence, economic impact

JEL Classification

M2, M20

1. Introduction

With rapid economic development and globalisation, large amounts of emissions and waste are being generated, leading to serious air pollution. It is a phenomenon harmful to the ecological system as well as the fundamentals of human existence, when some substances in the atmosphere exceed a certain concentration. Increasingly serious environmental pollution problems resulted in a number of related research, where the forecasting of air pollution has been of paramount importance (Bai et al., 2018). It is a major issue all over the world due to its impact on the environment and human beings. The impact on air quality can be divided into two broad categories: safety effects and socio-economic effects (Qingxin, 2020).

Artificial Intelligence (AI) is among the fastest growing technologies in human history and can also aid in issues associated with poor air quality. Specialised softwares use AI to predict pollution for days ahead as well as the effectiveness of possible countermeasures. Cities around the world suffer from high concentrations of pollutants that degrade air quality, and more than

half of the world's population lives in cities. Nitrogen oxides and fine dust, in particular, often exceed the permitted limits and residents, especially children and the elderly, suffer health consequences. It is therefore both an environmental and economic problem, and the paper aims to focus on this problem.

1.1 Literature review

There are a number of factors, which are increasing air pollution on a daily basis, including the number of cars on the streets, industrialization, municipal and agricultural waste burning, inadequate transportation network and environmental regulations (Purushothaman et al., 2020). Air pollution risks are usually quantified for particulate air pollution, household air pollution, and tropospheric ozone (Guttikunda et al., 2014; Arku et al., 2018). Lu (2019) adds that air pollution is a mixture of particulate matter (e.g., PM2.5, PM10), gases (e.g., carbon monoxide [CO], nitrogen dioxide [NO_2], ozone [O_3], sulfur dioxide [SO_2]), organic compounds (e.g., polycyclic aromatic hydrocarbons [PAHs]), and metals (e.g., lead).

Up to 91% of the world population live in places with ambient air pollution levels higher than those defined by the WHO guidelines (Lui et al., 2020). The long-term impact of emissions caused that air quality is not only a global concern, but also a public health issue (Zeng et al., 2019). Air pollution is the leading cause of premature death and disease in recent years (Zivin & Neidell, 2012). Extensive research shows that it is even associated with increased unethical behaviour (Younan, 2018), since psychological experience of air pollution can raise unethical behaviour by increasing anxiety (Fehr, 2018). Accordingly, on days with high air pollution, individuals tend to be more selfish and less pro-social (Chew et al., 2021). In the context of the negative effects of air pollution on employee well-being and cognitive function, numerous studies suggest that it can reduce work productivity and has a negative impact on economic productivity (Roth, 2017). Aragón et al. (2017) found that moderate levels of PM2.5 reduce adults' work time, likely due to their need to care for family members. It is still debated whether the impact of air pollution is more physiological or psychological, however, both actual and perceived pollution levels matter (Neidell, 2009).

Research on the application of AI in air pollution is increasing (Bellinger et al., 2017), and is widely used in a variety of fields, including disease prediction, environmental monitoring, and pollutant prediction (Guo et al., 2022). The review by Subramaniam et al. (2022) discussed the sources and impacts of pollutants on environmental and human health and the research status on environmental pollution forecasting techniques. They presented details of the Artificial Intelligence (AI) methodologies and Machine Learning (ML) algorithms used in environmental pollution forecasting and early-warning systems. Fu et al. (2023) focused on the application of big data and AI technology in environmental protection monitoring. They analyzed the application principle of big data in environmental data collection based on atmospheric science and AI technology, and proposed a combined model of air quality forecasting based on ML to resolve real air quality monitoring challenges in environmental protection. Hu et al. (2017) created a random forest model, incorporating aerosol optical depth data, meteorological fields, and land use variables to estimate daily 24 h averaged ground-level fine particulate matter (PM2.5) concentrations over the USA. Furthermore, a long short-term memory neural network extended model was developed by Li et al. (2017) to predict the air pollutant concentration. Huang and Kuo (2018) also developed a deep neural network model to apply the PM2.5 forecasting system. Alimissis et al. (2018) investigated two ways for modelling urban air pollution using interpolation, giving a great capacity for tracking the present pollution scenario and demonstrating a precise and quick method for identifying pollution hotspots (Masood & Ahmad, 2021).

Liu and Liang (2024) found more substantial environmental benefits in areas with stricter environmental regulations and higher initial levels of pollution. In addition, AI is facilitating a symbiotic relationship between economic growth and environmental management. According to Essamlali et al. (2024), the combination of pioneering technology and environmental priorities has enabled a more effective approach to air quality management and climate change mitigation. By integrating data collected from governmental agencies, academic literature, and own measuring stations, along with AI tools and other methods, the study aims to provide a comprehensive analysis of the economic impact of air pollution in Slovakia and the efficacy of AI-driven interventions in addressing this pressing environmental challenge.

2. Data and Methods

Data for this study were collected from a combination of sources, and the methodology employed a multi-faceted approach, integrating AI tools to analyse the data and derive meaningful insights. The research methodology involved these steps.

Data Collection: Data were collected from governmental environmental monitoring agencies, academic literature, and own measuring stations established at four locations in Slovakia (Bratislava, Brezno, Nitra, and Turany). This comprehensive approach ensured a diverse and representative dataset for analysis. The measuring stations were strategically located to capture localized variations in air quality and pollutant concentrations within Slovakia:

- The roof of the building of the Secondary Medical School in Bratislava – Petržalka (GPS 48°6'17.61"N, 17°6'5.51"E)
- Brezno-Mazorníkovo (GPS 48°47'12.35"N, 19°38'15.69"E)
- The roof of the building of the Slovak University of Agriculture in Nitra (GPS 48°18'15.71"N, 18°5'34.41"E)
- Turany nad Váhom (GPS 49°6'28.41"N, 19°2'24.10"E)

The measurements were carried out using four measuring devices for PM2.5 and PM10. Accuracy for PM2.5 measurements was in the range of 0 to 100 $\mu g/m^3 \pm [5\ \mu g/m^3 + 5\%$ m.h.] and in the range of 100 to 1000 $\mu g/m^3 \pm 10$ % m.h. Accuracy for PM10 was in the range of 0 to 100 $\mu g/m^3 \pm 25\ \mu g/m^3$ and in the range 100 to 1000 $\mu g/m^3 \pm 25$ % m.h. (Sensirion, 2020).

The selection of datasets was based on their applicability and relevance to the goals of the study and their coverage of key variables, such as traffic patterns, pollutant concentrations, climatic conditions, and demographic characteristics. Data gathered from the measuring stations, which focused on particulate matter concentrations (PM2.5 and PM10) during the heating season, were averaged and displayed daily for the month of January 2024. To make comparing urban and rural settings easier, data collected at one-minute intervals were combined into daily averages. The stations' high-resolution, real-time insights enabled monitoring air quality trends and spatial variations in great detail, adding to the body of knowledge already available from scholarly and governmental sources.

Data Pre-processing: The collected data underwent pre-processing steps to clean and prepare it for analysis. This included handling missing values, outlier detection, and standardization of data formats to ensure consistency across different sources.

AI Analysis: AI tools, including chatGPT, were applied to analyse the processed data. Natural language processing techniques were used to extract insights from textual data sources, while ML algorithms were employed to identify patterns and trends in the data.

Forecasting: AI techniques were utilized to forecast future pollution levels based on historical data and relevant environmental factors. Time series analysis and predictive modelling were

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employed to generate forecasts with appropriate confidence intervals, enabling proactive measures to mitigate air pollution.

Compliance: Adherence to the guidelines ensured transparency and reproducibility. The systematic review of literature and the synthesis of evidence followed established protocols to minimize bias and enhance the reliability of the findings.

3. Results and Discussion

The measured pollutants PM2.5 and PM10 are small particles or droplets with an aerodynamic diameter of less than 2.5 μm and 10 μm. The term particulate matter (PM) includes both solid and liquid phases. PM dispersed in the air forms atmospheric aerosol. The smaller the particles, the deeper they penetrate into the respiratory system. The health effects depend not only on their size but also on their chemical composition. Long-term exposure can have negative effects on the respiratory and cardiovascular systems. Main sources of PM2.5 or PM10 particles are of diverse composition and origin, both natural and anthropogenic. The most important source of PM emissions is domestic heating with solid fuel, high concentrations can be measured at busy road sections and car parks, and locally the influence of large industrial sources may be evident. Solid fuel heating is a serious problem, often complicated by unfavourable dispersion conditions with frequent temperature inversions in mountain valleys (SHMÚ, 2022).

In Bratislava, a significant exceedance was monitored on 18 January 2024 (Fig. 1). This was probably related to the weather conditions and higher dispersion intensity. Exceedances were also seen on the 30th and 31st day of that month.

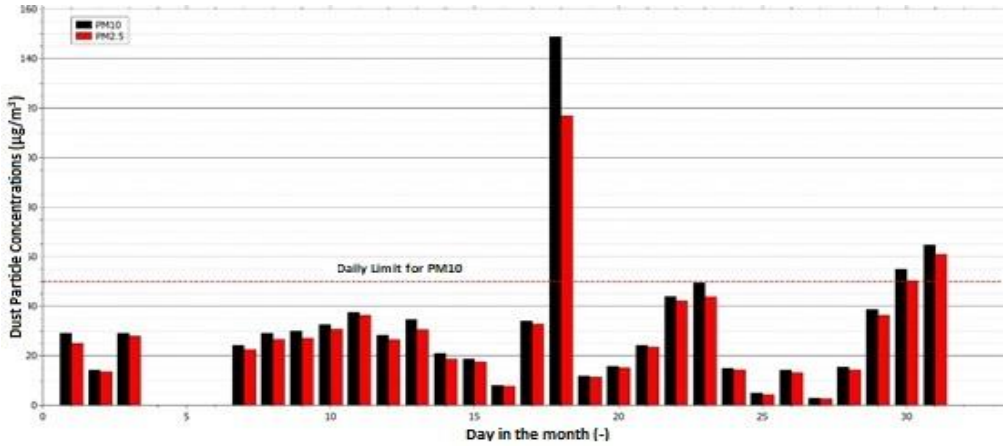

Figure 1: Daily average PM2.5 and PM10 concentrations in January 2024 – Bratislava

Source: Own processing based on measured data 2024

In Brezno, similarly, there was an exceedance of values on 18 January 2024 to a significant extent (Fig. 2). This was probably caused by the weather conditions and the higher dispersion intensity that occurred over most of the territory of the Slovak Republic. Higher values were also recorded at the end of that month (30th and 31st).

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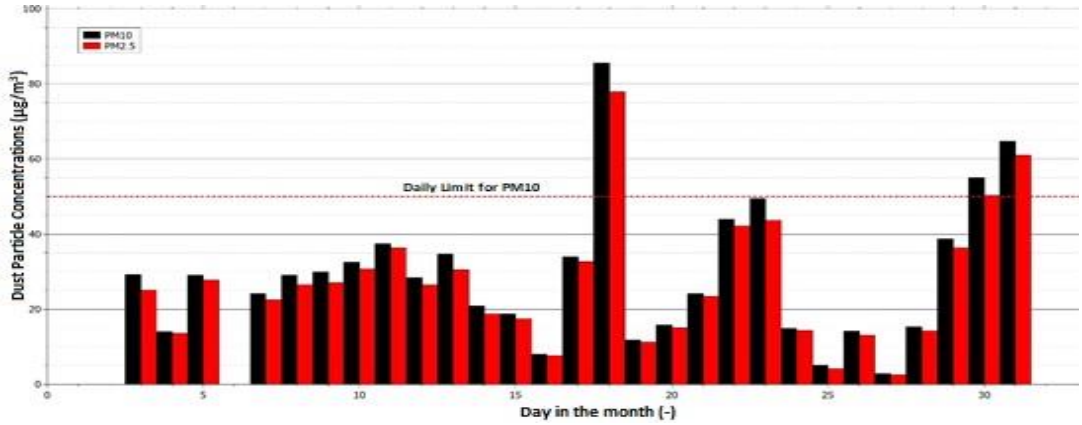

Figure 2: Values of average daily concentration of PM2.5 and PM10 in January 2024 – Brezno
Source: Own processing based on measured data 2024

In Nitra, an exceedance of the values was visible on the 10th, 11th and 23rd day of the month of January (Fig. 3). However, these exceedances were not at the same levels as at the other measuring stations.

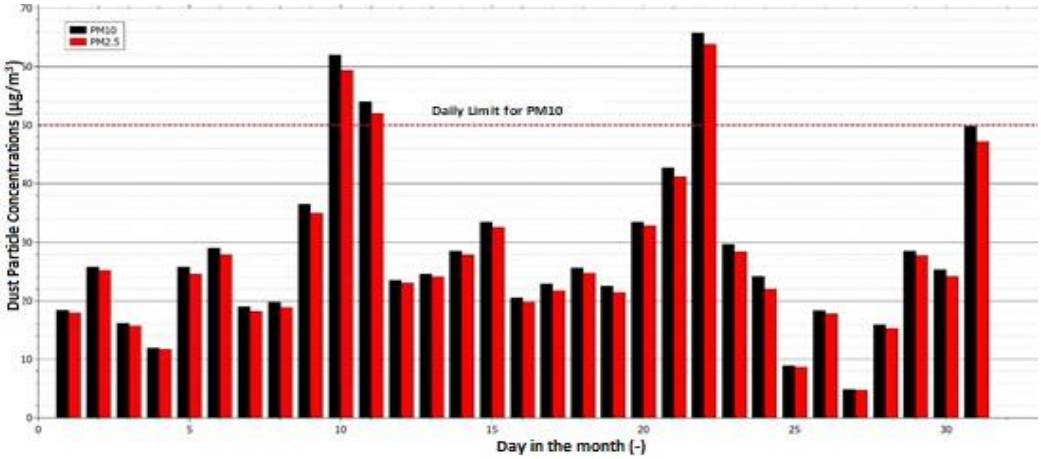

Figure 3: Daily average PM2.5 and PM10 concentrations in January 2024 – Nitra
Source: Own processing based on measured data 2024

In Turany, there was an exceedance of values on the 10th, 11th, 18th, 21st, 29th, 30th and 31st day of January 2024 to a significant extent (Fig. 4). This was probably caused by heating in houses by solid fuel as well as weather conditions and higher dispersion intensity.

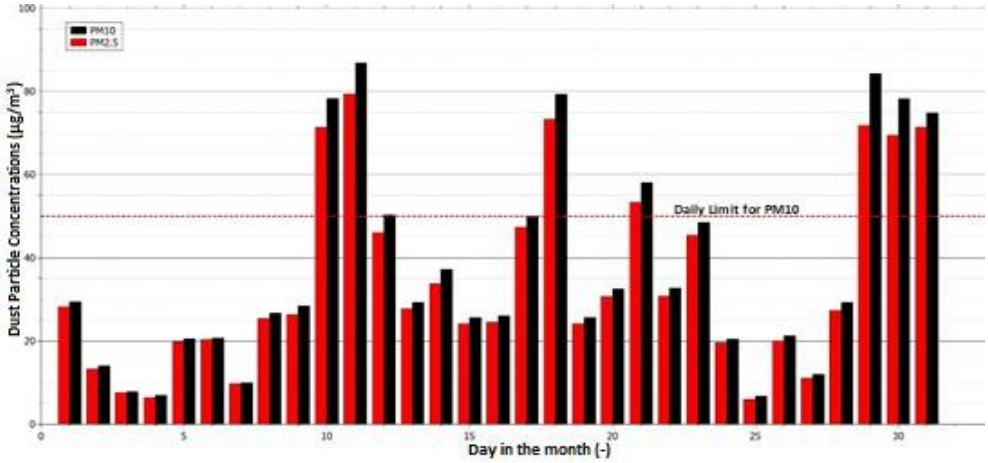

Figure 4: Daily mean PM2.5 and PM10 concentrations in January 2024 – Turany
Source: Own processing based on measured data 2024

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EU and the WHO legislation sets limit and target values for concentrations of air pollutants. The limit value for the annual average concentration of PM10 is 40 μg/m3. Also, the average daily concentration of PM10 must not exceed 50 μg/m3 more than 35 times per calendar year (SHMÚ, 2022; MŽPSR, 2016; WHO, 2021).

Nowadays, thanks to the Internet of Things (IoT), a huge amount of data on actual air pollution ca be obtained from various sources, such as sensors located in cities, weather stations and satellite imagery. This data can then be processed and analysed using AI to create effective strategies to reduce the economic impact of air pollution.

A possible use of AI is the creation of predictive weather models based on meteorological data. AI can analyse data on current weather conditions and predict when dispersion conditions are likely to be greatest, which has a major impact on the dispersion of airborne dust particles. This information can then be used to optimise processes such as controlling emissions from solid fuel heating or industrial facilities.

AI contributed to solving air pollution problems in the selected regions by providing real-time data analysis and creating accurate pollution forecasts within the monitored areas. Real-time data analysis can clearly inform the population about high pollution hazard, to avoid ventilation in certain times of the day. In the long run, this model helps to monitor external environmental parameters to be more critical to traditional wood heating or unsustainable use of resources as well as high impact on population health in monitored regions.

In addition, AI can help in developing energy efficiency strategies. Based on predictions about dispersion conditions and energy consumption, AI can suggest the most efficient way to use energy resources. For example, at times when dispersion conditions are predicted to be good and energy consumption is low, AI can recommend the use of stored energy or renewable energy sources to minimize emissions.

It is important to note that improving air quality has a direct impact on public health and public finances. Lower air pollution can lead to a lower incidence of respiratory diseases, which means a lower burden on the public health system and lower costs associated with treatment and absenteeism from work. These savings can have a significant economic impact, which could be another reason to invest in AI and IoT technologies to improve air quality.

Overall, the potential for using AI to reduce the economic impacts of air pollution is large and offers many opportunities to effectively manage air pollution and protect public health.

4. Conclusion

This study underscores the critical importance of addressing air pollution, a pressing global challenge with far-reaching implications for human health, economic productivity, and environmental sustainability. As highlighted throughout the study, air pollution not only poses significant risks to human health and well-being but also imposes substantial economic burdens, exacerbating inequalities and hindering sustainable development efforts.

The review of literature focused on the multifaceted nature of air pollution, encompassing a wide array of pollutants emitted from various sources, including industrial activities, transportation, and residential heating. Anthropogenic activities continue to contribute significantly to air pollution, necessitating concerted efforts to mitigate air pollution through effective environmental management strategies and regulatory interventions.

The integration of AI and ML techniques emerges as a promising avenue for addressing the complex challenges posed by air pollution. By leveraging AI-driven predictive models and data

analytics, researchers and policymakers can gain deeper insights into air quality dynamics, identify pollution hotspots, and forecast pollutant concentrations with greater accuracy. Such advancements not only facilitate early warning systems and proactive interventions but also enable the optimization of energy consumption patterns and the development of targeted mitigation strategies.

Furthermore, the study highlights the importance of interdisciplinary collaboration and the adoption of innovative approaches to air quality management. By harnessing the power of big data, IoT technologies, and AI-driven analytics, stakeholders can forge a path towards a cleaner, healthier future. The alignment of research efforts with the principles of the Sustainable Development Goals (SDGs) offers a blueprint for advancing environmental sustainability and fostering inclusive growth.

In the future, the combination of machine learning and AI-based prediction models may improve our comprehension of pollution patterns by modelling scenarios under different traffic and weather situations. Because these models estimate exceedances based on both historical and real-time data, they would allow for proactive responses. However, this study serves primarily as a demonstration of data collected from measuring stations and highlights the potential applications of AI in predicting the economic impacts of air pollution, as the presented data have not been subjected to AI-based analysis or modelling.

As we navigate the complexities of environmental degradation and socioeconomic disparities, a collective commitment to innovation, collaboration, and sustainability will be indispensable in shaping a more equitable and prosperous world.

Discussion

The findings of this study highlight the significant potential of Artificial Intelligence (AI) in mitigating the economic impact of air pollution. The results indicate that AI-driven predictive models and data analytics can enhance the accuracy of air quality forecasting, allowing for more effective pollution control strategies. Monitoring dust particles (such as PM2.5 and PM10 concentrations) demonstrates its ability to provide timely and precise assessments, which is crucial for public health interventions and policy-making.

A key insight from this study is the role of AI in data monitoring and processing, data analysis in emissions management. AI-based models can predict air pollution conditions and warn relevant individuals or institutions and adjust industrial operations or traffic flow. Moreover, AI-driven strategies can support regulatory compliance by offering real-time monitoring and automated reporting, which enhances transparency and enforcement of air quality standards.

Air quality levels translate into lower healthcare costs due to a decline in respiratory and cardiovascular diseases. Furthermore, improved air quality enhances worker productivity, as exposure to high pollution levels has been linked to increased absenteeism and reduced cognitive function. These economic advantages underscore the necessity of investing in AI-driven solutions to address environmental and public health challenges.

Despite these findings, the study also highlights several limitations. The effectiveness of AI models depends on the availability and quality of data, necessitating robust data collection infrastructure. Additionally, while AI can support decision-making, it requires integration with policy frameworks and cross-sectoral collaboration to maximize its impact. Ethical considerations, such as data privacy and algorithmic transparency, must also be addressed to ensure responsible AI deployment.

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Digitalization in Bulgarian Agriculture: Challenges of Implementation

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Abstract

Paper's objective and research background

The digitization of the agricultural sector in Bulgaria is a key stage in the transition to sustainable agriculture and create new opportunities for growth and development. The digitalization of agriculture includes a wide range of technological innovations and applications aimed at improving production processes, resource management and increasing productivity. This leads to the achievement of an efficient, competitive and environmentally friendly agricultural sector. The aim of the paper is to examine the challenges of the implementation of new technologies and to reveal to what extent Bulgarian agriculture is taking advantage of their opportunities.

Data/Methods

A three-stage approach is used to accomplish the aim of the paper. The first part of the publication presents basic theories related to digitization in the agricultural sector. The second part of the paper includes the methodology used and the choice of method, which is a case study. Three cases were investigated. The level of digitization and the challenges for the implementation of new technologies in three farms from the main subsectors typical for the Bulgarian agriculture have been studied. The selection of agricultural subsectors is based on the economic volume of production and within the scope of the study fall farms growing wheat, dairy cattle and vineyards. The developed methodology of the research case studies, looking for answers connected, as with financial framework of the implementation of digital services, but also with their impact on the activities of the farms from the point of view of the need for personnel, risk management etc.

Results

The third part of the paper includes the research results, findings and conclusions. The conclusions drawn reveal the problems in the implementation of innovations and digitization of agriculture in Bulgaria, and proposals for their overcoming. The recommendations are related to improving the awareness of agricultural producers about digital technologies and solutions, opportunities for finding sources for financing new technologies, increasing the qualification of the staff when using them, etc. In addition, the proposals and recommendations could be used as a basis for developing guidelines for improving process of the digitalization in agriculture.

Key words: digitalization, agriculture, Bulgaria, new technologies, innovation, risk management

JEL Classification

Q10, Q16

1. Introduction

Some of the theories for need of digital transformation stressed that the main reason is for coping with scarcity of food, food supply and to reduce the negative impact from agriculture on environment (Mendes, Carvalho, Mourarias, Careta, Zuin & Gerolamo, 2022). In addition is made a bridge between the digitalization of agriculture, industry and society. According to

Bachev (2020) the level of digitization depends on the agricultural sub-sector, the legal status and the size of the farm, as well as the region, in which it is located. Other authors (Ionitescu, Popescu, Gudanescu & Cristea, 2023) are on the opinion that the level of the digitalization rely on the size of the farm, the age of the producers, the level of education, financial resources, the importance of communication between farmers and their customers. The main factors and restriction related to the processes of digitalization are described as economical, political and environmental. The main finding is that there are still legislative issues, lack of finances and undevelopment infrastructure on macro level. In other research (Kurnosova, Kurnosov, & Ulez'ko, 2021) the main barriers which effect the level of digitalization is related not only to individual economic entities, but also the social production entire system. Specially in agriculture is explained that level of digitalization is very low, in comparison with the industry and the biggest challenge which the sector is facing is due to the old technological base. Other significant factor mentioned by numerous of authors is related to the lack of labour (Nezamova & Olentsova, 2022; Vaishnavi & Manisankar, 2022), which is capable to work with digital solution, and as well is capable to use of the full capacity of technology. Some authors stress that this gap can be solved by trainings in all educational level on direction up to date work with innovations and digitalization (Peicheva, 2022) in order to make the trainees more employable in the labor market, where digital knowledge and skills are important and necessary (Ionitescu, De Melo, Popovici & Conci, 2019). In addition, the stress is given to the nature of agricultural process and the inability to be implemented digital solutions. As a result of the digitalization is expected the main financial indicators to be affected, but as well there is a large application of monitoring of the activities, which gave to the producers to take action in early signs of problems, or risk occurrence (Dayioğlu & Turker, 2021). By Internet of Things (IoT) in a possibility for digitalization in rural areas, which can affect the access of the producers to the developed infrastructure and access to a big data for further analysis and decision making (Lima, Figueiredo, Barbieri & Seki, 2021). The proposed model of IoT in agriculture is reflecting to big data sets for monitoring the natural recourses which can help farmers and their needs. Researchers in both the agricultural and digital solutions fields highlight the challenges posed by digitalization. They emphasize that the agricultural sector's dilemma, which is lagging in digital development, may pose more risks to its operations than benefits (Kashapov, Nafikov, Gazetdinov, Gazetdinov & Nigmatzyanov, 2019; Nemchenko, Dugina, Shaldokhina, Likholetov & Likholetov, 2022).

As well the focus of agriculture is directed to Agriculture 4.0 and is shown a timeline between agriculture 1.0 to 4.0 by compared with the industrial revolution as a main driving force for high tech and digital transformation (Dayıoğlu,& Turker, 2021). In addition, the digitalization is related to the main SDG goals by United Nation. This kind of agriculture focuses on a methodical approach, including the resources of water, energy, and food, as well as the digital transformation of agriculture, which will contribute to sustainable development and are given some new possibilities which provide a synergy between technologies such as agrivoltaics and aquavoltaics combining food and energy production in rural areas, besides solar-powered pivot and drip irrigation systems and environmental monitoring systems. Furthermore, during the last decades the society changed its preferences toward healthy food (Horská, Janšto, & Šedík,2023), and the less impact on the enviromnet. Digitization will lead to added value and precision in land monitoring, spatial planning and cadastral data registration (Popescu, Dinu & Stoian, 2019). According to FAO (2017), agriculture is the main polluter of natural recourses, mostly –contaminating soils and water, so by digital transformation is possible to be reduced the stress on the environment. Nikolov, Boevski, Atanasova – Chopeva, Kostenarov, Petkov, Fidanska (2022) also consider that digitalization could lead to the reduce of negative impact of agriculture on ecosystem, but the implementation of technologies and systems for sustainable

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agriculture is a challenge for agricultural producers, not only because of the high price of the machines, the lack of infrastructure and knowledge.

In conclusion, there is a strong demand for digitization in agriculture, as both macro and micro implications have been seen. Nevertheless, despite the wealth of research on the topic, there aren't enough particular business unit-level (farmer) justifications for constraints and associated presumptions about the application of digital solutions. This is the exact field in which the paper seeks to identify Bulgaria's main obstacles to the agricultural sector's adoption of digital innovations.

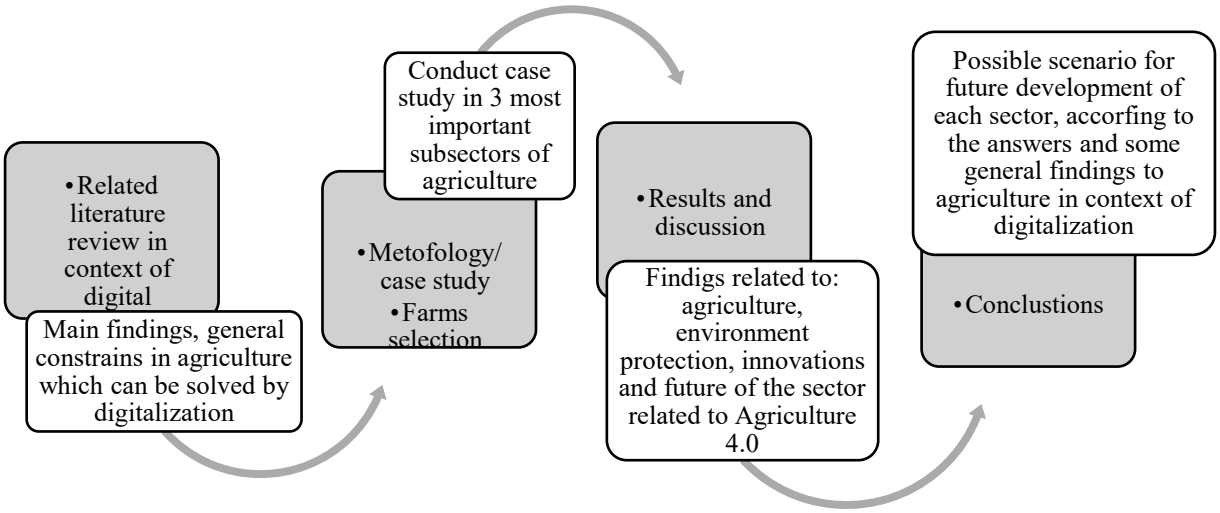
2. Data and Methods

The aim of the paper is to examine the challenges to the implementation of new technologies and to reveal to what extent Bulgarian agriculture is taking advantage of their opportunities. A three-stage approach is used to accomplish the goal. The first part of the publication presents basic theories related to digitization in the agricultural sector. The second part of the paper is the methodology used and the choice of method, which is a case study. Three cases were investigated. The level of digitization and the challenges for the implementation of new technologies in three farms from the main subsectors typical for the Bulgarian agriculture have been studied. The selection of agricultural subsectors is based on the economic volume of production and within the scope of the study fall farms growing wheat, dairy cattle and vineyards.

The selected farms for conducting the case study are representatives of the specialized farms with the greatest economic importance and presence in Bulgarian agriculture - production volume of wheat, cattle farming, and vineyards. Based on the summarizing results of previous research, factors, opportunities and barriers for the digitalization of agriculture have been identified. The survey was conducted in January 2024. They are tested and evaluated through a ten-score scale.

The methodology is presented on figure 1.

Figure 1: Methodology of the study



In Bulgaria, at this stage, no official statistical data on the progress in agriculture related to its digitalization have been presented. For this reason, it is a challenge to reveal the effects and directions in which Bulgarian farms should develop. For this reason, it was chosen to use case

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studies in the publication, which include representatives of agriculture with activities that are of the greatest importance, such as economic size. The selection is reduced to the following steps. 1. The farms are listed in the table, according to Economic size and their specialization. 2. Based on the data, it can be seen that crop production makes up nearly 2/3 of the total economic size and 1/3 of livestock breeding. 3. This is also the reason for choosing two specializations in crop production and one in livestock breeding. 4. Of the crop production, cereals are the most important and for this reason the choice is reduced to a wheat producer, which is also a representative in the group with the standard output. In second place was chosen a grape producer, due to Bulgaria's traditions in wine production and among the lowest of production output 5. Of the livestock farms, dairy cattle breeding is of greatest economic importance for Bulgaria, and therefore a farm was chosen in the case study, on the basis of which an analysis for the sector can be proposed. The data of latest census in Agriculture is shown in table 1.

Table 1: Distribution of Bulgarians farms by number and standard output (2020)

specialization	BULGARIA Number of Farms	Standard outputs (common land inc.) by type of farming, econimic size
Total	132 742	4 091 460
Cereals, oilseeds and protein crops	16 962	2 188 496
Other arable crop	22 971	328 927
Vegetables, flowers and mushrooms	7 146	125 375
Vineyards	5 871	49 211
Fruit trees	10 775	70 247
Mixed permanent crops	891	5 829
Milk cattle	14 438	355 967
Meat cattle	6 333	70 345
Mixed milk and meat cattle	1 670	32 057
Sheep, goats and other grazing livestock	16 852	156 838
Pigs, poultry and rabbits	2 523	386 278
Crops growing	5 510	67 528
Grazing livestock	2 401	7 385
Pigs, poultry and rabbits	896	1 866
Arable crops and grazing livestock	3 507	138 621
Other crops and livestock	13 759	106 492

Source: MAF(2020)

3. Results and Discussion

The comparison between the three farms reveals that wheat producer has the highest average score for awareness and readiness for digitization (Table 2). This farm also shows more belief in the potential of digital solutions to improve personnel management efficiency and reduce operational risks associated with labor shortages (score 9). Vineyard farm takes second place with relatively high scores for awareness and belief in the potential of digital solutions, but slightly lower scores for reducing operational risks and readiness for adopting digital solutions

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(score 8). The lowest ranking is for cattle farm, which has lower scores for awareness and belief in the potential of digital solutions. It also demonstrates less readiness for adopting digital solutions and a lower assessment of the potential benefits of digitization.

According to the data above, the lowest level of digitalization is observing in the cattle farm, so only to this farm, further analysis will be performed, to be reviled the reason behind the current situation. As well the farm will give score for the sector where it is operate - overall.

Based on the answers of the agricultural producers in the studied farms on the question "What are the primary challenges encountered during the implementation of digital solutions?" could be made conclusions as follows:

✓ The wheat producer indicates that their main challenges revolve around making decisions regarding which technological-digital solution will yield the highest productivity and how quickly a new technology, either more effective or with a lower cost, will be introduced. Another major issue is that some digital solutions fail to accurately capture information due to environmental factors such as sensor malfunctions, animal interference, and others.

✓ The biggest challenge for the grape producer is successfully integrating new technologies with existing personnel and finding funds to purchase digital solutions for some of the cultivated areas.

Table 2: Levels of awareness related to digitalization of the studied farms

Main questions	Level of awareness (scale from 1 not at all, to 10 absolutely yes)		
	Wheat producer	Cattle farm	Vineyard farm
What is the level of awareness of your farm regarding the core digital advancements in the agricultural sector?	10	6	8
Do you believe that digital solutions can enhance personnel management efficiency?	9	5	8
Will digital solutions decrease operational risks associated with labor shortages?	9	2	5
What is the level of awareness among your personnel regarding their readiness to adopt digital solutions?	6	1	5
How do you evaluate the benefits of digitalization and identify perceived risks based on your assessments?	9	5	7

Source: own survey

✓ The owner of the cattle farm considers that neither their operation nor the entire livestock sector is ready for transition to digitalization due to the need of numerous activities that cannot be replaced, such as herders, veterinarians, etc., who can detect changes in animal behavior and identify early-stage problems requiring timely intervention, such as the onset of animal diseases. The owner acknowledges the achievements in the digital world, primarily contributing, according to him, to cost reduction. However, at this stage, digital advancements in the sector are either very expensive or have highly restrictive implementation requirements. Despite the lack of digital solutions in farming, the same farm takes advantage of digital technology achievements for marketing programs, procurement, monitoring inventory levels in storage facilities for available animal feed, automated delivery systems, payments, and other electronic advancements.

Table 3 presents the producer's self-evaluation about some statement related to the factors and challenges in front of digitalization. The producer's opinion and evaluation could be summarized as follows:

✓ **Complexity of the processes:** The high score of the cattle farm (5) and the cattle sector (4) could be explained with the fact that cattle farms may have complex processes that are not easily automated or digitized, especially when it comes to animal care and management. The

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statement that complexity of the processes does not lead to easy digitalization is evaluated with average score from the wheat and grape producers, because of the specifics of cultivation technology of the plants in these subsectors and the relatively greater possibility of easier digitization.

Table 3: Factors/challenges affecting digital transformation in Bulgarian agriculture

Factor/challenge To what degree does the statement apply to your farm /"From 1 to 5, where 1 indicates 'not true and 5 indicates true"/	Cattle farm self-evaluation	Cattle sector	Wheat producer self-evaluation	Grain sector	Vineyard producer self-evaluation	Vineyard sector
Complexity of Processes: The complexity of the processes does not lead to easy digitalization	5	4	2	2	3	3
Investment Costs: Despite the potential benefits of digitization, the investment costs for implementing digital technologies in the farm/sector can be high and may not be justified in terms of profitability	5	5	1	2	2	4
Need for Human Interaction: Agriculture often require manual handling and care, which is difficult to fully automate through digital solutions.	5	5	1	1	3	4
Training and Restructuring Needs: Introducing new digital systems may require significant training of staff and restructuring of work processes, which can be challenging and may face resistance from workers.	5	5	4	4	4	4
Challenging Environmental Conditions: External conditions, such as uneven terrain, varying climatic conditions, and limited internet connectivity, can hinder the effective operation of digital systems.	5	3	5	4	4	4
Aging Infrastructure: Many farms may have outdated infrastructure, including older buildings, equipment, and technology, which can pose barriers to implementing digital solutions. Upgrading such infrastructure to support digitalization may require additional investment and resources.	5	5	1	2	3	3
Lack of Qualified Personnel: The shortage of qualified personnel with the necessary skills and knowledge to manage digital systems can hinder the implementation of such technologies. This may be due to a lack of training and experience in digital technologies, as well as reluctance on the part of staff to adapt to new processes and methods of work. As a result, companies may postpone or refrain from investing in digitization or may encounter difficulties in implementing digital projects.	4	3	5	4	5	5

Source: own survey

✓ **Investment Costs:** Cattle farm evaluate strongly positive the statement that despite the potential benefits of digitization, the investment costs for implementing digital technologies in the farm/sector can be high and may not be justified in terms of profitability (score 5). This could be explained with the fact that it operates on relatively tight profit margins and the decision to invest in digital technologies must be carefully weighed against the potential return on investment. Wheat producer evaluate with low score (1) the statement related to the benefits and effectiveness of the investment cost and this is due to the fact that this producer perceives digitization as a strategic investment that can yield returns in terms of profitability.

✓ **Need for Human Interaction:** The high score (5) for livestock farming and the livestock sector could be explained with the fact that this subsector inherently requires substantial human involvement due to the intricate nature of animal care. Tasks such as feeding, healthcare, and handling are typically labor-intensive and demand human intervention. While digital

technologies can streamline some processes, such as data management and monitoring, they often complement rather than fully replace human interaction. In contrast, management of grain (score 1) and vineyard farms may involve fewer direct interactions with animals, resulting in a lower overall need for human involvement. However, human oversight remains crucial in various aspects of crop cultivation and vineyard maintenance.

✓ **Training and Restructuring Needs:** Introducing new digital systems entails significant training for personnel and restructuring of work processes to integrate these technologies effectively. The producers, participated in the study evaluate with high scores (score 4 and 5) the training and restructuring needs. Livestock farming and grain production operations can be complex, requiring extensive training to ensure staff proficiency in using digital tools for tasks such as herd management, crop monitoring, and equipment operation. Resistance to change and traditional work practices may further complicate the implementation process. While vineyard production may involve less intricate operations, transitioning to digital solutions still necessitates training and restructuring efforts to optimize vineyard management practices and improve yield and quality.

✓ **Challenging Environmental Conditions:** Livestock farming and grain production are susceptible to various environmental challenges (score 5), including rugged terrains, adverse weather conditions, and limited connectivity in remote areas. These conditions can impede the seamless operation of digital systems, affecting data transmission, equipment functionality, and overall system reliability. In contrast, although the vineyard production depend on environmental factors, may encounter fewer obstacles in deploying digital technologies due to the relatively controlled environments of vineyards and the availability of modern infrastructure in many viticultural regions.

✓ **Aging Infrastructure:** Livestock farms often grapple with outdated infrastructure, including aging buildings, equipment, and technology (score 5). Upgrading these facilities to support digitalization requires substantial investment and resources, posing financial challenges for many farmers. Similarly, grain producers may face obstacles in modernizing aging infrastructure, albeit to a lesser extent compared to livestock operations (score 1 and 2). Vineyard producers may encounter similar issues, particularly in regions with long-standing vineyards where infrastructure upgrades are necessary to accommodate digital solutions effectively.

✓ **Lack of Qualified Personnel:** Across all sectors, a shortage of skilled personnel proficient in managing digital systems is a significant impediment to successful technology adoption (scores from 3 to 5). The complexity of agricultural operations coupled with the rapid evolution of digital technologies exacerbates this challenge. Livestock farming and vineyard management, in particular, demand personnel with diverse skills, including agronomy, data analytics, and technology integration. Addressing this shortage requires comprehensive training programs and initiatives to attract and retain qualified professionals in the agricultural workforce.

In summary, while each agricultural sector faces unique challenges in adopting digital technologies, common themes such as the need for human interaction, training, infrastructure modernization, and skilled personnel underscore the complexity of transitioning to a digitalized farming paradigm. Overcoming these challenges necessitates a concerted effort from stakeholders, including policymakers, industry leaders, and educational institutions, to provide the necessary support and resources for successful technology integration in agriculture.

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4. Conclusions

The research on the need for digital transformation in agriculture emphasizes its crucial role in addressing food scarcity, enhancing food supply, and mitigating agriculture's adverse environmental impact. Despite acknowledging the interconnectedness between agricultural, industrial, and societal digitalization, challenges persist on economic, political, and environmental fronts, with legislative issues, financial constraints, and underdeveloped infrastructure posing significant barriers. The low level of digitalization in agriculture, compounded by outdated technological bases and a shortage of skilled labor capable of leveraging digital solutions, underscores the sector's struggle to embrace innovation. Nonetheless, digitalization holds promise for improving financial indicators and enabling proactive decision-making through advanced monitoring systems. The integration of IoT technologies in rural areas offers opportunities to bridge infrastructure gaps and access extensive data for informed decision-making. However, researchers caution that the agricultural sector's lagging digital development may pose more risks than benefits without addressing these challenges. The concept of Agriculture 4.0, aligned with the United Nations' Sustainable Development Goals, emphasizes a systematic approach to resource management and sustainable development, leveraging digital transformation to achieve synergy between technology, food, and energy production. As society increasingly values healthy and environmentally friendly food production, digital transformation emerges as a key tool in reducing agriculture's environmental footprint. In conclusion, while there is a pressing demand for digitalization in agriculture, overcoming constraints and harnessing its full potential requires a deeper understanding of business unit-level obstacles and tailored solutions to drive innovation in the agricultural sector, as highlighted in the study focusing on Bulgaria's agricultural sector.

The comparison of the three Bulgarian farms reveals a clear disparity in their readiness and perception towards digitalization. The wheat producer farm emerges as the most prepared and optimistic about the potential benefits of digital solutions, particularly in enhancing personnel management efficiency and mitigating operational risks. Conversely, the cattle farm exhibits the lowest level of digitalization and expresses skepticism towards transitioning to digital solutions, citing the irreplaceability of certain traditional activities and the high costs associated with available technologies. These findings underscore the diverse challenges and attitudes towards digitization within the agricultural sector, emphasizing the importance of tailored approaches to address sector-specific barriers and foster digital adoption.

Livestock farming and grain production, characterized by labor-intensive tasks and complex operations, require substantial human interaction and restructuring efforts for effective digital integration. Environmental conditions pose additional hurdles, particularly in rugged terrains and remote areas, affecting data transmission and system reliability. Aging infrastructure presents financial obstacles, especially for livestock farms, necessitating substantial investments for modernization. The shortage of qualified personnel further compounds these challenges, emphasizing the need for comprehensive training programs and collaborative efforts to facilitate successful technology adoption in agriculture. Overall, addressing these common themes requires a holistic approach involving policymakers, industry stakeholders, and educational institutions to support the transition towards a digitalized farming paradigm.

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Water Management Issues in Slovakia in the Context of Climate Change

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Abstract

Paper's Objective(s) and Research Background: This paper aims to provide an overview of the current state of agricultural water management infrastructure in Slovakia, with a particular focus on irrigation and drainage systems. It explores historical development patterns, identifies key challenges associated with infrastructure degradation, and examines the broader implications for sustainable water resource management in the context of climate change. The research also seeks to highlight the need for modernization and to propose strategies for enhancing the resilience and functionality of existing systems.

Data/Methods: The study utilizes comprehensive data on irrigated agricultural areas and water management channels, collected from national databases and relevant institutional sources. Analytical methods include quantitative analysis to assess the functionality, distribution, and historical trends of hydromelioration infrastructure. The evaluation considers regional disparities, the age of systems, and their current operational status. Comparative analysis is employed to identify best practices and gaps in management strategies.

Results/Conclusions/Value Added: The research highlights significant findings regarding the condition and effectiveness of Slovakia's water management infrastructure. It reveals notable regional disparities in the functionality of irrigation systems and identifies critical areas requiring urgent intervention. The conclusions emphasize the need for targeted modernization efforts, improved financial mechanisms, and legislative reforms to support sustainable management. Additionally, the study provides strategic recommendations to enhance water retention capacities and promote integrated water-energy-food-ecosystem (WEFE) approaches. The added value of this paper lies in its comprehensive assessment, which offers valuable insights for policymakers, stakeholders, and agricultural managers aiming to strengthen the resilience of water systems amidst evolving climatic conditions.

Key words: irrigation, water retention, drainage, climate change, land improvement

JEL Classification: Q25, Q15, Q18

1. Introduction

Climate change is understood as a significant deviation in weather conditions from the long-term average over several decades, which represents its key distinction compared to ordinary weather fluctuations (Minďaš et al., 2011; UN, n.d.; SHMÚ, n.d.).

As illustrated in Figure 1, over the past 80 years, each decade has been warmer than the preceding one, confirming the severity of the current climate situation on our planet (NASA, 2023; SHMÚ, 2023; NRDC, 2021). This trend has triggered numerous adverse impacts, including intense heatwaves, droughts, extreme storms, and floods (Perkins-Kirkpatrick & Lewis, 2020; Watts et al., 2017; Westra et al., 2013; Nerem et al., 2018; UCAR, n.d.).

Moreover, it contributes to increasingly pronounced changes in the hydrological regime and the uneven distribution of precipitation. This leads to higher levels of waterlogging in already humid areas and the drying out of arid regions (Konapala et al., 2020; D'Odorico et al., 2018;

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EEA, 2018), posing risks to societal well-being, ecosystem health, and the agricultural sector's ability to produce food (Challinor et al., 2014; UN, n.d.; NRDC, 2021).

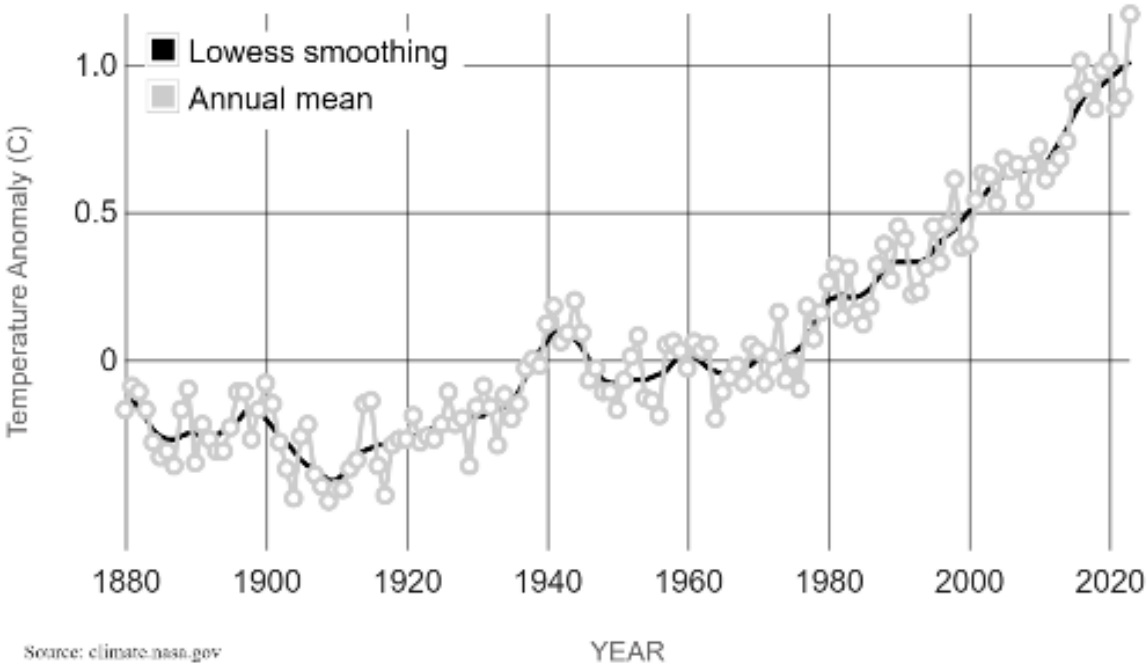

Figure 1: Global land-ocean temperature index
Source: NASA, 2023

For these reasons, water management systems, as an integral part of watershed management, play a crucial role in the process of adapting to the impacts of climate change (Szolgay & Lapin, 2007; Berbel et al., 2024; Haq & Shafique, 2009). It is essential to develop and implement sustainable systems that are sufficiently efficient to at least maintain, or ideally enhance, the level of agricultural production (MŽP SR, 2018; Grusson et al., 2021; Kader et al., 2019), while simultaneously striving to reduce environmental degradation (OECD, 2010; Ecologic Institute & IEEP, 2024; Dirwai et al., 2021).

The gradual implementation of the WEFE Nexus (Water-Energy-Food-Ecosystems) approach appears to be the most viable path forward (UN, 2015; EC, n.d.). This is a comprehensive, multi-level strategy that integrates the interconnections and interdependencies among water, food, energy, and ecosystems. It replaces traditional approaches that focus on individual sectors in isolation and, therefore, fail to effectively address current challenges (GWP, 2019; UNU Flores, n.d.; Albrecht et al., 2018; Wolfe et al., 2016; Sorek et al., 2022).

The WEFE Nexus aims to maximize synergies across sectors while minimizing the necessary trade-offs to achieve resource security and sustainable natural resource management (Kurian, 2017; Kurian & Ardakanian, 2015; Hanumante et al., 2022). It also seeks to mitigate conflicts of interest among different stakeholders and reduce competition for limited resources between various users, striving to enhance benefits and minimize negative impacts (Tye et al., 2022; Lawford, 2019; Smajgl et al., 2016; Canessa et al., 2022).

2. Data and Methods

This research focuses on the analysis and development of recommendations to address selected water management issues in the agricultural sector of the Slovak Republic, specifically related to the poor condition of water infrastructure. It examines the current state and historical development of drainage and irrigation infrastructure across the country, which serves as a

fundamental tool for the utilization and management of water resources in agriculture. Based on these findings, related problems and their underlying causes are described, with the study concluding with recommendations aimed at improving the situation in the examined area.

The data for this research originate from two datasets available in the National Open Data Catalogue. The first dataset contains information on irrigated agricultural areas, with the analysis focusing on the following indicators: area, year of inclusion, functionality, and administrative unit. The second dataset consists of data related to the network of water management channels serving both irrigation and drainage functions, with attention directed towards the indicators: length, year of inclusion, type, and administrative unit.

The indicator "area" represents the extent of agricultural land in hectares that falls under the operation of a specific irrigation system. The years of inclusion were tracked across the entire historical timeline of hydromelioration system development available from the analyzed datasets. For irrigation systems, this period spans from 1961 to 2003, while for water management channels, it covers the years 1900 to 2018. The "administrative unit" indicator includes districts where the respective hydromelioration systems are registered, specifically: Bratislava (BA), Malacky (MA), Nitra (NR), Šaľa (SA), Komárno (KN), Piešťany (PN), Prievidza (PD), Levice (LV), Košice (KE), and Michalovce (MI). Channels are categorized into three groups based on type: drainage channels (type 1), irrigation channels (type 3), and modified watercourses (type 2).

The analyzed data were processed into three types of outputs using various visualization tools. The first type consists of historical overviews of the construction of specific components of hydromelioration infrastructure over the years. The overview of irrigation systems is measured in hectares of associated agricultural land and presented through a bar chart. For better data readability, the values are rounded to the nearest thousand. The extent of the constructed network of water management channels is expressed in kilometers and visualized using a density plot, including only those channels for which the year of inclusion was available. Almost none of the modified watercourses contained this information. The second type of output utilizes pie charts to categorize the respective hydromelioration systems, focusing on functionality in the case of irrigation systems and type for water channels. Tables in the third type of output correspond to the described categories of hydromelioration systems, distributing the data across the relevant administrative units to which the individual systems are assigned.

The resulting information serves to describe the age of hydromelioration infrastructure across different regions. This indicator is crucial within the framework of recommendation development, as it helps determine the need to reassess the relevance, functionality, and efficiency of older systems, along with their impacts on surrounding ecosystems. Data on the functionality of irrigation systems combined with their age provide a reliable metric for identifying where investments should be directed after re-evaluating specific factors in the given area. The geographical distribution of these systems within their respective categories constitutes a key element that enables the effective application of insights derived from the first two types of outputs.

After analyzing the current state of irrigation and drainage hydromelioration infrastructure in Slovakia, based on the results of the processed graphical outputs, a set of appropriate recommendations for future improvements is proposed.

3. Results and Discussion

As shown in Figure 2, the first irrigation system within the current network of agricultural irrigations in Slovakia was established in 1961 in the Šahy area, covering 66 hectares. The construction process initially progressed rather slowly, but after the first three years, it gained momentum, with systems added over an area of 9,656 hectares in 1964. The most extensive

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development occurred in 1985, when an additional 37,355 hectares of agricultural land were brought under irrigation.
Irrigation systems in Slovakia expanded at an average rate of 7,852 hectares per year. In terms of total development, the highest construction activity occurred in the 1980s, with an additional 127,876 hectares brought under irrigation. However, a significant increase had already taken place in the preceding decade, with construction intensity rising by 68% compared to the 1960s. Despite all the positive changes brought by the Velvet Revolution, the construction of irrigation systems gradually declined, with the last systems, just like the first ones, added in the Šahy area in 2003.

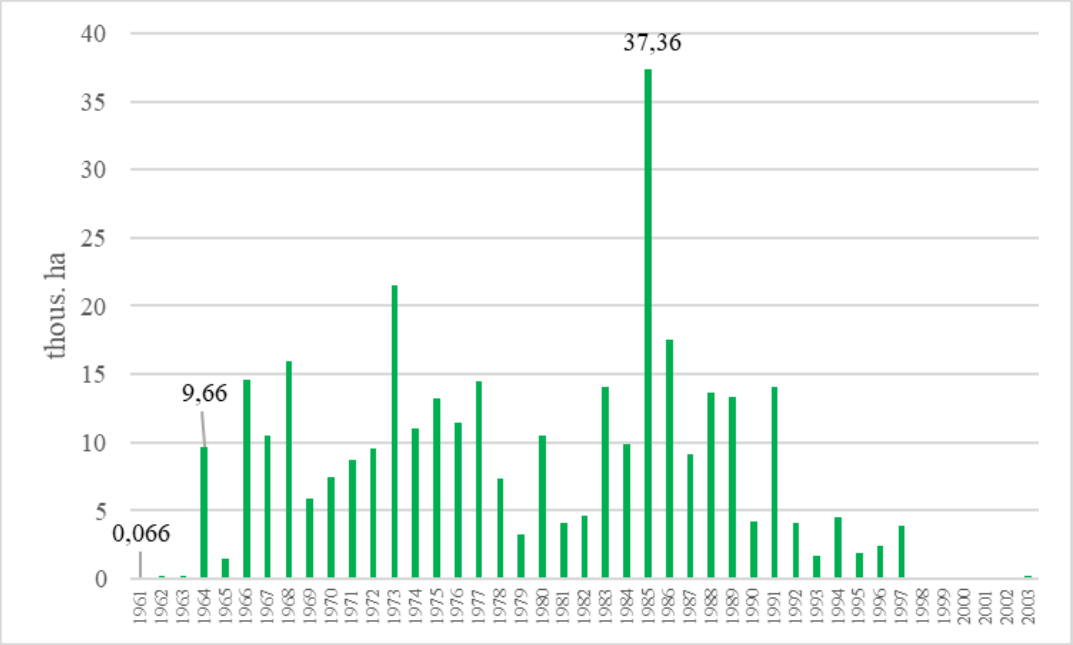

Figure 2: Increase in the area of irrigated agricultural land in Slovakia in thousands of hectares from 1961 to 2003
Source: National Catalogue of Open Data (a), own elaboration

Currently, there are 337,626 hectares of irrigated land in Slovakia, of which 72.38% are still functional, representing an area of 244,377 hectares. According to Table 1, the majority of these systems are located in the Bratislava area, accounting for 21.48% of the total irrigated area, with as much as 81% of them still operational.
The highest proportion of operational irrigation systems is found in the Piešťany area, where it reaches 90%. On the other hand, the most critical situation is in the Košice area, where irrigation covers only 797 hectares, representing 20% of its total potential in that locality.
With the exception of Košice and Prievidza, where irrigation systems are functional on less than 45% of their original area, the majority of irrigation systems in other regions of Slovakia remain operational.

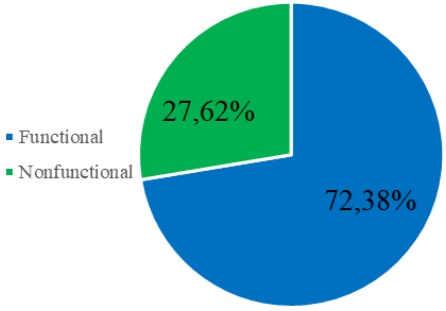

Figure 3: Proportion of functional and non-functional agricultural irrigations in Slovakia
Source: National Catalogue of Open Data (a), own elaboration

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Table 1: Areas of agricultural irrigations in Slovakia in hectares by individual areas

Location	Total	Functional	Nonfunctional
BA	72 523	58 725	13 797
MA	24 221	16 583	7 638
KN	54 708	37 451	17 257
SA	50 887	36 635	14 252
NR	8 518	4 528	3 990
PD	6 735	3 013	3 723
PN	37 394	33 646	3 748
LV	47 392	34 326	13 066
KE	3 979	797	3 182
MI	31 267	18 673	12 595
Total	337 626	244 377	93 249

Source: National Catalogue of Open Data (a), own elabora

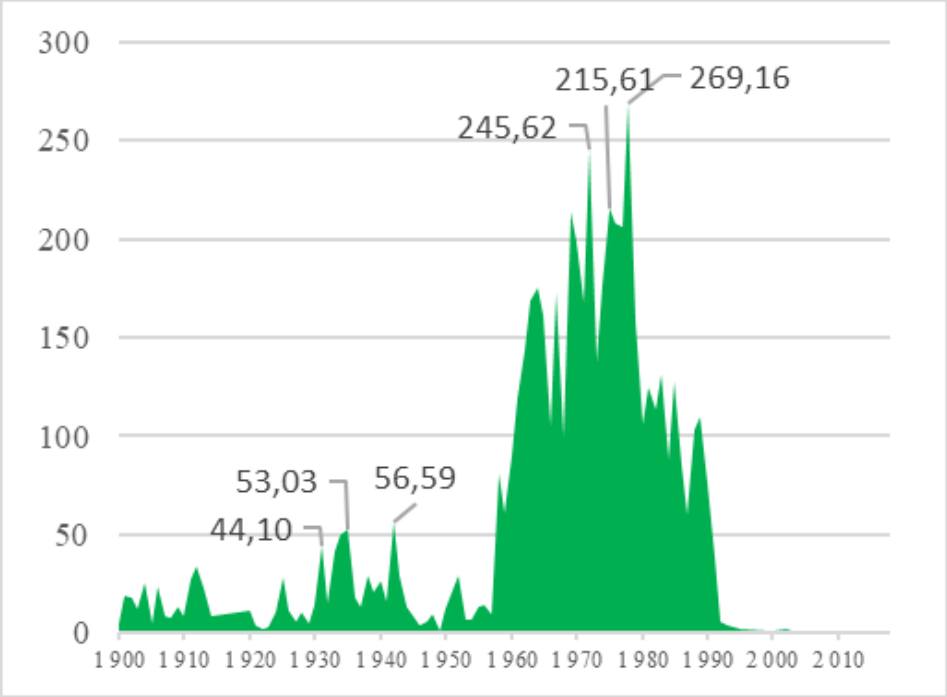

Figure 4: Increase in the network of agricultural channels in kilometers by individual decades from 1900 to 2018

Source: National Catalogue of Open Data (b), own elaboration

The data presented in Figure 4 show that the network of irrigation and drainage channels has been constructed since the beginning of the last century, albeit with varying intensity. In the first half of the 20th century, channels were added at an average rate of 17.78 kilometers per year, with the highest construction activity recorded in 1942, totaling 56.59 kilometers. Significant increases in length were also observed in 1935 (53.03 km) and in 1931 (44.1 km).
In contrast, the second half of the century saw a significant surge in the intensity of channel construction, with the average annual increase reaching 109.73 kilometers, representing a sixfold acceleration. The highest number of channels was built in 1978, totaling 269.16 kilometers. Notable construction activity also occurred in 1972 and 1975, with 245.62 km and 215.61 km of channels added, respectively.
In terms of total values by decade, the 1970s were the most productive, with 1,983 kilometers of channels constructed. They were closely followed by the 1960s and 1980s. The overall

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increase during these three decades accounts for as much as 79.57% of the total length of channels built.

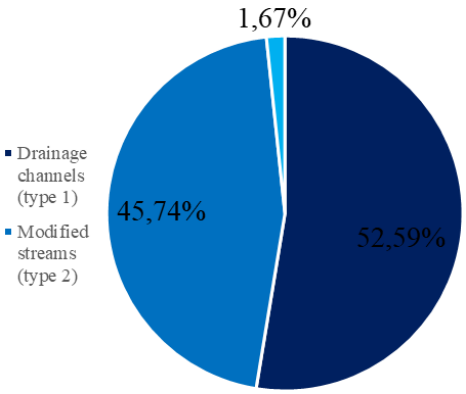

Figure 5: Share of individual types of agricultural channels in Slovakia
Source: National Catalogue of Open Data (b), own elaboration

Table 2: Length of the network of agricultural channels in Slovakia in kilometers by individual types and areas

Canals (km)	Total	Drainage channels (type 1)	Modified streams (type 2)	Irrigation canals (type 3)
BA	127	127	-	-
PD	237	237	-	-
MA	510	510	-	-
KN	600	600	-	-
PN	98	98	-	-
SA	466	466	-	-
NR	287	287	-	-
LV	872	871	0,82	-
KE	725	725	-	-
MI	1 710	1 709	0,62	-
Blank	5 084	5,33	4 899	179
Total	10 714	5 634	4 901	179

Source: National Catalogue of Open Data (b), own elaboration

The Slovak agricultural sector has a total of 10,714 kilometers of channels, as shown in Table 2, which are divided into three main types. According to Figure 5, drainage channels account for 52.59% of the total, with an overall length of 5,634 kilometers. The majority of these channels are located in the Michalovce area, where nearly one-third of them are concentrated. Irrigation channels represent only 1.67% of the total network length, while the remaining 4,901 kilometers consist of modified watercourses, accounting for 45.74% of the channel network.
The analysis of irrigated agricultural areas and the lengths of agricultural water channels in Slovakia reveals that an extensive hydromelioration infrastructure was developed in the past. This infrastructure experienced intensive growth, particularly in the 1970s and 1980s, leading to a widespread network of irrigation systems and water management channels.
Following the establishment of the independent Slovak Republic, the expansion of this infrastructure virtually came to a halt, resulting in the obsolescence of many systems and a decline in their functionality. Out of the total 337,626 hectares of irrigated agricultural land, 72.38% remains functional, indicating the need for systematic renewal and maintenance. The highest concentration of operational systems is found in the Bratislava and Piešťany regions, while the most critical situation is observed in the Košice area.
Hydromelioration infrastructure in Slovakia experienced intensive development, particularly during the 1970s and 1980s, leading to an extensive network of irrigation systems and water management channels. After the establishment of the independent Slovak Republic, the expansion of this infrastructure virtually ceased, resulting in the obsolescence of many systems

and a decline in their functionality. Out of the total 337,626 hectares of irrigated agricultural land, 72.38% remains functional, indicating the need for systematic renewal and maintenance. The highest concentration of operational systems is found in the Bratislava and Piešťany regions, while the most critical situation is observed in the Košice area.

With reference to the Set of Measures in the Field of Hydromelioration for Climate Change Adaptation and the Renewal of Irrigation Infrastructure in Slovakia (MPRV SR, 2022), it can be stated that despite the functionality of most irrigation infrastructure, these systems are utilized only to a limited extent. There are several reasons for this, including the absence of a systematic subsidy policy, high operational costs, and insufficient investments in infrastructure. In all cases, the core issue lies in the financing of maintenance and operation of the entire infrastructure.

Since there was no comprehensive policy directly supporting this area until 2023, farmers had little motivation to engage in these processes, as it represented both an economically and legislatively challenging task for them. Even when some of them invested resources, it was almost exclusively in end-use equipment, for which subsidies could be obtained through the Rural Development Program 2014–2020 (MPRV SR, 2015). However, this support was insufficient, as hydromelioration infrastructure includes many other components. As a result, even in cases where the end section was functional, it was often impossible to deliver water to the intended location, or water was completely absent.

Additional obstacles to the renewal of hydromelioration infrastructure include issues related to fragmented land ownership, complex legislation concerning land consolidation, and excessive centralization in the management of drainage and irrigation infrastructure (MPRV SR, 2022).

To improve the current situation, it is essential to prioritize the restoration of irrigation systems in critical areas such as Košice and Prievidza, and to implement modern technologies for more efficient water use and the enhancement of existing system functionality. Furthermore, it is crucial to establish a systematic subsidy policy to support the maintenance and development of hydromelioration infrastructure and to create financial mechanisms to cover the high operational costs associated with maintaining the network of channels and irrigation systems.

Improving the legislative and organizational framework involves simplifying legislation related to land consolidation and property ownership relations, as well as strengthening the decentralization of infrastructure management and involving local governments in decision-making processes. In the context of climate change, it is important to implement water retention measures to mitigate its impacts and promote WEFE Nexus approaches for the integrated management of water, energy, food, and ecosystems.

An integral part of these measures is education and awareness-raising. Organizing educational activities for farmers on the efficient use of irrigation systems and increasing public awareness of the importance of hydromelioration infrastructure for climate change adaptation are crucial for ensuring the sustainable development of agriculture in Slovakia.

In the coming years, the Strategic Plan of the Common Agricultural Policy 2023–2027 offers farmers a sense of hope for improving the situation, as it includes support for water retention measures and the renewal of hydromelioration infrastructure (MPRV SR, 2022).

4. Conclusion

The results of our analysis of hydromelioration infrastructure in Slovakia highlight an extensive network of irrigation systems and water management channels, which were developed with high intensity, particularly in the second half of the 20th century. Despite this historical scale, the current state of the infrastructure is marked by insufficient maintenance, outdated technologies, and limited utilization, which are consequences of the lack of systematic support and investments following the establishment of the independent Slovak Republic.

Based on the analysis of available data, it can be concluded that the functionality of existing irrigation systems reaches 72.38%, with the most critical areas identified in Košice and Prievidza. The distribution of water management channels reveals the predominance of drainage channels, which account for more than half of the entire network, while irrigation channels are represented only to a minimal extent.

The recommendations emphasize the need for the comprehensive restoration and modernization of existing systems, focusing on improving their functionality and the efficiency of water resource utilization. A key step is to ensure a systematic subsidy policy and to establish stable financial mechanisms to support the maintenance and development of the infrastructure. At the same time, it is essential to simplify legislative processes related to land ownership and land consolidation, which will enable more efficient management and decision-making at the regional level.

In the context of climate change, it is crucial to focus on the implementation of water retention measures and approaches that promote integrated management of water, energy, food, and ecosystems. Education and awareness-raising among farmers and the general public are integral parts of these efforts, as they contribute to the long-term sustainability and resilience of the agricultural sector in the face of environmental challenges.

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Next-Generation Tools for Analysing Consumer Attitudes and Perceptions Toward Probiotic Products

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Abstract

Paper's objective(s) and research background

In the ever-evolving landscape of consumer preferences and health-conscious choices, the investigation of attitudes and perceptions toward probiotic products stands at the forefront of market research. As consumers increasingly prioritize wellness and functional foods, the probiotic market witnesses unprecedented growth, necessitating innovative methodologies to grasp the intricacies of consumer behaviour. Traditional research methods often struggle to capture the nuanced factors influencing consumer decisions in the probiotic product domain. Main aim of the paper is to point out the use of selected neuroimaging methods as a part of market research on consumer attitude towards probiotic products/yoghurts.

Data/Methods

In the current studies, next-generation tools with advanced technologies like real-time data analytics using face readers and eye trackers are employed to address these issues and analyse European consumer views and preferences for probiotic yogurts. Besides these innovative tools, the sensory analysis of the products was also performed using a triangle test and 9-point hedonic scale rating to collate both the data.

Results/Conclusions/Value added

The initial results obtained by using 9-point hedonic scale rating for the preference of different yogurts revealed that the consumers of Slovak Republic have more liking for the traditional yogurts prepared in the region rather than the multinational company (MNC) product. Although the product from MNC had higher nutritional and functional value as compared to the traditional product. Further, the studies are in process and data from new-generation tools will also be compared before finalizing the recommendations to the stakeholders. New innovative tools also offer a transformative approach, providing a comprehensive understanding of consumer sentiments and preferences, thus enabling stakeholders to make informed decisions about probiotic yogurts. To ensure that the data produced is Findable, Accessible, Interoperable, and Reusable (FAIR), the presentation emphasizes the critical role that food consumer science plays in transitions related to individual health.

Scientific Acknowledgement

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Key words

Consumer preferences, triangle test, real time data analytics, eye trackers, face reader, package, probiotic yoghurt

JEL Classification

M31, Q13

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1. Introduction

Consumer attitudes and perceptions toward probiotic products have become increasingly significant in the contemporary landscape of consumer behavior and health-conscious choices. The increasing interest in wellness and functional foods has propelled the probiotic market to unprecedented heights, necessitating innovative methodologies to comprehend the intricacies of consumer preferences. Traditional research methods often fall short in capturing the multifaceted factors influencing consumer decisions within the probiotic product domain (Torrico et al., 2018). In response to these challenges, the current studies employ next-generation tools embedded with advanced technologies like virtual reality (VR) and real-time data analytics utilizing face readers and eye trackers (Alsaeedi & Wloka, 2019; Holland & Lee, 2019). These innovative approaches aim to address the limitations of conventional methodologies and provide a deeper insight into European consumer views and preferences regarding probiotic yogurts. In recent years, the field of consumer research has witnessed a paradigm shift with the introduction of next-generation tools that leverage cutting-edge technologies to unravel consumer behaviour patterns (George et al., 2023). As consumers become increasingly discerning and health-conscious, there is a growing demand for methodologies that can capture the subtle nuances of their preferences and perceptions. Traditional research methods, such as surveys and focus groups, while informative, often fail to provide a comprehensive understanding of consumer sentiments, particularly in complex domains like probiotic products. Therefore, there is a pressing need for innovative tools that can delve deeper into the subconscious drivers of consumer behaviour.

The adoption of advanced technologies like virtual reality (VR), real-time data analytics, face readers, and eye trackers represents a significant leap forward in consumer research methodologies. These tools offer a holistic approach to understanding consumer attitudes and perceptions by providing real-time insights into their cognitive and emotional responses (Alsaeedi & Wloka, 2019). By immersing participants in virtual environments or tracking their facial expressions and eye movements, researchers can uncover implicit preferences and subconscious reactions that traditional methods may overlook. This allows for a more nuanced analysis of consumer behavior, particularly in areas where rational decision-making interlinks with emotional and sensory experiences.

Probiotic products present a unique set of challenges in understanding consumer preferences. Various factors such as taste, texture, and packaging play crucial roles in product acceptance, consumers perceptions of health benefits and brand trust also significantly influence their choices (Ballco & Gracia, 2022). Moreover, cultural and regional differences further complicate the landscape, as preferences for probiotic yogurts can vary widely across different demographic groups (Spacova et al., 2023). Traditional research methods often struggle to capture these complexities comprehensively. Hence, the integration of next-generation tools offers a promising avenue to delve deeper into the multifaceted nature of consumer attitudes and preferences toward probiotic products (Torrico et al., 2018).

The primary objective of this study is to utilize next-generation tools embedded with advanced technologies to analyze European consumer attitudes and perceptions toward probiotic yoghurts. Specifically, the study investigates the factors influencing consumer preferences, including taste, texture, nutritional value, brand trust, and cultural influences. This research offers a unique contribution by bridging the gap between traditional research methods and innovative technologies in the domain of consumer behaviour analysis. By integrating tools such as virtual reality, real-time data analytics, and sensory analysis techniques, this study provides a comprehensive understanding of consumer sentiments and preferences toward probiotic products. This holistic approach enables stakeholders to make informed decisions

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and develop targeted marketing strategies tailored to the diverse needs of consumers in the probiotic market.

2. Review of Literature

Consumer attitudes and perceptions towards probiotic products have garnered significant attention in recent literature, reflecting the growing importance of health-conscious choices in the consumer landscape. Studies by (Srinivasan & Sasikala (2024) delve into consumer preferences and behaviors regarding functional dairy products and probiotic foods, respectively, shedding light on factors influencing purchase intentions and consumption patterns. Srinivasan and Sasikala's study in Bengaluru North reveals that while functional dairy products like probiotic milk and yogurt are steadily gaining popularity, consumer awareness and perception remain crucial determinants of market success. Similarly, Çelik (2023) study in Turkey highlights the high awareness level of probiotic foods among consumers, with sour milk products being the most frequently consumed. The influence of factors such as knowledge level, income, and perceived benefits on purchase intention underscores the complex interplay between consumer perceptions and behavioral intentions. Furthermore, studies by Ávila et al. (2020); Pocol et al. (2024); Yilmaz-Ersan et al. (2020), explore the effectiveness of marketing strategies, socio-demographic determinants, and consumer perceptions of probiotic products, offering valuable insights into the multifaceted nature of consumer behavior in this domain. Additionally, Baker et al. (2022) provide a comprehensive scoping review of consumer acceptance toward functional foods, identifying various determinants such as product characteristics, socio-demographic factors, and psychological attributes that influence consumer behavior. Collectively, these studies underscore the need for innovative methodologies, including next-generation tools and advanced analytics, to gain a comprehensive understanding of consumer sentiments and preferences towards probiotic products. The transformative approach offered by these methodologies enables stakeholders to make informed decisions and develop targeted marketing strategies, thereby contributing to the advancement of consumer health and well-being in the ever-evolving landscape of functional foods. The given pieces of the literature suggest that consumer attitudes and preferences towards probiotic products are multifaceted, influenced by a combination of health consciousness, brand trust, cultural factors, and innovative research methodologies. Understanding these dynamics is crucial for companies seeking to capitalize on the growing demand for probiotic products and tailor their marketing strategies to effectively target their diverse consumer base.

3. Methodology:

Experimental Design

This research employed a multi-method approach to investigate European consumer attitudes and preferences towards probiotic yoghurts. The study utilized both traditional sensory research methods such as triangle test, 9 point hedonic scale rating and next-generation tools with advanced technologies to capture a comprehensive understanding of consumer behavior in the probiotic product domain. In the current studies three different types of yogurts from European market have been selected for studying their consumer preference. The different products selected in studies include, one probiotic brand Activia (T1) from Danone and two traditional non-probiotic yogurts from Slovakian companies i.e. Rajo (T2) and Zvolensky (T3). During the studies, the consumers were served with three different yogurts without their names and asked to evaluate the products for any differences based on probiotic or sensory

characteristics on a triangle test performa of sensory analysis. In the second set of experiments, the judges or the panel members were served with the same set of experimental products without the name of the brand or company and asked to evaluate the products for their acceptability on 9 point hedonic scale rating test Performa for various sensory attributes. The mean sensory scores were calculated and the best product based on sensory analysis was selected. In the last experiment, the samples were shown to the same panel of judges along with packages and their preferences were evaluated based on an eye-tracking device.

Research Design

A qualitative adhoc research approach was employed, integrating computer vision tools including eye tracking as per the earlier method described by Berčík et al. (2022). These eye tracking tool facilitated the examination of visual attention patterns of participants during the products selection. The eye-tracking data was captured using a Tobii X2-30 static eye-tracking camera, providing insights into participants' gaze behavior. Additionally, participants were prompted to provide verbal commentary on their actions and decision-making processes during the simulated probiotic yoghurt purchasing scenario.

Participant Recruitment and Demographics

Twenty participants, from different genders, and falling within the age range of 18 to 40, were recruited for the study. Participants were selected based on their status as yoghurt consumers and their relevance to the target demographic. Besides, that the questionnaire was shared with different respondents for their demographic details and likings about the yogurts available in the European market.

Scenario and Task

Participants were presented with a scenario wherein they were served with three different types of yoghurts manufactured by three different companies. The sensory analysis of different yogurts was conducted by semi-trained panel of judges for liking on 9 point hedonic scale rating performa for various quality. The online survey included 170 respondents. The research includes respondents who buy probiotic yogurts. Questions covered yogurt consumption habits, brand preference and decision-making factors.

4. Data Collection Methods

The data collection process encompassed both qualitative and quantitative techniques. Visual attention of participants was tracked using a Tobii X2-30 static eye-tracking camera to understand their browsing behaviour and preferences during the digital purchasing process.

Input and Output Interviews

In addition to the sensory analysis, computer vision tools, input and output interviews were conducted to gather further insights into participants' perceptions and decision-making processes. Participants were prompted to provide feedback on their experiences and perceptions for the yogurt consumption pattern through structured questionnaires.

Online Questionnaire Survey

Online questionnaire survey was conducted using Google Forms and questionnaires were distributed in online version via emails. Out of total number of 170 respondents, Table 1 describes that obtained research sample contains 29.4% males and 70.6% females. Ratio of place of residence between village (47.6%) and town (52.4%) is balanced. The most numerous is the 18 - 24 years (68.1%). In addition, other factors were also considered such as household income, economic activity and number of household members.

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Table 1:The overall profile of respondents

Characteristics	Description	N=170
Gender	Male	29.4%
	Female	70.6%
Age	18-24	68.2%
	25 and more	31.8%
Place of residence	Village	47.6%
	Town	52.4%
Household income	Less than 900€	17.1%
	901€ - 1100€	14.1%
	More than 1100€	68.8%
Ecomonic activity	Retiree	1.2%
	Entrepreneur, Self-employed person	4.1%
	Maternity leave	0.6%
	Student	71.8%
	Employed	22.4%
Number of household members	1	5.9%
	2-3	45.9%
	4-5	45.3%
	6 and more	2.9%

Source: own proccesing

Hypothesis for statistical evaluation:

H1: It is assumed that there exist dependency between age and yoghurt flavor preference.

H2: It is assumed that there exist difference between consumer purchase behaviour and household income.

The dependencies in responses were analysed using Chi-square test with Cramer V coefficient in order to determine the intensity of thread and Kruskal – Wallis test. The statistical analyses were performed using MS Excel for tabular and graphical data presentation and IBM SPSS at 5% level of significance.

Sensory Analysis

To complement the insights gained from the questionnaire and next-generation tools, sensory analysis of the different yogurts was conducted using a 9-point hedonic scale rating (Loucks et al., 2017). This allowed for a comprehensive evaluation of the products based on taste, texture, and overall preference. The sensory analysis of different yogurts was conducted by semi-trained panel of judges. Coded samples of yogurts were given to judges. They were asked to rinse their mouth before or in between tasting the given sample. Each sample was evaluated

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for liking on 9 point hedonic scale rating performa for various quality attributes. On the basis of sensory characteristics different yogurts were scored by the panel of judges.

Data Analysis

The data of sensory evaluation was analysed by the Randomized Block Design (RBD) as described by Mahony (1985).

5. Results and Discussion

The questionnaire results revealed the Slovakian consumers often choose a range of differently flavoured yoghurts in order to satisfy their needs for variety (Gullo et al., 2019). In our study, we found out that yoghurt flavor is a key factor in influencing yoghurt purchases rather then the health benefit. In overall preferences 48.2% respondents consider taste of yoghurt as very important and 38.2% as an important. The most favourite yoghurt flavor is fruity flavor (41.8%), followed by vanilla and other sweet flavors (31.8%). A total of 26.5% like natural flavoured yoghurt.

The first hypothesis assumes a dependence between age and yoghurt flavor preferences. This hypothesis was rejected by the Chi-square test (p-value = 0.004). There exist dependency between age and yoghurt flavor preference. Cramer's contingency coefficient is 0.253, which may be considered a relatively weak correlation (Table 2).

Table 2: Statistical dependence of yoghurt consumers between age and yoghurt flavor preference.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.860a	2	.004
Likelihood Ratio	10.476	2	.005
Cramer's V	0.253		.004

Source: own research, output of IBM SPSS

The second hypothesis assumes differences between consumer purchase behavior and household income. The *p* value is 0.022 (Table 3) Therefore, we do reject the null hypothesis by the Kruskal - Wallis test. There exist differences between consumer purchase behaviour and household income.

Table 3: Statistical difference of yoghurt consumers between consumer purchase behavior and household income

	Value	df	Asymptotic Significance (2-sided)
Test Statistic	7.605a	2	0.022

Source: own research, output of IBM SPSS

It seems that consumers who eat more yoghurt are more likely to be healthy, well-educated and from higher socioeconomics groups (Fisberg-Machando, 2015). Consumers who consume yoghurt tend to have a higher family income (Possa et al., 2015). The results of the studies also revealed that respondents with higher household income consider health benefits of yoghurt as very important in their overall prefences and purchasing decisions (Figure 1).

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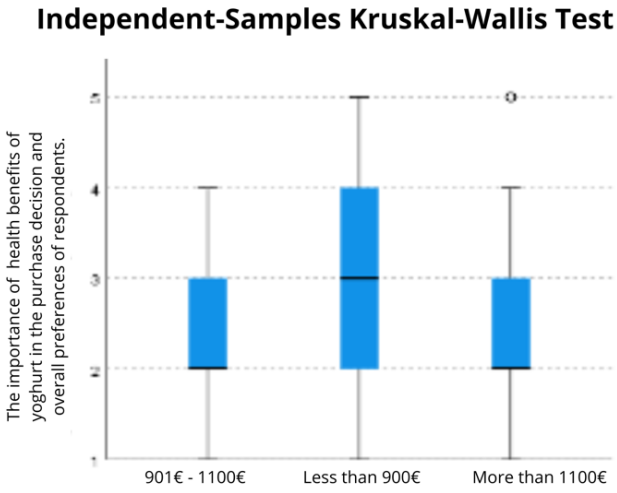

Figure 1 : Kruskal Wallis test for the importance of health benefits in purchase decision of respondents
Source: own processing

The initial results obtained by using 9-point hedonic scale rating for the preference of different yogurts revealed that the consumers of Slovak Republic have more liking for the traditional yogurts i.e Rajo and Zvolensky prepared in the region rather than the multinational company (MNC) product i.e activia (Table 4). The results of the sensory analysis revealed that there are differences among the three products for various characteristics such as visual scores, taste, after taste and general acceptance.

Table 4 : Sensory Scores (Out of 9) on 9 point hedonic scale rating performa for various experimental yogurts

Sensory Characteristics	**Sensory Scores (out of 9)**		
	Activia (T1) Probiotic	**Rajo (T2) Non Probiotic**	**Zvolensky (T3) Traditional Non Probiotic**
Visual consistency	7.30±1.17^{a}	7.30±1.08^{a}	7.57±1.05^{a,b}
Synersis	5.95±1.05^{a}	7.12±1.33^{b}	8.25±1.11^{c,b}
Colour	7.00±1.21^{a,b,c}	6.65±1.42^{a,b,c}	6.85±1.03^{a,b,c}
Spoon Strength	5.30±0.59^{a}	7.45±1.09^{b}	7.9±0.91^{c,b}
Firmness	5.95±0.76^{a}	7.15±1.53^{b}	7.65±1.13^{c,b}
Sourness	5.40±1.08^{a}	7.70±1.45^{b}	8.85±1.81^{b,c}
Oiliness	6.00±1.02^{a}	7.68±1.35^{b}	8.70±1.55^{b,c}
Consistency	6.65±1.42^{a}	8.20±1.05^{b}	8.40±1.53^{b,c}
After taste	5.35±0.74^{a}	7.35±0.74^{b}	8.40±0.75^{b,c}
General acceptance	5.75±0.71^{a}	7.30±0.73^{b}	8.35±0.67^{b,c}

Source:own proccesing

The results presented in Figure 2 revealed that for visual acceptability activia probiotic yogurt was quit similar to Zvolensky and Rajo in visual score likings. Further, there are non significant differences among all the three yogurts for visual scores. However, judges have given higher scores/likings for non probiotic yogurts manufactured by Rajo and Zvolensky for taste, after taste and general acceptance in comparison to Activia. The results also depict that rajo and zvolensky are significantly different from activia for taste, after taste and general acceptance of the products. Hence, from the sensory scores of the products it can be concluded that

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consumers in Slovakia especially in Nitra prefer to have traditional yogurt products made by Rajo and Zvolensky rather than the product manufactured by Danone i.e Activia.

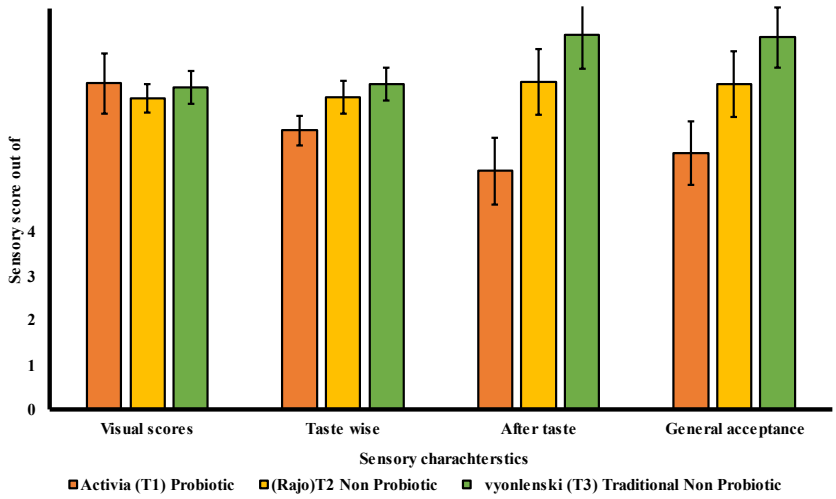
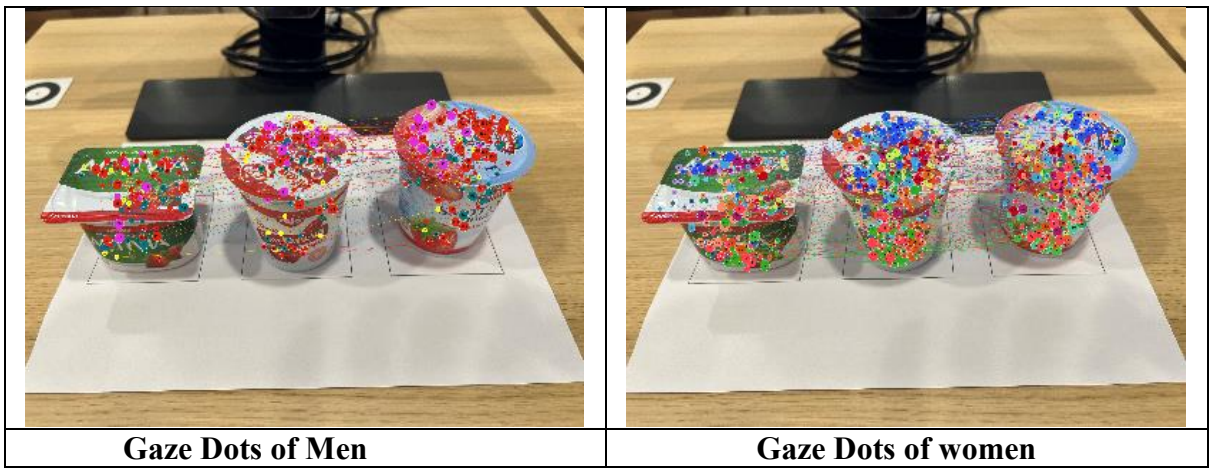


Figure 2: Sensory score for various characteristics of yogurts purchased from Slovakian market
Source: own proccesing

The similar observation was also recorded when the innovative tools such as eye tracker was `used to study the acceptance of these three products. As from the gaze charts of women and men (Figure 3) experts it can be clearly seen that for the yogurts with higher preference levels, the number of gaze point fixations increased significantly and the total gaze point fixation time also significantly increased.

Although the product Activia from Danone had higher nutritional and functional value as compared to the traditional product but still as per the sensory analysis traditional yogurts were extremely liked by the sensory panel members. Further, the studies are in process and data from new-generation tools will also be compared before finalizing the recommendations to the stakeholders.



Gaze Dots of Men	Gaze Dots of women

Figure 3 : Gaze dot chart of Men and women for the experimental yogurts
Source: own processing

6. Conclusion

The integration of next-generation tools with traditional sensory and survey-based research techniques has provided a thorough insight into consumer attitudes towards probiotic

yogurts.The findings show that Slovak consumers prefer traditional, locally produced yogurts over international probiotic brands. Sensory analysis using 9-point hedonic scale demonstrated that traditional yogurts had significantly better taste, texture and overall preference compared to probiotic alternatives. While Activia probiotic yogurt demonstrated similar visual appeal to Rajo and Zvolensky, it was less favored in terms of taste, after taste and overall acceptance. The sensory evaluation results indicate a consumer preference for traditional yogurts produced by Rajo and Zvolensky over Activia in the Slovak market, particularly in Nitra. The findings indicate that consumer preference, as observed through eye tracker, aligns with sensory analysis results, highlighting a stronger liking for traditional yogurts despite the higher nutritional value of Activia from Danone. Based on selected issue we conducted a questionnaire survey focused on consumers experiences and perceptions for their yogurt consumption pattern. The survey results were 170 participating respondents. Based on established hypotheses, we reached several conclusions. The results claim that participants with greater household income view the health advantages of yogurt as highly significant in their overall preferences and buying choices. We assumed that there would be dependence of yogurt consumers age and yogurt flavor preference. The results claim that there exist dependency between age and yoghurt flavor preference.

7. Limitations of the research

The study was conducted with a relatively small sample (20 participants for sensory analysis and 170 for the survey). The study analyzed only three yogurt brands, which may not represent full diversity of probiotic yogurts available in the market. Despite its limitations, this study offers valuable preliminary insights into further research in greater depth.

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Unveiling Generation X Taste: Flavoured Honey Preferences in Slovakia and Hungary

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Abstract

Paper's objective(s) and research background

Consumers are increasingly drawn to honey for its sweet taste and perceived nutritional benefits, including antioxidant properties and potential health advantages. Currently, new types of honey enriched with different flavours are coming to the market and are characterised by growing consumer interest. Flavoured honey is an innovative product that combines the natural sweetness of honey with a variety of complementary flavours and is described by higher antioxidant properties and nutritional values compared to traditional honey. The main objective of the paper is to study preferences for flavoured honey among Generation X both in Slovakia and Hungary.

Data/Methods

The research is based on primary data collected through an online questionnaire survey administered to Generation X respondents in Slovakia and Hungary in 2022. In each country, 286 responses were collected. Multiple correspondence analysis (MCA) was applied to study differences in consumer preferences of Generation X in the case of multiple choice questions (whether they know and purchase creamed and flavoured honey) in Slovakia and Hungary. Using the Friedman test, we identified the flavours that respondents in selected countries prefer.

Results/Conclusions/Value added

In Slovakia, honey is consumed mostly a few times a week, while in Hungary, it is consumed a few times per month. In both countries, the average annual honey consumption of the respondents is between 2 and 3 kilos. The MCA identified significant differences in the awareness of creamed honey and flavoured honey across selected countries. Respondents in Slovakia tend to know flavoured and creamed honey but do not purchase it. In Hungary, the data indicated that respondents either tend to know these two categories of honey and purchase them or do not know them. In addition, the results of the consumer study show statistically significant differences in preferences for flavoured honey. Based on the data, respondents of Generation X in Slovakia prefer flavoured honey with propolis, bee pollen, and royal jelly, followed by forest fruits, ginger, and cinnamon. In Hungary, the results slightly differ. Respondents of Generation X in Hungary prefer flavoured honey with forest fruits, propolis, and royal jelly, followed by bee pollen, ginger, and nuts. In both cases, spirulina was evaluated as the least attractive flavour of honey. The study provides important information for honey producers, and understanding these aspects of consumer behaviour can help honey producers tailor their strategies to meet the evolving preferences and demands of the market.

Keywords

Consumer Behaviour - Consumer Preferences - Flavoured Honey – Honey Market

JEL Classification

M31, M21, Q13

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1. Introduction

The growing awareness among consumers has prompted a transition towards the consumption of functional foods, and the market for health-oriented dietary options has expanded. Consequently, there is an evident rise in the availability of healthier food choices. Among these, honey stands out as a significant food, not only for its taste but also for its numerous health properties (Babbar, Bansal, Aggarwal, Singh & Kaur, 2022). Similarly, Oravecz and Kovács (2019) pointed out that the overall consumption of honey in the market is rising due to health-conscious consumers. Honey is considered the most widely consumed bee product. It is acknowledged as one of the earliest identified functional foods, with historical recognition for its positive impact on health (Majtan, Bucekova, Kafantaris, Szweda, Hammer & Mossialos, 2021). Honey is often considered a natural sweetener and a healthier alternative to refined sugar (Kuropatnicki, Kłósek & Kucharzewski, 2018; Atkinson, Foster-Powell, & Brand-Miller, 2008). As stated by Güleç and Sarper (2022), increased functional properties of honey can be achieved by adding it to milk products such as yoghurt, milk cream and cheese and using it with such common spices as ginger, turmeric, black pepper, and cinnamon. In addition to the above, several other health benefits are associated with the use of honey. Saikaly and Khachemoune (2017) reported that honey's antibacterial qualities help promote wound healing. Honey contains antibacterial and anti-inflammatory properties. Specifically, it has been discovered that honey helps with treating skin conditions such as burns, ulcers, and bedsores. Furthermore, honey contains antioxidants that support the immune system. Probiotics and enzymes included in honey can boost immune system performance and enhance the health of the digestive system (Yapıcı, İzol & Gülçin, 2023).

As a result of changing consumer preferences, the honey market is characterised by a notable variety of products, and new honey products are introduced as well (Żebracka, Mieczan, Nowakowicz-Dębek, Banach, Drabik, Pulit-Prociak & Chmielowiec-Korzeniowska, 2022). According to Kowalski and Makarewicz (2017), the market is witnessing a growing availability of products enriched with various bee components. Honey enriched with propolis, pollen, bee bread, or royal jelly is becoming increasingly common. According to Šedík, Predanócyová, Horská, and Kačániová (2021), enriched honey products have started to emerge in the European market in response to health trends. This claim is in line with Żebracka et al. (2022), who reported the growing interest in flavoured honey on the market. By incorporating various beneficial elements like spices (such as cinnamon), herbs, fruits (such as raspberries), pollen, and propolis into honey, beekeepers have the opportunity to create innovative and distinct products (Šedík, Pocol & Ivanišová, 2020). Flavoured honey represents a type of traditional honey that incorporates additional tastes and aromas beyond the natural sweetness of honey. The primary goal of these additions to honey is to enhance it with biologically active substances, thereby augmenting the product's health-promoting properties (Żebracka et al., 2022). Furthermore, by incorporating fruits into honey, not only the overall value can be improved, but also a broader spectrum of product variety can be achieved (Umesh Hebbar, Rastogi, & Subramanian, 2008). For example, Grabek-Lejko, Miłek, Sidor, Puchalski, and Dżugan (2022) found out that honey enriched with Rubus fruit or leaves has a higher health value and is a novel functional food that can be made. Moreover, adding turmeric to honey can enhance its anti-inflammatory properties, and adding lemon might strengthen its immune-stimulating properties (Kumar, Verma, Hajam, & Kumar, 2024). In summary, adding plants, fruits, and other beneficial ingredients to honey to fortify it produces a new product that shows promise as a treatment and preventive measure for numerous diseases (Sowa, Tarapatskyy, Puchalski, Jarecki & Dżugan, 2019).

In summary, the increasing health consciousness among consumers has led to higher consumption of functional products such as honey, enabling honey producers to develop new

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and unique products. The demand for flavoured honey is rising. The category of flavoured honey represents unique and novel products to enhance both the taste and nutritional profile of diets. Consumer preferences are changing constantly, and understanding consumer preferences towards honey is crucial for honey producers to tailor their strategies effectively. Therefore, this research is focused on identifying the taste preferences for flavoured honey within Generation X in Slovakia and Hungary. The study is organised into several sections. The introductory part describes honey, its functional properties, flavoured honey, and the goal of the research. The subsequent section covers the research methodology, the outcomes of the findings, and the ensuing discussion. The final section describes the concluding remarks.

2. Data and Methods

The research is based on primary data obtained by conducting an online questionnaire survey in Slovakia and Hungary. The data were collected in 2022. The research sample in each country comprises 286 honey consumers belonging to Generation X (42 – 57 years). Table 1 presents the socio-demographic profile of both research samples.

Table 1: Profile of both research samples

Variables		Slovakia	Hungary
Gender	Female	70.27 %	48.95 %
	Male	29.72 %	51.10 %
Level of education	Primary	0.34 %	0.34 %
	Secondary	50.69 %	48.95 %
	University degree	48.95 %	50.69 %
Economic activity	Employed	74.12 %	74.12 %
	Entrepreneur	18.88 %	22.37 %
	Retired	3.49 %	2.79 %
	Maternity leave	1.04 %	1.39 %
	Unemployed	2.44 %	0 %
Monthly income (netto)	Up to 400 €	5.24 %	5.24 %
	401 – 600 €	5.94 %	14.68 %
	601 – 800 €	16.43 %	22.02 %
	801 – 1000 €	21.32 %	20.62 %
	1001 - °1500 €	29.02 %	16.43 %
	More than 1500 €	22.02 %	20.97 %

Source: author's calculations

2.1 Statistical analysis

Multiple correspondence analysis (MCA) was applied to identify differences in preferences of Generation X in the case of multiple-choice questions (whether they know and purchase creamed and flavoured honey) both in Slovakia and Hungary. Moreover, the non-parametric tests such as the Friedman test and multiple pairwise comparisons using the Nemenyi procedure were applied to examine differences in the evaluation of selected honey flavours among Generation X.

3. Results and Discussion

The first question in the questionnaire survey focused on the frequency of honey consumption among Generation X consumers. Based on the results, it was found that the majority of Slovak respondents consume honey a few times a week (37.06 %). Everyday honey consumption was declared by 28.67 % of Slovak respondents. Approximately 22.72 % of participants in Slovakia consume honey a few times per month. Moreover, only 12 % of Slovak respondents declared occasional honey consumption. In the case of Hungary, it could be stated that nearly 29 % of the sample consumes honey a few times per month. More than 27 % indicated that they

consume honey a few times per week and nearly 18 % consume honey on a daily basis. Finally, almost 6 % of Hungarian respondents consume honey only when they are ill.

According to the results, Slovak respondents mostly consume honey a few times per week, on the other hand, Hungarian respondents declared honey consumption a few times per month. Several studies have investigated the frequency of honey consumption in different countries. In Croatia, Glasnović et al. (2021) found that honey is a frequently consumed product and the majority of the sample (36.57%) consume honey at least once a week. In Poland, more than 43 % of the respondents declared that they consume honey several times per month, and only about 6 % consume honey on a daily basis (Kowalczuk, Jeżewska-Zychowicz & Trafiałek, 2017). Vida and Feketéné Ferenczi (2023) researched honey consumption patterns in Hungary. The highest proportion of respondents consumed a few times a month (29.8 %), followed by weekly consumption (22.9 %). In Romania, the results of the questionnaire survey showed that the young segment of respondents consume honey a few times per week (25.6 %) or occasionally (21.9 %) (Pocol, Šedík & Horská, 2018). In Brazil, de Oliveira Neto, do Nascimento Paiva, and de Novais (2020) observed that 67 % of participants consume honey at least once a month, and 23 % of participants consume honey once a week. Moreover, in Italy, Palmieri, Stefanoni, Latterini and Pari (2022) found that 43 % of the sample consume honey more than four times per month, followed by 32 % of the respondents, who consume honey less than twice per month.

When discovering the annual honey consumption, the results indicate that the majority of Slovak consumers eat between 2 – 3 kilograms per year (40.20 %). Almost 24 % of respondents consume 0.5 – 1 kilogram per year, and the same amount of respondents consume 6 kilograms and more. Additionally, 1.74 % of the sample consumes only a few spoons of honey per year. Similar results were obtained in Hungary, where 27.97 % of respondents declared that the annual honey consumption was between 2 – 3 kilograms. Approximately 27 % of Hungarian respondents consume 0.5 – 1 kilogram of honey per year. In addition, 7.69 % consume only a few spoons of honey per year.

Other studies have been dealing with the annual consumption of honey. The research by Guziy, Šedík and Horská (2017) investigated honey consumption in Russia and Slovakia. The findings indicate that more than 50% of respondents in both countries consume between 2 and 5 kilograms of honey per year. In the case of Slovakia, approximately 21 % of the sample tend to consume between 6 – 10 kilograms of honey and more than 10 kilograms (15.51 %). On the other hand, Russian consumers tend to eat less honey. Almost 38 % of the Russian sample consume honey between 0.5 to 1 kilogram. In Morocco, a study by Khaoula, Zineb, Zakaria, Abdelmajid, Asmae and Abderrazak (2019) suggested that the majority of consumers (34 %) eat honey occasionally and the annual consumption was between 1.5 to 2.5 kilograms. Approximately 27 % of the study sample consumes between 2.5 to 4 kilograms of honey yearly, while those who consume more than 4 kilograms were less represented (18 %).

Based on the results of the next question, it could be concluded that 63 % of Slovak respondents use honey as an alternative to sugar occasionally. A similar trend was observed in Hungary, where the majority of respondents (56 %) also reported occasional use of honey as a sugar substitute. Additionally, 23 % of Slovak and 22 % of Hungarian respondents always use honey as an alternative sweetener. Finally, in Slovakia, almost 12 % of the sample declared that they do not sweeten with honey, and in the case of Hungary, approximately 16 % of respondents do not use honey as a sweetener.

As reported by Guziy et al. (2017), there is a growing trend in the consumption of honey as more people view it as a healthier substitute for refined sugar. A previous research connected with forms of honey consumption was conducted by Ribeiro, Fernandes, Do Cabo, and Diniz

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(2019). Only 9 % out of 474 consumers use honey as a sugar substitute. The majority of the sample use honey as a medicine, when they are ill (35 %) or use honey combined with other foods (38 %). The study by Kowalczuk et al. (2017) found out that honey was primarily used for culinary purposes usually as a sandwich spread and natural sweetener. Moreover, according to the results, it could be concluded that honey was used as a sandwich spread by more men and younger consumers, whereas as a sweetener it was consumed by more women, older consumers and respondents who rated their nutritional knowledge higher. Finally, Oravecz and Kovácz (2019) conducted a study focusing on preferences and attitudes towards honey among 86 respondents. Approximately 5.3% of the study sample associated honey as a natural sugar substitute, therefore it could be mentioned that the participants consider honey as a healthful and natural sugar replacement with significant nutritional value.

Moreover, further relationships among selected categorical variables were studied. The results of MCA show that there exist statistically significant differences in awareness of flavoured and creamed honey among countries. Slovak consumers tend to know flavoured and creamed honey but they do not purchase them. On the other hand, Hungarian consumers either know flavoured and creamed honey and purchase them or they do not know them (Figure 1).

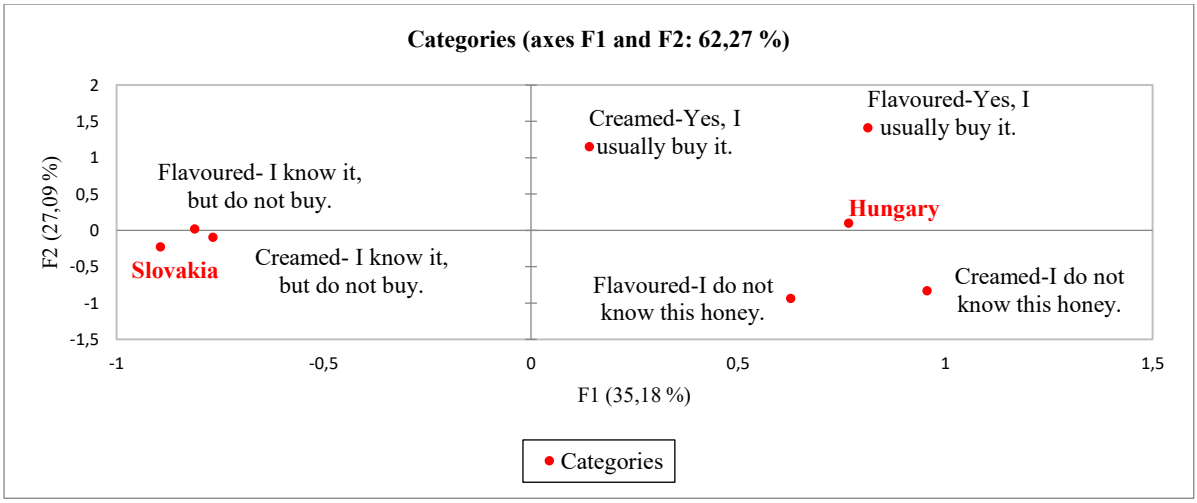

Figure 1: Multiple correspondence analysis (MCA) illustrating two dimensions acquired using the following questions: country, attitudes towards creamed honey and flavoured honey.
Source: author's calculations

Furthermore, the attractiveness of the selected flavours was also examined for Generation X in both countries. In the questionnaire survey, respondents were asked to evaluate different flavours of honey using a 5-point Likert scale ranging from 1 to 5, where 1 represented the most attractive flavour, and 5 represented the least attractive flavour. Statistically significant differences were identified in the evaluation of flavours among Generation X consumers using the applied Friedman test ($p < 0.0001$). Based on the results, it could be concluded that there exist different preferences in flavours in both countries. The subsequent Nemenyi post hoc test was used to investigate between which flavours the mentioned differences existed.

In the case of Slovakia, the findings suggest that honey enriched with propolis (mean = 1.954), bee pollen (mean = 1.951), royal jelly (mean = 2.038), forest fruit (mean = 2.472), ginger (mean = 2.695) and cinnamon (mean = 2.751) are acceptable for Slovak consumers of Generation X. On the other hand, consumers of this generation are not attracted to honey with the flavours of grapes (mean = 3.597), cocoa (mean = 3.636), coconut (mean = 3.618), exotic fruits (mean = 3.744) and spirulina (mean = 3.737) (Table 2).

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Table 2: Differences in the evaluation of selected honey flavours in Slovakia

Sample	Frequency	Sum of ranks	Mean of ranks	Groups							
Propolis	286	1988,5	6,953	A							
Bee pollen	286	2005	7,01	A							
Royal jelly	286	2114	7,392	A							
Forest fruits	286	2452	8,573	A	B						
Ginger	286	2798,5	9,785		B	C					
Cinnamon	286	2875	10,052		B	C					
Nuts	286	3039	10,626			C	D				
Sea buckthorn	286	3062	10,706			C	D				
Cranberries	286	3247,5	11,355			C	D	E			
Raspberry	286	3300,5	11,54			C	D	E			
Blueberry	286	3330,5	11,645			C	D	E			
Currant	286	3472,5	12,142				D	E	F		
Strawberry	286	3479	12,164				D	E	F		
Chokeberry	286	3493,5	12,215				D	E	F		
Cherry	286	3510	12,273				D	E	F		
Apricot	286	3643,5	12,74					E	F	G	
Chilli	286	3899,5	13,635						F	G	H
Grapes	286	4006	14,007						F	G	H
Cocoa	286	4076	14,252							G	H
Coconut	286	4086,5	14,288							G	H
Exotic fruits	286	4230	14,79								H
Spirulina (algae)	286	4249	14,857								H

Source: author's calculations

Both studied countries prefer flavoured honeys enriched with other bee products. Regarding Hungary, the most attractive flavours of Generation X were forest fruits (mean = 2.157), propolis (2.076), royal jelly (mean 2.090), bee pollen (mean = 2.262), followed by ginger (mean 2.454) and nuts (mean = 2.479). Contrarily, honey enriched with chokeberry (mean = 2.975), coconut (mean = 3.223), and cocoa (mean = 3.300) followed by chilli (mean = 3.461) and spirulina (mean = 3.699) are not attractive to the sample and respondents would not likely to try them (Table 3).

Table 3: Differences in the evaluation of selected honey flavours in Hungary

Sample	Frequency	Sum of ranks	Mean of ranks	Groups						
Forest fruits	286	2438,000	8,524	A						
Propolis	286	2474,000	8,650	A	B					
Royal jelly	286	2505,500	8,760	A	B					
Bee pollen	286	2758,000	9,643	A	B	C				
Ginger	286	2903,000	10,150	A	B	C	D			
Nuts	286	2919,000	10,206	A	B	C	D	E		
Blueberry	286	3028,500	10,589		B	C	D	E	F	
Raspberry	286	3148,500	11,009			C	D	E	F	G
Apricot	286	3191,000	11,157			C	D	E	F	G

Cranberries	286	3255,500	11,383		C	D	E	F	G				
Strawberry	286	3265,500	11,418		C	D	E	F	G				
Currant	286	3275,500	11,453		C	D	E	F	G				
Cherry	286	3285,500	11,488		C	D	E	F	G				
Cinnamon	286	3339,500	11,677			D	E	F	G				
Sea buckthorn	286	3344,000	11,692			D	E	F	G				
Exotic fruits	286	3469,000	12,129				E	F	G	H			
Grapes	286	3502,000	12,245					F	G	H	I		
Chokeberry	286	3606,500	12,610						G	H	I		
Coconut	286	3931,500	13,747							H	I	J	
Cocoa	286	4052,000	14,168								I	J	
Chilli	286	4175,500	14,600									J	
Spirulina (algae)	286	4490,500	15,701									J	

Source: author's calculations

To conclude, our study dealt with the attractiveness of different flavours of honey. According to Muharemagić, Šabanović, Mustedanagić, Jašić, Aličić and Čačić-Kenjerić (2016), products derived from honey combined with additional functional elements like pollen, propolis, royal jelly, cinnamon, nuts, ginger, turmeric, and black cumin may exert more significant impacts on human health when compared to pure bee products. In the study by Šedík, Predanócyová and Hudecová (2022), participants expressed their preferences for 13 distinct flavours. The results show that the most appealing flavours were ginger-infused honey and strawberry-infused honey, closely followed by raspberry-infused honey and cinnamon-infused honey. Conversely, the least attractive flavour was poppy followed by turmeric. Notably, despite respondents reporting infrequent consumption of propolis, royal jelly, and bee pollen, these products, when incorporated as additives to honey, received positive evaluations. Furthermore, research by Šedík, Hudecová and Predanócyová (2023) conducted in Slovakia also dealt with the consumption and preference of creamed honey and flavoured honey in different age cohorts. According to the results, in all generations, the most preferred flavours were propolis, royal jelly and bee pollen-enriched honey. Silver Generation was least attracted to flavours of spirulina, coconut, cocoa and chilli. Moreover, the least attractive flavours of Generation Z were chilli and spirulina while Generation Y were not attracted to flavours of spirulina, chilli and grapes followed by exotic fruits. Another research carried out in Slovakia highlights that consumers favour honey infused with cinnamon and cocoa (Šedík, Horská, Skowron-Grabowska & Illés, 2018). The study done by Šedík, Tkáč and Predanocyová (2019) explored how young consumers between 18 to 24 years perceive honey enhanced with cocoa powder. According to the results, the majority of young consumers view it as an innovative and natural product, expressing a willingness to make a purchase. Finally, the study by Leaka, Lavanya, Mahendran and Praveena (2020) highlights that consumers show a preference for honey infused with dried fruit or flavoured varieties like lemon or cinnamon. Creamed honey, flavoured with essential oils, offers a broader and more impactful range of health benefits (Mateescu, Duta, Onisei, Şerbancea, Utoiu, Manolache & Dune, 2020). In light of the above information, it can be concluded that flavoured honey is gaining increasing popularity among consumers. The incorporation of honey with other health-promoting ingredients like spices, herbs, dried fruits, pollen, propolis, coumarin, and spirulina introduces novel and innovative food products (Habryka, Socha & Juszczak 2020; Miłek, Grabek-Lejko, Stępień, Sidor, Mołoń & Dżugan, 2021).

4. Conclusion

The paper investigated the preferences for flavoured honey within Generation X in Slovakia and Hungary. Based on the results, in Slovakia, honey is typically consumed a few times a week, whereas in Hungary, it is more commonly enjoyed a few times per month. Despite this difference, both countries share a similar annual honey consumption range among respondents, falling between 2 and 3 kilograms. The results of MCA revealed significant differences in awareness regarding creamed and flavoured honey across the surveyed nations. Slovak consumers are generally familiar with these honey varieties but tend not to purchase them. Conversely, Hungarian respondents either display knowledge of these honey variations and purchase them, or they do not know flavoured and creamed honey. The consumer study also highlighted statistically significant distinctions in preferences for flavoured honey. By studying collected data, it becomes evident that Generation X respondents in Slovakia favour flavoured honey infused with propolis, bee pollen, and royal jelly, followed by options like forest fruits, ginger, and cinnamon. In Hungary, preferences slightly differ, with Generation X respondents expressing a preference for flavoured honey featuring forest fruits, propolis, and royal jelly, followed by bee pollen, ginger, and nuts. Spirulina consistently ranks as the least attractive honey flavour in both countries. This study yields valuable insights for honey producers, enabling them to align their strategies with the dynamic preferences and demands of the market, as informed by consumer behaviour.

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Beyond The Bottle: Understanding Czech Wine Consumers Through Wine-Lifestyle Segmentation

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Abstract

Paper's objective(s) and research background

The wine market is constantly evolving and understanding consumer behaviour is not only a strategic choice for wine producers but an essential roadmap to success. This study aims to identify segments of Czech wine consumers based on selected attributes related to consumer purchasing behaviour and the wine lifestyle.

Data/Methods

Data were collected through an online questionnaire survey conducted in all regions of the Czech Republic, resulting in a final sample size of N = 428. Principal component analysis (PCA) was used to uncover latent factors, revealing four latent factors. Hierarchical cluster analysis and K-means cluster analysis were then used to identify distinct segments of wine consumers. Cross-tabulation analysis was subsequently performed to examine and compare the demographic and behavioural characteristics across the identified segments, providing deeper insights into their distinctions.

Results/Added value

The study revealed three distinct segments of Czech wine consumers: Wine enthusiasts, Image-oriented, and a new segment called Self-Guided Tasters. While two segments are consistent with findings from other countries, the emergence of the Self-guided Tasters segment is a unique contribution. The research also delved into the motivations, habits and buying preferences of consumers within each segment. This nuanced research adds value by allowing producers to tailor their strategies, offerings, and communication approaches to each specific segment to better meet the diverse preferences and expectations of the Czech wine market.

Key words

Consumer Behaviour - Czech Republic – Segmentation - Wine lifestyle

JEL Classification

M31, L66, Q13

1. Introduction

The wine market is impacted by various drivers, including consumer demand trends influenced by geography and time (Santeramo, Lamonaca, Nardone & Secccia, 2019), governmental policies and regulations (Meloni, Anderson, Deconinck & Swinnen, 2019), concerns regarding public health and food safety (Mariani & Pomarici, 2019), and economic fluctuations (Banks & Overton, 2010). As reported by Mariani, Pomarici and Boatto (2012), the global wine trade has changed and led to an increasing preference for imported wines. Similarly, Bianchi (2015) highlights that the global wine market has grown extremely competitive in recent decades, and consumers now have access to an ever-widening selection of wines. Due to increased competition, wineries are seeking to better understand consumer behaviour, and decision preferences and develop marketing strategies that cater to various customer segments (Sogari, Mora & Mennozi, 2016, Capitello, Agnoli & Begalli, 2016).

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There have been numerous studies that dealt with understanding consumer behaviour in the wine market based on various aspects. A research done by Rodríguez-Donate, Romero-Rodríguez, Cano-Fernández and Ginés Guirao-Pérez (2019) examined wine consumption regarding gender in Spain. According to the results, both men and women mostly consumed wine at low frequency. Moreover, women were often associated with lower weekly consumption and lower weekly expenditure. Men were more likely to consume red wine, and on the other hand, women preferred to consume white and rosé wine. In the context of purchasing behaviour, women focused more on its availability in stores and were influenced by advertising and expert opinions. Respecting age cohorts, Chivu-Draghia and Antoce (2016) found out that Millennials tend to consume wine in clubs and bars. These findings highlight a strong link between drinking and socialising, with the primary motivation for consumption being enjoyment with friends and family. In addition, Millenials chose wine over other drinks due to its taste, perceived health benefits, suitability for social occasions, and romantic allure. In contrast, Generation X preferred to consume wine at home with their partners or families, particularly enjoying wine during meals without any special occasion. Němcová and Staňková (2019) dealt with the purchasing behaviour of Generation Y in the Czech Republic. According to the results, it could be concluded that previous experience, followed by references to family and friends, were evaluated as the most important factors in wine purchasing. On the contrary, bottle colour and advertising were the least significant factors in purchasing decisions. In addition, in the USA, taste, price, and type of wine had the most significant impact on purchasing decisions, while nutritional aspects had no impact at all (Higgins & Llanos, 2015). A study by Pagliarini, Laureati and Gaeta (2013) dealt with consumer preferences regarding organic wine in Italy. Results showed that consumers would be willing to pay more for organically produced wines than traditional ones. When exploring wine consumption motives, consumers in Romania primarily value the taste (Brata, Chiciudean, Brata, Popa, Chiciudean, & Muresan, 2022). These findings are consistent with those of Rahman and Reynolds (2015) and MacDonald, Saliba and Bruwer (2013). Deroover, Siegrist, Brain, McIntyre and Bucher (2021) investigated the link between wine consumption and healthiness. The results suggest that consumers identify wine as healthier compared to white wine.

Moreover, the majority of available research aims at understanding wine consumer behaviour through segmentation methodologies (Bruwen, Li & Reid, 2002, Thach & Olsen, 2006, Kolyesnikova, Dodd, & Duhan, 2008, Wolf, Higgins, Wolf, & Qenani, 2018). As reported by Nazan Gunay and Baker (2011), market segmentation helps with understanding the features of each segment and with the decision-making processes of segments. Furthermore, Jain, Haley, Voola and Wickman (2012) stated that there are various methods to divide markets, one approach is to categorise them into seven groups: geographic factors, demographic factors (such as age, income, and gender), psychological factors (variables such as personality traits and lifestyle), socio-economic factors (for instance, social class and family life stage), consumption patterns (such as heavy, moderate, and light users), perceptual factors (for instance, benefit segmentation and perceptual mapping), and brand loyalty patterns. Bo Liu, McCarthy, Chen, Guo and Song (2014) carried out a behavioural market segmentation on wine attributes and wine information sources. Based on the findings, three segments of consumers were created in China: “the extrinsic attribute-seeking customers,”. Grape variety, design of the bottle, wine produced in a foreign country, award-winning wine, and older, mature-age wine were the most significant attributes when wine purchasing in this segment. The next segment, “the intrinsic attribute-seeking customers,” looked for several aspects while wine purchasing - good value for money, taste, offering a health benefit, high quality, and brand name The last segment, “traditional consumers,” looked for wines with high alcohol level and produced in China. Similarly, Geraghty and Torres (2009) applied behavioural segmentation in studying the Irish wine market, pinpointing three distinct segments: casual consumers, value-

oriented buyers, and traditionalists. Seyedimany and Koksal (2022) used the segmentation of generational cohorts in Turkey. The findings revealed disparities across generational consumer groups in terms of their motivations for drinking wine. Baby Boomers exhibited a stronger inclination towards consuming wine for health and socialisation purposes compared to other generations. Millennials, on the other hand, were more likely to drink wine for coping and hedonistic reasons, while Generation X showed a higher propensity to consume wine for enjoyment motivations than other generations. Pomarici, Lerro, Chrysochou, Vecchio and Krystallis (2017) identified four segments of wine consumers: experiential, connoisseurs, risk minimizes, and price-sensitive individuals who differ significantly in terms of their preferences towards wine and psychographic characteristics, indicating that a one-size-fits-all marketing strategy is no longer appropriate.

In conclusion, it could be concluded that the relationship between consumer segmentation and the wine market highlights the importance of understanding and responding to the diverse needs and preferences of wine consumers to succeed in a competitive market landscape. Wine businesses may create strategies that are tailored to their target audience and increase market share, profitability, and brand loyalty in the ever-changing wine industry by utilising segmentation analytics. The study is focused on the Czech wine market. Although beer is considered a popular drink of the Czechs, wine consumption is increasing in the Czech Republic (Němcová & Staňková, 2019). Therefore, there has been a lack of research studies focused on the segmentation of wine consumers in the Czech Republic. In order to fill up the scientific gap, the main purpose of this research is to determine segments of Czech wine consumers based on selected attributes related to consumer purchasing behaviour and wine lifestyle. The paper is organised as follows: the first section describes the importance of understanding consumer behaviour in the wine market. The next section deals with the hypothesis and research framework. In the following section, outputs are presented. The conclusions of the study are discussed in the final section of the paper.

2. Data and Methods

The data were collected through an online questionnaire survey conducted in early 2022. A total of 520 respondents from the Czech Republic participated in the research. Those who did not drink wine or whose questionnaires were incomplete were excluded from the sample. The final research sample consisted of 428 wine drinkers. The socio-demographic data of the respondents are shown in Table 1.

Table 1: Profile of respondents

Variables		Frequency	%
Gender	Male	184	43.0 %
	Female	244	57.0 %
Age	18 – 30	171	40.0 %
	31 - 40	70	16.4 %
	41 - 50	79	18.5 %
	51 and more	108	25.2 %
Level of education	Secondary	220	51.4 %
	University degree	208	48.6 %
Residence	Urban	311	72.7 %
	Rural	117	27.3 %
Marital status	Single	240	56.1 %
	Widow	14	3.3 %
	Married	174	40.7 %
Economic activity	Employed	249	58.2 %
	Student	89	20.8 %
	Entrepreneur	45	10.5 %
	Retired	32	7.5 %

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	Maternity leave	11	2.6 %
	Unemployed	2	0.5 %
Monthly income (netto)	Up to 7400 CZK	47	11.0 %
	7401 – 12 000 CZK	44	10.3 %
	12 001 – 18 000 CZK	36	8.4 %
	18 001 – 24 500 CZK	65	15.2 %
	24 501 – 30 500 CZK	73	17.1 %
	30 501 – 36 000 CZK	73	17.1%
	More than 36 501 CZK	90	21.0 %

Source: author's calculations

The structure of the questionnaire was adapted from a study by Risius et al. (2019) and shortened for suitability in an online survey. The questionnaire consisted of three sections: socio-demographic data, consumption and purchasing behaviour, and lifestyle segmentation questions. A total of 21 segmentation questions were used, of which three were excluded for factor loading less than 0.4. In this study, principal component analysis (PCA) with varimax rotation was employed to identify four latent factors, which exhibited eigenvalues greater than one and collectively explained 61% of the variance. The Kaiser-Meyer-Olkin (KMO) measure was utilized to assess the suitability of the sample (KMO = 0.897), indicating a value well above the acceptable threshold of 0.5. A reliability analysis yielded a highly satisfactory coefficient (Cronbach's alpha = 0.889). The second step involved a cluster analysis to identify homogeneous clusters of selected Czech wine consumers. Initially, a preliminary analysis was conducted using Ward's method approach to create clusters of equal size and a dendrogram to understand the relationship between variables. This helped to determine the appropriate number of clusters. Subsequently, a K-means cluster analysis was conducted utilising factor scores, resulting in the identification of three segments. Once the clusters had been validated, a cross-tab analysis was performed to examine the demographic, consumer and purchase behaviour variables. The statistical analysis was performed using SPSS (IBM SPSS 27.0) with a significance level of less than 0.05.

3. Results and Discussion

The factors were identified using a varimax-normalized factor loading approach. Each item was assigned a value for each factor. A high value indicates that the item belongs to a factor. Table 2 displays the four factors.

Table 2: Description factors of the wine-related lifestyle

Code	ITEM	1	2	3	4
KN_1	I buy wine with a tendency to store and improve its quality	0.823	0.067	-0.023	0.173
KN_2	I have a special place for wine, e.g. wine racks for storing wine	0.815	0.014	0.046	-0.016
KN_3	I use special accessories for drinking wine, e.g. filters, funnels, etc.	0.807	0.090	-0.001	-0.025
PH_1	I usually seek out unique wines for casual consumption	0.734	0.114	0.029	0.116
PP_1	I am very picky when buying if I have to choose from a particular vintage	0.716	0.258	0.114	0.026
CON_1	I usually decant red wine before pouring it into a glass.	0.708	0.182	-0.066	-0.028
CON_2	I usually start with lighter wines and move on to heavier ones.	0.689	0.315	-0.083	0.006
KN_4	Being knowledgeable about wines gives me a sense of satisfaction	0.648	0.411	-0.023	-0.071

KN_5	I usually use the right type of glass for different types of wine	0.528	0.335	0.180	-0.338
PH_2	I often take advice from the shop assistant	0.114	0.687	0.139	0.397
CON_3	I think the combination of wine and food has a great effect on the overall taste.	0.140	0.678	0.019	-0.197
PP_2	Whenever possible, I consult tasting experiences when buying wine in wine shops	0.490	0.595	0.040	0.127
PP_3	When choosing a wine, I often follow the recommendations of experienced sommeliers	0.520	0.535	0.000	0.189
PH_3	I always buy the same brand of wine	-0.038	-0.046	0.863	0.157
PH_4	I always buy the same type of wine (sparkling, white, rosé, light red, etc.)	-0.156	0.005	0.732	0.263
PH_5	I usually have an idea of the brand of wine I want before I enter the shop.	0.252	0.231	0.703	-0.185
PP_4	I am more attracted to wines in elegant, specially shaped bottles than to standard bottles.	0.017	0.060	0.080	0.784
PP_5	I am convinced that wines that have won medals are of higher quality than those that have not won medals	0.105	0.023	0.129	0.752
Extraction method: PCA, rotation method: varimax with kaiser normalization, a. rotation converged in 5 iterations.					

Source: author's calculations

Factor 1: Wine knowledge and seeking for experiences (explained 35.3 % of total variance): The first factor represents items that are deeply engaged in wine-related knowledge and seeking unique experiences with wine. Those within this factor exhibit a strong affinity for storing and improving wine quality, as evidenced by high factor loadings for items such as "I buy wine with a tendency to store and improve its quality" (KN_01: 0.823), "I have a special place for wine, e.g., wine racks for storing wine" (KN_02: 0.815) and "I usually seek out unique wines for casual consumption" (PH_1: 0.734) suggest a strong interest in wine connoisseurship and collecting. Factor highlights the appeal of tailored experiences and premium wine offerings to knowledgeable consumers who appreciate quality and uniqueness.

Factor 2: Foodie Connoisseurship (explained 12.1 % of total variance)

The second factor reflects a sophisticated approach to wine consumption. The results indicate that key items contributing to this factor include the responses "I often take advice from the shop assistant" (PH_2: 0.687) and "I think the combination of wine and food has a great effect on the overall taste" (CON_3: 0.678). This factor emphasises the importance of gastronomic experiences and expert guidance in wine selection. This entails the promotion of wine-food pairing and the provision of knowledgeable support to enhance dining experiences.

Factor 3: Consistent shopping (explained 7.9 % of total variance)

The third factor highlights habitual and predictable purchasing behaviours when it comes to wine. It is characterised by consistent brand loyalty and product preferences. Latent factors tend to adhere to specific wine brands (PH_03: 0.863) and types (PH_04: 0.732) for regular consumption. It can be observed that these consumers frequently enter wine shops with a pre-determined purchasing intention (PH_05: 0.703), which serves to emphasise the importance of familiarity and routine in their shopping experience. This factor underlines the importance of brand consistency and product reliability as key factors influencing purchase decisions.

Factor 4: Visual prestige of wine (explained 6.2 % of total variance)

The fourth factor relates to the visual and aesthetic aspects of wine presentation. This factor is characterised by a preference for wines packaged in elegant and unique bottles (PP_04: 0.784)

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and the perception of award-winning wines as an indication of higher quality (PP_05: 0.752). This factor highlights the role of aesthetics and perceived prestige in shaping consumer perceptions to increase product desirability and perceived value

Clustering identified three segments with distinct behavioural patterns in terms of knowledge, purchasing habits and preferences, and wine consumption (Figure 1).

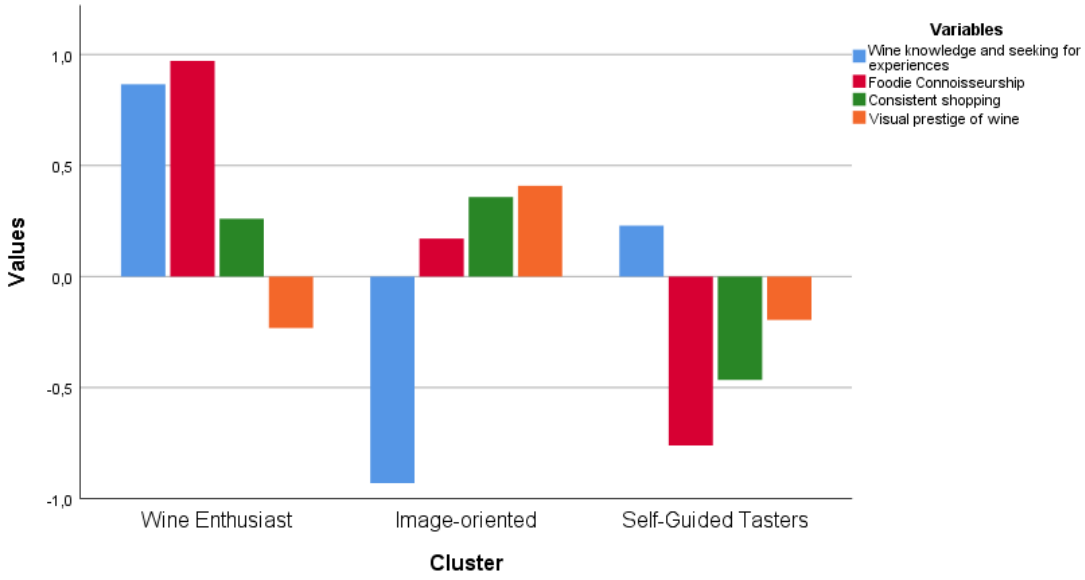

Figure 1: Description segments of the wine-related lifestyle based on factor scores

Source: author's calculations

Segment 1: Wine enthusiast (N=110): are relatively young, with a majority of single, educated women with moderate incomes. The demographic profile suggests an openness to social engagement and a progressive approach to wine culture. The consumption patterns demonstrate a regular consumption of wine, with preferences towards moderately priced wines suitable for social occasions and everyday enjoyment.

Their preference for dry wines suggests a refined palate, indicating a taste for more complex flavors compared to sweeter varieties, although their preferences are perhaps more diverse than Image-oriented segment. The wine enthusiast cluster represents a group of consumers within the wider wine market, characterised by a deep interest in wine as more than just a beverage. Their interests extend beyond pure consumption to include gastronomic pleasures such as food pairing. Unlike other segments, this segment may be less concerned with visual aesthetics and packaging prestige and more concerned with the intrinsic qualities of wine and the context in which it is enjoyed.

Image-oriented (N=145): are more evenly distributed across gender and age groups, with a significant proportion in the 51+ age category (37.2%) a men (51.7%). Most of this segment are married and have a higher net income. This segment demonstrates the highest frequency and quantity of wine consumption compared to other consumer segments, indicating a strong integration of wine into their lifestyle. They gravitate towards more expensive wines, often consumed at home for personal enjoyment.

In terms of wine preferences, members of this segment show a strong preference for dry wines, with an emphasis on quality and sophistication in their choices.. Conversely, they have the lowest preference for sweet wines, preferring the refined and drier varieties. The image-oriented cluster includes consumers who value the visual appeal and perceived prestige of wine products over extensive wine knowledge or unique experiences. This segment is drawn to

wines with elegant packaging and a luxurious appeal. Their shopping behaviour demonstrates moderate consistency, and they show a moderate interest in pairing wines with food.

Self-Guided tasters (N=173): are relatively young, with 57.8% of the segment aged between 18 and 30. The demographic profile indicates a slight predominance of women, a high proportion of single individuals, and moderate income levels. This suggests a preference for self-discovery and enjoyment in wine consumption. In terms of consumption patterns, Self-Guided tasters adopt a balanced approach, prioritizing the enjoyment of the wine itself and the relaxation it provides, rather than focusing on social aspects of wine drinking. This segment is particularly notable for its willingness to explore wines across various price ranges, indicating a value-driven yet exploratory mindset.

When examining wine preferences, the Self-Guided tasters demonstrate moderate inclinations across all wine types, although they show slightly lower preferences for sweet and semi-sweet wines compared to other consumer segments. This preference aligns with their independent and taste-driven approach to wine selection.

Furthermore, this cluster represents a unique group of wine consumers who prioritize personal enjoyment and exploration in their wine choices, reflecting broader trends in contemporary wine consumption among younger adults. The segmentation analysis reveals the presence of distinct consumer profiles within the Czech wine market, each characterised by unique demographic attributes, consumption behaviours, and preferences. These findings provide insights into the key factors influencing consumer choices and perceptions of wine. Firstly, the wine enthusiast segment can be defined as a group of relatively young, educated single women with moderate incomes who exhibit a deep interest in wine culture and seek enriching experiences centred on wine appreciation. As Chaney (2000) reported, consumers' knowledge and information play a critical role in their selection of wine, aligning with the interests of wine enthusiasts in wine knowledge and gastronomic pleasures, such as food pairing. Conversely, the image-oriented segment places a high value on visual appeal and perceived prestige in wine products, often opting for dry varietals that emphasise quality and sophistication. The emphasis on packaging and luxury aligns with findings by Lynch and Ariely (2000), which highlight price as a distinguishing factor used by consumers to infer quality and mitigate risk. In addition, the overreliance on brand names, as highlighted by Lockshin et al. (2000), functions as a heuristic device for product cues and risk mitigation within this market segment.

As noted by Beccaria & Pretto (2021), the brand takes on a dual meaning, as consumers associate it not only with the winery where the wine is produced but also with the wine type. However, the Self-Guided Tasters segment places greater emphasis on taste and personal exploration, prioritizing their sensory experience over external factors like food pairing or brand name. This segment's inclination towards moderate wine preferences and independent purchasing behaviours underscores the value-driven yet taste-driven mindset of younger wine consumers. This is consistent with the findings of Risius et al. (2019), who highlight that younger consumers increasingly prioritize wine for its quality and origin, particularly on special occasions. Such behaviour reflects a broader trend among this demographic, wherein personal exploration and sensory experiences outweigh traditional factors like branding or social conventions. Agnoli & Outreville (2020) further contextualize this behaviour by discussing the relationship between individualistic cultures and wine consumption. Their research suggests that as societies become more individualistic, wine consumption is increasingly driven by personal enjoyment rather than social obligations. Additionally, McIntyre et al. (2015) provide insights into alcohol consumers who choose to avoid wine, illustrating that motivations for wine consumption can vary significantly depending on personal experiences and preferences. Their study emphasizes the importance of individual

enjoyment and the situational context in which wine is consumed. The COVID-19 pandemic has significantly reshaped consumer behaviours, leading to a notable increase in home wine consumption as individuals sought comfort and relaxation during periods of social isolation (Grossman et al., 2020; Pollard et al., 2020). This shift has prompted a reevaluation of purchasing habits, with consumers increasingly favoring local and affordable wines, reflecting a desire for personal enjoyment over social drinking experiences (Compés et al., 2021; Agnoli & Charters, 2022). Furthermore, the pandemic has highlighted the importance of individual circumstances, such as anxiety and employment stability, which have been shown to influence changes in drinking patterns among various demographic groups (Agnoli & Charters, 2022; Kilian et al., 2022). As a result, the Self-Guided Tasters segment emerges as a distinct group of consumers who prioritize personal exploration and enjoyment in their wine choices, aligning with broader trends of individualism and value-driven consumption in the post-pandemic landscape (Martínez-Falcó et al., 2023; Castillo, 2023).

Furthermore, the segmentation findings highlight the varying degrees of consumer involvement and information processing in wine selection. As previously discussed by Lockshin et al. (2006), highly involved consumers utilise information on grape variety, brand, and vintage to predict wine flavours, reflecting a sophisticated level of wine knowledge and discernment among certain segments. Brunner et al. (2023) emphasise the importance of recurring market-specific segmentation studies and clearly demonstrate that mass marketing is inappropriate, particularly for a product that defines a category on its own.

4. Conclusion

This paper undertakes an analysis of Czech wine consumer segmentation based on key attributes related to purchasing behaviour and wine lifestyle. The study helps wine producers, retailers, and restaurateurs to understand consumers by defining distinct segments that align with their strategic objectives. By defining these segments, businesses can craft targeted marketing approaches and customize product offerings. Moreover, understanding of consumer segments can influence purchasing decisions, facilitating the optimization of pricing strategies and improved their brand awareness. The results indicate that the segment in question demonstrates a refined palate and a deep interest in wine culture, seeking enriching experiences and valuing wine knowledge and gastronomic pleasures. Other segmentation approaches prioritise wine consumption at home for personal enjoyment, gravitating towards premium wines with elegant packaging and a sense of luxury. The final segment allows businesses to optimise their product portfolios, enhance customer experiences, and strengthen brand loyalty within the Czech wine market. Future research might explore the evolution of consumer segments across diverse regions and countries with distinct wine cultures. Additionally, an examination of psychographic segmentation factors, such as lifestyle, values, and attitudes, could be of interest in order to provide more detailed insights into consumer profiles.

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Financial Planning of Marketing Activities in Industrial Enterprises

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Abstract

The paper examines the financial planning of marketing activities in industrial enterprises, focusing on key strategies for optimizing resource allocation, monitoring investments, and evaluating marketing effectiveness. The research adopts a mixed-methods approach, combining a comprehensive literature review with a detailed questionnaire survey. The study involved 61 Slovak industrial enterprises of varying sizes, categorized into small, medium, and large companies. The questionnaire covered topics such as investment levels, preferred marketing tools, and factors influencing resource allocation decisions. Key findings reveal that most companies invest between €10,000 and €50,000 annually in marketing, with digital marketing and social media being the most prominent tools. The economic situation and competitive environment were identified as primary factors in resource allocation. Tools like Google Analytics and Facebook Insights emerged as the most commonly used metrics for measuring campaign success. The study provides actionable recommendations for enhancing financial planning practices, emphasizing the importance of digital strategies and data-driven decision-making in competitive industrial markets.

Key words

Marketing, financial planning, financial plan, marketing communication

JEL Classification

M21

1. Introduction

In today's dynamic business environment, the industrial sector faces constant challenges and growing competition. In this context, the ability to effectively plan and manage financial resources, particularly in the area of marketing activities, becomes increasingly crucial for success. Industrial enterprises encounter complex decisions regarding the allocation of financial resources to marketing in order to achieve optimal results and maintain a competitive advantage. This contribution focuses on the importance of financial planning in the context of marketing activities in industrial sectors. Given the constantly evolving trends in consumer behaviour, technological innovations, and growing customer expectations, it is critical for businesses to systematically evaluate the effectiveness of their marketing investments. The aim of this study is to provide insights into financial planning for marketing activities in industrial enterprises. The research framework includes an analysis of resource allocation methods, measurement of return on marketing investments, and assessment of the overall impact of marketing strategies on business success. The results of this analysis will be utilized to formulate recommendations that can serve as a valuable guide for managers and professionals to better understand and more effectively manage financial resources in the marketing domain within industrial sectors.

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1.1 Financial Planning

Financial planning is a key aspect of business management that influences its success and sustainability. The goal of this section of the contribution is to provide an overview of the business financial planning process, its components, and important factors to consider when creating an effective financial plan. Proper financial planning for a business is an essential part of its management and governance. A well-implemented financial plan is a key tool for achieving long-term business success. The financial plan of a business is an important management tool that helps to plan and manage the financial resources of the company (Syriopoulos, 2022). It is a document that contains detailed information about the expected financial results of the business over a certain period, often for a period of one year (Královič, 2010). A financial plan typically consists of several main parts like income, expenses, investments, financing, cash flow, profit and loss balance sheet (Hussam, Krištofík, Vinczeová, 2023).

According to Hyránka and Grella (2016), a financial plan should be realistic, based on thorough market analysis and internal business capacities. It is essential for effectively managing financial resources, planning development, and ensuring the long-term survival of the company. Additionally, it can serve as a tool for investors and creditors to evaluate the financial performance and stability of the business. Stolper and Walter (2017) further suggest that a financial plan should be flexible to respond to changes and uncertainties in the business environment. Its aim is to provide entrepreneurs, investors, and other stakeholders with a clear view of the financial situation and future of the business.

Yeo, Lim, and Yii (2023) highlight that effective financial planning integrates both short-term and long-term objectives, balancing immediate operational needs with future strategic goals. Financial planning in industrial enterprises often incorporates advanced forecasting techniques, including sensitivity analyses and scenario planning, to navigate market fluctuations and uncertainties. Other scholars, such as Syriopoulos et al. (2022), emphasize the role of technology in improving financial planning processes, such as through the adoption of automated budgeting tools and predictive analytics.

Financial planning is particularly crucial in industrial enterprises, where marketing activities represent a significant portion of financial resources. Effective planning allows companies to allocate resources to marketing tools that have the highest impact, ensuring that expenditures contribute directly to achieving business objectives. Financial plans in these enterprises often integrate forecasting models that consider fluctuations in market demand, changes in raw material costs, and other external economic factors. These factors make precise and adaptable financial planning indispensable for maintaining competitiveness and profitability.

1.1.1 Marketing Communication

In their publication, Hussam, Krištofík, Vinczeová (2023) state that marketing communication is an integral part of business financial planning because it directly impacts the organization's revenues and expenditures. Successful marketing communication can lead to increased sales and revenue, positively influencing the financial results of the business. Here are several ways in which marketing communication intersects with financial planning (Kita, 2017):

- **Revenue Increase**: Effective advertising and marketing communication can attract new customers and raise awareness of products or services. This can result in increased sales and revenue, which is a critical factor for financial planning.
- **Return on Investment (ROI)**: Businesses invest financial resources in various forms of marketing communication. Measuring and tracking the ROI of these investments is essential

for effective financial planning. Successful campaigns should achieve a positive ROI, meaning that sales profits exceed marketing costs.

- **Brand Building and Long-Term Customer Value**: Marketing communication can help build a strong brand and customer loyalty. Acquiring and maintaining long-term customer value is a key factor for sustainable financial success of the business.
- **Optimization of Marketing Expenditures**: Financial planning requires effective expenditure management. Analyzing the performance of different marketing channels and tactics helps businesses make decisions on optimal budget allocation and achieve maximum performance with minimum costs.
- **Campaign Timing Considering Seasonality**: Within financial planning, it is important to plan marketing campaigns considering seasonality and demand cycles. For example, if a business operates in an area with seasonal demand fluctuations, marketing communication should be adapted to effectively respond to these changes.

McDonald and Wilson (2016) define marketing communication as a managerial discipline that involves systematic planning, implementation, and control of all forms of communication that an organization uses to achieve its marketing goals. This communication can be targeted at various stakeholder groups, including customers, employees, shareholders, suppliers, and the general public.

Marketing communication in industrial enterprises often requires a multi-faceted approach that integrates digital and traditional tools. Digital tools like search engine marketing, social media campaigns, and email newsletters are combined with trade shows, direct selling, and industry-specific publications to create a comprehensive strategy. The complexity of the industrial market necessitates precise targeting and clear messaging to convey technical details effectively. The financial planning process ensures that these diverse tools are used in a cost-effective manner, aligned with overall business objectives.

Kotler and Armstrong (2019) define marketing communication as the process through which organizations and firms communicate with their target audiences and customers to achieve their marketing goals. This process involves various forms of communication, including advertising, public relations, direct marketing, personal selling, and other tools. The goal is to effectively inform, persuade, and encourage customers to respond to marketing messages, such as purchasing products, using services, or expressing other forms of interest. Marketing communication encompasses the following tools (Hanuláková, 2021) (Kita, 2017):

- **Advertising**: Paid presentation of a product, service, or brand through various media, such as television, radio, print, online advertising, etc.
- **Public Relations (PR)**: Building and maintaining a positive image and relationship with the public, crisis management, and communication with the general public.
- **Direct Marketing**: Personal contact with the customer, including direct sales, telemarketing, direct mail, and other forms of individual communication channels.
- **Personal Selling**: Communication between the salesperson and the customer to persuade and close the deal.
- **Digital Communication**: Using online media, social networks, email, and other digital tools to communicate with the target audience.
- **Events and Sponsorships**: Participation in events, sponsorships, and other activities that allow the organization to directly interact with its customers.

Effective marketing communication is crucial for brand building, creating loyal customers, and achieving the business goals of an organization. Ultimately, effective marketing

communication is a key tool for financial planning because it helps to achieve and maintain healthy financial results for the business through increased sales, optimized return on investment, and building a loyal customer base. By aligning communication strategies with financial objectives, industrial enterprises can maximize the value derived from their marketing investments.

2.1 Financial Planning

Financial planning is integral to a company's strategic management, encompassing resource allocation, cash flow analysis, and investment strategies. Key studies, such as Hyránek and Grell (2016), highlight the importance of aligning financial plans with market dynamics and internal capabilities. Stolper and Walter (2017) emphasize flexibility in financial planning to adapt to uncertainties. Comparative analyses of international financial planning practices, such as those by Yeo, Lim, and Yii (2023), provide valuable benchmarks for Slovak enterprises. Syriopoulos et al. (2022) argue for the importance of technological integration in financial planning, suggesting that tools like predictive analytics can enhance planning accuracy and effectiveness.

2. Data and Methods

This contribution focuses on financial planning of marketing activities in industrial enterprises in Slovakia. Financial planning is a key element of the managerial process that ensures the efficient utilization of financial resources to achieve set goals. Effective allocation of financial resources in marketing is particularly important for industrial enterprises as it influences product sales, acquiring new customers, and brand building in a competitive environment. The contribution begins with theoretical foundations of the addressed issue. In the following section, we formulated four research questions and proposed a questionnaire study to provide answers to these questions. We utilized the website vyplnto.cz for this survey. The results were processed using MS Excel.The questionnaire consisted of 14 questions, which were dichotomous, closed, and semi-closed. The survey took place from January 22, 2024, to February 18, 2024, which represents 28 days. During this period, we approached 198 companies. These companies were categorized by size: small (up to 50 employees), medium (up to 250 employees), and large (over 250 employees). These companies primarily operated in the fields of industry, services, agriculture, and construction. The questionnaire return rate was 30.80%, with 61 correctly filled questionnaires. Within the research, we established the following research questions:

1. What is the average level of financing for marketing communication?
2. Which marketing communication tools are most funded by companies?
3. What factors are important for companies in resource allocation?
4. Which tools are most commonly used to measure the success of marketing campaigns?
5. What is the success rate of investments in marketing campaigns?

3. Results and Discussion

In this section of the article, the results of the questionnaire survey are processed. A total of 61 questionnaires were processed and evaluated. The research sample consisted of 11 small enterprises, 15 medium enterprises, and 35 large enterprises operating in the territory of the Slovak Republic.

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Research Question 1: What is the average level of financing for marketing communication? An important area we focused on was the level of financing for marketing activities. The results in this area are as follows:

- Less than 10,000 Euros was invested by 8 small enterprises and 3 large enterprises.
- 10,000 – 50,000 Euros was invested by 12 large enterprises, 8 medium enterprises, and 1 small enterprise.
- 51,000 – 100,000 Euros was invested by 4 large enterprises and 2 medium enterprises.
- More than 100,000 Euros was invested by 9 large enterprises, 2 medium enterprises, and 1 small enterprise.
- Refused to answer: 7 large enterprises, 3 medium enterprises, and 1 small enterprise.

Companies in Slovakia most commonly invest in marketing in the range of 10,000 to 50,000 euros, as indicated by 21 companies. As seen in Figure 1, small enterprises most commonly invest less than 10,000 Euros in marketing. Medium and large enterprises most commonly invest in the range of 10,000 to 50,000 Euros. Sums exceeding 50,000 Euros are predominantly invested by large enterprises.

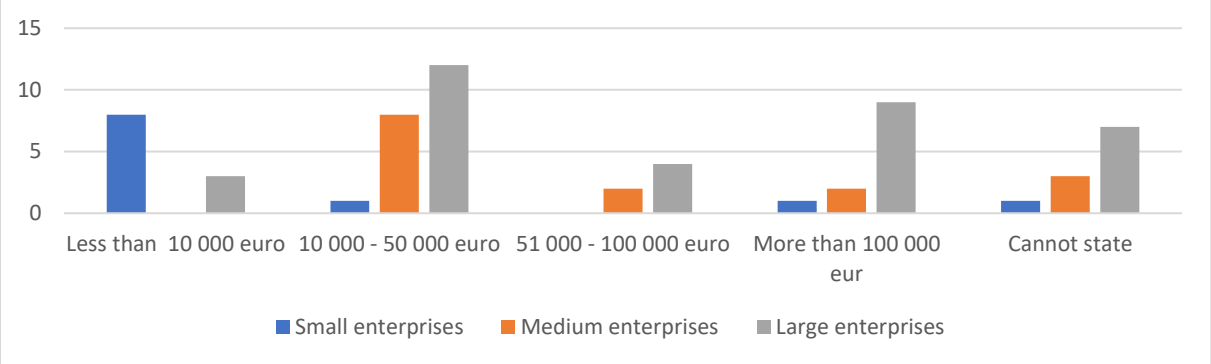

Figure 1: Financial planning of marketing activities

Source: own processing

Research question 2: Which marketing communication tools are financed the most by businesses?

The second research question is focused on how financial resources for marketing are distributed between individual marketing communication tools. On the graph below, we can see that:

- 15.04% of businesses marked the advertisement.
- Sales support was indicated by 6.50% of enterprises.
- Relations with the public were indicated by 9.34% of enterprises.
- 11.78% of companies indicated personal selling.
- Direct marketing was indicated by 5.69% of enterprises.
- Event marketing was indicated by 12.60% of enterprises.
- Digital marketing was indicated by 15.85% of enterprises.
- Social media marketing was indicated by 17.07% of businesses.
- Mobile marketing was indicated by 2.43% of enterprises.
- Product placement was indicated by 2.80% of enterprises.

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• Guerrilla marketing was indicated by 0.81% of enterprises.

On graph 2, we can see that companies in Slovakia most often invest in social media marketing, 17.07% of companies indicated this option. Other investments are mainly in digital marketing (15.85%) and advertising (15.04%). To a lesser extent, companies also invest in event marketing (12.60%) and personal selling (11.78%). So we can say that businesses in Slovakia primarily use marketing communication tools using the Internet. However, advertising is still a communication tool that cannot be neglected due to its mass nature, and businesses in Slovakia are aware of this.

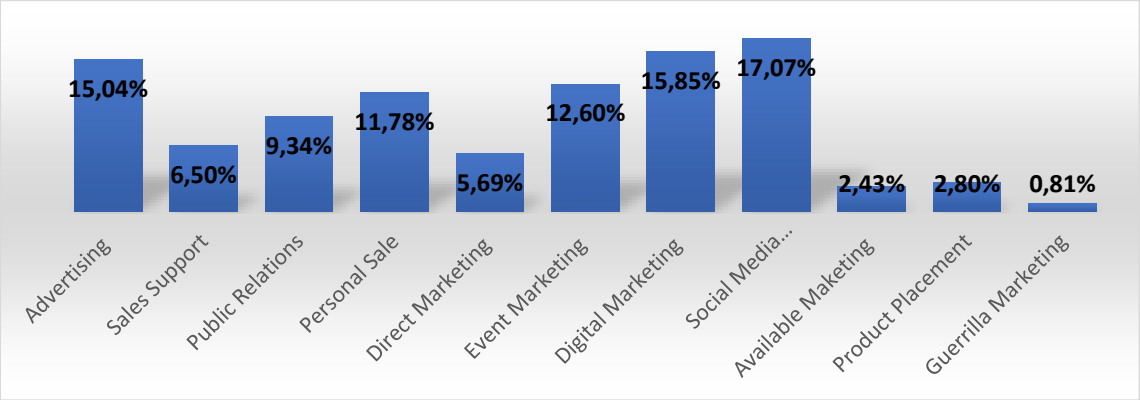

Figure 2: Marketing communication tools

Source: own processing

Research question 3: What factors are important for companies in allocating resources?

In the following part of the research, we focused on what factors are important for companies when allocating resources. Chart 3 shows the following findings:

• 17.64% of enterprises indicated a competitive environment.

• 26.12% of enterprises indicated the economic situation.

• Historical results were indicated by 5.88% of enterprises.

• 15.03% of companies indicated trends in the industry.

• Successes/inaccuracies of the campaign change were indicated by 12.41% of businesses.

• Changes in consumer behavior were indicated by 13.07% of enterprises.

• Changes in legislation were indicated by 2.61% of enterprises.

• New technological possibilities were indicated by 7.18% of enterprises.

From the above values, we can see that the most important factor is the current financial situation in which the company is located. This option was indicated by up to 26.12% of enterprises. The second most important factor was the competitive environment in which the company operates. This option was indicated by 17.64% of enterprises. Subsequently, businesses also indicated factors such as industry trends, changes in consumer behavior and successes/failures of previous campaigns. These options were indicated by 13.07% to 15.03% of enterprises. Other options were indicated to a minimal extent.

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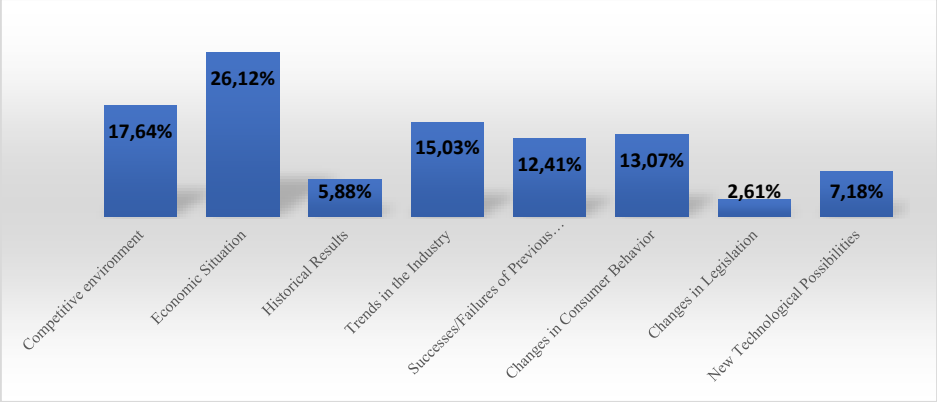

Figure 3: Factors important for resource allocation

Source: own processing

Research question 4: What tools are most used to measure the success of a marketing campaign?

For investments in marketing, the last investment of the success of these investments is important. That's why we also analyzed what tools are most often used by companies for measurement. We see these values in Figure 4:

- Google Analytics reported by 28.16% of businesses.
- Facebook Insights flagged 21.12% of businesses.
- CRM system was indicated by 16.90% of companies.
- 6.33% of companies indicated the cost of customer acquisition.
- 9.15% of companies indicated the click-through rate.
- 8.45% of companies indicated the customer's lifetime value.
- 4.22% of companies marked the Heatmap.
- 2.11% indicated the option not following.
- 3.51% of enterprises indicated the other option.

Based on these data, we see that companies use the Google Analytics tool most often. As many as 28.16% of enterprises indicated this option. The second most common option is Facebook Insights, which was indicated by 21.12% of businesses. The third most common option was the CRM system. This option was indicated by 16.90% of enterprises. Other options ranged from 9.15% to 2.11%.

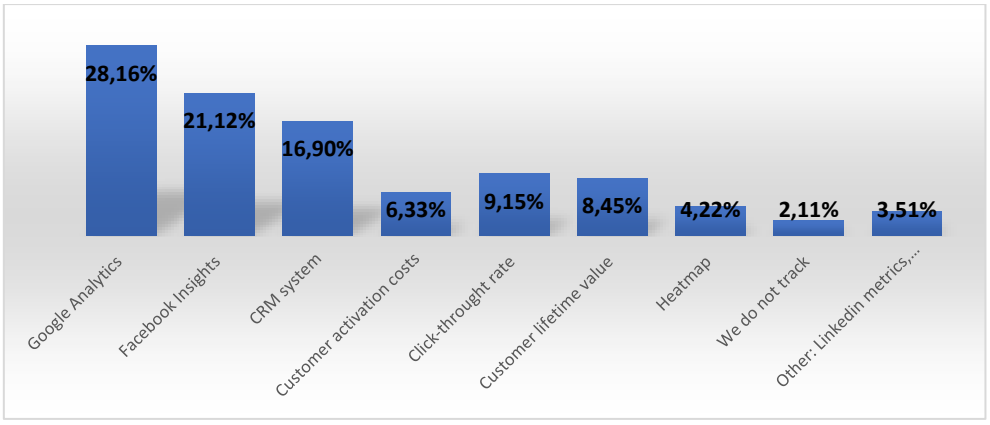

Figure 4: Tools for measuring marketing activities

Source: own processing

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Research question 5: What is the success rate of drip marketing investments?

In the last area, we focused on how the companies themselves evaluate the success of their investments. We see these values in Figure 5:

• Excellent was marked by 13.79% of enterprises.

• Good was marked by 36.20% of enterprises.

• Average was indicated by 41.37% of enterprises.

• Below average was indicated by 8.62% of enterprises.

Enterprises most often rated their investments as average. 41.37% of enterprises indicated this option. They further described their investments as good. 36.20% of enterprises marked this as possible. 13.79% of enterprises have an excellent return on investment, and 8.62% of enterprises indicated a below-average return.

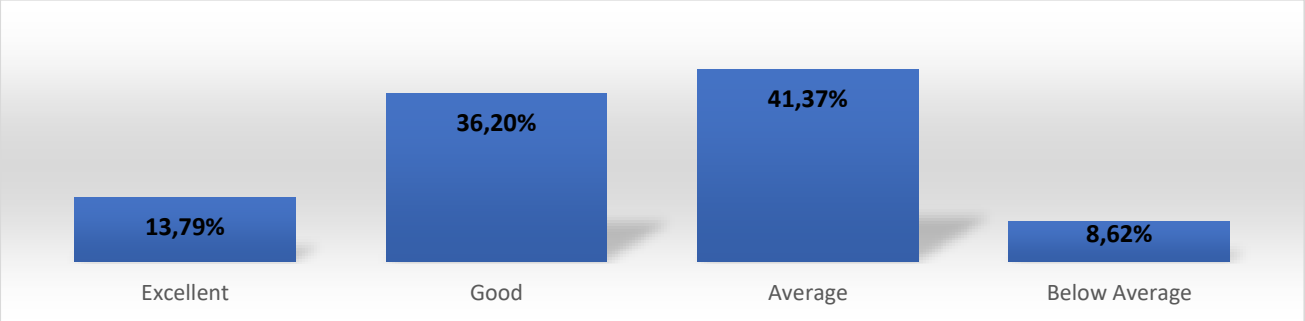

Figure 5: Return on investment in marketing

Source: own processing

The contribution presents the results of the research, which was focused on the financial planning of marketing activities in industrial enterprises in Slovakia. In the methodology, we defined 4 research questions that emerged from the theoretical foundations presented in the article. Financial planning of marketing communication in industrial enterprises is a key element of a successful marketing strategy. Based on the analysis of the mentioned data, it appears that Slovak industrial enterprises approach marketing financing with diverse approaches and preferences. We will discuss some of the main aspects of financial planning and their impact on the success of marketing activities in industrial enterprises. The first key point is the amount of marketing communication funding. One of the main findings is the diversity of the amount of investment in marketing according to the size of the company. Small businesses prefer lower budgets, while large businesses invest significantly larger amounts, often over 100,000 euros. This difference may be related to the different capacities and resources of individual enterprises. We found that most businesses prefer investments in the range from 10,000 to 50,000 euros. This can be seen as the optimal range between the maximum funds for a more effective marketing strategy and the risk associated with larger investments. Another important aspect is the distribution of funds between individual marketing communication tools. The findings require that Slovak industrial enterprises most often invest in social media, digital marketing and advertising. This trend testifies to the importance of online presence and digital marketing channels for industrial enterprises in today's digital sphere. Another important step is how businesses decide on resource allocation. The current financial situation and the competitive environment are key factors related to companies' decisions about investments in marketing. These factors underline every market situation and competitive dynamics when planning marketing expenditures. Measuring the success of marketing campaigns is another critical step in financial planning. Businesses use a

variety of performance measurement tools, with Google Analytics, Facebook Insights, and CRM systems being among the most common. These tools provide businesses with important data to assess the effectiveness of their investments and contribute to a better understanding of customer needs. Finally, evaluating the success of marketing investments is key to evaluating the performance of marketing strategies. Most businesses rate their investments as average and good, meaning that marketing is seen as an effective investment with positive results. We can conclude that the financial planning of marketing communication in industrial enterprises is a complex process that includes consideration of various factors and contributes to the successful achievement of marketing strategy goals. It is important for businesses to constantly monitor and adjust their financial planning as market conditions and the needs of their customers change.

A comparison of our research with similar international studies reveals several common trends as well as some key differences in the area of financial planning for marketing activities in industrial enterprises.

Common Trends

- **Emphasis on Digital Marketing** - Similar to our research, international studies highlight the growing importance of digital channels, particularly social media, in marketing strategies for industrial enterprises. For instance, a study published in *Vilakshan - XIMB Journal of Management* analyzed the impact of financial management practices on the performance of small and medium-sized enterprises. The findings emphasized the significance of digital tools in marketing, which contribute to more effective customer engagement and improved return on investment (Uniwork, 2023).
- **Use of Analytical Tools** - As in our research, international enterprises frequently utilize tools like Google Analytics and CRM systems to measure the success of marketing campaigns. This approach reflects a global trend towards data-driven marketing, enabling companies to optimize their campaigns and ensure the efficient use of resources (SpringerLink, 2023).

Differences

- **Marketing Budgets** - Our study indicates that Slovak enterprises most commonly invest in marketing budgets ranging from €10,000 to €50,000. In contrast, international studies report significantly higher budgets, particularly in developed economies where businesses regularly exceed these investment thresholds. Higher marketing expenditures often result from greater purchasing power and increased competition in global markets (Munich Business School, 2023).
- **Factors Influencing Resource Allocation** - In our study, factors such as the economic situation and competitive environment dominate resource allocation decisions. Conversely, international research often emphasizes technological innovations and global market trends as critical influences on marketing investment decisions. These differences highlight the distinct priorities and challenges faced by businesses in various regions (SpringerLink, 2023).

These comparisons suggest that while there are shared global trends in marketing strategies for industrial enterprises, regional differences in budgets and priorities can significantly influence specific approaches to financial planning for marketing activities. Research in Slovakia provides valuable insights that may be relevant for businesses with more limited resources, whereas international studies offer examples of expanded opportunities and advanced approaches to marketing strategies.

4. Conclusion

The study highlights the critical role of financial planning in the effective and sustainable execution of marketing activities within industrial enterprises. Based on a survey of 61 Slovak enterprises, it was observed that marketing budgets are predominantly allocated in the range of €10,000 to €50,000. This reflects a pragmatic approach that balances cost considerations with potential returns. Social media, digital marketing, and advertising were identified as the most significant tools, underscoring the increasing reliance on online platforms in modern marketing strategies.

Resource allocation decisions are strongly influenced by external factors, such as economic conditions and competitive pressures, along with internal metrics, including campaign performance and consumer behavior. Performance measurement tools, such as Google Analytics and CRM systems, were found to play a pivotal role in optimizing marketing strategies through actionable insights, supporting data-driven decision-making.

The findings also indicate variability in financial practices across enterprises, depending on company size, available resources, and strategic priorities. Smaller enterprises typically operate within constrained budgets, whereas larger companies demonstrate the capacity for more extensive marketing initiatives.

This research underscores the need for adaptability and strategic foresight in financial planning as market dynamics evolve and digital transformation accelerates. Future studies should explore the integration of advanced analytical tools, the role of technological innovations, and the impact of global market trends on marketing financial planning. A flexible and innovative approach will allow industrial enterprises to enhance marketing effectiveness and maintain competitive advantages in an increasingly dynamic environment.

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Preferences of Consumer Generations Towards Green Products on the Slovak Market: Application of the AHP Method

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Abstract

Today, sustainability is often debated and seen as justified because of its ability to use natural resources efficiently, protect the environment and improve living conditions, while ensuring the protection of future generations. The growing emphasis on sustainable practices is evident in business, public policy, and everyday life. In this context, customers should prefer sustainable, so-called green products not only for their personal benefit but also for their benefits to the environment, society, and future generations. In this way, consumers can actively contribute to promoting sustainable lifestyles and protecting the planet. Generation Z is characterized by a positive attitude towards green products, but other generations are also showing changes in preferences regarding sustainability. Knowledge of customer preferences is proving to be a strategic tool for effective business management, enabling a better understanding and response to market needs, thus contributing to competitiveness and long-term business success. Understanding current customer preferences is crucial in the face of unexpected challenges such as the COVID-19 pandemic and the conflict in Ukraine. Research on consumer preferences can provide important insights into the impact of these events on customers' financial security, values, and behavior. At the core of the research are the preferences of different consumer generations currently active in the market regarding green products in the Slovak territory. The aim of the paper is to identify the key criteria based on which individual consumers make their purchasing decisions for different products and also to identify which consumer generation most prefers green products. The AHP method is used to assess the preferences of generations in relation to the criteria that influence their decision making when purchasing green products. The research has the potential to contribute to a more thorough understanding of the relationship between consumer generations and green products, which may have important implications for business, public policy, and society as a whole.

Key words
green product, consumer generations, Analytical Hierarchical Process (AHP)

JEL Classification
E21; E23; M11; C44; Q01.

1. Introduction

Sustainability is a key issue today due to growing environmental and social problems as well as economic stability and regulations. The world faces various environmental threats such as global warming, biodiversity loss and pollution (World Economic Forum, 2024). Unsustainable practices can lead to social problems such as poverty and inequality in living conditions (United Nations, 2024). Sustainable societies are better prepared for risks such as climate change and regulation. Companies ignoring sustainability may face various sanctions and restrictions from government and regulators (Ashford & Hall, 2011). Sustainability is a

complex concept that focuses on meeting the needs of the present without compromising the ability of future generations to meet their needs. It is a global approach focused on economic growth, social equity and environmental protection. Green products that minimize negative impacts throughout the entire life cycle, including preparation, production, use and disposal, are important to achieve environmental sustainability (UN Environment Program, 2019). These products are designed to minimize resource consumption and greenhouse gas emissions (Mont, 2002). Green products contribute to a healthier environment, innovation and competitiveness of firms, thereby increasing customer trust and loyalty (Hargroves & Smith, 2006; Shrivastava, 1995).

Consumers increasingly prefer products and services from companies that are environmentally responsible. The formation of consumer preferences is a key aspect of consumer behavior. The mechanisms influencing preference formation are diverse and complex. Social interaction and experiences gained through family, friends and work relationships play an important role (Hogg & Vaughan, 2018). Marketing campaigns and advertising also influence consumer preferences (Solomon et al., 2014). Equally important are personal experiences and product evaluations that can influence future decision making (Schmitt, 1999). Consumer preferences are the result of the interaction between various internal and external factors. Consumers around the world have experienced rising costs of living, including energy and food, with inflation exceeding 10% in some countries (European Union, 2022). High inflation affects savings, purchasing decisions and wage demands (National Bank of Slovakia, 2024). The war in Ukraine and COVID-19 have caused changes in consumer behavior (Grunert et al., 2023).

The characteristics of different consumer generations suggest positive tendencies towards green products, which is confirmed by some surveys. However, crises can change behavior and disrupt the stability of habits (Błoński et al., 2023). Understanding consumer preferences is crucial for the success of companies and the effectiveness of public policy. Research shows that considering ethical and environmental factors can improve brand image and customer loyalty (Grissemann & Stokburger-Sauer, 2012). According to a Nielsen survey, 66% of consumers are willing to pay more for a product from a sustainable brand (Forliance, 2023). The trend of consumer support for sustainability is growing, especially with the increasing numbers of Generation Y and Z. It is imperative for companies and policy actors to monitor and analyze consumer preferences to achieve long-term sustainability and prosperity (Dragolea, 2023). According to Deloitte research (2024), the biggest societal challenges for Generation Z and Y are the high cost of living, unemployment and climate change. These factors may create unsuitable conditions for the growth of green products (Smolka et al., 2021).

2. Data and Methods

The typology of consumers we worked with, according to Smolka et al. (2021), is as follows: Generation X (1966-1976; GEN_X); Generation Y (1977-1995; GEN_Y); Generation Z (1996-2012; GEN_Z); and the "Baby Boomers" (1946-1965; GEN_BB). The analysis of consumer preferences consisted of three separate parts. The first part was a questionnaire survey. The questionnaire consisted of two questions. The first question was an identification question used to classify respondents into the appropriate consumer generation. The second question was aimed at the respondents' evaluation of the set criteria. Respondents rated the importance of each criterion on a scale of 1 to 7, with 1 being the least important and 7 being the most important.

The criteria were established based on a study of consumer behavior and interviews with experts. The number of criteria sets was 29 (Product price, Manufacturer's brand, Environmentally focused product production, Material from which the product is made,

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Environmental product label, Method of sourcing raw materials for the production of products that do not have a negative impact on the environment, Environmental/ecological parameters of the product, Distribution of the product that does not have a negative impact on the environment, Environmental activities of the company selling the product, Product purpose, functions and features, Product design, Product durability, Product recyclability, Manufacturer services, Product quality, Reviews and ratings, Marketing and advertising activities, Convenience and ease of use, Current trends and fashions, Personnel impact: Interactions with sales or service staff, Product experience: Overall experience associated with owning and using the product, Trust in dealer, Word-of-mouth recommendations, Current needs, Ergonomics, Ease of maintenance, Certifications and safety, Local manufacturing, Availability of colors and sizes).

The above questionnaire survey was conducted from 13 November 2023 to 31 January 2024. The questionnaire was distributed through social networks and personal outreach. The number of respondents contacted was 451. The questionnaire was completed by 267 respondents, representing a 59.2% return rate. At the same time, we carried out the 2nd part, which consisted in contacting selected experts in relevant fields to create a list of ranking criteria for deciding the "ideal green consumer". We refer to this ranking list as the "green consumer profile". The resulting values of the criteria were obtained based on the ratings from all experts. The experts for the evaluation of the criteria by which the 'ideal green consumer' is decided were selected based on their teaching, research, consultancy and marketing experience, knowledge and experience in consumer behavior and green production. The 6 experts approached were 6 and the areas they represented are sustainable business, business logistics, production management, industrial engineering, management, finance, strategic management with a focus on sustainable development and corporate social responsibility, operations analysis, multi-criteria optimization, marketing, human resources, and education. Based on the assessment of all experts, we further worked with the 12 most relevant criteria (Figure 1).

The third step was the application of multi-criteria evaluation. Due to the nature of the present paper, we chose the Analytic Hierarchy Process method using Expert Choice software. AHP, developed by Thomas L. Saaty in the 1970s, is a decision-making model used in a variety of fields ranging from project management to selecting the best alternatives. This method provides a structured approach to solving complex decision problems with multiple criteria and alternatives. AHP represents a discipline supporting decision making in multi-criteria problems where various conflicting decision criteria need to be considered (Sakal et al. 2010).

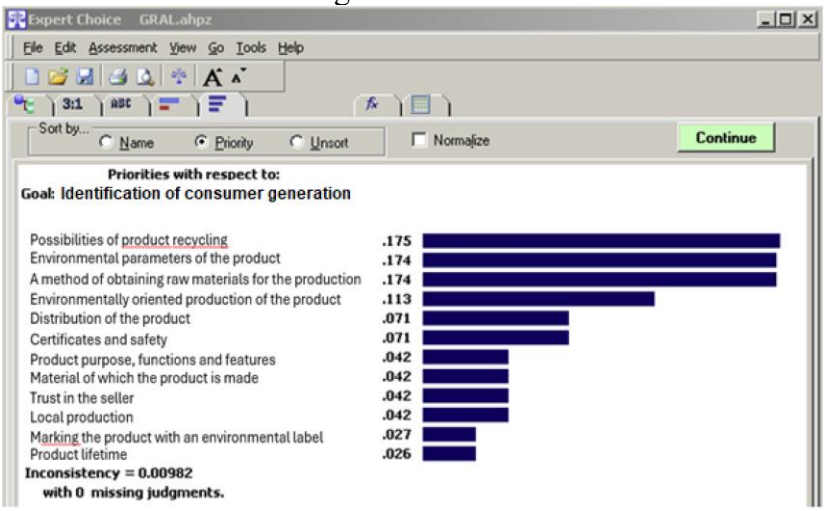

Figure 1: Pairwise comparison of the most important criteria according to experts (own research 2024)

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The hierarchical arrangement of criteria and alternatives allows for a systematic comparison of their relative importance and contributes to the transparency of the decision-making process. AHP relies on mathematical models of pairwise comparisons and assignment of weights to criteria, which allows quantifying the subjective preferences of decision makers and improves consistent and rational evaluation of alternatives (Stěrba, 2007).

In addition to the significance ratings for each criterion, Figure 1 also shows the value and analysis of consistency, which should be within 0.1. In this case, the consistency value is 0.009, so logical consistency in the pairwise comparison was maintained. The most important criterion is the possibilities of product recycling with an important value of 0.175. The following criteria are Environmental parameters of the product and Method of obtaining raw materials for the production with the same importance value of 0.174. The least important criteria based on our survey are Marking the product with an environmental label with an important value of 0.027 and Product lifetime with an important value of 0.026.

3. Results and Discussion

The evaluation of the results of the AHP analysis provides an interesting insight into the preferences of consumers in Slovakia towards green products and their association with different generations (Figure 2). Based on this analysis, we have identified that Generation X shows the highest positive preferences towards green products, which indicates their strong interest in environmental protection and sustainability. We can confirm the result of the survey conducted by Smolka et al. (2021) where they investigated sustainability as a factor for changing marketing strategies based on customer preferences in the context of different generations in the Slovak Republic, where they claim that "the generations that were the subject of the research are changing their purchasing behavior and changing their purchasing preferences. Customers learn and have the opportunity to acquire information, they prefer products that they can clearly identify, and they prefer those that are produced or grown in accordance with the principles of sustainability and their production is as environmentally friendly as possible."

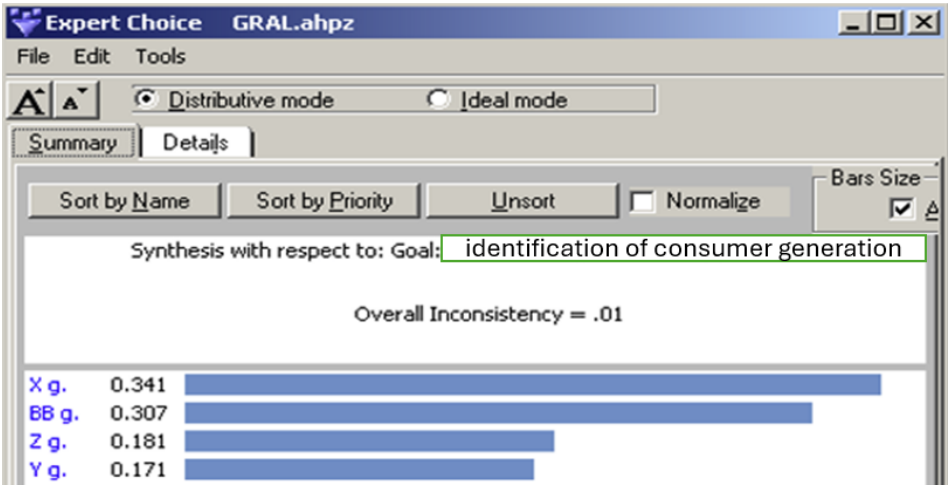

Figure 2: Result of the AHP method (own research 2024)

Interestingly, the second most responsive generation is the Baby Boomers, indicating their potential interest in environmentally responsible products and a possible shift towards a more sustainable lifestyle. These results contradict assumptions that Generation Z would have the highest preferences, but it turns out that they are only in third place. This discrepancy with expectations is an interesting finding that points to the need for further research and a more accurate understanding of the factors influencing different generations' preferences towards

green products. According to Dragole et al. (2023), their research results show "that there is no relationship between the sustainable behavior of Generation Z consumers and organizations' green marketing practices, environmental issues and their identification with being an environmentally responsible consumer". We believe that non-positive events such as the COVID 19 pandemic, the war in Ukraine, high inflation and overall uncertainty about the future may be influencing the given preferences of Generation Z respondents. These findings have important implications for marketing strategies and green product development.

An interesting finding of this study is that Generation Z showed a lower preference for green products than originally thought. This result may be influenced by several factors. Global crises such as the COVID-19 pandemic, the war in Ukraine and high inflation are likely to have created economic uncertainty that has negatively affected consumer decision-making, especially among younger generations. While Generation Z is generally considered to be environmentally conscious, price and availability of products may now be more important to them than their green features. Another factor may be a certain skepticism towards marketing practices that try to appeal to this generation through green values, but do not always meet consumer expectations. These factors point to the need for further research to more accurately identify the determinants of this generation's sustainable consumption behavior.

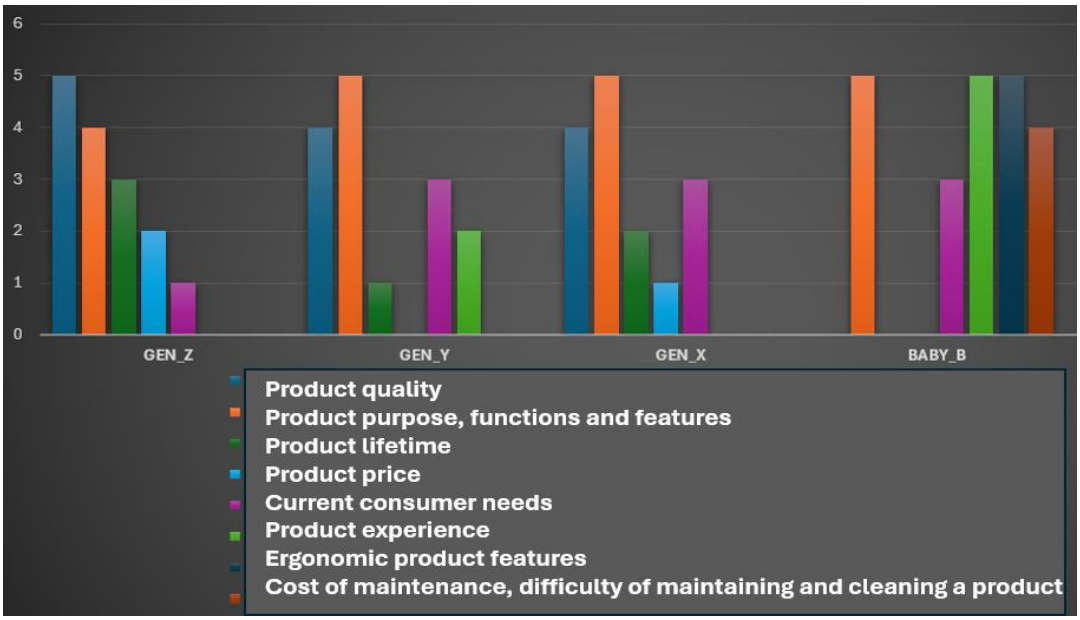

Figure 3: Overview of the most important criteria by consumer generation (own research 2024)

Figure 3 shows the criteria that individual respondents from the respective consumer generations consider most when deciding to buy a particular product. For Generation Z, quality is the most important criterion, with the purpose of the product its functions and features as the second most important criterion, and the experience with the product as the third most important criterion. Generation Z also looks at the price of the products in a significant way. The criterion 'purpose of the product' is the most important criterion for Generations X, Y and BB. For Generation BB, the criteria 'product experience' and 'product ergonomics' have the same level of importance as the purpose of the product. The second most important criterion for Generation Y and Generation X is 'Product quality'. It can be concluded that Generations X, Y and Z have approximately the same preferences or are similarly influenced by certain factors when deciding to buy a green product.

The study has several limitations that need to be considered when interpreting the results. The first limitation is the sample size. 267 respondents completed the questionnaire, which represents 59.2% of the total 451 persons approached. While this sample provides valuable insights, its size may limit the ability to generalize the findings to the general population. Further research with a larger sample size would be advisable to test the robustness and extend the findings. Another limitation is the geographical focus of the research, which concentrated on the Slovak market. Consumer preferences may differ across regions and countries depending on cultural, economic or environmental factors. Therefore, the results of this study should be interpreted in the context of the Slovak Republic and further research could provide valuable comparisons with other countries.

Based on the results of this study, we can provide several recommendations for businesses and policy makers that can help improve access to green products and sustainability:

- **Businesses:** marketing strategies need to be adapted to the preferences of each generation. Generation Z prefers quality and functionality. Businesses should highlight the innovation and technological advantages of green products. It is also important to be transparent about environmental practices, which will help reduce skepticism towards 'green marketing'.
- **Policymakers**: They should support businesses investing in sustainable development and eco-innovation. Policymakers should focus their efforts on promoting green technologies and providing consumers with access to information to enable them to make informed choices about green products.

4. Conclusion

The war in Ukraine and the subsequent price increases, together with the COVID-19 crisis, have led to certain changes in consumer behavior. However, few studies have focused on whether the COVID-19 pandemic induced lasting changes in consumer food preferences. Moreover, the lack of research on the impact of inflation and price instability on consumer behavior represents a knowledge gap. Crises such as these events can disrupt existing consumer habits and encourage the formation of new ones. These changes are visible across generations and have the potential to influence preferences towards environmentally responsible products. Understanding consumer preferences is key to the success of businesses and the effectiveness of public policy. The results of the AHP analysis provide valuable insights into consumer preferences and their association with different generations. Identifying and interpreting these preferences allows businesses to adapt their strategies and products to better meet consumer needs. At the same time, public policies shaped by an understanding of consumer preferences can positively influence economic and social development. Findings suggest an increased interest in environmentally responsible products, but preferences differ between generations. Older generations show an interest in sustainable products, which has important implications for marketing strategies and the development of environmentally oriented products. Finally, the trend towards environmental responsibility seems to be becoming more pronounced. Customers of all generations express an interest in products produced with sustainability in mind. Marketing strategies based on sustainability are therefore becoming essential for the competitiveness and success of businesses in the future. A significant limitation of the research is the sample size and consequently the responses received from only 267 respondents. Studies with larger samples may allow for greater generalization and confirmation of the findings.

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Can Music Affect Visual Attention when Testing a Selected Dessert? Case Study: Generation Z

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Abstract
Engaging multiple human senses is already an essential part of any successful business that seeks to guide customer decisions, create a welcoming environment and achieve higher sales. One way to create a pleasant atmosphere in a shopping environment is through the use of musical backdrops and related factors. Music influences consumers more than they can imagine. It has an impact on psychological well-being, significantly changes people's emotions, improves mood and can positively (but also negatively) affect appetite or time spent in a shop. The influence of music on consumption is a significant factor of the internal environment that can alter the perception of food. The main aim of this paper is to find out what effect background music has on the visual attention and emotions of the consumer when eating a selected dessert (chocolate prepared in three different ways). Visual performance and perception of background music were tested using a biometric Eye tracking (mobile eye camera) method used to obtain unconscious feedback from participants. We linked this measured data with data obtained from conscious responses via questionnaire. During the consumption of chocolate desserts, selected music (the jazz instrumental Warm Autumn Morning) was played in the study environment at a tempo of 146BPM. During the chocolate dessert testing, the noise level in the space was also monitored using the UT353UNI-T Noise and Sound Intensity Meter. The contribution of this paper lies in gaining new insights into demonstrating the impact of music on consumer preference and emotional response in order to advance research on the fine-tuning of background music for specific establishments and the targeted impact of audio stimulation on purchase decision making.

Key words
Chocolate dessert, eye tracking, generation Z, music, visual design, sound

JEL Classification
M31

1. Introduction

1.1 The Relationship Between Music Application and Consumer Behavior

According to the music history and research fields (Booth & Kuhn, 1990; Fuld, 2000; Olson, 2008), music types can be generally classified into three basic categories: a) western art music, b) folk music, and c) popular music. Western art music refers to the styles and genres that have been inherited from western art music and classical tradition, and is characterized by compositional sophistication, virtuosity on the part of individual musicians, and use of standardized musical notation. Folk music can be understood as the traditional music of any particular ethnical group or community that is passed down through informal ways from one generation to the next. Popular music refers to any form of music that is mass produced and distributed to large audiences through films, television, or online for commercial purposes,

such as blues, jazz, rock and roll, country, soul and hip hop. In addition, popular music also includes light music with through composed feature, crossover music, and ambient music (Chen et al., 2023). Atmospherics consist of many elements, such as color, brightness, shape, size, music, odor, softness, smoothness, and temperature (Mandila & Gerogiannis, 2012). Listening to music can make many people forget about worry and relieve tension in life (Miranda & Claes, 2009; Sakka & Juslin, 2018). In recent years, the application of music has been extended from a traditional form of pure art to modern applications, such as medical treatment, and consumer behavior (Areni, 2003; Meng et al., 2018; Teng & Lin, 2006). Music with attractive melody and slow tempo such as Nocturnes by Frédéric François Chopin (1810–1849) can make people feel warm and calm. However, even music with simple melody and normal tempo such as O Fortuna in Carmina Burana by Carl Orff (1895–1982) can still make people feel powerful and inspiring as long as it's dynamics changes intensely (Huang, 2012). Studies also show that listening to music with soft melody and slow tempo such as Adagio in G minor by Johann Sebastian Bach (1685–1750) or Taiwanese song Wife (Taiwanese translation: Gie Ao) sung by Jody Chiang (Taiwanese singer) can keep people's brain waves calm and stable (Balasubramanian et al., 2018; Shih & Chiang, 2004). Among them, the atmospheric music is especially important in perceiving the atmosphere of service environments, and accordingly it has attracted considerable attention from academia, as implied by the term ''music scape'' (Jeon et al., 2016; Oakes & North, 2008). Atmospheric music is also called ''background music'' or ''ambient music.'' It is played at a relatively low volume to create ambient feelings while also filling the empty air between people to protect their private conversations (Areni, 2003; Wang, 2008). The broad definition refers to music that is closely related to people's lives and is one of the background elements of people's living environment. Therefore, a music is a simple tool to create the atmosphere for specific activities and spaces (Tang & Vezeau, 2010). Listening to music can make many people forget about worry and relieve tension in life (Miranda & Claes, 2009; Sakka & Juslin, 2018). In recent years, the application of music has been extended from a traditional form of pure art to modern applications, such as medical treatment (Tang & Vezeau, 2010; Vik et al., 2018), emotion (Miranda & Claes, 2009; Sakka & Juslin, 2018; Schubert, 2007) and consumer behavior. Music is based on traditional music, performs through modern music technology (Teoh, 2012) and is applied to real life with specific practical properties, it is in the field of ''applied music'' (Tsai, 2013). Prior studies have examined the effects of ambient music on a wide range of variables including time perceptions (Yalch and Spangenberg 2000), store evaluations (Spangenberg et al. 2005; Berčík et al, 2016), amount of time and money spent in a store (Caldwell and Hibbert 2002), consumption volume, and overall shopping experience (Garlin and Owen 2006), among others. In practice, in the case of establishments, there are two basic situations of use of copyright works (in our case, sound and audiovisual recordings): a) public performance, e.g. a live concert, a disco with reproduced music. Since it is not only copyright works such as music or lyrics that are used, it is necessary to obtain a license and to pay for the use. B) public transmission, radio play or television broadcasting, here also a license agreement and payment of remuneration is required (Petkov & Co, 2023).

1.2 Visual Attention when Eating Food

Various studies have already shown that different food stimuli can affect visual attention (Hummel, 2018) and that attentional bias can have an influence on eating behavior (Field et al., 2016). Visual attention also seems to be affected by an individual's eating behavior style. Previous research has highlighted the associations between eating behavior and visual attention to food stimuli (Polivy & Herman, 2017). Kumar et al. (2016) found food related objects increased visual attention towards food cues, whereby merely thinking about food modulated the extent to which attention was captured, and holding specific information caused attention

to be automatically drawn towards food stimuli. Similarly, Werthermann et al. (2014) found manipulating attentional bias for food cues increased cravings and food intake, suggesting a link between attention for food and food intake. Visual attention is thought to play an important role for appetitive motivation and eating behavior (Field et al., 2016). According to the elaborated intrusion theory of desire (Kavanagh, Andrade, & May 2005) external stimuli can trigger intrusive thoughts about appetitive targets (objects associated with pleasure or relief of discomfort).

1.3 Neuromarketing and Eye Tracker as a Neuroimaging Tool

Neuromarketing/ or neuroscience focuses on subconscious rather than conscious because according to previous studies, consumer behavior and consumers´ cognitive responses are inconsistent (Renvoise & Morin, 2016). Brain imaging and body response measurement techniques used in neuromarketing aim to measure consumer reactions to product/service, packaging, advertisement, or an emotional marketing method too. Neuromarketing aims to motivate limbic system to direct the consumers to the desired behavior. Neuroscientific methods are applied to obtain objective consumer responses from their body language eliminating inconsistency of verbal responses (Calvert & Brammer, 2012; Horská & Berčík et al., 2017). To get information about where people look and to track their eye movements, the eye tracker (ET) tool has a special place among modern neurophysiological techniques. It allows to measure different processes of the human brain to salience stimuli, giving a useful insight into advertising and marketing stimuli (Berčík et al., 2021). Based on the relationship between visual attention and eye movements, the ET is an effective tool for experimental psychology and neurological research. It detects eye position, gaze direction, a sequence of eye movements, and visual adaptation during cognitive activities and allows users to analyses behavior and cognition by exploring the subject's gaze (Semmelmann & Weigelt, 2018). It records where and what the person is looking at (fixations), the time of fixations spent on a specific area of interest (AoI) on the stimulus, the movement of the eyes in relation to the subject' head to get information about specific patterns of visualization, pupil dilation, and the number of blinks (Zurawicki, 2010; Chavaglia et al., 2011; Veneri, 2010]. The main types of eye movements which can be detected by ET are saccades, smooth pursuit eye movement (SPEM), and vestibule ocular reflex (Vidal et al., 2012). Eye fixations usually range from approximately 200 ms during the reading of a text to 350 ms during viewing of a scene.

2. Data and Methods

The object of the research was food - sweet desert prepared and served in three different ways in cooperation with the Ľudovít Winter Hotel Academy in Piešťany. At first glance, the first two desserts looked identical, differing only in the ingredients used, the third one also differed in the aesthetic appearance of the added ingredients. The first variant (EGLO) was baked with white flour and white sugar coated with chocolate. EGLO is higher/fluffier, which usually at least to says it has better structure. The second dessert (ENGA) was baked with almond flour and coconut sugar, covered in chocolate. The third (EGGC) contained ingredients such as pumpkin puree, coconut sugar, coconut, ground nuts, coated with chocolate with cream and fruit deposited on top (Figure 1). All three desserts were served together on a stone black plate.

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Figure 1: Testing variants of individual visual designs
Source: own research, 2024

During dessert testing, we monitored the noise intensity using a VOLTCRAFT noise meter SL-10 30 - 130 dB 31.5 Hz - 8 kHzv in a given room, taking into account the conditions necessary for the research. As a background, jazz instrumental music called Warm Autumn Morning in Outdoor Coffee Shop Ambience_ Smooth Ethereal Jazz Instrumental Music was used with a tempo of 146BPM reproduced at 58dB. The background music was played with every second respondent (15 people in total). The waveform of the musical stimulus can be seen in Figure 2.

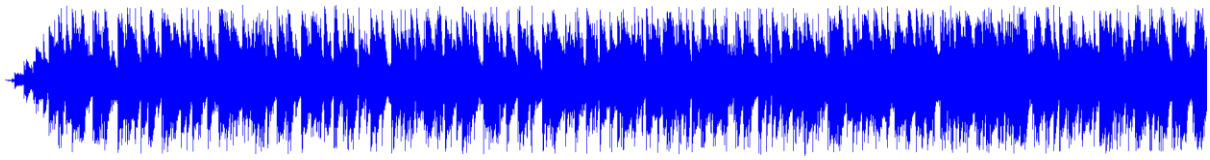

Figure 2: Waveforms of the musical stimulus "beats per minute" using free software
Source: Audioalter. (2024). BPM detector. Retrieved March 6, 2024, from https://audioalter.com/bpm-detector based on own data.

A total of 30 healthy high school respondents aged 16 - 30 years. took part in the testing. The condition for participation in the testing was the smelling and consumption of sweet foods too. The size of our sample is comparable to similar neuromarketing studies using eye tracking, in which a sample ranging from 6 to 30 respondents was used with respect to international standards (Goldberg, 2003). Of course, each survey is unique in its own way and the size and selection of the sample of respondents must be adapted accordingly. The whole testing process was governed by the Code of Ethics “Laboratory of Consumer Studies” of the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra and by the neuromarketing science and business association (NMSBA).

In addition to the conscious and unconscious evaluation of the visual performance of the same food, the perceptual effect on the musical perception of the sound of sweet food was also observed. Subsequently, an initial interview and calibration of the instruments took place. This is the stage where the experimenter has the greatest control over the quality of the eye tracking data, and extra care was taken to ensure that the calibration achieved acceptable levels of accuracy and precision. After calibration, the respondents were gradually served meals in the specified order with a 15 s minimum looking-before-tasting phase. In order to eliminate manipulation of the results, recalibration was performed between respondents who wore glasses and lenses between serving individual meals**.** In this case, special glasses were used to monitor eye movements-mobile Eye tracker glasses 2 by the Tobii Company (Danderyd, Sweden). This device uses the Pupil Centred Corneal Reflection-Dark pupil eye-tracking technique, which is a binocular system focusing on both eyes with a sampling frequency of 120 Hz. Primary data recorded by this method were processed in the Tobii Pro Lab software environment version 1.83.11324.

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3. Results and Discussion

According to conventional knowledge, the four key musical elements that affect the urge to purchase are tempo, mode, genre, and loudness. Brands may leverage this information to boost sales and improve the in-store customer experience by understanding the psychology of music and the products that it produces. By using a music curation service in the venue, people can boost customer engagement, increase retention, and drive sales.

Ten males and twenty females aged 18-30 years participated in the survey, with the highest representation being 18 year olds (11 respondents), 19 year olds (10 people) and 20 year olds were three. We divided the research results into two parts: exploratory results (conscious level) from the questionnaire and biometric results (unconscious level) through eye camera monitoring of visual attention and points of interest. The questionnaire survey showed us that respondents like to try new things in catering establishments, 17 people said they "sometimes" try, 10 people said they "always" try and only three people said they "never" try new things in catering. Regarding the consumption of desserts, 22 of the respondents stated that they 'sometimes' eat them, 8 'regularly ' eat them. 16 people said that they "maybe" gain weight from sweets such as desserts. 11 believe that they "definitely" gain weight and only three said that they do not like sweets. At a conscious level (Figure 3), probands indicated that the visual presentation of dessert was "rather" important to them (14 people), with a similar response for "definitely yes" (12 people).

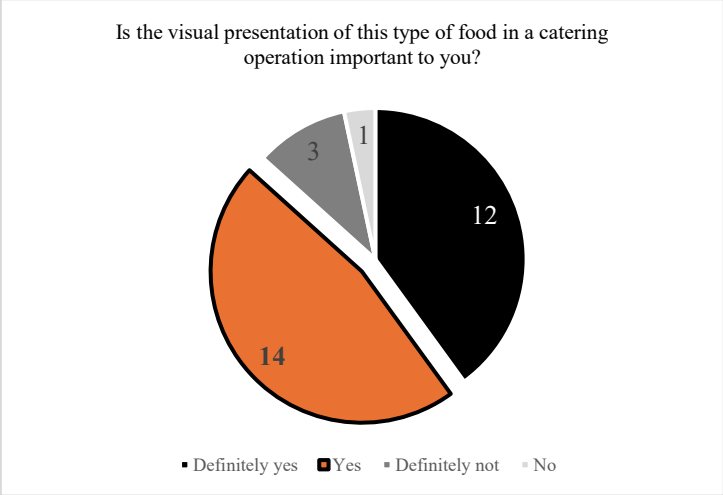

Figure 3: Visual serving of desert in gastronomy
Source: own research, 2024

The majority of respondents occasionally (25 people) go to a patisserie/café for dessert (Figure 4). Only three go regularly and two do not go at all. Next, we investigated what are the preferences of consumers 19 people like to try food from different countries and also like to try new food at parties or celebrations (15 people).12 people will eat almost everything. Preference one, i.e. when they least preferred the statement, was for the statement I am afraid to eat things I have never eaten before.

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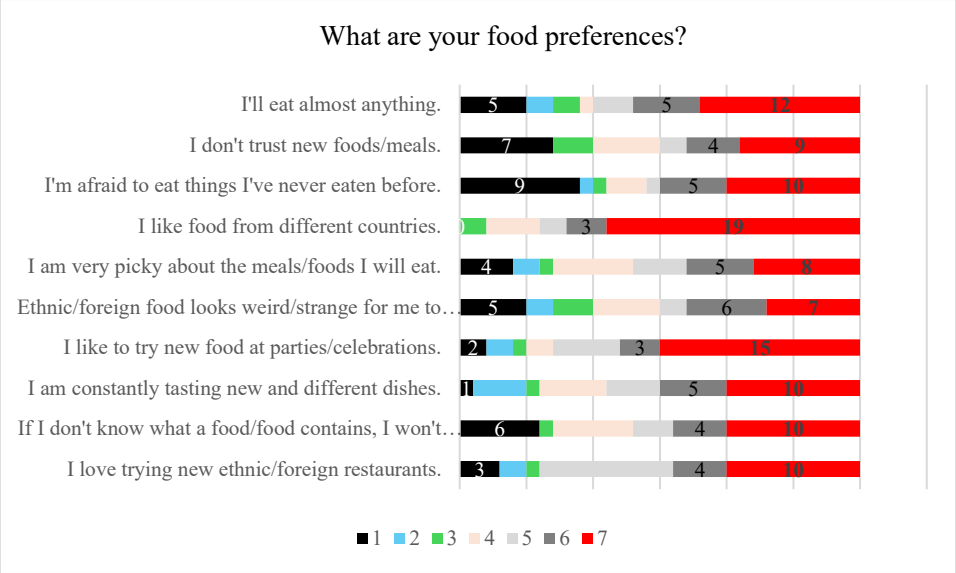

Figure 4: Preferences when consumer eat the food
Source: own research, 2024

Up to 27 of our respondents listen to music regularly (Figure 5). Only three listens to it occasionally, and no one indicated not listening to it at all as an answer. The most frequent musical preferences of the respondents were pop (25 people), rock (17), hip hop/rap (16), folk (12), classical/classical music (10) but also jazz (8) and funk/soul (6). Up to 29 respondents are aware that in catering establishments background music can play.

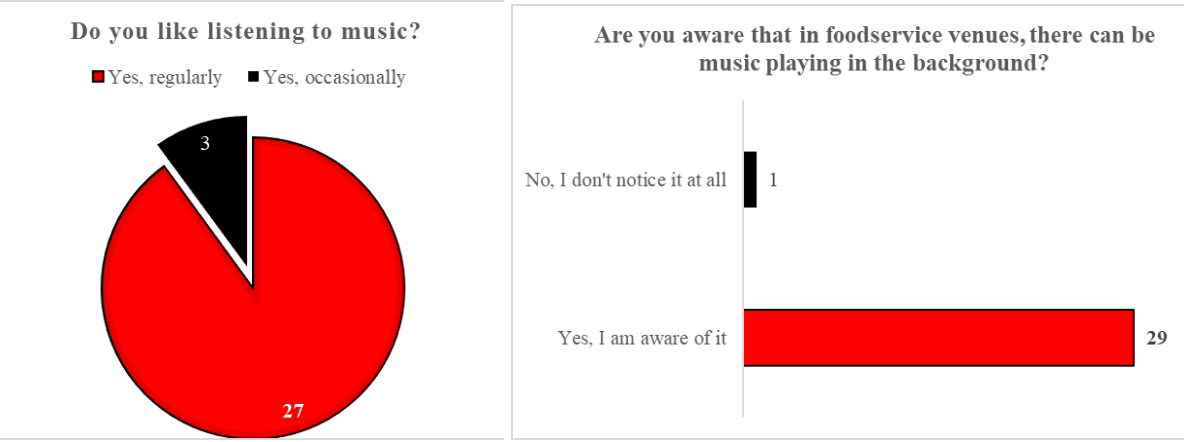

Figure 5: Listening the music and music background in gastronomy
Source: own research, 2024

From the biometric measurements using the Eye tracker, we obtained data from the heat map and from the points of interest while tracking the selected dessert type. The Heat Map presents aggregated data telling us about the visual attention of respondents primarily in terms of the number and length of time spent eye gazing (the warmer the color, the longer and greater the number of consumer gazes). It can be seen from the heat map resulting from the glances of 30 respondents when selecting cakes without music (Figure 6) that respondents viewed the EGGC sample that included a decorative element (cream with fruit laid on top) the most. From the visual attention heat map, it can be seen that respondents viewed the entire surface of the cakes to a significant degree, except for the ENGA sample where the attention level is concentrated at the bottom. Visual attention was also significant when looking at the names alone for all three samples.

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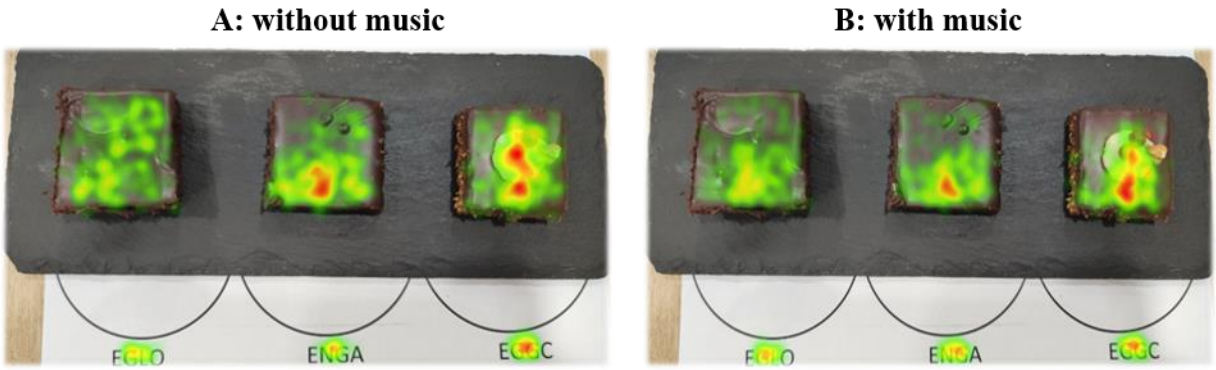

Figure 6: Heatmap of visual attention
Source: own research, 2024

In the case of music sampling - Jazz Instrumental Music called Warm Autumn Morning in Outdoor Coffee Shop Ambience_ Smooth Ethereal Jazz Instrumental Music with a tempo of 146BPM reproduced at an intensity of 58dB (Figure XY), a lower visual attention rate can be seen for all three samples. This may be related to the fact that the music shortened the overall time of pie selection. Also in this case, the EGGC sample was the most visually preferred, probably due to the distinguishing feature (ornament). In terms of identical-looking samples, approximately the same level of visual attention can be seen focused on the middle sample (ENGA).
We also compared the responses from the eye tracker questionnaire and came to the following conclusions. Respondents were asked to rank the prepared dessert samples according to how much they liked the visual presentation (1-most, 3-least). From Tab. 1 shows that respondents liked the EGGC sample the most when music was playing in the background, at the same time, even when music was not playing the EGGC sample remained the highest ranked by visuals with the same ranking as the ENGA sample.

Table 1: Influence of music on customer preference

Music			
	1	2	3
EGLO	4	8	3
ENGA	3	5	7
EGGC	10	2	3

No music			
	1	2	3
EGLO	5	3	7
ENGA	4	8	3
EGGC	8	3	4

Source: own elaboration, 2024

Seven people would have tasted the EGLO sample (while music was playing) as the first sample based on visual presentation, and there was equal representation (5 people) for all three samples (without music playing). The most frequent comments for the EGLO sample were that the sample looks nice, looks smallest, seems tastier, they like it, it looks fluffy, it reminds them of grandma's cake. There were similar responses for the ENGA and EGGC sample, where consumers still reported that it looks the tastiest, the texture of the chocolate is nice, it looks nice, and for EGGC they also reported that it looks nutty. In addition to visual attention (Figure 7), we also looked at Areas of Interest (AOI).

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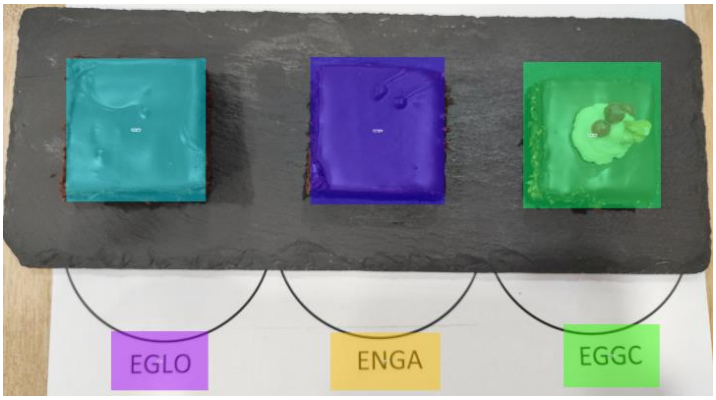

Figure 7: Comparison of visual attention through Areas of Interest (AOI)
Source: own elaboration, 2024

In the data association between visual attention and background music perception (Tab. 2), respondents noticed the ENGA sample first in both the no-music (0.16 s) and with-music (0.29 s) selections. The longest initial glance for the cake selection without music was made at the name EGGC alone (0.32s) and for the selection with music at the cake sample EGLO (0.35). In both cases, the longest gaze time was spent on the sample cake with the name EGGC (in the case of the cake selection without music (5.49s) and in the case of the cake selection with music (7.09s)), which contained a garnish. In both cases, the highest number of repeated views was made to the ENGA cake sample, with 10 for the selection without music and 15 for the selection with music.

Table 2: Overview of data association between visual attention and music background perception

Without Music						
	EGGC	**EGGC**	**EGLO**	**EGLO**	**ENGA**	**ENGA**
Time to First Fixation	7.07	0.87	7.03	1.74	3.17	0.16
First Fixation Duration	0.32	0.28	0.27	0.28	0.23	0.21
Total Fixation Duration	1.00	5.49	1.03	3.82	0.61	4.35
Visit Count	3.00	9.00	4.00	8.00	3.00	10.00
With Music						
	EGGC	**EGGC**	**EGLO**	**EGLO**	**ENGA**	**ENGA**
Time to First Fixation	6.95	1.79	5.38	2.22	4.39	0.29
First Fixation Duration	0.28	0.28	0.29	0.35	0.22	0.22
Total Fixation Duration	1.43	7.09	0.94	5.43	1.04	4.66
Visit Count	4.00	10.00	3.00	11.00	4.00	13.00

Source: own elaboration, 2024

4. Conclusion

Based on the results of the research, which involved ten men and twenty women aged 18-30, it can be concluded that there is a strong interest and preference among the respondents in the

field of gastronomy and music. The data obtained from the questionnaire survey indicate that the majority of participants are open to new developments in catering and shows an interest in eating desserts. It is also evident that the visual presentation of dessert plays an important role in their choice. From the biometric data collected by the Eye tracker, we found that music affects respondents' visual attention during dessert selection, possibly reducing overall selection time. However, despite the presence of music, most participants noticed the decorative elements of the desserts, suggesting their strong influence on visual appeal. The results also show differences in the perception of the different dessert samples, with some showing higher levels of visual attention and interest. At the same time, it appears that music may also influence the primary points of interest in dessert selection. Overall, it can be concluded that the visual presentation of desserts and the presence of music in foodservice establishments have a significant impact on consumer preferences and behavior, which is an important factor for the foodservice industry when developing menus and marketing strategies. After conducting the research, we also came up with a few shortcomings that we can incorporate in future research, e.g. the special distribution of cakes on the plate, the extension of the consumer segment by a different age group. Thus, the use of other methods, consideration of the respondent's satiety after consumption, gnawing and clarity of the cakes before and during tasting.

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Consumer Behavior and Decision-Making in the Purchase of Milk and Dairy Products in Crisis and Beyond

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Abstract
The submitted paper examines consumer behaviour and the importance of consumer rationality and irrationality in purchasing decisions at the threshold of the 3rd millennium. It primarily points to consumer behaviour in the food market in crises and beyond. Many factors condition purchasing behaviour. Knowing them is important because it identifies the driving forces and motives of consumer behaviour and the reasons for the consumers' purchases.

Paper's objective(s) and research background
The main goal of the contribution is to use selected marketing methods, tools and techniques to point out rationality and irrationality in consumer behaviour at the threshold of the 3rd millennium. Emphasis is placed primarily on the influence of external factors on consumer behaviour and decision-making in the Slovak Republic. At the same time, attention is paid to selected food categories, specifically milk and milk products.

Data/Methods
To obtain data on the influence of rationality and irrationality on consumer behaviour in the milk and dairy products market in crisis and beyond, a questionnaire survey was conducted in Slovakia, in which 1,091 respondents participated. Statistical methods and tests such as Friedman's test, Nemenyi's procedure, Kruskal-Wallis test, Fisher's exact test, Pearson's Phi coefficient and Cramer's V coefficient were used to evaluate the results.

Results/Conclusions/Value added
The survey results showed that during a crisis, despite the expected irrational behaviour, the consumer acts rather rationally and does not modify his usual consumer behaviour and habits in any significant way.

Key words
Consumer Behavior, Milk and Dairy Products, Crisis, Irrationality, Rationality.

JEL Classification
M21, M30, M3, M39, M59

1. Introduction

Consumer behaviour is a complex process that is influenced by various factors in addition to demographics, as well as behaviour, family and friendship ties, reference groups and groups in society in general *(Yarimoglu & Binboga, 2018*). Each consumer has his own characteristics that make him unique, but he may also have some characteristics in common with other consumers. Thanks to these characteristics, consumers are divided into groups, which is useful for businesses and can help them better understand their customers, adapt marketing strategies to meet the needs of different groups, and so on. *(Hoyer et al., 2017)* Today, there are many different typologies that help sellers better understand their customers and adapt their

behaviour to them. It segments customers based on different criteria, such as their needs, preferences, behaviour or lifestyle. *(Filipová, 2011)*

Pčolinská (2007) states that consumer behaviour can be defined as the behaviour that consumers show when they search for, buy, use, evaluate and dispose of products, services and ideas that they expect to satisfy their needs. Consumer behaviour has overt and observable behaviours such as purchasing and consumption. These are all important aspects of the consumer's decision-making process. The term consumer behaviour refers to the psychological and social processes that take place:

a) Before the purchase (e.g. need for awareness, attitude formation, information search, evaluation, product, brand or store selection),

b) In the purchasing process (such as contextual factors that influence purchasing, negotiation), i.e. purchasing behaviour,

c) Post-purchase (assessment of usefulness after purchase, non-compliance).

Consumer behaviour of individuals and families as a process is determined by several factors in its various stages. They are not only research objects for marketing analysts but also research objects for sociologists, psychologists, and experts from other scientific disciplines. Most authors mentioned the following groups of factors that influence consumer behaviour. Cultural factors, including culture, subculture, and social class, represent the first category. Among the social factors, consumer behaviour is influenced by the role and status of the reference group, family and society. Psychological factors influence consumer purchasing behaviour, including motivation, perception, learning, beliefs, and attitudes. Regarding personal factors, the theory points out that the buyer's age, the current stage of the family life cycle, employment and economic environment, his personality and self-image, lifestyle and values significantly influence the purchase decision. *(Janovská et al. 2021)*

Some studies also demonstrate the influence of social media on the consumer purchasing decision process. On the one hand, it can be difficult for consumers to distinguish advertising from authentic recommendations, leading to wrong decisions. In addition, social media can create feelings of inadequacy and comparison with other consumers, hurting a consumer's self-esteem and satisfaction. *(Claro et al., 2020)*

Today's consumers are more engaged and curious than ever, and they use various social media platforms to share their opinions, reviews, and product suggestions. This shift in consumer behaviour has given them the power to shape retailers' services, products and quality. Retailers who take advantage of this opportunity and listen to their customers have a great chance to connect with them and satisfy their needs. The use of social media is wider than that of younger generations, as it is also growing rapidly among older age groups. *(Harrigan et al., 2021)*

The current food market is characterised by intense and growing competition. This is due to the variety and interchangeability of food products that consumers can choose from. Consumers' decision-making in the pre-purchase phase, and especially in their purchasing process, is influenced by several factors, the existence of which they often do not notice. Determinants include consumer income levels, the price level of goods, and marketing factors. Cultural, political and technological influences on the consumer environment play an important role in consumer behaviour. Regional sales of food products are subject to specific consumer demand factors. When making a purchase decision, the consumer uses various criteria to choose the product that best meets his needs from the current offer. The criteria' number, type and importance varies according to the specific consumer, product and situation. *(Récky and Durec, 2020)*

Milk and dairy products are irreplaceable in everyday food consumption *(Nicklas, 2009)*. Milk consumption positively impacts human health (*Košičiarová et al., 2017)*, strengthening of cognitive processes, health protection and prevention of various diseases *(The Dairy Council, 2014).*

Kubicová et al. (2019) pointed out that consumers buy milk and dairy products on an everyday basis; however, under the influence of surrounding conditions, this behaviour may differ.
Such changed usual conditions can also include a time of crisis when the consumer reacts sensitively to every change, not only the price but also the security and availability of goods or services *(Lincényi & Bulanda, 2023)*
The Ukrainian war and subsequent price increases come in the wake of the COVID-19 crisis, which resulted in certain changes in consumer behaviour: consumers prepared more food at home, online buying of food and ready-to-eat meals increased and people's involvement with preparing meals and eating them at home with their families seemed to increase, together with, at least for some consumers, a tendency towards more mindfulness in their food choices *(Grunert et al., 2021)*. Based on the research by *Grunert et al. (2023),* 81% of consumers have changed food-related behaviour in the wake of the Ukraine war and rising prices; the increased price sensitivity was most common change in the wake of the Ukraine war and rising prices and 32% of participants reported more mindful food choices compared to pre-COVID-19.

2. Data and Methods

The main aim of the present paper was to highlight rationality and irrationality in consumer behaviour on the threshold of the 3rd millennium using selected marketing methods, tools, and techniques. The main focus was on the influence of external factors on consumer behaviour and decision-making in crisis and beyond in the conditions of the Slovak Republic. At the same time, attention was paid to selected food categories, specifically milk and dairy products.

The crisis examined in the paper means the conditions for consumer decisions were changed and influenced by the COVID-19 pandemic and conflict in Ukraine and, subsequently, rising food and living costs.

Research assumptions:

Research assumption 1: Consumer behaviour is changing due to changed conditions on the market and is more irrational than rational.

Research Assumption 2: Men, as well as respondents with lower levels of education, tend to shop for stock rather than women or respondents with higher levels of education.

Research assumption 3: When market conditions change, respondents' consumer behaviour in the dairy category also changes - respondents are more likely to buy dairy products to stock up.

Research assumption 4: The price of dairy products is a decisive factor in the purchase of milk and dairy products, mainly affecting households with a lower net monthly income and the unemployed.

In order to obtain data on the impact of rationality and irrationality on consumer behaviour in the market of the foodstuffs mentioned above during the crisis and beyond in the conditions of the Slovak Republic, a questionnaire survey was carried out, which was attended by a total of 1,091 respondents. The largest representation of theses was of female respondents (65.54% of respondents); then respondents with secondary education (34.56% of respondents) or with a first degree of higher education (32.72% of respondents); respondents from the category of employed (41.15% of respondents), resp. Students (39.32% of respondents); respondents with four household members (35.01% of respondents); with a net monthly household income of more than 1.501 € (43.26% of respondents); respondents coming from the Nitra region (49.50% of respondents) and respondents living in the city (51.15% of respondents). This sample of respondents can be considered representative at 95% confidence level and 3% margin of mistakes, or at 99.7% confidence level and 5% margin of mistakes, as $n \geq 1,067.12$, resp. $n \geq 900$.

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Statistical methods and tests such as Friedman's test, Nemenyi's procedure, Kruskal-Wallis test, Fisher's exact test, Pearson's Phi coefficient, or Cramer's V coefficient were used to process the obtained data and evaluate our research assumptions.

3. Results and Discussion

Research assumption 1: Consumer behaviour is changing due to changed conditions on the market and is more irrational than rational.

Panic buying is generally known as the behaviour of consumers who purchase an abnormally high amount or an unusually varied assortment of products in anticipation of, during, or after a crisis situation or in expectation of a large price increase or shortage in a higher tier of the market *(Yoon et al., 2017; Yuen et al., 2020)*. Rational consumers judge the desirability and likelihood of an outcome and integrate this information into the decision *(Loewenstein et al., 2001)*; however, the theoretical perspective of 'risk as feelings' describes the tendency towards irrational consumption in cases of perceived high risk, such as crises *(Slovic et al. 2004)*.

In order to identify rationality and irrationality in consumer behaviour on the dairy market during the crisis and beyond in the conditions of the Slovak Republic, various questions were formulated in the questionnaire survey, where respondents were asked, for example, how much money they spent on their food purchases in the past and vice versa at the time of the changed market conditions, whether they started to buy into the stock as a result of the changed conditions, or whether their purchasing behaviour changed in any way specifically in the case of milk and dairy products.

Based on the results of our research, it can be concluded that our respondents behave rationally rather than irrationally as the average amount of weekly expenditure on food purchases of our respondents' households was 83 EUR in the past and currently (in times of changed market conditions) it is at the level of 102 EUR, which may be primarily due to inflation and not to "panic" buying to stockpile. The above is largely confirmed by the results from the evaluation of other questions, where respondents reported that they do not think that their buying behaviour has changed and that they do not stock up more than they did in the past (48.12% of respondents), they try not to panic and buy food they do not need (50.69% of respondents), they are not afraid of food shortages in the market (41.61% of respondents), they have always had non-perishable food at home to stock up on (53.16% of respondents). They do not buy larger quantities of food to be on the safe side (46.47% of respondents).

Research Assumption 2: Men, as well as respondents with lower levels of education, tend to shop for stock rather than women or respondents with higher levels of education.

There have been various types of research investigating whether selected characteristics of buyers have an impact on panic/impulsive shopping and stockpiling *(e.g. Garbe et al., 2020; Brizi & Biraglia, 2021; Dammeyer, 2020)*, where it has been shown that males rather than females tend to engage in such behaviour *(Lins & Aquino, 2020; Micalizii et al. 2020)*, our second research assumption was formulated, where we assumed that men rather than women, or respondents with lower levels of education than those with higher one, tend to shop for stock. Therefore, we subjected the aforementioned questions to selected statistical methods and techniques and based on the results of Pearson's Phi coefficient, Cramer's V coefficient and Fisher's exact test, it can be stated that the above assumption was not confirmed. The only confirmed dependence was shown in the case of the question of buying non-perishable food items for stock, where it was found that the respondent's answer to the question was influenced by their gender. As can be seen from Table 1, there is a small but statistically still significant relationship between the variables, with women purchasing non-perishable food items for stock

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before men, which confirms the results of research realised by *Tzur Bitan et al. (2020)* or *Broche-Péerez et al. (2022)* who have revealed that female are more inclined to panic buying and stockpiling as male.

Table 1: The dependence between the purchase of non-perishable food for stockpiling and the gender of the respondent

Test of independence between the rows and the columns (Chi-square):	
Chi-square (Observed value)	15,779
Chi-square (Critical value)	9,488
DF	4
p-value	< 0,0003
Alpha	0,05

Fisher's exact test:	
p-value (Two-tailed)	0,0004
Alpha	0,05

Association coefficients (1):

Coefficient	Value
Pearson's Phi	0,120
Contingency coefficient	0,119
Cramer's V	0,120
Tschuprow s T	0,085
Goodman and Kruskal tau (R/C)	0,002
Goodman and Kruskal tau (C/R)	0,014

Source: authors´ research and calculations

Research assumption 3: When market conditions change, respondents' consumer behaviour in the dairy category also changes - respondents are more likely to buy dairy products to stock up.

Rational consumer behaviour is characterised by decision-making based on a logical evaluation of the available information, resulting in the selection of the best available options. This type of decision-making is usually guided by a deliberate and systematic thought process rather than by emotional, social, or cognitive factors. Research in this area has shown that people are more likely to behave rationally during purchases if they can access accurate and complete information about the products or services they are considering. Studies conducted by e.g. *Kuo & Wu (2012),* reps. *Kuo, Wu & Deng (2009)* explicitly suggest that providing detailed product information can help consumers make more informed and rational purchasing decisions.

On the other hand, impulse/irrational purchases can cover a wide range of products and categories and what people buy in this way can vary depending on various factors. One common category for impulse buying is food, particularly fast food and sweets *(Rook & Fisher, 1995)*. However, it is imperative to note that the COVID-19 pandemic has significantly impacted consumer behaviour and impulse purchasing behaviour, which may vary depending on what has been observed in previous research. Studies such as *Chiu, Oh & Cho (2022), Ekinci (2021)* and *Das, Sarkar & Debroy (2022)* have found that consumers during a pandemic are more likely to make impulse purchases of essentials such as food and household items.

As regards the purchasing behaviour of respondents in the case of milk and dairy products, it can be noted that rationality rather than irrationality is evident among the respondents. While they have always bought long-life milk (both in the past and in times of changed market

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conditions), they have never bought fresh milk (some do not even buy it at all), and they have bought dairy products both before and now, or they have never bought them in this way.

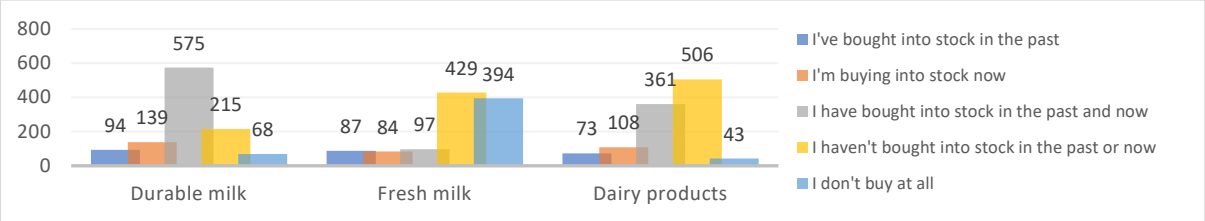

Figure 1: Buying into stock in the past and in times of changed market conditions (in persons)

Source: authors´ research and calculations

Let us examine these foods more thoroughly by evaluating other questions about purchasing milk and dairy products. We can see that the purchasing behaviour of our respondents does not change substantially due to the changed market conditions - as can be seen in Figure 2, the difference in the amount of food purchased per week changes minimally due to the changes in the market, and most often respondents purchase from 2 to 4 pieces or packages/litres of milk and dairy products. These results are confirmed by the results of Friedman's test, where we can see that which specific product, i.e., shelf-stable milk, fresh milk, or dairy products, is purchased the most also does not change over time and under the influence of changed market conditions - our respondents purchase dairy products the most (Table 2, 3).

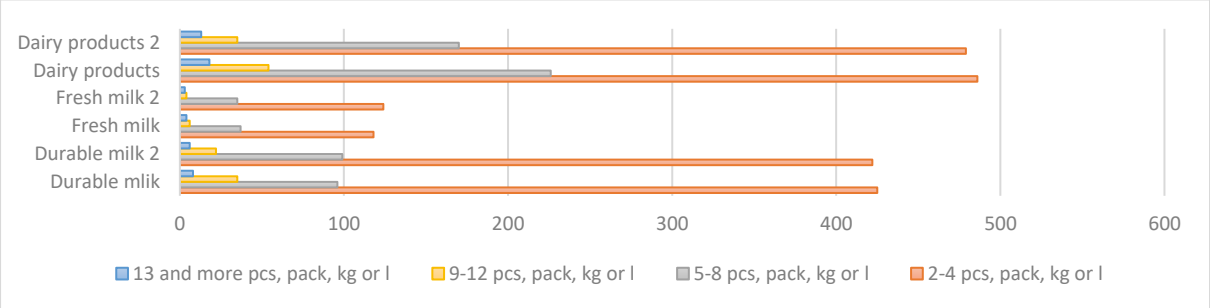

Figure 2: Comparison of weekly purchase volumes of selected food products (in persons)

Source: authors´ research and calculations

Table 2: Results of Friedman's test and Nemenyi's procedure - weekly purchases before

Friedman's test:	
Q (Observed value)	940,217
Q (Critical value)	5,991
DF	2
p-value (Two-tailed)	< 0,0001
Alpha	0,05

Multiple pairwise comparisons using Nemenyi's procedure / Two-tailed test:

Sample	Frequency	Sum of ranks	Mean of ranks	Groups
weekly purchase before [fresh milk]	1091	1489,500	1,365	A
weekly purchase before [durable milk]	1091	2303,000	2,111	B
weekly purchase before [dairy products]	1091	2753,500	2,524	C

Source: authors´ research and calculations

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Table 3: Results of Friedman's test and Nemenyi's procedure - weekly purchases now

Friedman's test:	
Q (Observed value)	811,200
Q (Critical value)	5,991
DF	2
p-value (Two-tailed)	< 0,0001
Alpha	0,05

Multiple pairwise comparisons using Nemenyi's procedure / Two-tailed test:

Sample	Frequency	Sum of ranks	Mean of ranks	Groups
weekly purchase now [fresh milk]	1091	1541,500	1,413	A
weekly purchase now [durable milk]	1091	2337,500	2,143	B
weekly purchase now [dairy products]	1091	2667,000	2,445	C

Source: authors´ research and calculations

The results of the Kruskal-Wallis test tell us whether we can observe differences in our respondents' answers to the selected questions depending on their characteristics. Based on the results of the test mentioned above, it can be stated that while differences in the answers of our respondents to the question on the volume of weekly purchases of selected foods in the past were detected in the case of their characteristics such as gender, level of education, economic activity, place of residence, number of household members and net monthly household income; in the case of the question on the volume of weekly purchases of selected foods in the present (under changed market conditions), identical characteristics were detected, except for economic activity, where this difference was not observed.

Research assumption 4: The price of dairy products is a decisive factor in purchasing milk and dairy products, mainly affecting households with a lower net monthly income and the unemployed.

As regards the factors determining the purchase of milk and dairy products, again, minimal changes in consumer behaviour can be observed, as the quality of the product was the decisive factor both in the past and in times of changed market conditions, followed by price and lastly, freshness (Figure 3).

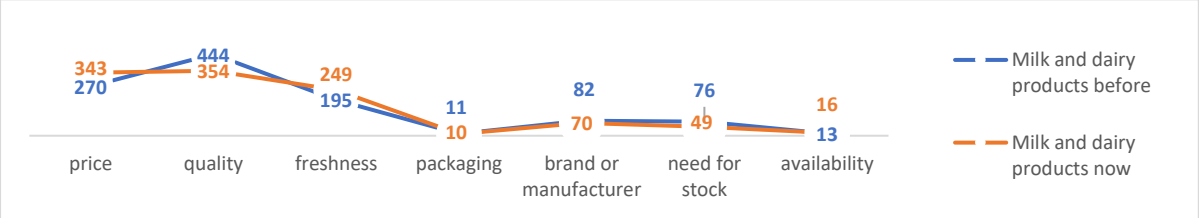

Figure 3: Comparison of determinants influencing the purchase of milk and dairy products (in persons)

Source: authors´ research and calculations

Based on the results of Pearson's Phi coefficient and Cramer's V coefficient, it can be concluded that there is a significant relationship between the studied variables, namely the respondent's answer to the question of the decisive factor in the purchase of milk and dairy products in the past and now and its selected characteristic, i.e. the net monthly household income and the economic activity of the respondent, there is a weak but statistically still significant relationship (The p-value was equal to 0.002, 0.002 and 0.001; Pearson's Phi was equal to 0.212, 0.214 and 0.249; and Cramer's V coefficient was equal to 0.106, 0.107 and 0.102). The only exception is

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the dependence between the past determinant and the respondent's economic activity, which was not demonstrated (The p-value was equal to 0.184. As the computed p-value is greater than the significance level alpha=0.05, one cannot reject the null hypothesis H0).

The fourth research assumption was formulated following the results of the study by *Huang et al. (2021), Loxton et al. (2020)* and *Andreyeva et al. (2010)*, when it was clearly stated that changes in food prices could have a significant impact on consumption behaviour, especially in the time of crisis and in low-income households. The results of our research confirm the above, as the price was and is a critical, decisive criterion for respondents with lower net household income (Figure 4) and is currently a critical, decisive criterion for respondents in the category of unemployed and retired or it is a significant factor for students and women on maternity leave (Figure 5).

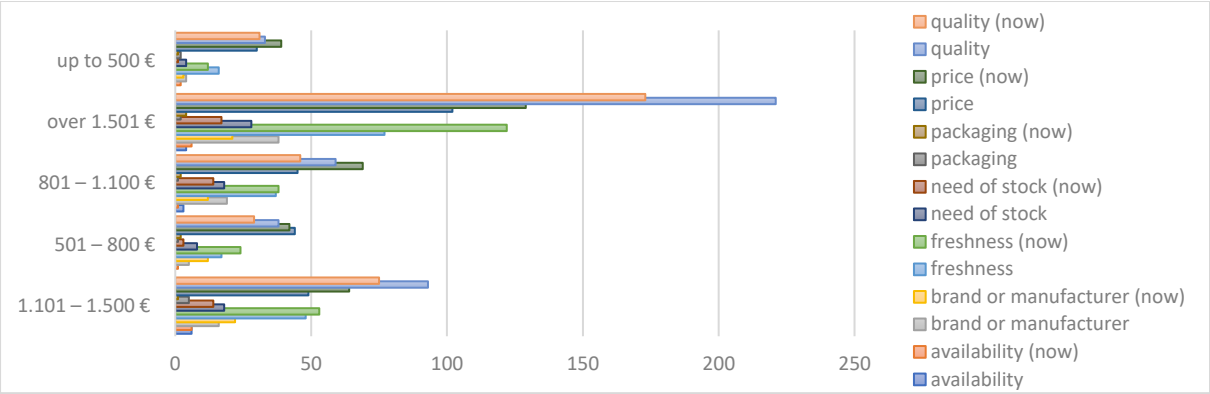

Figure 4: Comparison of past and current milk and dairy purchasing decision factors as a function of net monthly household income (in persons)

Source: authors´ research and calculations

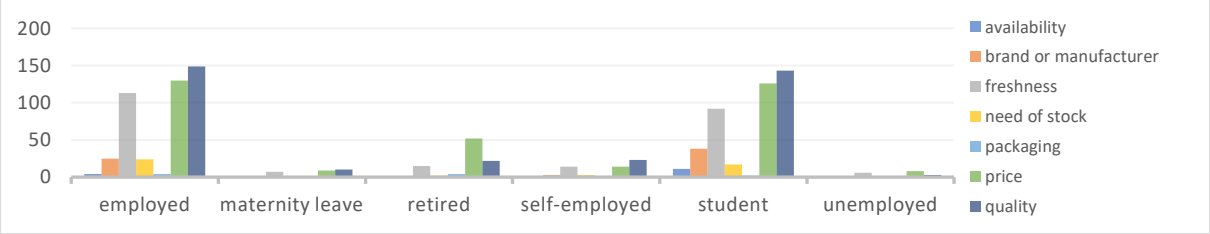

Figure 5: Relationship between current milk and dairy purchasing decision factor and respondent's economic activity (in persons)

Source: authors´ research and calculations

4. Conclusion

The issue of rational and irrational consumer behaviour is a complex and ongoing debate within the study of consumer behaviour. While some argue that consumers make rational choices and carefully consider the consequences of their decisions, others suggest that consumers are influenced by emotions, biases, and heuristics that can lead to irrational decision-making. Both perspectives have important implications for marketers and policymakers, and the challenge is to understand how consumers behave in different contexts and how best to influence their decision-making.

The submitted paper examined consumer behaviour and the importance of consumer rationality and irrationality in purchasing decisions at the threshold of the 3rd millennium. It has primarily

pointed to the consumer behaviour in the milk and dairy products market in crises and beyond. The main goal of the contribution was to use selected marketing methods, tools, and techniques to point out rationality and irrationality in consumer behaviour at the threshold of the 3rd millennium.

Our results show that rationality prevails over irrationality in consumer behaviour, at least as far as Slovak respondents are concerned about milk and dairy products. In our research, we have formulated four research assumptions, which, however, were largely unconfirmed. While we assume that consumer behaviour changes due to changes in market conditions and is more irrational than rational, our results do not confirm this. In the case of the second research assumption, we have assumed that men and respondents with lower education levels tend to shop for stock rather than women or respondents with higher levels of education. In this case, both men and respondents with lower levels of education do not panic and do not buy into the stock. On the contrary, women are more likely to stockpile and buy mainly non-perishable food, which is again a logical and rational decision rather than an irrational one.

Regarding the third research assumption that respondents' purchasing behaviour in the dairy category changes when the market conditions change – respondents are more inclined to buy dairy products to stock up – we cannot say that this assumption is confirmed in this case either. While our respondents have always bought shelf-stable milk (both in the past and in times of changed market conditions), they have never bought fresh milk (some do not even buy it at all), and they have either bought dairy products both before and now or have never bought them in this way. The last research assumption that the price of dairy products is a decisive factor in purchasing milk and dairy products, mainly affecting households with a lower net monthly income and the unemployed, was partially confirmed. While in general, it can be stated that quality was and is a decisive factor in the purchase of milk and dairy products and price is only the second factor, if we look at the answers of the respondents in more detail and only from the point of view of price, it can be stated that it was and is indeed decisive in the case of respondents with a lower net household income and is also currently is a decisive criterion for respondents in the unemployed and retired categories.

Although our results are now more likely to speak of rationality in consumer behaviour, it is challenging to make a general statement about whether people are nowadays more rational or irrational in their purchases, as consumer behaviour can vary greatly depending on the product, the individual and the context. However, some evidence suggests that consumers may be becoming more aware of the impact of their choices on their health and the environment and may be making more rational choices in these areas. Overall, the field of consumer behaviour is complex and multifaceted, and further research is needed to understand better the many factors that can influence consumer preferences and purchasing behaviour.

Acknowledgements

The paper is the outcome of the research project VEGA 1/0404/22, "Rationality and irrationality in creating preferences in consumer shopping behaviour on the threshold of the 3rd millennium", solved at the Institute of Marketing, Trade and Social Studies, Faculty of Economics and Management, Slovak University of Agriculture in Nitra; and KEGA 030SPU-4/2022 "Implementation of selected goals of 2030 Agenda in Consumer Psychology education – Production of multimedia e-textbooks and web-based platform for the higher education", as well as one of the partial outputs under the scientific research grant GAAA/2023/17 "Rationality and irrationality in consumer behavior", solved at the Department of Marketing, Faculty of Entrepreneurship and Law, Pan-European University in Prague.

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Evaluation of Selected Economic Indicators of Agricultural Sector in Slovakia

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Abstract

Agriculture is one of the most important industries, because its primary goal is to provide people with enough healthy and harmless commodities for direct consumption and food production. In the 20th century, agriculture turned into an industrial sector with an effort to minimize costs and maximize profit, which follows from the principles of conventional agriculture. The production function of agriculture represents the production process of agricultural enterprises, which significantly affects the efficiency of enterprises and the competitiveness of their products. The production function expresses the relationship between input and output and determines the maximum volume of production, i.e. the production capacity of enterprises. The social function of agriculture is also important, which contributes to this sector in solving employment and using available labour resources. In financing agriculture, the Ministry of Agriculture of the Slovak Republic uses funds from the state budget as well as funds from the European Union.

Paper's objective(s) and research background

The main goal of the contribution is the evaluation of selected economic indicators of the agricultural sector in the Slovak Republic. Specifically, attention is focused on:
- Number of enterprises in the agricultural sector,
- Gross agricultural production from gross turnover,
- Sales of agricultural products from primary production,
- Employment in agriculture sector.

Data and methods

Data from the portal of the Statistical Office of the Slovak Republic (Datacube) were used in the analysis. We applied the method of analysis and comparison, as well as the method of time series analysis, when investigating the mentioned issue.

Results/Conclusion/Value added

Agrarian enterprises belong to the primary sector of the national economy. In the Slovak Republic, up to 99.69% of agricultural enterprises are privately owned by domestic persons or cooperatively owned. The development of agriculture is also conditioned by the age structure of employees, which is currently unsatisfactory in the Slovak Republic, because most farmers are of retirement age. The contribution of agriculture to the demographic reproduction of the population and its influence on the migration of population and mobility is also significant.

Key words

Agrarian sector, gross agricultural production, sales revenue, employment in agriculture, wages in agriculture

JEL Classification

O13, Q10, J43

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1. Introduction

The total budget for agriculture and rural development represents approximately 46% of EU spending per year. Agriculture and rural development have once again become a central theme and the main determinant of EU development (Dudić et al., 2020).

Correct diagnosis of critical aspects and measurement of the development of individual financial indicators of agricultural enterprises are basic prerequisites for eliminating these risks and maintaining, as well as increasing, their competitiveness (Vavrek et al., 2021).

According to Košařová and Pokrivčák (2023), the agricultural sector in Slovakia is characterized by low productivity and diversification. There is considerable prospect of increasing agricultural productivity through more efficient use of existing level of inputs and limited resources.

Slovakian agriculture ranks seventh in terms of performance and, compared to developed countries, shows a low input of investment assets, intermediate products, livestock units, but also a lower volume of subsidies than developed countries. Slovak agriculture does not use its competitive advantages, which are mainly the size of enterprises, economies of scale and labor productivity (Szabo and Grznár, 2015).

FAO (2022) emphasizes not only linking markets with smallholder farmers, but also considers primary production to increase diversification at the farm level. Horská et al. (2020) based on the results of research that focuses on the success factors of selling family farms, states that the most important success factor is customer loyalty. These customers buy directly local products, that is, authentically directly from farmers who guarantee the freshness of these products.

According to the Green Report on Agriculture and Food Industry (2018), employment in agriculture is important on a global scale, accounting for up to 30.7% of total employment in the world. Although it is decreasing year by year. Some authors state that a percentage increase in the Common Agricultural Policy budget would then save 16 000 jobs in agriculture every year (Garronea et al., 2019). The fourth industrial revolution has had a strong impact on agriculture and the organizations that serve them (Lezoche et al., 2020) in terms of workers' compensation and working conditions (Min et al., 2019).

According to the study by Jankelová et al. (2020) Slovakia is constantly struggling with a labor crisis in agriculture, especially skilled labor. Although the crisis caused by the COVID 19 pandemic is expected to lead to an increase in available workforce in the labor market due to reduced economic growth and related unemployment, it is likely that these unemployed people will continue not to be interested in working in agriculture.

2. Data and Methods

The paper evaluates selected economic indicators of the agricultural sector in Slovakia with a prediction of their development in the near future. The research data base was created from the available data of the Statistical Office of the Slovak Republic DATAcube (Statistical Office, 2019). The following economic indicators were analysed: the number of enterprises in the agricultural sector (period 2017-2023), gross agricultural production from gross turnover (period 1997-2022), revenue from the sale of agricultural products from primary production (period 2001-2022), and the development of employment in agriculture sector (period 1993-2022). According to the number of employees, companies are divided into following three categories: small companies (20-49 employees), medium-sized companies (50-249 employees), large companies (250 and more employees) (Hollá and Danko, 2019).

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Data analysis was conducted via quantitative methods of mathematical statistics and modelling of trend functions in MS Excel (linear, exponential, and quadratic trend functions). The significance of used model was assessed via the coefficient of determination R^2. Results interpretation was made via graphic presentation with short-term indicators prediction.

3. Results and Discussion

During the last three decades, agriculture in the Slovak Republic has gone through several stages of development. The most significant changes in Slovak agriculture include the changes related to the pre-accession process and the accession of Slovakia to the EU, when it was necessary to harmonize Slovakia's agrarian policy with the Common Agricultural Policy of the EU. The current European model of multifunctional agriculture does not only consider food production, but also considers the environmental, social, and cultural functions associated with agricultural activity.

3.1 Development of the number of enterprises in the agricultural sector and gross agricultural production from gross turnover

The first evaluated indicator is the number of enterprises in the agricultural sector of the Slovak Republic, where the data obtained from the Statistical Office are in the category Agriculture, forestry, and fishing. Agricultural enterprises are classified as primary production enterprises, which are characterized by obtaining goods from nature in the form of raw materials and goods.

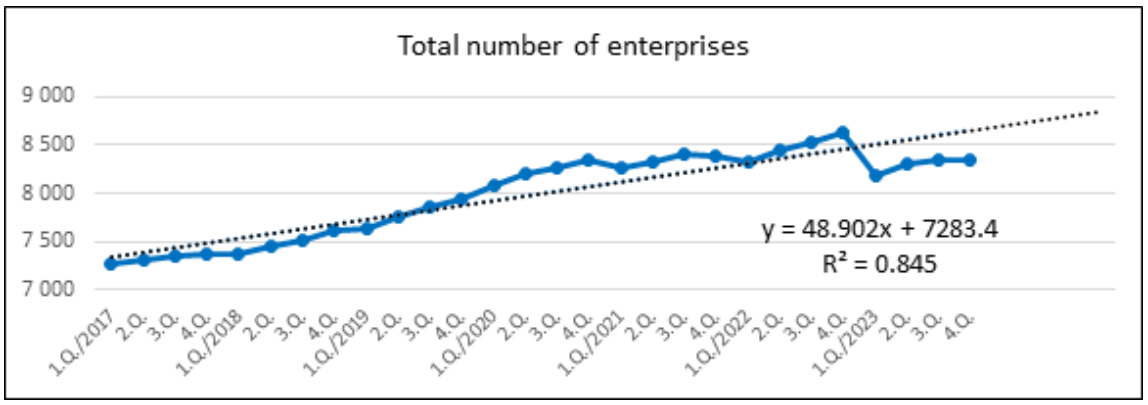

Figure 1: Development of the total number of enterprises - Agriculture, forestry, and fishing, in the years 2017 - 2023

Source: Datacube, own processing

The development of the total number of enterprises in the agricultural sector is presented in Figure 1. From the graph, we can see that the development of the total number of enterprises has an increasing trend, which can be estimated using a linear function. A more significant decrease occurred between 2022 and 2023; the following values in individual quarters have an increasing trend. The linear model predicts an increase in the number of enterprises in the coming period (the slope is positive, 48.902). The strength of the relation between independent and dependent variables demonstrates the coefficient of determination R^2. The value of the coefficient of determination is 0.845 thus 84.5% of the variation in the dependent variable can be explained by the variation in the independent variable. The remaining 15.5% is explained by other independent variables not included in the presented regression model.

The results showed a different trend in the development of the number of small and medium enterprises in the agricultural sector. The development of the number of small businesses is presented in Figure 2. From the graph, we can see that the number of businesses has an

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increasing trend, which can be estimated using a linear function. The prediction for the next period also confirmed the increase in the number of small agricultural enterprises (the slope of the linear trend is positive, 48.799). The coefficient of determination $R^2 = 0.889$, thus the model for small agricultural enterprises was appropriately chosen. 88.9% of the variability of the dependent variable can be explained by a linear relationship with the independent variable.

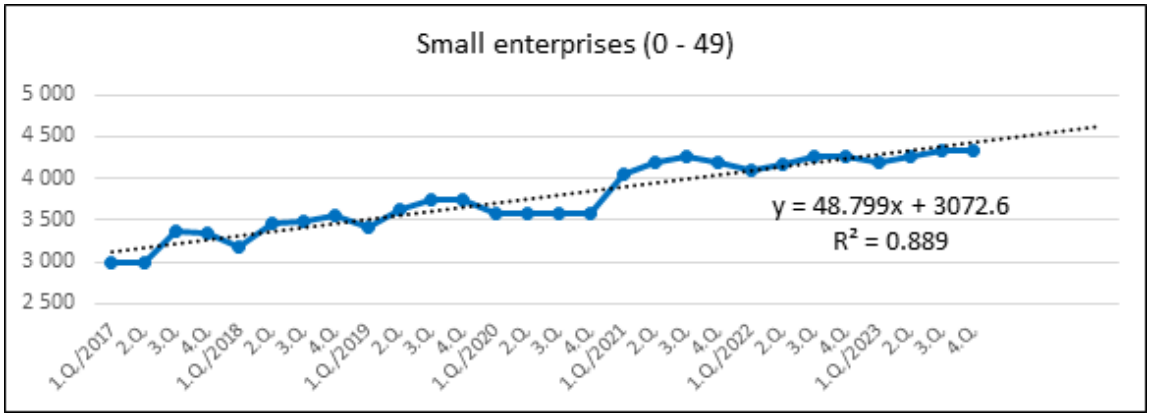

Figure 2: Development of the number of small businesses - Agriculture, forestry, and fishing, in the years 2017 – 2023
Source: Datacube, own processing

The development of the number of medium-sized enterprises is presented in Figure 3. We can see that the development of the number of medium-sized enterprises has a decreasing tendency (in contrast to the number of small enterprises). The development of the data is estimated by a linear model with negative slope (-2.2657) which predicts a decrease even in the near future. The coefficient of determination $R^2 = 0.939$, therefore, the model for medium-sized agricultural enterprises was appropriately chosen.

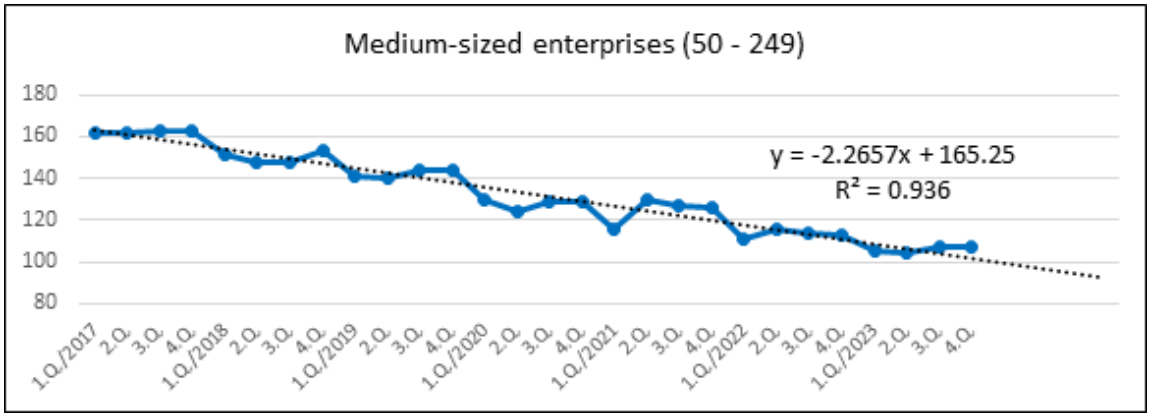

Figure 3: Development of the number of medium-sized enterprises - Agriculture, forestry, and fishing, in the years 2017 – 2023
Source: Datacube, own processing

We did not analyse the number of large agricultural enterprises, as the data varied only between values 1 and 2 in the long term.

Another analysed indicator was gross agricultural production from gross turnover in the Slovak Republic. Gross agricultural production is the sum of sales outside the enterprise, intra-enterprise turnover and the difference in stock levels at the beginning and end of the year (gross turnover method). We analysed separately the gross agricultural production from the gross turnover for plant and animal production.

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The development of gross plant agricultural production from gross turnover in the period 1997-2022 is shown in Figure 4. The presented development of gross plant agricultural production shows an increase until 2009, when the effects of the global financial and economic crisis became apparent and persisted in 2010. Subsequently, in 2011, there was a slight revival of plant production. It was applied linear model with the positive slope (29.045, $R^2 = 0.746$) which predicts increase in the plat production in the next period.

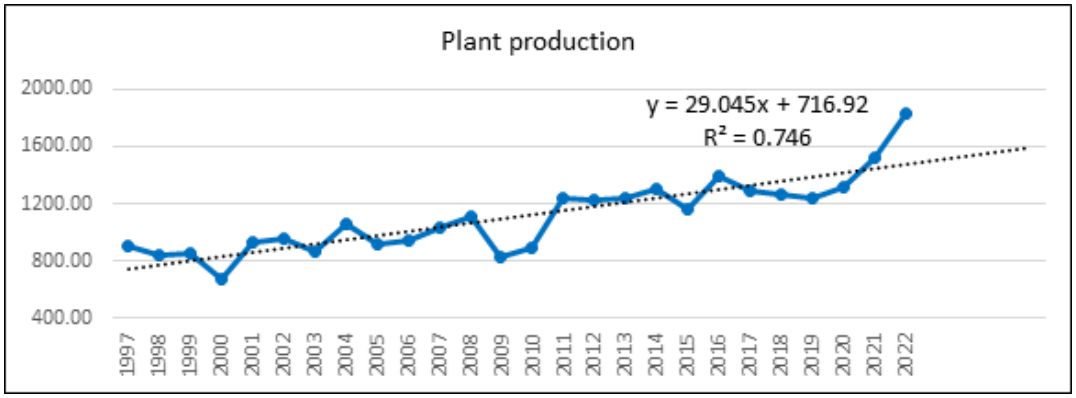

Figure 4: Gross plant agricultural production from gross turnover in Slovakia
Source: Datacube, own processing

The development of gross animal agricultural production from gross turnover in the period 1997-2022 is presented in Figure 5. The trend function of the linear model confirms the decreasing tendency, which should continue even in the forecast for the next period. The slope of the linear model is negative (-15.247) and the coefficient of determination $R^2 = 0.6994$.
Changes occurred in the structure of agricultural production after 2004, which manifested in the growth of plant production and the decrease of animal production. After joining the EU, it was necessary to implement all relevant legislative regulations in the field of plant production into national legislation, which mainly concerned the fruit, vegetable, and wine sectors.
Similarly, data on gross animal agricultural production confirmed the impact of the financial and economic crisis, which caused a significant decrease in production in 2009 and 2010. The trend function of the linear model confirms the downward trend, which, based on the forecast, will continue in the next period (Fig. 5). After the Slovak Republic joined the EU, there was a significant decrease in the numbers of all important species of farm animals, there was a decrease in the use of processing capacities, which was subsequently reflected in a decrease in employment in the livestock industry. Livestock production in Slovakia has been declining for a long time due to low competitiveness, which is related (among other things) to the economic conditions of production and worse capital and technological equipment of Slovak farms.

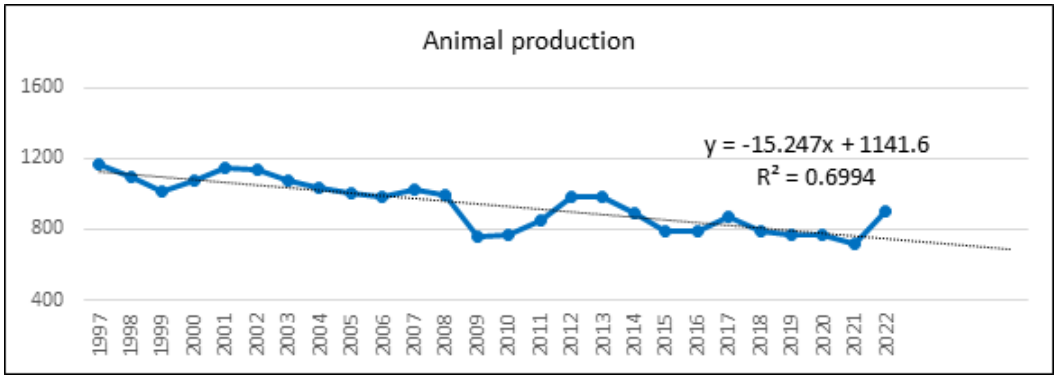

Figure 5: Gross animal agricultural production from gross turnover in Slovakia
Source: Datacube, own processing

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3.2 Development of revenues from the sale of primary agricultural products and the number of permanent employees in the agricultural sector

Another indicator is sales of agricultural products from primary production (Fig. 6). Graphical presentation of data and estimation of the development by a quadratic trend is increasing. The coefficient of determination R^2 = 0.816 which means that 81.6% of the variation in the dependent variable can be explained by the variation in the independent variable. Development can be assessed as relatively stable; the decrease in sales is visible in 2009 and 2010, when the impact of the financial and economic crisis became apparent. A slight increase in sales in the following period is confirmed by the trend function.

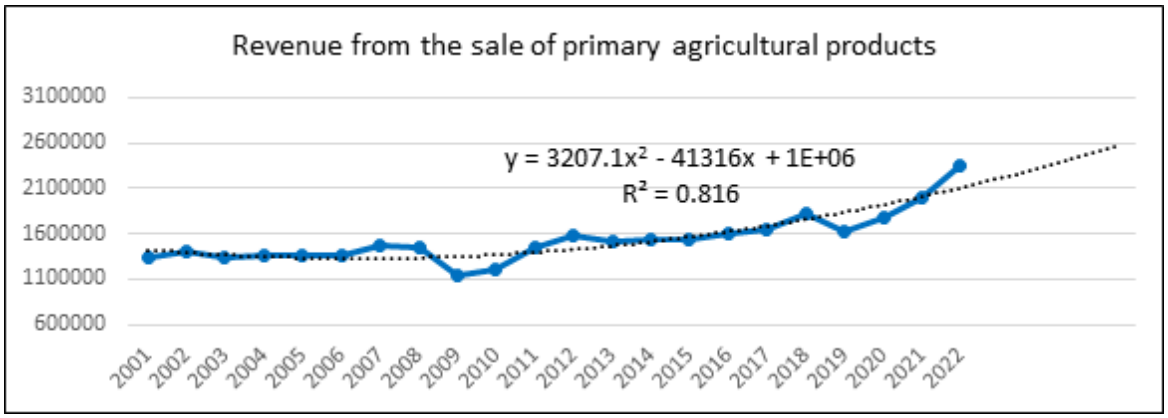

Figure 6: Revenues from the sale of primary agricultural products
Source: Datacube, own processing

The last analysed indicator is the number of permanent employees in agriculture. The graphic presentation of the data and the estimated trend via exponential function confirmed the decreasing tendency in the number of employees in agricultural enterprises (Fig. 7). The coefficient of determination R^2 = 0.956 which means the estimated model fits the analyzed data very well (the model explains 95.6% of the variability of the dependent variable. After the start of the transformation process, it was assumed that in the competitive environment there would be pressure to reduce the number of workers in agricultural enterprises. Actual labour losses were much higher than expected, as businesses watched for increased labour productivity and increased profit generation.

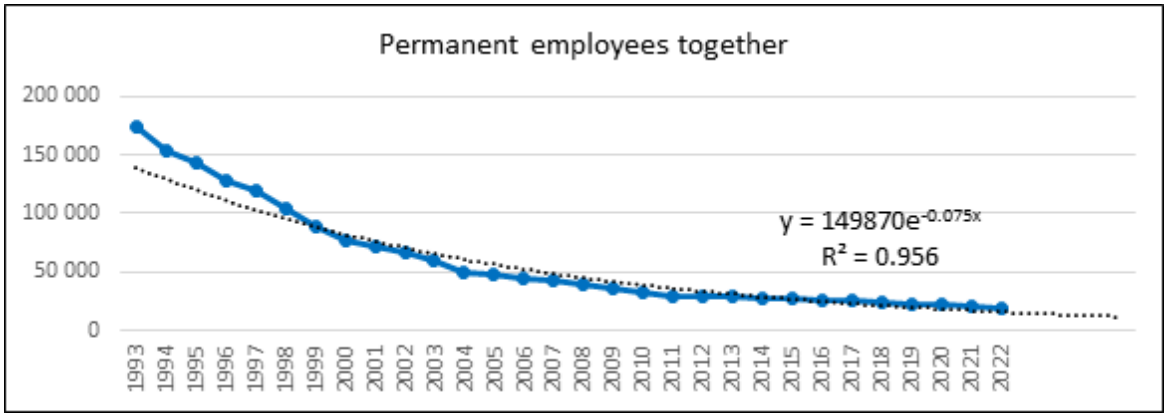

Figure 7: Development of the number of permanent employees in agriculture
Source: Datacube, own processing

As stated by Vojtech and Levický (2019), improving the conditions for doing business for small and medium-sized enterprises is an important factor in creating new jobs and reducing

the unemployment rate. From the point of view of the sectoral structure, small and medium-sized agricultural enterprises have a specific position (the share of the total number of small and medium-sized enterprises in 2019 was 4.1%).

Slovak agricultural companies, in addition to depending on the quality of the soil, climate, weather, employment during the season, etc., are also threatened by foreign competition, which after 1998 expanded its sales to the regions of Slovakia (Fiľarská, 2017; Zalai, 2013).

Hudáková et al. (2020) investigated the correlation between foreign direct investment and indicators of productivity and labor costs. Identification of strong and weak economic aspects of business activity becomes a decisive factor for the integration of the company into the business environment; it is an important condition for reflecting changes to maintain and increase the competitiveness of every company (Kuzma and Dvořák, 2006).

4. Conclusion

The main purpose of the paper was to evaluate selected economic indicators of the agricultural sector in the Slovak Republic during the last three decades. The results indicate that agricultural sector enterprises have constantly more demanding conditions to be successful in their activities. The current main reasons include climate change, which significantly changes the conditions in the cultivation processes of primary producers in the agricultural sector.

Another reason for the difficulty of doing business in the agricultural sector in Slovakia is strong foreign competition, which puts pressure on Slovak agricultural companies, and they must closely monitor their financial status and evaluate their financial health. After Slovakia's accession to the European Union, Slovak agricultural enterprises have new possibilities for obtaining financial compensation and mitigating losses caused by external influences.

The analysis of data on the number of enterprises in the agricultural sector confirmed the increasing trend in the development of the number of small enterprises and the decreasing trend in the development of medium-sized enterprises. The growing trend was confirmed in the development of gross plant agricultural production; on the other hand, a downward trend was demonstrated in the development of gross animal agricultural production. Revenues from the sale of agricultural products from primary production have a growing trend that will continue in the next period as well. The fourth analyzed indicator was the development of the number of permanent employees in agriculture, which showed a significant decrease in the monitored period. The forecast for the next period shows a stabilized situation, or a very slight decline.

Agricultural and food industry enterprises are of irreplaceable importance in providing food and nutrition for the population. In addition, the social function of the agricultural sector is also significant, which is beneficial to this sector in solving overall employment and using available labour resources. The contribution of agriculture to the demographic reproduction of the population and its influence on the processes of population migration and mobility is also significant.

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The Influence of Company Size on CSR Practices in Slovak Businesses: An Empirical Study

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Abstract

This study aims to explore the relationship between company size and the adoption of Corporate Social Responsibility (CSR) practices among Slovak businesses. Given the growing importance of CSR in the global business landscape, understanding how organizational size influences CSR integration, certification, awarding, and reporting can provide critical insights for policymakers, business leaders, and stakeholders. The research fills a gap in the existing literature by focusing on the Slovak business environment, where such studies are relatively scarce.

The study utilized a structured questionnaire distributed to a sample of 125 Slovak businesses, spanning a range of sizes from microenterprises to extra-large enterprises. The research design employed the Independent-Samples Kruskal-Wallis Test for hypothesis testing, alongside pairwise comparisons to analyse differences in CSR practices across company sizes. This non-parametric approach was chosen to accommodate the ordinal nature of the data and the non-normal distribution of responses.

The findings reveal significant differences in CSR practices related to organizational integration, awarding, certification, and reporting across different company sizes. Larger companies are more likely to have formal CSR departments, certifications, receive awards for their CSR activities, and engage in regular reporting compared to smaller businesses. These results suggest that company size is a determinant factor in the depth and breadth of CSR engagement. The study contributes to the understanding of CSR in Slovakia, highlighting the disparities in CSR adoption and suggesting a potential need for tailored strategies to enhance CSR across all business sizes. By shedding light on these differences, the research adds value to the ongoing dialogue on CSR implementation and encourages further exploration into the factors influencing CSR practices in varying business contexts.

Key words: Corporate Social Responsibility (CSR); company size; Slovak businesses, CSR practices; CSR certification; CSR reporting

JEL Classification: M14, L25, Q56

1. Introduction

Corporate Social Responsibility (CSR) CSR refers to the voluntary integration of social and environmental concerns into a company's business operations and interactions with stakeholders (Choi et al., 2013; Lu et al., 2022). It encompasses ethical, philanthropic, and environmental dimensions that go beyond legal compliance and economic interests (Kun-

Hsiang, 2020). The concept has become increasingly important in contemporary business practices globally and within the European Union. The European Commission has issued several directives emphasizing the significance of CSR, such as the 2014 Directive on non-financial reporting (Javeed & Lin, 2019) and the 2022 proposal for a Corporate Sustainability Reporting Directive (Stawicka, 2021).

Prior studies have explored how company size impacts CSR practices. Larger enterprises tend to have more formalized and mature CSR practices due to greater resources, stakeholder expectations, and regulatory compliance (Li et al., 2019; Xia et al., 2018; Kiss, 2018). Larger firms often have dedicated CSR departments, receive CSR awards, obtain CSR certifications, and engage in comprehensive CSR reporting (Poudel, 2016; Wang & Sun, 2021). In contrast, smaller enterprises often face challenges in adopting CSR, such as limited resources, lack of expertise, and competing priorities (Li & He, 2013; Kang & Chiu, 2016 Stawicka, 2021). Smaller firms may struggle to allocate resources toward CSR initiatives and lack the visibility and stakeholder pressure that larger companies experience (Hasan et al., 2016; Li et al., 2019; Shen et al., 2021). According to Udayasankar (2008), firm size could be the key driving force behind CSR activities (Nur, 2021). This study examines four key dimensions of CSR implementation: organizational integration of CSR, CSR awards, CSR certifications, and CSR reporting (Poudel, 2016; Wang & Sun, 2021). These dimensions reflect the maturity and effectiveness of a company's CSR practices. Organizational integration of CSR indicates the level of strategic alignment and commitment, while CSR awards, certifications, and reporting demonstrate external recognition and transparency (Cho et al., 2015; Choongo, 2017; Thao & Le, 2019).

CSR trends in Slovakia and Central and Eastern Europe are influenced by cultural, economic, and regulatory factors. Studies have highlighted the growing awareness and adoption of CSR among Slovak businesses, particularly among larger enterprises (Nadanyiova, 2021). However, challenges remain, such as limited resources and expertise, especially for smaller firms (Li & He, 2013; Stawicka, 2021). The regulatory environment in Slovakia and the EU has been driving increased CSR disclosure and sustainability reporting (Javeed & Lin, 2019; Stawicka, 2021). In conclusion, the existing literature suggests that company size significantly influences the implementation and maturity of CSR practices. Larger enterprises tend to have more formalized and comprehensive CSR initiatives, while smaller firms often face barriers in adopting CSR. The four dimensions examined in this study provide a comprehensive framework for evaluating the CSR practices of Slovak businesses of varying sizes. Further research is needed to understand the specific factors and challenges faced by Slovak companies in integrating CSR into their operations.

2. Data and Methods

Study was realized on the sample of 125 Slovak businesses stratified to ensure a balanced representation across companies of diverse sizes: 25 of Extra-Large enterprises (more than 500 employees), 25 of large enterprises (250-499 employees), 25 of Medium-sized enterprises (50-249 employees), 25 of small enterprises (10-49 employees) and 25 Microenterprises (0-9 employees). Incorporating the “Extra Large” category relates to the European Commission's directives regarding the obligation to report socially responsible activities (EC, 2022; EC, 2014). According to legal form, Limited Liability Company (LLC), representing 70.4% of the businesses in the sample. Joint Stock Companies make up 20.8% of the sample, Limited Partnerships, Public Companies, and Sole Proprietorships are relatively rare, together accounting for only 8.8% of the businesses. According to sector, the Production sector is the most represented, with 42.4% of businesses involved in manufacturing or production activities. The Trade sector follows with 33.6% participation and Service sector businesses account for 24% of the sample. Respecting the Establishment Year, a significant portion of the businesses,

42.4%, were established between 1991 and 2000, followed by those established between 2001 and 2010, making up 32.8% and between 2011 and 2020 represent 21.6% of the sample. Very few businesses (2.4%) were established in 2020 or later, and only a single business (0.8%) was established before 1990.

Data was collected through a structured questionnaire distributed to a sample of Slovak businesses. The questionnaire included items related to CSR practices and recognition, as well as company size and sector. For statistical analysis the Kruskal-Wallis Test was used to test the null hypotheses by comparing the distribution of CSR-related variables across different company sizes. This non-parametric test is chosen due to its ability to handle non-normal distributions and ordinal data. Found differences were post hoc tested using Bonferroni Pairwise Comparisons conducted to identify specific differences between company size categories.

Aim of this study is to describe selected aspects of CSR implementation in Slovak business sector and finding statistically significant differences between businesses of various size. According this the, the general hypothesis H0 and alternative hypothesis Ha were established:

- H0: There is no statistically significant difference between businesses of various size in selected aspects of CSR implementation.
- Ha: There is a statistically significant difference between businesses of various size in selected aspects of CSR implementation.

Selected aspects of CSR implementation are in this study represented by four variables (Table 1)

Table 1: Operationalization of variables

Variable Category	Variable Name	Description	Measurement & Categories or Scale	Total Responses
Dependent Variables	V1_Organizational integration of CSR	Degree to which CSR is integrated within the organizational structure.	- Separate CSR department: 1; - Under the Compliance department: 33; - Under the Marketing or PR Department: 8; - Under the Human Resources (HR) department: 28; - CSR is not organizationally integrated: 27	125
Dependent Variables	V2_CSR awarding	Whether the company has been awarded for its CSR activities.	- Yes, they were awarded: 32; - No, they were not awarded: 93	125
Dependent Variables	V3_CSR certification	Whether the company has certified CSR processes.	- Yes, they have certified CSR processes: 52; - No, they do not have certified CSR processes: 73	125
Dependent Variables	V4_CSR reporting	Frequency and manner of CSR reporting by the company.	- Regular CSR reporting: 33; - Occasional CSR reporting (once per 3 years): 20; - Limited CSR reporting (over 3 years periods): 18; - No formal CSR reporting: 54	125
Independent Variable	F3_Company size	Size of the company based on the number of employees.	- Microenterprise (0-9 employees): 25; - Small enterprise (10-49 employees): 25; - Medium size enterprise (50-249 employees): 25; - Large enterprise (250+ employees): 25; - Extra-large enterprise (500 and more employees): 25	125

Source: own design

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This study, while providing valuable insights into CSR practices across different company sizes in Slovakia, has some limitations which must be mentioned. The sample size of 125 businesses, although diverse, may not fully represent the vast spectrum of Slovak companies, potentially affecting the generalizability of the findings to the entire business population. Also, the reliance on self-reported data through questionnaires introduces the possibility of response bias, as companies might portray their CSR practices in a more favourable light and the study's focus on specific aspects of CSR (integration, awarding, certification, and reporting) may overlook other crucial dimensions of CSR practices. Finally, the cross-sectional design of this study limits the ability to infer causality or changes in CSR practices over time, suggesting the need for longitudinal studies to understand the evolution of CSR in Slovak businesses.

3. Results and Discussion

This study investigates the relationship between company size and the adoption of Corporate Social Responsibility (CSR) practices among Slovak businesses.

Based on the results of statistical significance between the observed parameters, which were evaluated by Independent-Samples Kruskal-Wallis Test, we found that there is a statistically significant difference between:

- Organizational integration of CSR (V1) across categories of company size (F3) (significant: 0.000)
- CSR awarding (V2) across categories of company size (F3) (significant: 0,015).
- CSR certification (V3) across categories of company size (F3) (significant: 0,004).
- CSR reporting (V4) across categories of company size (F3) (significant: 0,000).

Based on the results, we reject the H0 hypothesis in all four domains examined and accept the Ha hypothesis.

A more detailed analysis of Organizational integration of CSR (V1) across categories of Company size (F3) was conducted by Bonferroni Pairwise Comparisons. Table 2 shows the results of a more in-depth analysis, where we examined in which categories of companies statistically significant differences emerged. A statistically significant difference arose between:

- extra-large enterprise (5) and medium size enterprise (3) – extra-large enterprise was more often referred to by the Separate CSR Department as medium size enterprise;
- extra-large enterprise (5) and small enterprise (2) – extra-large enterprise was more often referred to by the Separate CSR Department as small enterprise.
- extra-large enterprise (5) and microenterprise (1) – extra-large enterprise was more often referred to by Separate CSR Department as microenterprise, while microenterprise was more often referred to as CSR is not organizationally integrated;
- large enterprise (4) and microenterprise (1) - microenterprise indicated the option CSR is not organizationally integrated to a higher degree than large enterprise;
- medium size enterprise (3) and microenterprise (1) - microenterprise indicated to a higher extent the option CSR is not organizationally integrated than medium size enterprise;
- small enterprise (2) and microenterprise (1) - microenterprise indicated to a higher degree the option CSR is not organizationally integrated, than small enterprise.

Table 2: Pairwise Comparisons of Company size across Organizational integration of CSR

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
5-4	11.560	9.975	1.159	.246	1.000
5-3	20.060	9.975	2.011	.044	.443
5-2	23.100	9.975	2.316	.021	.206

5-1	44.480	9.975	4.459	.000	.000
4-3	8.500	9.975	.852	.394	1.000
4-2	11.540	9.975	1.157	.247	1.000
4-1	32.920	9.975	3.300	.001	.010
3-2	3.040	9.975	.305	.761	1.000
3-1	24.420	9.975	2.448	.014	.144
2-1	21.380	9.975	2.143	.032	.321

Source: own design

A more detailed analysis of CSR awarding (V2) across categories of Company size (F3) was conducted by Bonferroni Pairwise Comparisons. Table 3 shows the results of a more in-depth analysis, where we examined in which categories of companies statistically significant differences emerged. A statistically significant difference arose between:

- extra-large enterprise (5) and microenterprise (1) – microenterprise indicated to a higher extent the option "No. they were not awarded" than an extra-large enterprise;
- extra-large enterprise (5) and small enterprise (2) – small enterprise indicated to a higher extent the option "No. they were not awarded “, than an extra-large enterprise;
- medium size enterprise (3) and small enterprise (2) – small enterprise indicated to a higher extent the option "No. they were not awarded" than a medium size enterprise.

Table 3: Pairwise Comparisons of Company size across CSR awarding

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
5-3	5.000	7.746	.645	.519	1.000
5-4	10.000	7.746	1.291	.197	1.000
5-1	20.000	7.746	2.582	.010	.098
5-2	22.500	7.746	2.905	.004	.037
3-4	-5.000	7.746	-.645	.519	1.000
3-1	15.000	7.746	1.936	.053	.528
3-2	17.500	7.746	2.259	.024	.239
4-1	10.000	7.746	1.291	.197	1.000
4-2	12.500	7.746	1.614	.107	1.000
1-2	-2.500	7.746	-.323	.747	1.000

Source: own design

Another more detailed analysis of CSR (V3) across company size categories (F3) was performed by Bonferroni Pairwise Comparisons. Table 4 shows the results of a more in-depth analysis, where we examined in which categories of companies statistically significant differences emerged. A statistically significant difference arose between:

- extra-large enterprise (5) and certification microenterprise (1) – microenterprise indicated to a higher extent the option "No. they do not have certified CSR processes" than an extra-large enterprise;
- extra-large enterprise (5) and small enterprise (2) - small enterprise indicated to a higher extent the option "No. they do not have certified CSR processes" than an extra-large enterprise;
- Large enterprise (4) and small enterprise (2) - small enterprise indicated to a higher extent the option "No. they do not have certified CSR processes" than a large enterprise;

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- Large enterprise (4) and microenterprise (1) - microenterprise indicated to a higher extent the option "No. they do not have certified CSR processes" than a large enterprise.

Table 4: Pairwise Comparisons of Company size across CSR certification

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
5-4	5.000	8.748	.572	.568	1.000
5-3	12.500	8.748	1.429	.153	1.000
5-2	25.000	8.748	2.858	.004	.043
5-1	27.500	8.748	3.143	.002	.017
4-3	7.500	8.748	.857	.391	1.000
4-2	20.000	8.748	2.286	.022	.222
4-1	22.500	8.748	2.572	.010	.101
3-2	12.500	8.748	1.429	.153	1.000
3-1	15.000	8.748	1.715	.086	.864
2-1	2.500	8.748	.286	.775	1.000

Source: own design

The last detailed analysis, which focused on CSR (V4) across company size categories (F3) was performed by Bonferroni Pairwise Comparisons. Table 5 shows the results of a more in-depth analysis, where we examined in which reporting categories of companies statistically significant differences emerged. A statistically significant difference arose between:

- extra-large enterprise (5) and medium size enterprise (3) - extra-large enterprise indicated to a higher extent the option " Regular CSR reporting" than a medium size enterprise. Medium size enterprise indicated to a higher extent the option " No formal CSR reporting" than an extra-large enterprise;
- extra-large enterprise (5) and small enterprise (2) - extra-large enterprise indicated to a higher extent the option " Regular CSR reporting" than a small enterprise. Small enterprise indicated to a higher extent the option " No formal CSR reporting" than an extra-large enterprise;
- extra-large enterprise (5) and microenterprise (1) - extra-large enterprise indicated to a higher extent the option " Regular CSR reporting" than a microenterprise. Microenterprise indicated to a higher extent the option " No formal CSR reporting" than an extra-large enterprise;
- large enterprise (4) and small enterprise (2) - large enterprise indicated to a higher extent the option " Regular CSR reporting" than a small enterprise. Small enterprise indicated to a higher extent the option " No formal CSR reporting" than a large enterprise;
- large enterprise (4) and microenterprise (1) - large enterprise indicated to a higher extent the option " Regular CSR reporting" than a microenterprise. Microenterprise indicated to a higher extent the option " No formal CSR reporting" than a large enterprise;
- medium size enterprise (3) and microenterprise (1) - microenterprise indicated to a higher extent the option " No formal CSR reporting" than a medium size enterprise. Medium size enterprise indicated to a higher extent the option " No formal CSR reporting" than an extra-large enterprise.

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Table 5: Pairwise Comparisons of Company size across CSR reporting

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
5-4	10.160	9.688	1.049	.294	1.000
5-3	22.060	9.688	2.277	.023	.228
5-2	31.540	9.688	3.255	.001	.011
5-1	43.440	9.688	4.484	.000	.000
4-3	11.900	9.688	1.228	.219	1.000
4-2	21.380	9.688	2.207	.027	.273
4-1	33.280	9.688	3.435	.001	.006
3-2	9.480	9.688	.978	.328	1.000
3-1	21.380	9.688	2.207	.027	.273
2-1	11.900	9.688	1.228	.219	1.000

Source: own design

The findings of this study reveal significant differences in CSR practices across enterprises of varying sizes in the Slovak business context. Larger enterprises, including large and extra-large companies, generally displayed more advanced CSR integration, awarding, certification, and reporting compared to smaller businesses, such as micro, small, and medium enterprises (D'Amato & Falivena, 2019; Pinheiro et al., 2022; Chapagain, 2020).One pot ential explanation for this disparity is the greater availability of resources and capabilities in larger firms. As noted in prior literature, larger companies typically have more assets, funds, and flexibility to invest in CSR initiatives, while smaller enterprises often prioritize traditional performance improvement over formal CSR programs due to resource constraints (D'Amato & Falivena, 2019; Pinheiro et al., 2022; Winarto & Rachmawati, 2020). Additionally, larger firms may face stronger regulatory pressures and stakeholder expectations to engage in CSR, providing further incentives for their more extensive CSR practices (Daszyńska-Żygadło et al., 2016; Zhao, 2022). Our findings also suggest that company size can moderate the relationship between CSR and firm value. Larger and older enterprises tend to benefit more from CSR engagement in terms of enhanced firm value, compared to smaller and younger counterparts (D'Amato & Falivena, 2019; Hou, 2018). This may be attributed to the greater visibility and reputational gains that larger firms can achieve through their CSR efforts, as well as their ability to effectively communicate and build relationships with stakeholders (Salim, 2018; Ali et al., 2018; , Du et al., 2010).

The implications of these findings are twofold. For policymakers, the results highlight the need to develop targeted support and incentive mechanisms to encourage smaller enterprises to adopt more formal and comprehensive CSR practices. This could include providing guidance, training, and financial assistance to help SMEs overcome resource constraints and integrate CSR into their strategic decision-making (Laguir et al., 2015; Pinheiro et al., 2022). Additionally, fostering collaboration and knowledge-sharing between larger and smaller firms may facilitate the diffusion of best CSR practices (Gellert & Graaf, 2012; Kim et al., 2010). For smaller enterprises, the findings underscore the importance of proactively investing in CSR, as it can contribute to enhanced firm performance and stakeholder relationships (Simionescu & Dumitrescu, 2018; Torugsa et al., 2011). However, the specific CSR activities and communication strategies should be tailored to the unique needs and contexts of smaller businesses, rather than simply emulating the approaches of larger counterparts (Gellert & Graaf, 2012; Chalmeta & Viinikka, 2017).

4. Conclusion

Based on a comprehensive analysis of the relationship between firm size and the adoption of corporate social responsibility (CSR) practices among Slovak companies, it is evident that there are significant differences in various areas of CSR. In all four areas examined, the null hypothesis (H0) was rejected, and the alternative hypothesis (Ha) was accepted, indicating that company size does play a significant role in shaping CSR practices. The results reveal that larger enterprises, especially extra-large enterprises, tend to exhibit higher levels of organizational integration, CSR awarding, certification and regular CSR reporting compared to smaller ones such as micro and small enterprises. On the other hand, micro and small enterprises show a higher tendency towards non-adoption or less formal adoption of CSR practices. The results underline the importance of considering company size as a critical factor in understanding and effectively implementing CSR initiatives. Businesses, policy makers and stakeholders can use this knowledge to tailor CSR strategies to the unique characteristics and capacities of different company sizes, which ultimately promotes more inclusive and effective CSR practices within the Slovak business environment. We see potential for further research in extending the research to businesses outside of the Slovak Republic.

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Efficiency of Assets Utilization in Chosen Agricultural Companies

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Abstract

Paper's objective(s) and research background

The Nitra region is one of the regions with suitable climatic and natural conditions for the cultivation of agricultural crops, and the development of agricultural production. Several agricultural enterprises operate in the region. Assets and its various forms are an integrated part of the enterprise and it's recorded in the balance sheet. It is divided into the least liquid assets to most liquid. The main objective of the paper was to evaluate the efficiency of the use of assets in agricultural enterprises operating in Nitra region. The paper is focused on the assessment of the state, development, and structure of assets with the subsequent forecast for the next three years. By means of selected activity indicators (turnover time and turnover) was evaluated the ability of agricultural enterprises to use their assets.

Data / Methods

The basis for the processing of the paper was data from the financial statements of enterprises (balance sheet and profit and loss statements) for the period 2015 -2022. The total set of 149 enterprises was divided into agricultural cooperatives and trading companies. Based on the Intercept and Slope functions was forecasted the development of individual items of assets of agricultural enterprises. The efficiency of asset utilization was evaluated by calculating the inventory turnover ratio and inventory turnover time, receivable collection period, debt repayment ratio and assets turnover ratio and assets turnover time in both legal forms.

Results/Conclusions/Value added

The assets of the agricultural cooperatives exceeded those of the trading companies every year. Non-current assets (with an average share of 55 % over the whole period) accounted for the highest share of total assets in agricultural cooperative. Of the non-current assets, agricultural cooperatives reported mainly tangible fixed assets. Current assets accounted for an average share of total assets of 45 %. Inventories and short-term receivables were the most significant current assets. In the terms of forecast, current assets, especially inventories, and short-term financial assets are expected to decrease in agricultural cooperatives in 2025 compared to 2022. The trend in terms of assets was similar for trading companies. Non-current assets had the highest share of assets with an average share of 64 %. Of the non-current assets exceeded tangible fixed assets. Current assets in this legal form had average share of 36 %. Of the individual items, short-term receivables and inventories had the highest share, almost at the same level. In the terms of quantification of the forecast, current assets and its two items of non-current and current receivables are expected to decrease in trading companies, in 2025 compared to 2022. Based on the quantification of selected activity indicators, agricultural cooperatives show higher values than trading companies only for the indicator of inventory turnover time.

Key words

Agricultural companies, assets, financial statements, indicators, Nitra County

JEL Classification

M21, M41, Q13

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1. Introduction

Agricultural in Nitra region of the Slovak republic garners significant attention due to its fertile land (it plays a crucial role in agricultural development, including the production of organic food, regional tourism, and agrotourism) (*Valenćiková, 2021*), (they are influenced by factors such as land markets, ownership relations, land fragmentation, and the presence of foreign agricultural holding (*Takáč, et al. 2020*)). Research on soil fertile properties and agricultural practices in the Nitra region is essential (e.g. investigated the impact of fertilization on soil properties and plant growth, the effect of microplastics on soil properties and crop growth (*Toková, et al. 2020*; *Botyanszká, et al. 2022*).

For the efficient utilization of agricultural land and agricultural practices the consolidation of agricultural enterprises is essential (*Lysa et al. 2022*). To comprehend the dynamic and challenges faced by agricultural enterprises in the Nitra region, it is crucial to consider various aspects (*Kramáreková, et al. 2023*).

The evaluation of economics results of agricultural enterprises sheds light on the economics aspects of agriculture in this area (*Matušek and Ladvenicová, 2023*). Ensuring financial safety and optimizing the interaction of agrarian entities are essential considerations for the development and functioning of agricultural enterprises (*Molchan et al., 2020; Bezpartochnyi et al., 2021*).

Ensuring the financial safety of agricultural enterprises is a key indicator (*Bezpartochnyi et al., 2021*). Financial analysis of agricultural enterprises is a complex process that involves monitoring various financial aspects to understand and account for the principal areas affecting their financial performance (*Krasnostanova, et al. 2022*). Financial analysis of agricultural enterprises involves assessing various financial aspects to ensure stability and growth. Studies emphasize the importance of evaluating the financial stability of agricultural enterprises using fundamental parameters to gauge their financial health. Additionally, understanding the impact of economic risks on financial stability is crucial for managing the financial risks faced by agricultural enterprises (*Dadayan et al. 2020*). Developing managerial key competencies is essential for enhancing the financial management and decision-making process within agricultural enterprises (*Gregáňová and Hrdá, 2021*).

Financial statements are essential tools for evaluating the financial performance, stability, and health of agriculture enterprises. The standard composition of financial statements for agricultural enterprises typically includes the balance sheet, statements of financial and economic activities result (profit and loss statement), cash flow statements, and statement of owners' equity (*Khushvakhtzoda, 2022*). These statements offer a comprehensive overview of the financial position, profitability, cash flow, and ownership structure of agricultural business. Analysing the financial performance determinants of agricultural companies, as highlighted by *Lehenchuk et al., 2022,* provides insights into factors influencing profitability and return on assets.

2. Data and Methods

The basis for processing of the paper was data from the financial statements of agricultural enterprises (balance sheets and profit and loss statements) for the period 2015 – 2022. The total set of 149 enterprises was divided into agricultural cooperatives and trading companies. Based on the Intercept and Slope functions, the development of individual items of assets of agricultural enterprises was forecasted for the following three years. The efficiency of asset utilization was evaluated by calculating the inventory turnover ratio and the inventory turnover time, the receivable collection period, the debt repayment ratio and the assets turnover ratio and assets turnover time in both legal forms. In general, turnover time ratios should decrease, and turnover ratios should increase. Turnaround time ratios are expressed in days, so the

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formula is multiplied by the number of days in the year (n). The methodology for calculating each indicator is as follows:

$$\text{Inventory turnover time} = \frac{\text{inventory}}{\text{operating sales}}.n \quad \text{resp.} \quad \frac{\text{inventory}}{\text{operating costs}}.n \tag{1}$$

The inventory turnover time measures how many days it takes an enterprise to sell its inventory. The denominator of the indicator is operating sales, which include revenues from the sale of goods, revenues from the sale of services and revenues from the sale of own products, or operating costs, which include costs of goods sold, consumption of materials and energy, services.

$$\text{Receivable collection period} = \frac{\text{short-term receivable}}{\text{operating sales}}.n \tag{2}$$

The indicator receivable collection period, which measures how many days it takes for an enterprise to collect its receivables. The value of the indicator depends on the industry in which the enterprise operates, the sector in which it operates, etc.

$$\text{Debt repayment ratio} = \frac{\text{short-term liabilities}}{\text{operating sales}}.n \quad \text{resp.} \frac{\text{short-term liabilities}}{\text{operating costs}}.n \tag{3}$$

Debt repayment ratio express how many days it takes for an enterprise to pay all its short-term liabilities.

$$\text{Assets turnover time} = \frac{\text{assets}}{\text{sales}}.n \tag{4}$$

How long it takes for asset turnover to occur in relation to sales is indicated by the asset turnover time indicator. Since total asset include not only current assets but also non-current assets, all sales i.e. (operating sales, sales of revenues from the sale of non-current assets, and sales of securities) enter the indicator.

$$\text{Inventory turnover ratio} = \frac{operating\ sales}{inventories} \tag{5}$$

The asset turnover indicator measures the number of times per year that inventory sales are made in relation to operating sales.

$$\text{Assets turnover ratio} = \frac{sales}{assets} \tag{6}$$

How many times an asset is turned over during the year is expressed by the asset turnover ratio.

3. Results and Discussion

Agriculture plays and important role in Nitra region, there are suitable climatic and natural conditions for its development. Out of the total analysed set of agricultural enterprises operating in the Nitra region, 102 trading companies operating in this sector were analysed.

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The most valuable resources of enterprises, apart from human resources, are assets, which consist of non-current assets and current assets (*Abella et al., 2024*). The development of assets in trading companies in the Nitra region is in Table 1. The average value of assets of trading companies during the period under analysis (2015-2022) was at €3,689,985. Based on the evaluation of the assets, we can conclude that their value increased by €1,449,108 by 2022 compared to 2015 – both current assets and non-current assets contributed significantly to this increase. The average value of non-current assets was €2,341,715, their share in total assets was 64 %. Its development was mainly influenced by the development of tangible fixed assets, which had the highest share of non-current assets. Non-current assets act as a key element of the material and technical base of agricultural enterprises, which is due to the specifics of the products they produce and the work they carry out (*Takhumova et al. 2022*). Non-current assets accounted for an average of 36 % of total assets and were at an average level of € 1,318,887 for the period analysed – their development was mainly influenced by inventories and short-term receivables, which were approximately at the same level. Accruals showed an upward trend until 2022 compared to 2015, increasing by €22,912, their development was mainly influenced by short-term deferred expenses and short-term deferred revenue. Based on the forecast development until 2025 compared to 2022, a decrease of € 64 in expected mainly in accounts receivable and decrease of current financial assets.

Table 1: State, development and forecast of the development of assets and their indicators in trading companies in the Nitra region

Indicator/year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Assets	3165227	3058237	3325373	3535875	3833251	3866270	4121309	4614335	4621013	4827908	5034803
Non-current assets	1906344	1939579	2113114	2328471	2516383	2543142	2673038	2713650	2920095	3048624	3177153
Intangible fixed assets	12517	16780	14925	26345	22860	20182	14495	15756	19243	19523	19803
Tangible fixed assets	1605837	1629581	1709471	1827916	1934574	1978775	2076144	2117101	2220259	2300333	2380408
Non-current financial assets	287990	293219	388717	474209	558949	544185	582398	580793	680593	728768	776942
Current assets	1238003	1097813	1183004	1180671	1280609	1292827	1421272	1856894	1660615	1736555	1812495
Inventory	504660	502072	485264	533953	566470	575259	590479	761970	701393	731699	762005
Non-current receivables	6383	7646	7501	7359	11700	9426	3661	12098	9840	10199	10558
Current receivables	562971	455134	542804	498771	562711	544364	607837	833049	721813	754226	786639
Current financial assets	212	530	719	296	284	284	323	294	272	251	230
Financial accounts	163776	132430	146715	140292	139443	163494	218970	249483	227297	240180	253062
Accruals	20879	20845	29255	26734	36260	30301	27000	43791	40302	42729	45155

Source: own processing, balance sheets of trading companies

Development of assets in agricultural cooperatives in the Nitra region is in Table 2. The average value of assets during the analysis period 2015-2022 in agricultural companies amounted to €5,562,380. By 2022, compared to 2015, its value has increased by € 1,176,579. This increase was mainly influenced by the development of current assets and non-current assets. On average, non-current assets accounted for 55 % of total assets. The average value of non-current assets was € 3 044 962 during the period 2015-2022. The development of the indicator was mainly influenced by tangible fixed assets, as was also the case for trading companies. The lowest value of non-current assets was achieved by intangible fixed assets in both legal forms. The same opinion is held by *Rizaev and Kadirov (2022)* who argue that intangible assets constitute a very small share of the existing assets of an agribusiness entity. Current assets reached an average share of 45% in total assets. Its average value over the period analysed was

€2, 496, 781. As with trading companies, the most significant impact on the value of current assets was inventories and short-term receivables, which showed an increasing trend until 2022 compared to 2015. Accruals on the asset side complete the asset side, with an average value of €20,637. Its development was mainly influenced by deferred revenue, both non-current and current. In terms of the forecast until 2025 compared to 2022, all indicators are expected to increase except inventories and current financial assets, which will affect the decrease in current assets.

Table 2: State, development and forecast of the development of assets and their indicators in agricultural cooperatives in the Nitra region

Indicator/year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Assets	5176160	5368174	5334161	5441217	5532178	5605802	5688609	6352739	6137958	6265864	6393770
Non-current assets	2841252	2947268	2983826	3012548	3055299	3111266	3152507	3255732	3278139	3329955	3381772
Intangible fixed assets	5350	4390	11660	11250	9200	13780	13940	16270	17620	19150	20680
Tangible fixed assets	2801346	2912195	2957740	2988878	3026193	3077160	3112214	3228302	3247878	3300072	3352266
Non-current financial assets	393706	346343	249206	225460	281906	327286	389013	258050	284991	279683	274826
Current assets	2321210	2380460	2340206	2411854	2462446	2460115	2510602	3078542	2835819	2911141	2986468
Inventory	1151483	1167582	1058416	1143544	1150475	1100155	1156342	1578676	1350600	1389103	1427606
Non-current receivables	160480	138170	214710	134570	113500	186110	379570	482860	406080	446040	486000
Current receivables	8312370	8771030	9301290	9039990	9946820	9975070	9061790	1045842	1039787	1062887	1085987
Current financial assets	30830	36460	28290	34550	0	0	0	370	-11270	-17400	-23530
Financial accounts	3193650	3260310	3274480	3474010	3059450	3438380	4111230	4057040	4039400	4162920	4286440
Accruals	136940	327250	100430	168120	144310	344250	245010	184610	240130	247630	255130

Source: own processing, balance sheets of agricultural cooperatives

Agriculture faces a set of critical challenges in the years ahead, including efficiency enhancement, resilience building, digitalization, and sustainability practices (*Licciardo et al., 2023*). Asset utilization efficiency can be determined by quantifying selected activity indicators presented in Table 3 for trading companies and Table 4 for cooperatives. The average time if trading companies realized the sale of inventory reached 117 days in relation to sales and 148 days in relation to costs. Comparing the sales from operations and the costs from operations, each year the sales from operations reached higher values than these costs in both legal forms. Comparing their values, cooperatives showed higher values for both indicators than trading companies. In agricultural cooperatives, it took an average of 150 days in relation to revenues and 199 days in relation to costs as long as there was a sale of inventories. Inventories were realised more quickly in trading companies, where their value was about half that of cooperatives. The average collection period for receivables was 119 days in both the trading companies and the agricultural cooperatives over the whole period analysed. The development of the indicator was almost at the same level, even though the average value of short-term receivables was higher in cooperatives by € 359, 879 than in trading companies. In terms of repayment of liabilities, whether in relation to sales or costs, agricultural cooperatives had a shorter repayment period. The average time taken to pay their debts was 100 days in relation to sales and 132 days in relation to costs. Trading companies took 56 days longer to repay their debts in relation to sales and 65 days longer in relation to costs. Comparing the collection period of receivables and the accounts payable turnover, it took longer for trading companies to pay their payables than to collect their receivables, which is disadvantageous to their trading partners. In terms of the comparison of the indicators of the collection period of receivables and the accounts payable turnover of the agricultural cooperatives, they repaid their debts in relation to their sales before they collected their debts by an average of about 19 days. The

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maturity of payables in relation to costs was longer each year than the collection of receivables. The average turnaround time for assets was faster in agricultural cooperatives, at 669 days, and 44 days faster in trading companies, at 713 days. In both legal forms, the value of the indicator declines by 2022 compared to 2015, indicating that farms were using their assets more efficiently.

Table 3: Development of selected activity indicators in trading companies in the Nitra region

Indicator/year	2015	2016	2017	2018	2019	2020	2021	2022	Average
Inventory turnover time (sales)	124	118	111	120	122	119	104	118	117
Inventory turnover time (costs)	154	144	142	155	151	152	139	147	148
Receivable collection period	138	107	124	112	121	112	107	129	119
Debt repayment ratio (sales)	188	180	158	177	154	129	125	138	156
Debt repayment ratio (costs)	233	221	201	229	192	164	167	172	197
Assets turnover ratio	711	652	698	732	756	716	747	690	713

Source: own processing

Table 4: Development of selected activity indicators in agricultural cooperatives in the Nitra region

Indicator/year	2015	2016	2017	2018	2019	2020	2021	2022	Average
Inventory turnover time (sales)	161	162	143	159	157	139	129	150	150
Inventory turnover time (costs)	208	211	196	204	204	190	183	198	199
Receivable collection period	116	121	126	126	136	126	101	99	119
Debt repayment ratio (sales)	110	111	102	110	97	86	86	94	100
Debt repayment ratio (costs)	142	146	140	141	125	117	122	125	132
Assets turnover ratio	686	702	669	711	718	685	605	580	669

Source: own processing

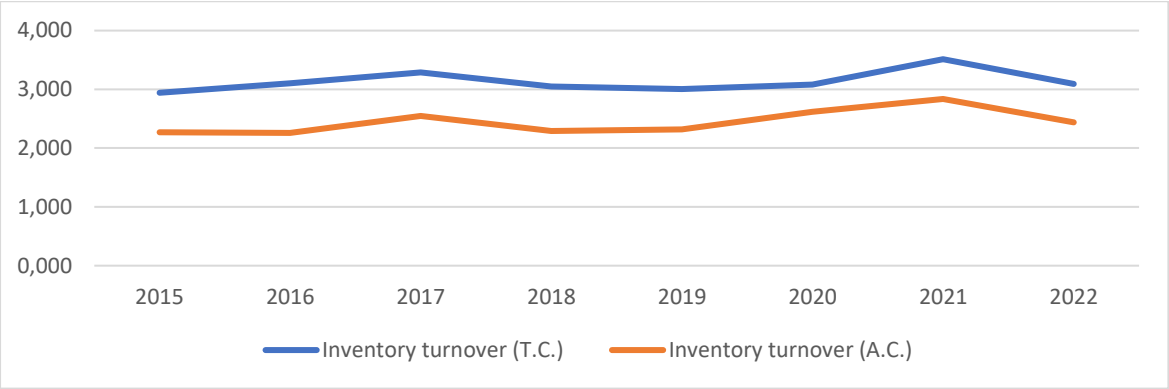

Figure 1: Development of inventory turnover ratio in trading companies and agricultural cooperatives

Source: own processing

Figure 1 shows the development of inventory turnover in both legal forms. Inventory turnover ratio is higher in trading companies, which logically follows from the development of the inventory turnover time indicators. In turnover time increases, turnover ratio decreases and vice-versa. The average time until inventories were realised within a year was more than 3 times in trading companies and more than 2.4 times in cooperatives.

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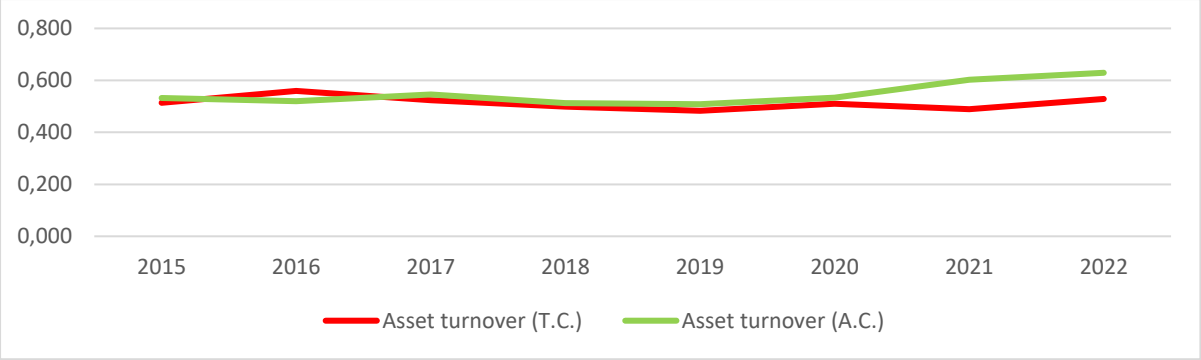

Figure 2: Development of assets turnover ratio in trading companies and agricultural cooperatives

Source: own processing

Figure 2 shows the evolution of the assets turnover ratio in both legal forms. As can be seen from the figure the development of the indicator is almost identical in both legal forms. There is a more pronounced deviation in 2021 and 2022, when the asset turnover of cooperatives exceeded the asset turnover of trading companies.

4. Conclusion

Labour (human resources) plays an important role in agricultural enterprises, but the assets of these enterprises and its forms are also valuable. Agricultural enterprises report both current and non-current assets, with a small part of assets being accured. The use of assets has a significant impact on the financial situation of agricultural enterprises. Non-current assets are predominant in the sample of agricultural enterprises in both legal forms. Through activity indicators we assessed the efficiency of the use of assets and their selected components. All indicators of turnover time have the required downward trend by 2022 compared to 2015, which indicates a better efficient use of assets in both legal forms. Trading companies and agricultural cooperatives in the Nitra region have areas for improvement in their operational and financial metrics. A common focus on improving inventory turnover, reducing receivable collection periods, and optimizing debt repayment can lead to enhanced liquidity, profitability, and long-term financial sustainability. Specific strategies tailored to each sector – such as optimizing asset utilization for trading companies and improving inventory management in agricultural cooperatives will help address the unique challenges of each group.

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Evaluating Socio-economic Trends in the EU: A Comparative Study of Living Standards using HICP and Economic Indicators

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Abstract

Paper's objective(s) and research background

The living standards of a population can be assessed from various perspectives, one of which is the analysis of household expenditure proportions among different demographic groups through the Harmonised Index of Consumer Prices (HICP). Shifts in consumer preferences, as reflected in the HICP's item weights, indicate economic changes and socio-economic trends across countries. This approach highlights the dynamic interplay between consumer behavior and broader societal conditions, with the HICP serving as a key tool for capturing these nuances. By examining these shifts, the HICP facilitates a comprehensive understanding of living standards, linking economic capabilities to socio-economic well-being. Thus, the HICP provides valuable insights into the evolving economic and socio-economic landscape of nations.

Data/Methods

The aim of this research is to examine shifts in consumer behavior and to classify European Union countries into clusters based on certain economic indicators for the period 2015 to 2022. This study specifically focuses on the components of the Harmonised Index of Consumer Prices (HICP), as well as GDP per capita, savings and investment rates, and other relevant economic metrics that are used as key benchmarks for comparing European Union countries. The analysis involves assessing both absolute and relative changes in consumer behavior, with the outcomes further analyzed through cluster analysis to facilitate a comparative review.

Results/Conclusions/Value added

Using the Average linkage method, the countries were organized into four distinct clusters. Nevertheless, Cyprus, Luxembourg, and Switzerland stand apart, each forming its own cluster due to the unique values of their variables. During the period 2015-2022, Slovakia has been among the countries with the highest weight of expenditure on housing, water, electricity, gas and with lowest weight of expenditure spent on health and transport as measured by the HICP.

Key words

Household food expenditures, consumption, HICP

JEL Classification

E21; E31

1. Introduction

The current state of living standards across European Union (EU) countries has been a subject of considerable interest and analysis in recent years. Living standards, which encompass a wide range of factors including income levels, health, education, and overall quality of life, are critical indicators of the well-being of a society. In the wake of global events such as the COVID-19 pandemic and sustained high levels of inflation following geopolitical tensions, the focus on living conditions and the most vulnerable groups in society has intensified. The significance of living conditions data in the face of disruptive global events and their role in policy-making is highlighted in the European Commission's (2023) document.

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1.2 Literature review of living standards in European Union

A numerous researchers have assessed the topic of living standards across Europe. This subsection summarize the findings of existing literature. While GDP remains the prevalent metric for accessing a country's wealth, it is increasingly recognized as inadequate for gauging the overall welfare. Report of Siglitz et al. (2009) proposes 12 recommendations to enhance the evaluation of economic performance, societal well-being, and sustainability. To provide a more comprehensive picture of how individuals are truly faring the authors reccomend to use GDP with other socio-economic indicators – like education, housing and employment – with subjective measures of life satisfaction, well-being, and quality of life. Birciaková et al. (2015) evaluated selected indicators of living standards, including economic, environmental and social factors using regression analysis to determine the most influential ones. The authors coclude, that the most reliable determinants of living standards are size and density of population, health care and education spending, while emissions of carbon dioxide appears to be least influential. Nolan (2020) in his research emphasizes the inadequacy of using per capita national income as a measure of household well-being. He proposes that the median income and a Gross National Income (GNI) adjusted for inequality are more accurate gauges for assessing living standards and promoting inclusive growth, especially in affluent nations such as those within the European Union.

A study by Cyrek and Cyrek (2023) explores the standard of living in rural areas compared to urban ones across the EU from 2010 to 2019 by analyzing spatial inequality in terms of standard of living and identifies reasons for differences between countries. The research clusters EU economies based on the Ward method and ranks the using aggregate measures of the relative living standards created with the usage of the Hellwig method. Rogge and Nijverseel (2019) quantify and analyze subjective quality of life in the EU countries as a multidimensional concept using subjective citizen satisfaction data on eight different life dimensions by composite index constructed using BoD method. Weziak-Bialowolska (2016) assessed the spatial variation in poverty within the EU, considering factors such as health, education, and living standards, highlighting a wide disparity. Denmark and Sweden rank as the wealthiest, while Latvia, Bulgaria and Romania are less prosperous. Some countries, like Denmark and Sweden, show uniform poverty levels nationwide, whereas others, notably Romania, Bulgaria, and Lithuania, exhibit significant regional poverty disparities.

1.1.1 HICP as a factor of living standards

The Harmonized Index of Consumer Prices (HICP) serves as a critical tool for tracking the average price changes faced by households, particularly in maintaining a consistent pattern of final monetary consumption expenditures. Wynne and Rodriguez-Palenzuela (2004) have elucidated this concept. The HICP methodology involves an annual revision of weights at the beginning of each year, reflecting the household consumption patterns from the previous year, and these weights remain unchanged until December. Studies such as Knetsch et al. (2022) have highlighted a close relationship between these weights and the quantitative effect on inflation, emphasizing the importance of this data for analysts and policymakers. Borrallo et al. (2022) further stress the necessity of accurately determining HICP weights, especially for food commodities, due to their significant impact on the HICP's overall composition. Lunnemann and Mathä (2004) discovered substantial heterogeneity across countries and indices within the EU15, the euro area, and its member states, using disaggregated price indices from the HICP. Lenart (2017) observed that in Baltic region countries, there is a notable seasonality in the weights of individual commodities in the HICP. This finding is echoed by Hupková (2016), and Páleník and Pauhófová (2005), who identified the share of population expenditures on food and non-alcoholic beverages as a significant indicator for assessing the quality of life and purchasing power. 'Household expenditures' encompass all expenses incurred by individuals or groups within a common household, including purchases made

within the domestic territory for direct need satisfaction, such as goods and services, self-produced goods consumption, and rental housing costs. Gonçalves et al. (2021) have indicated that the notable changes in household consumption during 2020 have been integrated into the latest HICP weights, which were utilized to compute the HICP inflation rates for 2021. Warzyniak (2016) in her research discusses the diversification of the standard of living among EU countries and the EU policy priority to reduce disparities in living standards.
The aim of this research is to examine shifts in consumer behavior and to classify European Union countries into clusters based on certain economic indicators representing quality of life for the period 2015 to 2022. We are assessing the concept of quality of life from the multivariate perspective rather than by an index measure, following concludements of Bramston et al. (2002), Potter et al. (2012) and Matarrita-Cancante (2010).

2. Data and Methods

All analyzed values of the examined indicators were drawn from the Eurostat database for the years 2015-2022. The basis of the examination consists of the weights of household consumption sectors defined in the Classification of Individual Consumption by Purpose (COICOP), and their usage is stated in the Eurostat methodology for the HICP. Simultaneously, the following were selected as basic economic indicators (ESA 2010;):
- the Gross household saving rate (B8G/(B6G+D8Net)*100; GHSR);
- the Gross debt-to-income ratio of households (AF4, liab)/(B6G+D8Net; GDIRofH);
- the share of Final consumption expenditure of households on Gross domestic product (C/GDP) at market prices in current prices, euro per capita.

The values of these indicators were determined for all countries of Europe; however, due to incomplete data, it was necessary to exclude Bulgaria, Iceland, Malta, Norway, Romania, Turkey, and Liechtenstein, as well as the newly formed countries Montenegro, Serbia, Kosovo, and North Macedonia. Consequently, 26 European countries will be compared in the end. Cluster analysis – the average method – will be applied for the comparison of consistency in the examined indicators. Cluster analysis is used for the identification and classification of different countries into groups with the maximum degree of association among countries in the same group and a minimum degree of association among countries in different clusters.

3. Results and Discussion

During the examined period, the Gross household saving rate indicator (ESA 2010; B8G/(B6G +D8Net) * 100) acquired negative values in several countries and in some, across multiple time periods (Greece, Serbia, Poland, etc.), with the minimum value of this indicator being recorded in 2018 in Greece at -5.97%. Similarly, the lowest savings value was reached by Switzerland in the same year but at a level of 20.42%, which is 5.64 percentage points lower than the highest recorded value of the Gross household saving rate in Switzerland in 2020 (26.06%). Under the conditions of the Slovak Republic, the Gross household saving rate achieved in the examined period ranged from 5.92-11.44%. The second assessed macroeconomic indicator was the Gross debt-to-income ratio of households (ESA 2010; AF4, liab / (B6G + D8Net)) which reached the lowest value, thus we can state that the lowest debt ratio is in Turkey, acquiring values from 16.85% to 27.19% (the lowest minimum and maximum values). The highest values of this indicator, both from the perspective of the minimum and maximum Gross household saving rate, were recorded for Denmark, which are in the range of 171.27 – 245.52%. The third factor examined was the share of Final consumption expenditure of households on Gross domestic product (C/GDP) at market prices in current prices, euro per capita (ESA 2010). The values of this indicator during the observed period ranged from 0.28 (Ireland) to 0.7 (Greece). Other examined factors were the weights of individual sectors or groups, presented in ‰, according

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to the Classification of individual consumption by purpose (COICOP) in various years in European countries. For all observed periods and economies, it holds that the highest share of household expenditures falls into the category 01- Food and non-alcoholic beverages, whose minimum and maximum values achieved in the examined period are graphically presented in Figure 1.

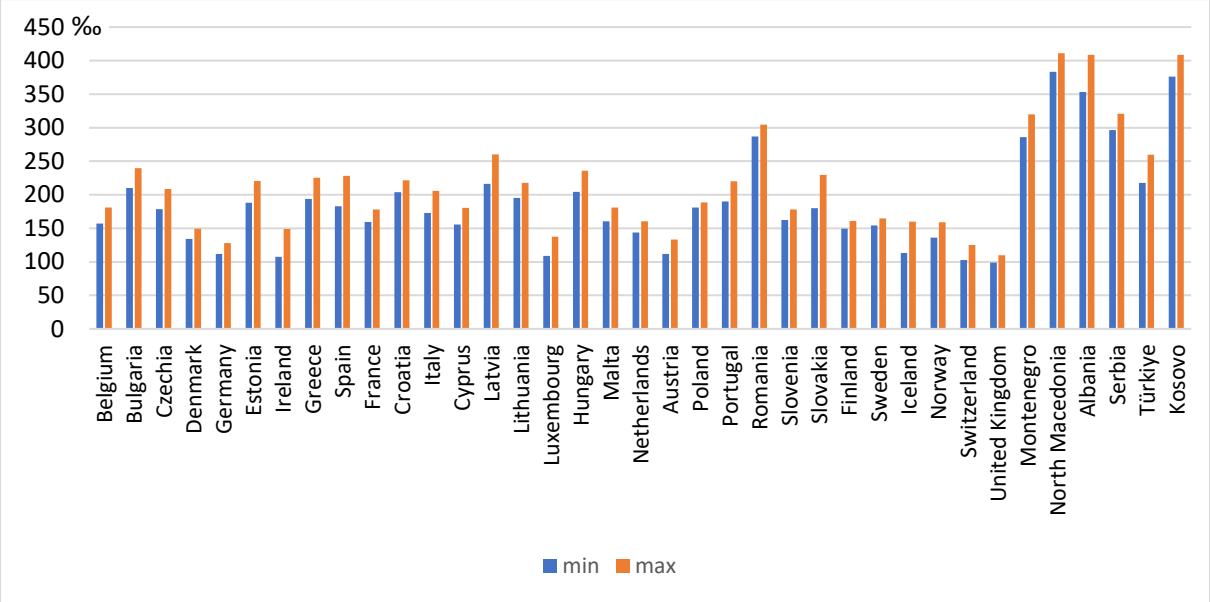

Figure 1: The minimum and maximum weight of the sector in HICP - 01 Food and non-alcoholic beverages during the examined period 2015-2022 (according to COICOP; in ‰)
Source: EUROSTAT, authors' processing

In the Figure 1, for comparison, the values of the indicator for countries that could not be included in the multidimensional comparison due to missing partial data are also shown, such as North Macedonia, where approximately 40% of household expenditures are made up of expenditures classified in the sector 01-Food. These values are very different from the expenditures of countries like the United Kingdom, Switzerland, or Austria, where only every tenth to eighth Euro of household expenditure is allocated for food provision. Within the examined periods, there is also a change in the weights of the individual sectors in the compared countries.

In Figure 2, through Box-plots, the basic descriptive characteristics for the weight indicator of sector 01-Food are illustrated for three countries with the smallest (Poland (7.57 p.p.; 4.19%), Sweden, and Finland) and the largest (Spain, Iceland, and Slovakia (49.66 p.p.; 27.58%)) volatility of weights, and at the same time, the share of this sector in the total HICP index for all EU-27 countries from 2020 (22.16 p.p.; 14.7%) is displayed for comparison.

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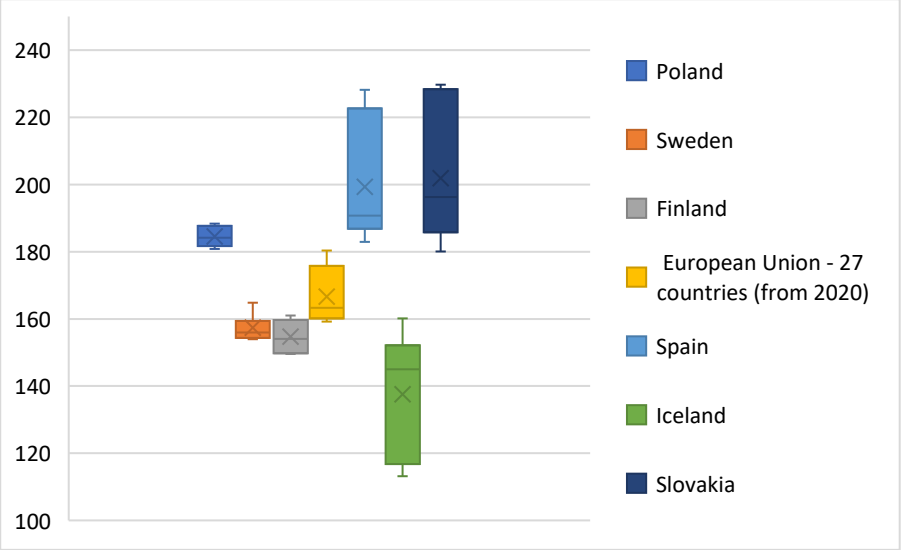

Figure 2: The range of weights of the HICP sector 01 - Food and non-alcoholic beverages in selected countries in the years 2015-2022 (in ‰)
Source: EUROSTAT, authors' processing

The weights of the individual sectors, or commodity groups, comprised a total of 16 indicators, which, along with macroeconomic indicators, entered as variables into the cluster analysis. Given the large number of indicators (19), it was necessary to verify whether there was any correlation between them. Except for a single case, where the correlation coefficient between the groups 01.01 Food and 01.02 Non-alcoholic beverages reached a value of 0.99, the values of all other pairwise correlation coefficients (in absolute value) ranged from (0.026; 0.595). This can be interpreted to mean that there is a weak to moderately strong dependency between the selected indicators, which will not affect the results of the cluster analysis.

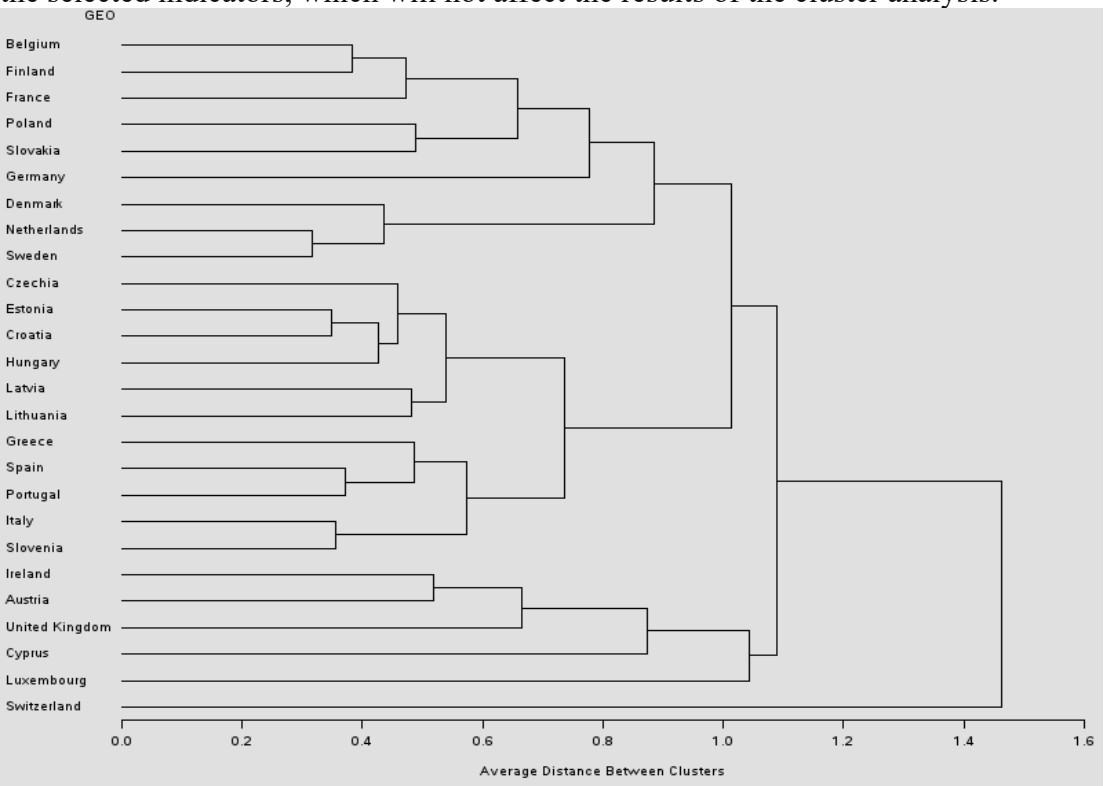

Figure 3: Dendogram – Average linkage
Source: EUROSTAT; authors' processing in SAS EG

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The dendrogram of the clustering process of countries based on the above-described indicators using the Average linkage method in the SAS EG environment is illustrated in Figure 3. From the given graphic presentation of the cluster analysis results (Figure 3) as well as its descriptive characteristics, it is evident that the optimal number of clusters can be the creation of 4 clusters of countries, with 3 other countries (Cyprus, Luxembourg, and Switzerland) forming separate clusters, the composition of which is listed in Table 1.

Table 1: Classification of the analyzed countries into clusters

Cluster number	Number of countries	Countries
1	3	Austria, Ireland, United Kingdom
2	6	Belgium, Finland, France, Germany, Poland, Slovakia
3	3	Denmark, Netherlands, Sweden
4	11	Croatia, Czechia, Estonia, Greece, Hungary, Italy, Latvia, Lithuania, Portugal, Slovenia, Spain
Cyprus	-	-
Luxembourg	-	-
Switzerland	-	-

Source: EUROSTAT; authors' processing in SAS EG

The grouping of countries is done based on the similarity of indicator values in individual clusters, so that there are the largest possible differences between the clusters. Table 2 lists the average values of selected indicators for each cluster, highlighting the values that influenced the non-inclusion of countries into any of the clusters.

Table 2: Average values of selected variables in individual clusters

Cluster	1	2	3	4	Cyprus	Luxembourg	Switzerland
GHSR	9.99	11.05	15.06	8.58	**4.55**	14.04	**22.18**
GDIRofH	109.66	87.29	189.38	60.54	135.81	172.08	189.20
C/GDP	0.47	0.52	0.44	0.55	0.62	**0.31**	0.50
Food (01.1)	101.41	149.22	133.14	183.69	155.15	104.16	**98.73**
Non-alcoholic (01.2)	12.46	15.63	14.90	17.89	15.75	15.70	9.38
Alcoholic (02.1)	21.97	28.13	20.95	29.78	23.11	28.89	11.40
Tabacco (02.2)	23.50	24.92	19.92	32.91	41.59	**73.46**	17.06
Housing (04)	132.32	181.59	169.63	121.82	**71.65**	116.28	210.60
Health (06)	47.57	55.53	35.06	49.80	53.13	22.38	**164.68**
Hospital (06.8)	18.86	10.51	2.09	5.42	8.70	1.85	**39.18**
Transport (07)	143.76	130.76	142.02	142.56	141.48	191.41	105.23
Recreation (09)	112.23	95.95	120.29	72.74	68.60	65.33	81.55
Restaurants (11)	150.32	66.37	77.44	105.48	176.05	87.28	88.83
Miscellaneous (12)	81.87	95.24	103.65	74.41	63.77	127.64	101.53

GHSR Gross household saving rate
GDIRofH Gross debt-to-income ratio of households
C/GDP Final consumption expenditure of households on GDP
01.1 Food
01.2 Non-alcoholic beverages
02.1 Alcoholic beverages
02.2 Tobacco
04 Housing, water, electricity, gas
06 Health
06.3 Hospital services
07 Transport
09 Recreation and culture
11 Restaurants and hotels
12 Miscellaneous goods and services

Source: EUROSTAT; authors' processing in SAS EG

For countries classified into the first cluster, a characteristic feature is the low share of expenditures on food (01-Food) and high weights for the group 06.8 (Hospital services) and

sector 11-Restaurants and hotels. For the 6 countries included in the second cluster, the highest share of expenditures is characteristic in sector 4-Housing, water, electricity, gas with a share of 181.59‰, which is 2.5 times the share of such expenditures in Cyprus. However, these countries also have the lowest share of expenditures in sectors 6-Health (55.53‰) and 07-Transport (130.76‰). Denmark, the Netherlands, and Sweden form cluster 3, which is characterized by the highest average values in macroeconomic indicators: Gross household saving rate (15.06%) and Gross debt-to-income ratio of households (189.38%), and in COICOP sectors 09-Recreation and culture and 12-Miscellaneous goods and services, with shares of 102.29‰ and 103.65‰, respectively. This can be interpreted to mean that every tenth monetary unit of household expenditure is consumed for the purpose of recreation and similarly on Miscellaneous goods and services. Countries in this cluster, like Luxembourg, have the lowest share of household expenditure on GDP at 0.44 (Luxembourg 0.31) and expenditures in sector 06-Health with shares of 35.06‰ and 22.38‰, respectively. The last, fourth cluster is the most numerous and is formed by 11 countries (Table 1), and to some extent, it can be stated that it is the opposite of the previous cluster, as the average values of the indicators of the above-described variables acquire minimum values, namely in macroeconomic indicators: Gross household saving rate (8.58%) and Gross debt-to-income ratio of households (60.54%), and in COICOP sectors 09-Recreation and culture and 12-Miscellaneous goods and services, with shares of 72.74‰ and 74.41‰, respectively.

4. Conclusion

The aim of this research is to examine shifts in consumer behavior and to classify European Union countries into clusters based on certain economic indicators for the period 2015 to 2022. From the original 38 European countries compared according to COICOP sector weights used in the construction of the national HICP, only 26 European countries could be included in the cluster analysis due to missing relevant macroeconomic indicators. After applying the Average linkage method, these countries were classified into 4 clusters; however, 3 countries, specifically Cyprus, Luxembourg, and Switzerland, based on their assessed variable values, form separate clusters. The countries excluded from the study are predominantly from Southern or Southeastern Europe, whether they are EU member states (Bulgaria, Romania, Malta) or countries aspiring to EU membership (Albania, Bosnia and Herzegovina, Montenegro, Serbia, Türkiye), or some that have only recently been recognized as independent countries (North Macedonia, Kosovo). The first cluster of countries (Ireland, Austria and United Kingdom) is typical with lowest share of expenditures spend on food and non-alcoholic beverages, but highest share of expenditures spent on restaurants and hotels and hospital services. Slovakia belongs to the second cluster of countries together with Belgium, Finland, France, Germany and Poland. These countries have highest average shares of spending on housing, water, electricity, gas and lowest shares of spending on health services and transport. Denmark, Netherlands and Sweden form third cluster typical with highest average values of macroeconomic indicators, such as gross household saving rate, gross debt-to-income ratio of households and by highest shares of spending on recreation and culture and miscellaneous goods and services. Luxembourg is a country with lowest shares of household expenditures on GDP and health sector. The fourth cluster is formed by 11 countries (South and East European countries) characterized with minimum values of gross household saving rate, gross debt-to-income ratio of households, lowest shares of spending on recreation and culture and miscellaneous goods and services. The stated findings will form the basis for further research addressed in subsequent projects and diploma theses.

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Small and Medium Enterprises in Global Value Chains: Insights from Theoretical Perspectives

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Abstract

The paper's objectives and research background

Global value chains are often considered the lead story of trade in the modern world, with an estimated 80 percent of international trade occurring through them. Small and medium enterprises (SMEs) are vital in integrating GVCs, contributing to economic growth and innovation. They are estimated to account for between 80-99 percent of firms in any given country and between 60-70 percent of global employment. Regardless of the nebulous way SMEs are defined, they are not well represented in international trade and GVCs worldwide. The paper summarizes knowledge about SMEs´ position in global trade based on available thematic resources. The importance and spillovers for SMEs participating in GVCs are named, addressing the obstacles small and medium enterprises face while participating in international trade relations.

Data/Methods

The study summarizes available literature on small and medium enterprises´ participation in global value chains. It uses a qualitative content analysis method to work with the basic definitions, followed by describing the current state of small and medium enterprises in global trade in European and Asian regions and the different obstacles SMEs face regarding participation in international trade.

Results/Conclusions/Value added.

The study defined that regardless of the ratio of SMEs compared to large firms, they could be better represented in international trade and GVC worldwide. Existing research claims that the smaller the company, the less export-oriented it is. The Eurostat database shows that only 41% of small companies participate in international trade, while the participation ratios of medium and large enterprises are 67% and 93%, respectively. Possible reasons for such situations were analyzed, defining obstacles small and medium enterprises can have regarding participating in global trade.

Keywords

Export; import; global trade; global value chains; small and medium enterprises

JEL Classification

F41, F60

1. Introduction

Approximately 80% of international trade is thought to occur through global value chains (GVCs), making them the main trade feature in the modern world (Agarwal et al., 2022). Regarding the global economy, in most cases, thematic literature analyses large organizations´ or multinational companies´ contributions. On the contrary, our research will focus on small and medium enterprises.

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Global value chains have become a dominant factor in international trade, representing a key aspect of economic interdependence across countries (Antraś, 2020; Beverelli et al., 2019; Wang et al., 2022). As companies spread across the globe in search of lower costs, production chains have become increasingly geographically fragmented. According to Pástor and Belvoncíková (2015), global value chains are related to the deepening international division of labor, manifested by the fragmentation of production operations into different countries. Countries specialize in those parts of the production process in which they have a particular advantage. Antraś (2020) describes GVCs as a series of production stages of a product or service sold to consumers, with value added at each production level and at least two production stages in different countries.

Cigna et al. (2022) define global value chains as the linkages that have emerged as the dominant production paradigm over the past 40 years. Advances in information and transportation technologies and falling trade barriers since the 1980s have forced firms to divide production into tasks and stages performed in different countries, thus creating global value chains. More than solely exporters or importers, firms participating in these networks share backward linkages with suppliers and forward linkages with customers along the entire value chain (Siewers et al., 2024). According to Errico et al. (2024), involvement in GVCs would allow individual firms to exploit financing opportunities provided by trading partners and other advantages related to foreign activities.

Small and medium-sized enterprises (SMEs) are a focal point in shaping European Union (EU) enterprise policy. The European Commission considers SMEs the backbone of Europe's economy, representing 99% of all businesses in the EU (Eurostat, 2022). Moreover, the situation is similar not only in the European continent but also worldwide. For instance, according to Abe and Proksch (2017), SMEs remain a critical source of employment creation and income generation in Asia and the Pacific, employing more employees per unit of capital invested than larger enterprises.

As for a definition based on quantitative information (for example, the number of employees), small and medium enterprises differ in different world parts (Abe & Proksch, 2017). The European Commission (Eurostat, 2022) defines SMEs as those enterprises employing fewer than 250 persons. SMEs are further divided into micro (less than 10 people), small (less than 50 employees), and medium-sized (less than 250 employees) companies.

In the study of Gamage et al. (2020), it is claimed that small and medium enterprises play an essential role in the global economies of both developed and developing countries. Furthermore, the article from Vasani and Abdulkareem (2024) emphasizes the critical role of SMEs in India's export market and the broader economy, stating that these firms are crucial for economies, mainly in emerging nations. SMEs are the world's most common type of business. In the European Union, they are the predominant businesses and the primary driver of employment, gross domestic product, and innovation (European Commission, 2021).

Small and medium-sized businesses contribute significantly to global economic development. They are thought to make up between 60 and 70 percent of all jobs worldwide and 80–99 percent of companies in any nation (World Trade Organization [WTO], 2016). SMEs have a plethora of options within global value chains. By taking part in value chains, they can reach a wide range of consumers, gain knowledge from big businesses, and compete in and survive in highly competitive global markets. For SMEs, however, the penetration of global value chains also poses significant and intimidating hurdles (Asian Development Bank [ADB], 2015; Dahal & Kharel, 2021).

Regardless of the nebulous way SMEs are defined, they are not well represented in international trade and GVC worldwide (WTO, 2016). In countries such as France, Germany, Slovakia, and Sweden, SMEs account for only 30 to 40 percent of gross exports, well below their contribution to value creation and employment. This is a distinct difference between large

and small firms, given that most large businesses are international exporters (World Bank, 2019). Similar situations also occur in other regions, such as Asia. Mukherjee et al. (2022) claimed that micro, small, and medium enterprises constitute around 30% of the gross domestic product, 50% of exports, and a significant share of employment in India. However, they are not represented in sufficient volume in international trade.
This study's foundation is mainly based on earlier research on the topic. The work includes a literature review defining GVCs and SMEs and analyzing SMEs' participation in GVCs. It also describes SMEs' current constraints in participating in global trade, relying on available literature in scientific databases.

2. Data and Methods

This article is primarily based on secondary data, with the methodology predominantly involving qualitative content analysis. The method was used to work with the definitions and existing literature addressing the problematics. In the case of small and medium enterprises, the European Commission report on SMEs was used to obtain secondary data for further analysis. The analyses of European and Asian countries were mainly used in the study.

The study results analyze different aspects of the connection between global value chains and small and medium enterprises. It uses a comparative analysis between various types of firms. As for the measurement of GVC participation, the World Bank (2019) approach was used, where imports and exports are part of GVC participation. Using the Eurostat database (datasets [sbs_sc_ovw] and [ext_tec01]), data about the number of micro, small, medium, and large enterprises in the European Union are compared to the percentage of each type of enterprise´s participation in exports and imports. For the comparative table (Table 1), 2021 was chosen as a year for comparison since it is the latest available data in the [ext_tec01] dataset at the time of the article creation.

In addition, the importance of SMEs' participation in GVC and the obstacles to such involvement were analyzed based on existing research. The 2020 World Bank Enterprise Survey (WBES) and available scientific literature were used to obtain secondary data about the obstacles SMEs perceive as the most crucial.

3. Results and Discussion

Regardless of the ratio of SMEs compared to large firms, they are not well represented in international trade and GVCs worldwide (WTO, 2016). Given the positive effects GVCs have been shown to bring, it is worth considering how to include more small firms in global production networks. For example, according to Kowalski et al. (2015), participation in GVC is associated with increased productivity, the export of more sophisticated products, and a more diversified national export basket.

Table 2 illustrates the current position of different types of enterprises in the European Union concerning international trade. The table shows that the larger the enterprise, the larger the percentage of companies participating in global trade. In the case of micro-enterprises, their ratio among all EU companies is the largest (more than 94%). Micro-enterprises have the lowest participation in international trade, with only 11.54%. Additionally, an apparent regularity is seen in the growing export and import participation rate as the companies´ size rises.

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Table 6 EU Enterprises in International Trade, 2021

Type of an enterprise	Number of enterprises in the EU	Number of exporting and importing enterprises	Percentage of exporting and importing enterprises
Micro	29 159 581	3 366 431	11.54%
Small	1 532 469	632 136	41.25%
Medium	240 000	161 717	67.38%
Large	51 000	47 398	92.94%

Source: own processing (2024) based on Eurostat (2021 a,b)

The necessity of incorporating SMEs into GVCs has previously been questioned due to the high competition and legal standards that some consider exceedingly tricky for SMEs to meet. This has led to the idea that only major multinational corporations can participate in GVCs, while SMEs must limit themselves to domestic operations (Brazinskas & Beinoravicius, 2014). This is because SMEs confront size limits in both local and international markets, exposing them to more significant risks than larger enterprises. However, due to the recent decades' drop in shipping costs and other hurdles that have enabled the fragmentation of manufacturing processes across borders, reconfiguring global trade, and making it more straightforward for SMEs to engage in GVCs, this concept is fast losing traction (Kristensen & Lilja, 2011).

Still, in several reports (World Bank, 2019; Ganne & Lundquist, 2019), the authors concluded that the smaller the company, the less export-oriented it is. Only a marginal number of micro companies export, while the participation of medium-sized companies in exports and imports is similar to that of large businesses. To a large extent, participation in global trade remains a "big firm story" in developed economies, except in some niche markets.

In their study, Epede and Wang (2022) did a three-step literature review, aiming to identify the specific factors that could enable developing country SMEs to collect, transfer, and transform the knowledge that they are exposed to thanks to their GVCs linkages while stressing the necessity of integrating SMEs into GVCs. The authors concluded that participation in the global value chain is essential for boosting company value, particularly for small and medium-sized businesses. Still, it will not be enough if done incorrectly. Furthermore, various enabling variables can facilitate the international insertion of SMEs, even in the face of the restrictive business environments prevalent in most developing nations, which provide significant barriers to SMEs' GVCs participation.

An empirical study from Stolzenburg, Taglioni, and Winkler (2019), dedicated to GVCs upgrading in developing and industrialized countries, states that the requirement for foreign buyers and customers for specialized and distinctive goods and services is one of the key causes propelling SMEs' involvement in GVCs. SMEs may provide customized solutions that cater to their client's needs and preferences using adaptability, inventiveness, and specialized knowledge. On the other hand, participation in GVCs can allow SMEs to acquire the information they need to upgrade in their sector and obtain a more decisive competitive advantage. Hence, it also helps developing economies expand overall.

As mentioned in different studies (Dallas et al., 2019; Su & Khan, 2020), firms gain various resources (e.g., product designs and market trends) through networks, facilitating their initial internationalization. Network relationships, especially customer relations, help firms learn about markets, designs, and sales. This compensates for and supplements their lack of foreign

market knowledge and resources. This claim is supported by the analysis from Wang & Xin (2024), which proved that GVC participation has a positive effect on SMEs' knowledge depth.

However, firm-level evidence (Ganne & Lundquist, 2019; WTO, 2016) reveals that despite SMEs making up the vast majority of firms in developed and developing countries, SMEs direct and indirect participation in GVCs remains limited relative to their share of overall activity and employment compared to large firms. Several studies have addressed the insufficient involvement of SMEs in global trade in southern Asian countries. For instance, as mentioned in the study of Mukherjee et al. (2022), the Indian central government intends to increase the share of SMEs in exports by 60% in the next 5 years. The government also plans to expand the contribution of the SMEs to 40% of the gross domestic product.

Following the grounded theory, the study from Abe and Proksch (2017) examines current policy measures, acts, documents, studies, and other secondary materials on SMEs' participation in GVCs, mainly in Asia and the Pacific. The article provides seven policy approaches for enhancing SMEs' effective participation in GVCs: SME development, trade policy, trade facilitation, regional economic integration, promotion of foreign direct investments, SME cluster, and national innovation system.

3.1 Barriers of SMEs to GVC Participation

There are different reasons why small and medium enterprises do not participate in global trade as much as they contribute to the world economy. According to Abe & Proksch (2017), to effectively participate in GVCs, SMEs must break high entry barriers by meeting increasingly stringent global standards concerning quality, price, timely delivery, and flexibility.

Access to finance is a crucial success factor for SMEs to participate in global value chains. The SMEs surveyed in the Asian Development Bank study (2015) demanded long-term funding from formal financial institutions to survive and grow in global value chains. The changing business environment brought by economic integration and foreign direct investments has encouraged SMEs to shift their business models from domestically focused to globally competitive. This requires new financing solutions for SMEs participating in global value chains.

Some of the other significant obstacles for small and medium enterprises to join global value chains include high tariffs on raw materials and intermediate goods, a lack of information about current facilities and incentives, a lack of trade and market intelligence, and a workforce that lacks the necessary training or skills (Dahal & Kharel, 2021).

The study of Su and Khan (2020) also highlights negative factors, such as concerns over competition, resource sharing, and design protection, that prevent firms from forming genuine international cooperation. Furthermore, SMEs frequently battle the risk of being overly dependent on important clients or suppliers in the value chain, which leaves them open to disruptions like market changes or supply shortages. To address these issues, robust risk management plans, flexible supply chain procedures, and purposeful partnership diversity are needed.

The World Bank Enterprise Survey (WBES, 2020) published a report in which owner-managers of SMEs in manufacturing, sales, and other service industries were asked to name their company's most significant difficulty. For the Europe and Central Asia region, 21.6% of firms identified an inadequately educated workforce as their biggest obstacle; 17.9% chose tax rates as their most significant difficulty in running a business; 10% voted for practices of the informal sector, and 10% of the firms – for political instability as their biggest challenge.

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3.2 Limitations of the study

Despite SMEs constituting a significant portion of firms globally, their representation in GVC literature is often overshadowed by larger multinational corporations. This discrepancy can lead to a skewed understanding of their role and contributions. In addition, much of the existing research is cross-sectional, providing a snapshot rather than a comprehensive view over time. Longitudinal studies are needed to understand how SME participation evolves with changing global dynamics.

Another limitation is that collecting data about SMEs' participation in GVCs is generally complicated. In their article, Ganne and Lundquist (2019) claim that the extent to which SMEs participate in GVCs is challenging to assess correctly. The availability of international trade data by enterprise size remains limited, making analysis difficult and often partial. Moreover, while GVCs trade is usually understood as trade in intermediates, available data sets do not necessarily distinguish between direct exports of final products and those of intermediates.

Additionally, specific regional disparities in the available thematic studies are another limitation of the study. Most of the literature (ADB, 2015; Dahal & Kharel, 2021; Su & Khan, 2020, etc.) dedicated to measuring GVC effects on SMEs was implemented in Asian countries—moreover, most of the research searches for a connection between SMEs and GVCs in developing economies. Regarding the existing resources, it is assumed that space for this type of research is opening in developed and emerging economies of Central and Eastern Europe.

While many studies highlight challenges SMEs face, actionable policy recommendations that could facilitate better integration into GVCs are often lacking. This gap limits policymakers' practical applicability of research findings. Moreover, existing literature frequently emphasizes economic metrics without adequately considering social and environmental factors that affect SME participation and sustainability within GVCs.

4. Conclusion

Global value chains (GVCs) are gradually altering international trade and the global economy, with important implications for employment and gross domestic product. With GVCs representing the new type of business organization that is widely affecting operations in many country business sectors, there has been increased interest in the integration of SMEs into GVCs and the possible spillover effects of their GVC participation on local enterprises and economies (Epede & Wang, 2022).

Small and medium-sized enterprises (SMEs) form the foundation of many economies worldwide, helping to create jobs, add value, and decrease poverty. The literature is emerging with evidence that integrating SMEs into GVCs improves their ability to contribute to the growth of their home economies (Epede & Wang, 2022; Wang & Xin, 2024; Abe & Proksch, 2017). Moreover, participating in GVC allows SMEs to expand their demand, obtain new production technologies and know-how, and create relations with other international firms and enterprises.

The study emphasized the need to integrate SMEs into GVCs and the barriers that may impede their internationalization process. The limitations of available resources were formulated through the qualitative research of scientific literature. It is essential to note that this study is primarily based on previously published works on the subject. Additional empirical and policy research is anticipated to expand our knowledge of current issues and produce helpful policy recommendations.

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Understanding V4 Trade Dynamics Before and After Key Global Events: an Empirical Analysis

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Abstract

This paper identifies structural breaks within the trade time series data of the Visegrad countries (V4). It meticulously examines the alignment of these breakpoints with significant historical events, including accession to the European Union, the ramifications of the global financial crisis, and the unprecedented disruptions caused by the COVID-19 pandemic.

Data comes from the Eurostat database, enclosing a detailed monthly time series of intra-Visegrad (V4) imports and exports from January 1999 to January 2024. Our methodological framework uses a robust analytical tool suite to dissect and analyze structural breaks occurring at undetermined points in time within this period. We employ the Bai & Perron methodology for the simultaneous estimation of multiple breakpoints in the data trend.

Our analysis covered key points affecting trade dynamics among the Visegrad Group (V4) countries, spanning from the entry into the European Union in 2004 through the financial and geopolitical challenges up to 2023. The accession to the EU catalyzed a significant increase in trade volumes and economic interdependence, enhancing the exchange of goods, services, capital, and labor and fostering competitiveness within the V4. Conversely, the Global Financial Crisis 2008 dramatically disrupted these dynamics, illustrating the susceptibility of interconnected economies to global shocks and underscoring the need for resilient economic strategies. Furthermore, a decline in trade dynamics preceding the COVID-19 pandemic points to systemic vulnerabilities influenced by geopolitical tensions, policy shifts, and technological changes. Lastly, the limited time series data available complicates the analysis of the economic recovery post-COVID-19 and the impact of the 2022-2023 geopolitical events.

This underscores the role of such global crises as catalysts that accelerated the decline in economic activity rather than being the primary causes of these declines. The temporal precedence of these breaks highlights the sensitivity of the V4 economies to pre-crisis vulnerabilities.

Key words

Global Economic Events; International Trade; Time Series Analysis; Trade Dynamics; Structural Breaks; Visegrad Countries

JEL Classification

C22 Time-Series Model, F14 Empirical Studies of Trade

1. Introduction

The analysis of structural breaks gained significant traction following the seminal work of (Perron, 1989), who conducted tests for breaks in economic series, thereby challenging the prior assumption by (Nelson & Plosser, 1982) hat economic data were inherently non-stationary and devoid of structural breaks. Initial methodologies predominantly employed

retrospective analysis, utilizing the entire dataset to identify breaks at unspecified times. In our paper, we use the "strucchange" R package (Zeileis et al., 2002), which implements the sequential procedure developed by Bai and Perron. This procedure allows for determining the optimal number of breakpoints based on various information criteria, as detailed in (Bai & Perron, 1998) and further elaborated in (Bai & Perron, 2003).

2. Data and Methods

Our methodology aligns with the approaches documented by (Hegerty, 2022), (Li, Lai, Wang, & Hsu, 2019), (Tommaso & Pauwels, 2006), (Jayanthakumaran & Pahlavani, 2007) and (Ketenci, 2016) to examine the impact of global and European events on trade dynamics among the Visegrad Group (V4) countries. The V4, an informal alliance comprising Czechia, Slovakia, Poland, and Hungary, was established to facilitate close cooperation among these nations. While our study does not assess the direct outcomes of this collaboration, it primarily investigates the susceptibility of V4 intra-trade to fluctuations triggered by significant worldwide or European affairs.

International trade is often challenged by suffering in statistical accuracy, where the recorded value (or volume) of trade differs between exporting and importing countries. Such variations are frequently attributed to factors such as indirect taxes. A common practice of tax evasion involves overreporting exports due to value-added tax refunds. Consequently, our analysis incorporates export and import time series data to mitigate these discrepancies and better understand trade dynamics. Despite these efforts, the time series data are notably similar, with exports generally exceeding imports, although by a marginal percentage, typically within a few points.

For our analysis, we utilize the Eurostat database dataset [ds-045409] (Eurostat, 2024), specifically export and import values in euros reported by the V4 countries with their V4 partners. The dataset provides a comprehensive monthly time series from January 1999 to January 2024, encompassing 301 data points. This extensive period allows for a detailed examination of trade patterns and trends within the Visegrad Group over 25 years.

Our export time series is the sum of all intra-V4 countries' exports, i.e., we sum up 12 between countries' exports to obtain the total value of intra-V4 trade measured as export. We followed the same procedure with the import time series. Then, we deflated the values using Euro area HPCI to obtain volumes (price changes adjusted time series). The last step of preparing data was the seasonal adjustment. We use Seasonal Extraction in ARIMA Time Series (SEATS decomposition) from R's “seasonal” package. SEATS employs an unobserved component approach where the time series is decomposed into trend, seasonal, irregular, and transitory components using ARIMA models (Gómez & Maraval, 1996). The method is based on the Wiener-Kolmogorov filter theory, which seeks to extract the signal (seasonal and trend components) from the noise (irregular components) through an optimal linear filter designed within the framework of ARIMA models. SEATS provides a robust framework for analyzing seasonal variations in time series, making it indispensable for detailed time series analysis.

The seasonally adjusted time series of actual volume and linear trend lines is depicted in Figure 1. To confirm trend stationarity within this data, appropriate statistical tests are conducted. Following the stationarity verification, we identify any structural breaks in the time series.

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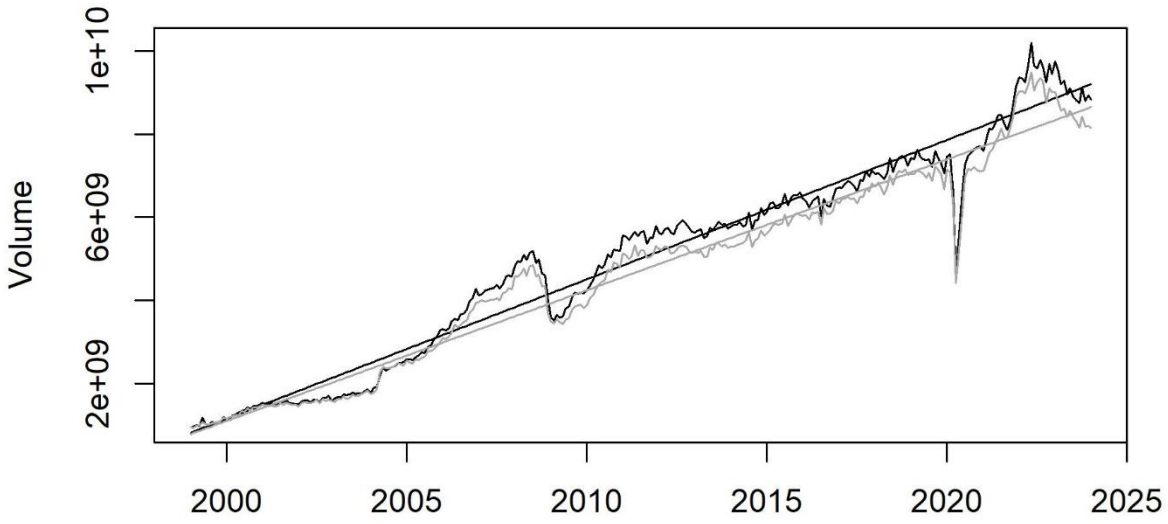

Figure 1 Seasonally adjusted intra-V4 trade (reported as export and import)
Source: Eurostat database and author's calculations

3. Results and Discussion

We initially performed a stationarity test to analyze the time series behavior comprehensively. For this purpose, we employ both the Augmented Dickey-Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, utilizing the "urca" package in R. These tests are instrumental in determining the presence of unit roots and the stationarity of the series, providing a foundational assessment of the data's characteristics.

The ADF test tests the model:

$$\Delta y_t = a_0 + \gamma y_{t-1} + a_2 t + e_t \quad (1)$$

With the H_0 hypotheses:

$\gamma = 0$, presence of unit root (i.e. non-stationarity), $test\ statistics: \tau_3$

$\gamma = a_2 = 0$, presence of unit root and no trend, $test\ staistics: \phi_3$

$a_0 = \gamma = a_2 = 0$, presence of unit root, no trend, and no drift, $test\ statistics: \phi_2$

The results are:

```
export
# Augmented Dickey-Fuller Test Unit Root Test #
Test regression trend
Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
Residuals:
       Min         1Q     Median         3Q        Max
-2.122e+09 -7.424e+07 -4.237e+06  9.134e+07  8.016e+08
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.081e+08  3.240e+07   3.336 0.000959 ***
z.lag.1     -1.031e-01  2.562e-02  -4.025 7.24e-05 ***
tt           2.868e+06  7.318e+05   3.920 0.000110 ***
z.diff.lag   6.931e-02  5.814e-02   1.192 0.234203
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 219700000 on 295 degrees of freedom
Multiple R-squared:  0.0524,  Adjusted R-squared:  0.04276
F-statistic: 5.437 on 3 and 295 DF,  p-value: 0.001187
The value of test-statistic is: -4.0252 6.7655 8.1075
Critical values for test statistics:
      1pct  5pct 10pct
```

```
tau3 -3.98 -3.42 -3.13
phi2  6.15  4.71  4.05
phi3  8.34  6.30  5.36

import
# Augmented Dickey-Fuller Test Unit Root Test #
Test regression trend
Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
Residuals:
       Min         1Q     Median         3Q        Max
-1.883e+09 -6.593e+07 -4.809e+06  7.071e+07  6.572e+08
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.010e+08  2.940e+07   3.436 0.000676 ***
z.lag.1     -1.008e-01  2.501e-02  -4.033 7.02e-05 ***
tt           2.625e+06  6.698e+05   3.919 0.000110 ***
z.diff.lag   1.036e-01  5.801e-02   1.786 0.075067 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Residual standard error: 195700000 on 295 degrees of freedom
Multiple R-squared:  0.05497,Adjusted R-squared:  0.04536
F-statistic:  5.72 on 3 and 295 DF,  p-value: 0.0008115
Value of test-statistic is: -4.0329 6.7692 8.1487
Critical values for test statistics:
      1pct  5pct 10pct
tau3 -3.98 -3.42 -3.13
phi2  6.15  4.71  4.05
phi3  8.34  6.30  5.36
```

The test statistics exhibit extremity when compared against the 5% significance levels of critical values, leading to rejecting all null hypotheses. Both time series lack unit roots and exhibit drifts and time trends. These findings are considered robust, given that the Augmented Dickey-Fuller (ADF) test typically exhibits a bias toward non-rejection of null hypotheses. Additionally, we employed the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, which assumes the null hypothesis of trend stationarity, characterized by a deterministic trend with stationary residuals. The KPSS test further scrutinizes the model:

$$y_t = \delta t + r_t + e_t, \qquad (2)$$

where δt is the deterministic trend, r_t is the random walk, and e_t is the stationary error with zero mean. The random walk can be displayed as

$$r_t = r_{t-1} + v_t, \qquad (3)$$

where v_t is $iid(0, \sigma_v^2)$ and r_0 is the equations intercept. The null hypothesis implies that $\sigma_v^2 = 0$. This results in y_t being trend stationary and KPSS tests if there is a unit root in r_t when δ is not zero.

```
export
# KPSS Unit Root Test #
Test is of type: tau with 15 lags.
Value of test-statistic is: 0.108
Critical value for a significance level of:
                10pct  5pct 2.5pct  1pct
critical values 0.119 0.146  0.176 0.216

import
# KPSS Unit Root Test #
Test is of type: tau with 15 lags.
Value of test-statistic is: 0.0746
Critical value for a significance level of:
                10pct  5pct 2.5pct  1pct
critical values 0.119 0.146  0.176 0.216
```

In both cases, we cannot reject the null hypothesis. Both time series exhibit stationary trends, rendering them appropriate for analysis of structural breaks within those trends. In the time series depicted in Figure 1, it is apparent that the existing global trend does not adequately

represent the data, suggesting the presence of breaks in the trend. Upon calculating these breaks, we obtain:

```
export
        Optimal (m+1)-segment partition:
Call:
breakpoints.formula(formula = my_ts ~ tt, h = 0.1)
Corresponding to breakdates:

m = 1                   2005(9)
m = 2                   2005(11)                                          2021(5)
m = 3           2004(3)           2008(9)                                 2021(7)
m = 4           2004(3)           2008(11) 2011(8)                        2021(5)
m = 5           2004(3)           2008(11) 2011(8)                  2018(5)  2021(2)
m = 6           2004(3)           2008(11) 2011(5) 2014(10)         2018(5)  2021(2)
m = 7           2003(9)  2006(5)  2008(11) 2011(5) 2014(10)         2018(5)  2021(2)
m = 8           2003(9)  2006(5)  2008(11) 2011(5) 2013(11) 2016(5) 2018(11) 2021(5)
m = 9   2001(6) 2003(12) 2006(6)  2008(12) 2011(6) 2013(12) 2016(6) 2019(1)  2021(7)

m   0         1         2         3         4         5         6         7         8         9
RSS 7.744e+19 6.303e+19 4.524e+19 3.750e+19 2.779e+19 2.646e+19 2.575e+19 2.551e+19 2.588e+19 2.658e+19
BIC 1.294e+04 1.289e+04 1.281e+04 1.277e+04 1.270e+04 1.270e+04 1.271e+04 1.272e+04 1.275e+04 1.277e+04


import
        Optimal (m+1)-segment partition:
Call:
breakpoints.formula(formula = my_ts ~ tt, h = 0.1)
Corresponding to breakdates:

m = 1                                                                     2021(7)
m = 2                   2005(12)                                          2021(6)
m = 3           2004(3)           2008(9)                                 2021(7)
m = 4           2004(3)           2008(11) 2011(8)                        2021(6)
m = 5           2004(3)           2008(11) 2011(8)          2017(9)       2021(5)
m = 6           2004(3)           2008(11) 2011(5) 2013(11)         2018(12) 2021(6)
m = 7           2003(4)  2006(4)  2008(11) 2011(5) 2013(11)         2018(12) 2021(6)
m = 8           2003(4)  2006(4)  2008(11) 2011(5) 2013(12) 2016(6) 2018(12) 2021(6)
m = 9   2001(6) 2003(12) 2006(6)  2008(12) 2011(6) 2013(12) 2016(6) 2018(12) 2021(6)

m   0         1         2         3         4         5         6         7         8         9
RSS 6.459e+19 5.349e+19 3.856e+19 3.092e+19 2.509e+19 2.386e+19 2.267e+19 2.249e+19 2.236e+19 2.307e+19
BIC 1.288e+04 1.284e+04 1.276e+04 1.271e+04 1.267e+04 1.267e+04 1.267e+04 1.269e+04 1.270e+04 1.273e+04
```

The table presented above delineates the dates of the computed breaks. Analysis reveals that the Bayesian Information Criterion (BIC) attains its lowest value when the model incorporates five breaks. Subsequently, we compute the trend terms for all identified subperiods. The results are in the Table 1:

Table 1 Structural breaks

export	(Intercept)	tt
1999 (1) – 2004 (3)	1034649537	13697328
2004 (4) – 2008 (11)	-1517361833	56719744
2008 (12) – 2011 (8)	-5374037970	73612695
2011 (9) – 2018 (5)	2417388793	19504970
2018 (6) – 2021 (2)	8494242370	-5001567
2021 (3) – 2024 (1)	3320594256	20164872
import	**(Intercept)**	**tt**
1999 (1) – 2004 (3)	1024989814	12855577
2004 (4) – 2008 (11)	-1095723356	49934592
2008 (12) – 2011 (8)	-4477517430	64603564
2011 (9) – 2017 (9)	1744541177	20696282
2017 (10) – 2021 (5)	5405735318	6015840
2021 (5) – 2024 (1)	9779455206	-3987663

Source: Author's calculations

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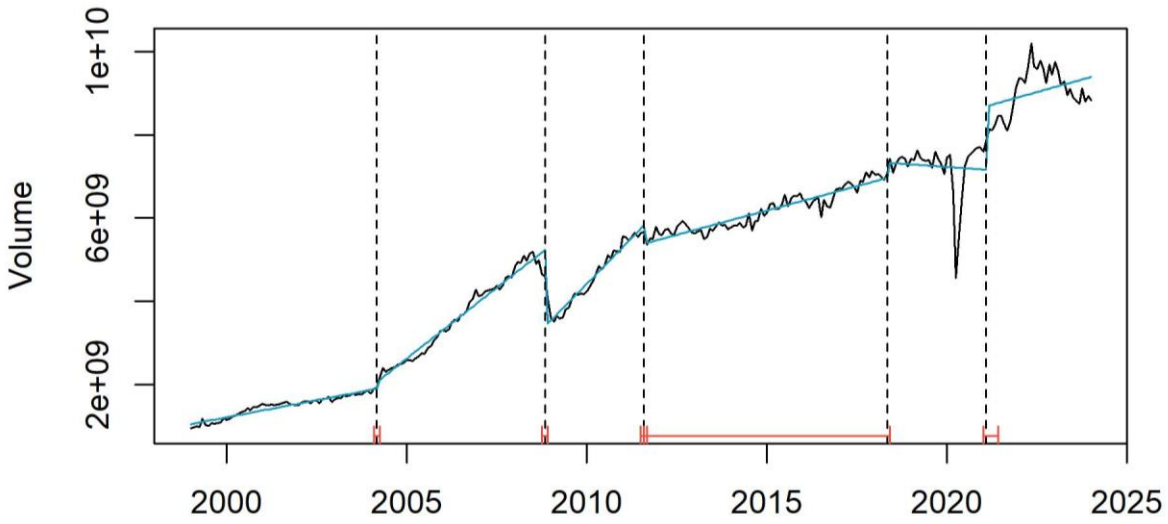

Figure 2 Trend breaks for seasonally adjusted export deflated
Source: Eurostat database and author's calculations

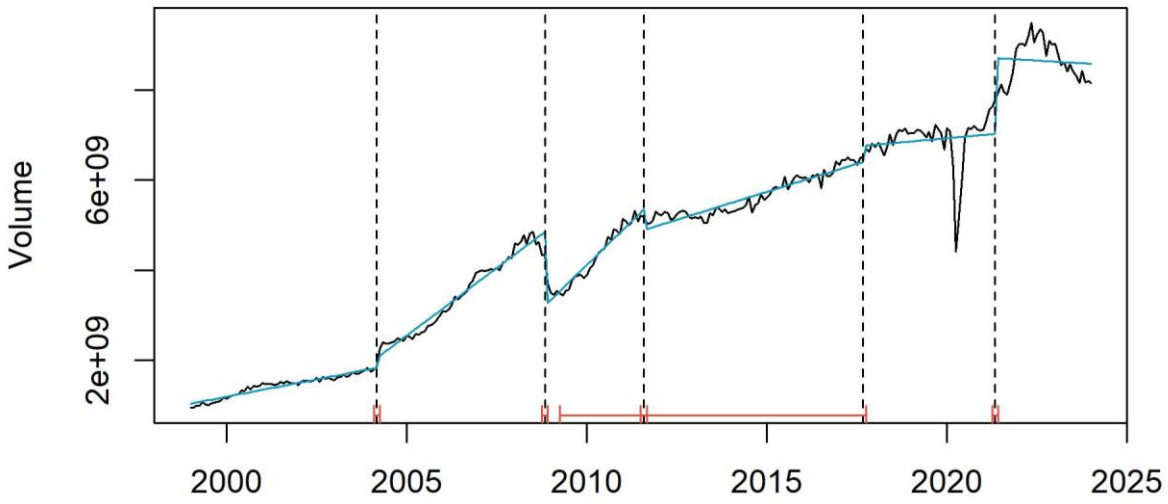

Figure 3 Trend breaks for seasonally adjusted import deflated
Source: Eurostat database and author's calculations

Observations from Figure 2 and Figure 3 indicate that the first three breaks are identical. However, the last two breaks display slight differences, which may be attributed to erratic behavior towards the end of the time series. Specifically, the fourth break occurs in May 2018 in the export time series and September 2017 in the import time series. The fifth break is noted in February 2021 and May 2021, indicating proximity in occurrence.

Within the time series, distinct breaks are identifiable:

- A significant instance is the entry into the European Union in May 2004, which markedly enhances intra-V4 trade.
- The global financial crisis in the autumn of 2008 resulted in a significant decline in intra-V4 trade.
- In the latter half of 2011, the rapid recovery from the financial crisis concluded, leading to a deceleration in trade dynamics.

- The deceleration or stagnation in trade was evident well before the onset of the COVID-19 pandemic, manifesting in the second half of 2017 for import data and the first half of 2018 for export data.
- The last break occurred in 2021, during the second year of the COVID-19 pandemic when most restrictions ended.
- The time series concludes in January 2024, and we can observe the adverse effects of the war in Ukraine. However, no break was detected in 2022, as indicated in the table above.

4. Conclusion

The entry into the European Union in 2004 profoundly and positively impacted trade dynamics among the V4 states. This pivotal moment facilitated the removal of trade barriers, which led to increased trade volumes and economic interdependence among countries. The bolstered trade dynamics are reflected in the heightened exchange of goods and services and the enhanced movement of capital and labor. Moreover, integrating into a larger, unified market spurred innovation and competitiveness among businesses within the member states. As such, the accession to the EU in 2004 marks a significant turning point, underpinning the expansion and deepening of trade relations, which have had lasting economic benefits for the involved nations.

The Global Financial Crisis of 2008 significantly negatively impacted trade dynamics worldwide, and the intra-V4 trade was no exception. This period marked a stark contraction in economic activity as financial institutions faltered, consumer confidence plummeted, and credit markets seized up, leading to a widespread reduction in trade volumes. For the V4 countries, which had been experiencing robust trade growth, the sudden economic downturn resulted in immediate and severe consequences. Businesses faced enormous challenges, including diminished export demand, disruptions in supply chains, and tightening financial conditions, which stifled investment and expansion plans. The ripple effects of the crisis not only curtailed the existing trade flows but also set back economic recovery efforts for several years. This episode starkly illustrates the vulnerability of interconnected economies to global financial instability and highlights the critical need for robust economic frameworks and policies designed to mitigate such shocks. The enduring impact of the 2008 crisis underscores the importance of economic resilience and the role of strategic planning in sustaining trade amid global economic uncertainties.

The observed slowdown in trade dynamics long before the advent of the COVID-19 pandemic highlights underlying vulnerabilities and systemic shifts within the global economic landscape. This deceleration, noted across various metrics, suggests that factors independent of the health crisis impacted trade efficiency and volume. Potential contributors to this trend may include geopolitical tensions, changes in global economic policies, technological disruptions, and shifts in consumer preferences, all of which can influence trade patterns over extended periods. Additionally, this protracted slowdown raises questions about the structural robustness of international trade networks and the ability of economies to adapt to evolving global conditions. Understanding these pre-pandemic trends is crucial for policymakers and business leaders as they devise strategies to enhance economic resilience and ensure sustainable growth in an increasingly interconnected world.

The limitation of the time series data makes it difficult to discern long-term trends and to robustly assess the total economic impacts of the economic recovery from COVID-19 in 2021 and the subsequent slowdown in 2022 and 2023, which can be attributed to the geopolitical upheaval following the Russian invasion of Ukraine. A more extended period is typically

required to accurately measure recovery patterns and understand economies' resilience in such disruptions.

Acknowledgements
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Food Security in European Union Countries: Development, The Current State and Perspectives

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Abstract

The paper's objectives and research background

Food security is a key priority for the European Union and its member states. Over the past decades, we have seen significant developments in the regulation, monitoring, and protection of food across Europe. The contribution is focused on the analysis of EU countries with a focus on key aspects of food security and sustainability. The research aims to evaluate the state and development of food security based on the composite index of food security, through which 26 EU member countries are evaluated in the period from 2015 to 2022.

Data/Methods

The food security situation is assessed based on 10 input indicators. Secondary data are obtained from the Faostat's, Eurostat's, and World Bank's databases. In addition to exploratory graphic methods, multivariate statistical methods (Factor and Cluster Analysis) are also used in the research. The composite index of food security is established using additive aggregation of the weighted indicators. The weights are estimated based on the correlation matrix of input indicators.

Results/Conclusions/Value added

The scores of the composite index showed that food security situation varied across countries during the period, while Ireland, Denmark, and the Netherlands were the most food secure and on the contrary, Bulgaria, Romania, and Slovakia are the least food secure countries in European Union. In terms of evaluating the final rankings, the level of food security increased most significantly in Croatia and Belgium during the period from 2015 to 2022, while it deteriorated notably in Hungary and Portugal. This analysis contributes to existing research by expanding the assessment of food security to include countries that are not covered in the Global Food Security Index. The value added of our contribution is the expansion of the possibility of assessing food security and sustainability for policymakers even for those countries that are not included in the evaluated set of countries through the GFSI.

Keywords

food security, composite index, multivariate analysis, European Union, member countries

JEL Classification

C10, C38, F62

1. Introduction

Food insecurity, once mainly a worry for developing countries, is now getting more attention in developed countries. While many European nations are doing well in terms of food security, the continent is facing new challenges. Research by d'Errico et al. (2023) has shown that the pandemic has highlighted how unexpected events can have a lasting impact on worldwide food security, nutrition, and standards of living. Agriculture plays a crucial role in important issues like food security, safety, and environmental sustainability. Recent geopolitical shifts have sparked conversations about food sovereignty and strategic independence (Bounds, 2022). For

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instance, the agricultural industry in the European Union heavily relies on imported energy, feed, additives, and fertilizers (EPRS, 2022). These essential resources are now at risk due to conflicts. Additionally, there has been a notable rise in global commodity prices (Baffel and Macadangdang, 2022; FAO, 2022), which could worsen food accessibility for low-income families, adding to challenges brought on by the pandemic (EPRS, 2022). The European Commission recently started a panel to oversee food security within the European Union, to offer up-to-date and easily understandable information, crucial for making decisions on how to address potential issues affecting food supplies and safety. This tool also looks at food availability, brings attention to food price increases, and breaks down food spending in EU households based on country and income level (Directorate–General for Agriculture and Rural Development 2022).

1.1 Food insecurity – literature review

Food and nutrition insecurity is a worldwide concern leading to both physical and psychological issues, including micronutrient deficiencies and decreased dietary variety throughout a lifetime (Hanson and Connor 2014, Pereira et al. 2022). (Barret 2010) defined food insecurity as restricted or unpredictable access to nutritionally sufficient and safe foods, or an inconsistent capability to obtain appropriate food through socially acceptable means. The definition of food security has evolved. According to FAO (2001), food security is attained when everyone consistently has physical, social, and economic access to adequate, safe, and nutritious food that satisfies their dietary requirements and preferences for a vigorous and healthy life. FAO (2009) first introduced the term 'four pillars of food security: availability, access, stability, and utilization. Visualizing the dimensions of food security as equally important pillars is problematic because these dimensions are interconnected and dependent on each other, and individual pillars cannot capture the connections between them. Furthermore, the method of weighting is also problematic because the pillars do not hold the same importance, and the weighting process should be tailored specifically to the context and country (Decancq and Lugo, 2013; Dobbie and Dail, 2013).

European countries are considered food secure in terms of malnutrition, but obesity and intake of food of inadequate quality have been a serious problem. According to Moradi et al. (2019), there is a lack of understanding about the relationship between economic hardship, weight abnormalities, such as being underweight, overweight or obesity, and food insecurity. The authors concluded that a higher level of food insecurity could cause a risk of weight abnormality and the state of economic growth was a significant determinant of weight status, however, the existing research papers are heterogenous in these conclusions. However, a persistent shortage of economic resources can lead to food insecurity, potentially causing malnutrition (Cardel et al. 2016 and Sim et al. 2018). Finney Rutten et al. (2010) summarized the results of research dealing with the mutual connection between poverty, obesity, food insecurity, and their health outcomes. Food security research is generally aimed at developing countries or on a global scale, but there is still a gap in research focusing on European countries. However, some authors shed light on the state of food security in Europe: Borch et al. (2016) concluded, that insufficient knowledge about food insecurity in Europe is challenging, especially when poverty and social inequalities were rising and policy regimes were changing, Davis & Geiger (2017) found that since economic crisis in 2008, the food insecurity had risen in European countries and varied by different welfare regimes. Garrat (2020) explored which groups of people were mostly affected by the risk of food insecurity and which social aids were effective, Loopstra (2020) pointed out that over the last twenty years, the increasing reliance on food banks indicated a worsening issue of severe food insecurity and reflected a deficiency in coordinated governmental actions to address hunger, food insecurity caused insufficient income is prevalent according to Penne & Goedemé (2021) mainly in Eastern and Southers

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Europe, Grimacca & Naccarato (2022) assessed food insecurity from gender perspective and concluded, that the main driver that could cause gender differences was education. Palkovič (2023) proposed a new index to measure food security in European countries from FAO indicators weighted by DEA method and concluded, that food security situation in Europe is good, but some countries, mainly situated in Eastern and Southern Europe still face challenges. The aim of the paper is to analyze food security and sustainability across EU countries from 2015 to 2022 by utilizing a composite food security index.

2. Data and Methods

The data for the analyses were extracted from the FAOSTAT and EUROSTAT databases. The EU 26 countries excluding Luxembourg were examined for 2015 and 2022 because Luxembourg appeared as an outlier, particularly for certain indicators. For this reason, analyses did not consider this country. Analyses were thus conducted in two periods: in 2015 when the situation in EU countries was relatively stable, and in 2022, a period when European countries were on one hand ending restrictive measures associated with the global COVID-19 pandemic and on the other hand, the beginning of the military conflict in Ukraine occurred. Additionally, 2022 was the last available year for data. Food security and sustainability were assessed based on the following indicators: HICP-food (index; 2010 = 100), gross national income per capita (PPS, 2017 international dollar), median equivalised net income (PPS, 2017 international dollar), food expenditures (share of total household expenditures), at risk of poverty (percentage of total population), government expenditures spent on R&D in agriculture (eur/capita), index of political stability/absence of violence or terrorism (index), average daily energy intake (kcal/cap/day), average daily protein intake (g/capita/day), average daily fruit and vegetables intake (g/capita/day).

In the analyses, the data underwent normalization to ensure consistency in the direction of development, employing the min-max method. Consequently, the obtained values fell within the range of [0; 1], where a value of 0 signifies a country with the minimum value of the given indicator, while a value of 1 denotes a country whose indicator value was maximal. This approach was applied to adjust the data for each year accordingly. The indicators were tailored to exhibit a growing trend, meaning that as the indicator value increased, the country received a more favorable evaluation in terms of the examined indicator. Food security was assessed based on a newly proposed comprehensive food security index, taking into account the varying weights of individual indicators during its construction. In determining the share of influence of indicators on the composite index, we relied on a correlation matrix. Subsequently, the overall Food Security Index was calculated according to the following equation:

$$FSI = \sum_{j=1}^{p} x_{ij} * v_i \quad (1)$$

Where: x_{ij} – normalized value of i-th indicator (i = 1, 2, ..., n) of j-th country (i = 1, 2, ..., m), v_i – weight of i-th indicator.

In the second part of the research, country classification based on their similarity concerning the examined issue was conducted using cluster analysis. Ward's method was utilized in forming the clusters. Existing correlations among the group of input variables were addressed through factor analysis, wherein the weights in the factor model were estimated using the principal component method, followed by the employment of the varimax method for factor weight rotation. The country classifications were subsequently verified using discriminant analysis, with the resubstitution method as the basis. The analyses in the paper were carried out using MS Excel as well as statistical software SAS EG 7.1.

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3. Results and Discussion

When assessing the food security of EU member countries, we relied on a food security index, considering the varied weights of the examined indicators during its construction. The weights were determined through correlation analysis. The weight values in both examined periods are presented in Table 1, indicating that the indicators GNI per capita, median equivalized net income, and food expenditures held the highest weight in index construction in both periods. Conversely, the indicator HICP – food had the lowest weight in 2015, while at risk of poverty after soc. transfers was the least influential indicator in the resulting index in 2022.

Table 1: Weights of the indicators

	2015	2022
HICP – food	7.0%	10.2%
GNI per capita	14.6%	14.4%
Median equivalised net income	13.4%	13.0%
Food expenditures (share)	11.9%	12.7%
At risk of poverty after soc. transfers	8.9%	7.2%
Gov. expenditures on R&D in agriculture	9.5%	10.1%
Political stability, absence of violence/terrorism	7.4%	7.3%
Daily energy intake per capita	9.6%	8.7%
Daily protein intake per capita	8.9%	8.2%
Daily fruit and vegetable intake per capita	8.8%	8.3%

Source: author's calculations

The ranking of EU member countries based on the composite food security index is shown in Figure 1. The bar chart displays the ranking for the year 2022, while the triangle symbol represents the EU countries' scores based on 2015 year.

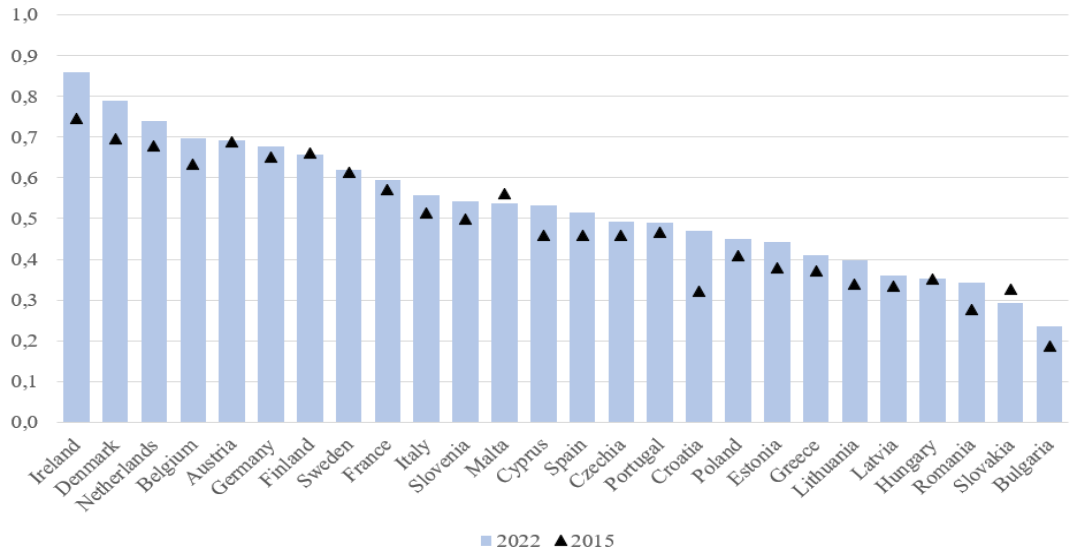

Figure 1: Ranking of EU member countries based on the food security index
Source: author's calculations

Figure 1 shows, that within the EU in 2022 was observed in 2022, the most food countries were Ireland, Denmark, and the Netherlands. Conversely, Bulgaria, Slovakia, and Romania were found at the bottom of the list based on food security within the EU. Regarding the comparison with 2015, we can observe that Croatia's position improved significantly (moved up by 7 positions) as well as Belgium's (moved up by 3 positions), while Portugal's and Hungary's

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positions deteriorated most prominently (moved down by 3 positions). The change in these countries concerning the input indicators is depicted in Figure 2, indicating that the HICP-food level increased in all countries. In the case of Croatia, the situation improved mainly in terms of energy intake, protein intake, and fruit and vegetable intake. Belgium saw improvement in median equivalized net income, At risk of poverty after social transfers, government expenditure on agricultural research and development, and nutritional indicators. The decline in Portugal's and Hungary's positions in 2022 compared to 2015 was primarily due to the increase in HICP - -food, as reflected by the lower value of this indicator in the figure, given that the data were adjusted in the same direction. The importance of the indicator in 2022 in constructing the food security index increased, which was the main reason for the deterioration of these countries' positions in the overall ranking.

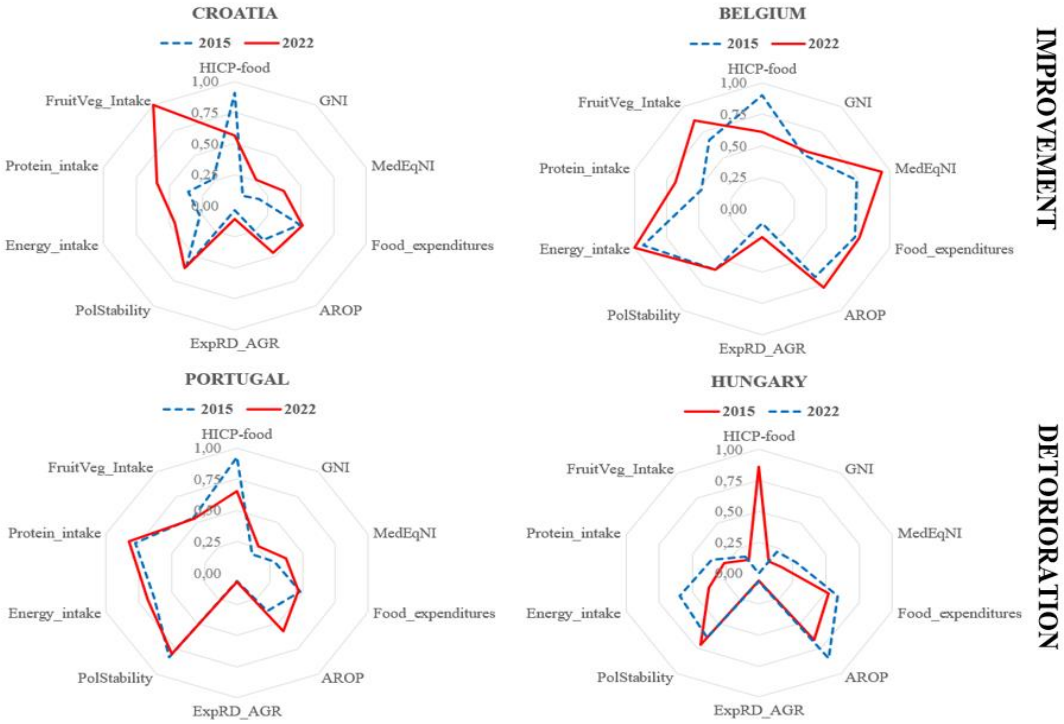

Figure 2: Development of individual indicators in selected countries
Source: author's calculations

The food security situation in EU countries was also assessed based on cluster analysis, whereby groups of countries with similar levels of food security were created and subsequently evaluated using the examined indicators. Analyses were conducted for both 2015 and 2022. Before the cluster analysis, factor analysis was performed due to significant correlations among the input indicators. When estimating the factor score, which served as input for the cluster analysis, we relied on two factors that explained 90.7% of the variability in the original data in 2015 and 86.7% in 2022. In both years, the first factor comprised socioeconomic determinants of food security - GNI per capita, median equivalized net income, at-risk-of-poverty rate, share of food expenditures, government expenditures on R&D in agriculture, and political stability index, while the second factor comprised nutritional determinants of food security: energy intake, protein intake, fruit, and vegetable intake. The cluster analysis results were subsequently verified using discriminant analysis, confirming countries' classification. The resubstitution method was used for verification, achieving a coefficient of predictive accuracy of 1.

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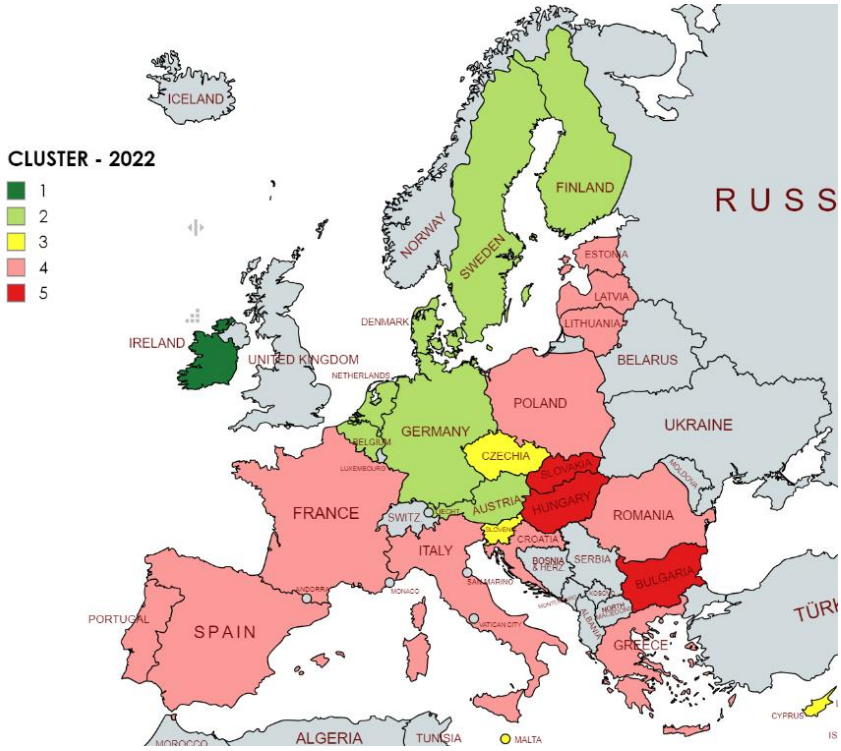

Figure 3: Classification of EU countries based on cluster analysis
Source: author's calculations

EU countries were classified into 5 clusters in both examined years. The results for 2022 are presented in Figure 3. The first group was represented by Ireland, indicating the highest level of food security, as illustrated in Figure 4. In this figure, the radar graph presents the centroids of each cluster of countries. Ireland had the highest values for almost all examined indicators, except for median equivalized net income, at-risk-of-poverty rate, and daily fruit and vegetable intake. The second group comprised developed countries in Western and Northern Europe: Austria, Belgium, Denmark, Germany, Netherlands, Sweden, and Finland. These countries were characterized primarily by the highest levels of median equivalized net income and fruit and vegetable intake. The third group included 4 countries: Cyprus, Czechia, Malta, and Slovenia. These countries had the lowest proportion of people at risk of poverty. The fourth group consisted of 11 EU countries: Croatia, Estonia, France, Greece, Italy, Latvia, Lithuania, Spain, Poland, Portugal, and Romania. This group of countries was characterized by the highest proportion of people at risk of poverty. Overall, from the perspective of socioeconomic indicators, the situation in these countries was at a lower level, with only the group of countries in cluster 5 having a worse situation. Regarding nutritional indicators, the situation was similar to that of the countries in the second or third cluster. The last group comprised Hungary, Slovakia, and Bulgaria. These countries had the worst situation in terms of the examined food security indicators. The only exception was the at-risk-of-poverty rate, which was worse in the previous group.

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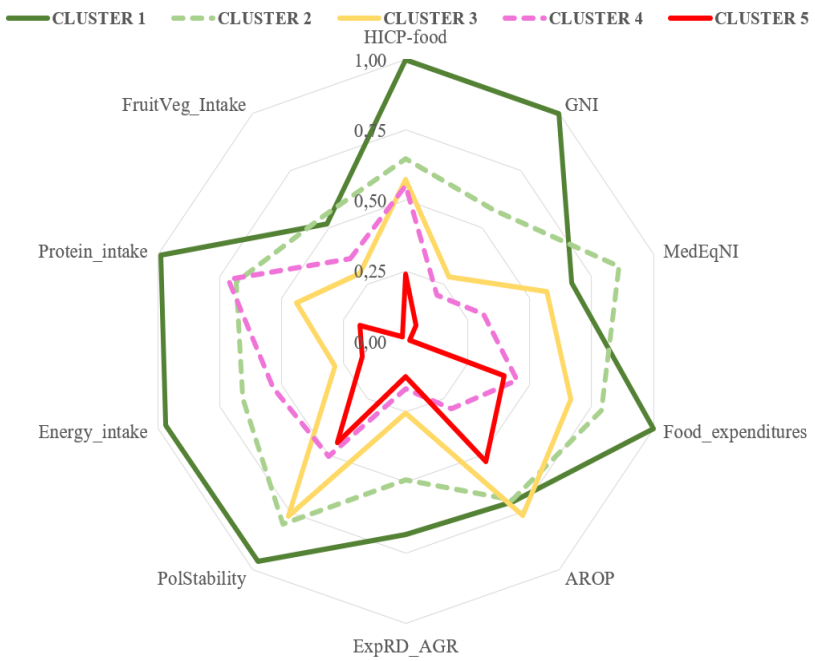

Figure 4: Scree plot of normalized clusters' centroids
Source: author's calculations

In comparison with 2015, significant changes in country classification did not occur. For 16 countries, there was no change, while three countries (Cyprus, Malta, and Slovenia) were moved from a worse group to a better one, indicating a positive change in terms of food security. Conversely, Greece, Italy, Portugal, Romania, and Spain were shifted in the opposite direction, from the third cluster to the fourth cluster in 2022. The Czech Republic experienced the most significant improvement, moving from the fifth group to the third group, primarily due to the enhancement of the indicator government expenditures on R&D in agriculture, representing 2022 1.5 times the level of the indicator in 2015. On the other hand, France belonged to the second cluster in 2015 but was reassigned to the fourth group in 2022, indicating a deterioration in food security, mainly due to a worsened perception of the country's political stability. In 2020, the value of this indicator was 3.42 times higher than in 2015.

4. Conclusion

Currently, due to the economic crisis and unstable political situation, there is a growing interest in food security issues in Europe, which are fundamentally linked to the development goals of Agenda 2030. Supporting a safe and sustainable food system addresses not only hunger and malnutrition but also promotes socioeconomic development and environmental sustainability. The study seeks to assess the status and progress of food security using a composite food security index based on 10 selected socioeconomic and nutritional indicators, examining 26 EU member countries from 2015 to 2022. The results showed that the most food-secure countries are those in Northern and Western Europe, especially Ireland, Denmark, and the Netherlands, while Eastern European countries, particularly Slovakia, Bulgaria, and Romania, face significant challenges in both socioeconomic and nutritional aspects of food security. Between 2015 and 2022, there was a significant improvement in the overall ranking assessed by the food security index in Croatia and Belgium, primarily due to a substantial increase in GNI per capita, median equivalised net income, and nutritional indicators, although these countries also improved in terms of other examined indicators. On the other hand, the situation deteriorated most significantly in Portugal and Hungary. In Portugal, stagnation in several

indicators combined with food inflation, measured through HICP, contributed to this outcome, while in Hungary, a significant worsening of food security was caused by high food price inflation, which seriously threatens food security levels. Multidimensional analysis demonstrated similar results to unidimensional analysis through the food security index. Countries are divided into 5 groups, with the top-rated group consisting of only one country, Ireland. The second group comprises countries from Northern Europe, including Belgium, the Netherlands, Germany, and Austria. The third group includes the Czech Republic, Slovenia, and Cyprus. The fourth group is formed by France along with countries from Southern and Eastern Europe, and the lowest-rated group includes Slovakia, Hungary, and Bulgaria, which among EU countries face the greatest challenges not only in terms of economic food accessibility but also sufficient nutritional food quality.

The findings suggest that targeted policies are needed to reduce food insecurity, particularly in Eastern and Southern Europe, by improving access to nutritious food and strengthening economic resilience. Future research could also be focused on the investigation of other factors (environmental, geopolitical, etc.), which in the future we expect to have a more significant impact on food security not only in EU countries.

Acknowledgments

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Gender Composition of Board and Top Management: A Driver of Company Performance?

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Abstract

Paper's objective(s) and research background

Recent research in financial management has shifted focus to gender studies in the workplace, uncovering that women's skills, often undervalued and underappreciated, play a significant role in enhancing companies' financial performance. The inclusion of women on corporate boards improves governance quality by promoting diverse perspectives and a greater inclination toward risk reduction. Women have also proven their critical leadership capabilities, particularly during times of crisis. However, findings on the link between gender diversity and performance remain inconsistent. This study specifically investigates the impact of gender composition in boards and top management on a company's financial performance, while also exploring how various company characteristics influence financial outcomes.

Data/Methods

The research draws on a sample of over 700 multinational corporations across nearly 40 countries. Using linear regression, the study analyses the relationship between selected company characteristics, the gender composition of boards and top management, and financial performance, measured as revenue per employee.

Results/Conclusions/Value added

The findings highlight a positive correlation between gender diversity in boards and top management and improved financial performance. Additionally, the study confirms that company size and ownership structure also significantly impact performance. A key contribution of this research lies in its comprehensive analysis of multiple factors and its extensive global scope, offering valuable insights into the role of gender diversity in corporate success.

Key words

board of directors, company characteristics, company performance, gender diversity, multinational corporation, top management

JEL Classification

J16, L25, M14

1. Introduction

With the increasing representation of women in the workforce, firms are witnessing notable changes in the available talent pool for top-level leadership roles (Burke & Nelson, 2002). The diversity of these resource pools can influence the composition of the board of directors, so affecting corporate governance. Although having a diverse board or top management can serve as a visual means of showcasing the absence of discrimination, it remains uncertain if such diversity actually has a tangible effect on firm performance (Erhardt, Werbel, & Shrader, 2003).

There are at least two opposing viewpoints in the current research about the relationship between team diversity and performance. According to Watson, Kumar, and Michaelsen (1993), certain researchers propose that diversity can result in a greater knowledge base,

enhanced creativity, and more innovation, hence providing a competitive edge. Simons, Pelled, and Smith (1999) reported comparable results in their study on the composition of leadership. Their findings suggest a relationship between the level of education and cognitive diversity, and the favourable impact they have on organisational performance. However, they contend that the presence of diverse experiences has an unfavourable impact on the company's return on investment and overall performance. This is attributed to the informal communication that takes place among top management teams. Additional research, specifically examining the relationship between board composition and performance, revealed favourable outcomes.

Another group of academics, who highlight the possible negative implications of diversity, argue that the fundamental challenge lies in combining the resources of employees of an organisation into a cohesive and efficient team. From this viewpoint, diversity might negatively impact collective performance. Hambrick, Cho, and Chen (1996) conducted longitudinal research to examine how diversity affects the performance of management teams at 32 leading US airlines. The measurement of diversity encompassed variations in functional, educational, and occupational backgrounds. Their findings indicated that leadership teams with homogeneous composition outperformed teams with diversified composition. Additionally, they observed that heterogeneous teams exhibited a slower pace in their actions and reactions and were less likely than homogenous teams to address the competitive initiatives. Based on their argument, individuals inside a heterogeneous group were more open to expressing differing opinions, which consequently undermined the overall agreement within the team. Previous research indicate that diversity has the capacity to enhance performance by improving decision-making skills. However, it can also hinder group performance by intensifying disagreements. The outcome of this conversation is the study inquiry, how do these issues impact the relationship between leadership team and company performance?

Another study (Terjesen, Aguilera, & Lorenz, 2015) analyses the role of women on corporate boards and the factors influencing their representation globally. The study highlights the growing but uneven presence of women on boards across different countries, emphasizing the influence of institutional, cultural, and legal factors. The authors discuss how national policies, such as gender quotas and corporate governance codes, have played a significant role in increasing female board representation in some regions, particularly in Europe. They also explore the business case for gender diversity, noting that diverse boards can enhance decision-making, innovation, and firm performance by bringing varied perspectives and reducing groupthink. However, the study acknowledges that the impact of gender diversity on firm performance is complex and context-dependent, with mixed evidence across different studies. Terjesen et al. call for further research to better understand the mechanisms through which gender diversity affects corporate governance and performance, as well as the broader societal and organizational barriers that continue to limit women's advancement to board positions. The paper underscores the importance of addressing structural and cultural challenges to achieve meaningful and sustainable progress in board gender diversity.

Shrader, Blackburn, and Iles (1997) examined the relation between gender diversity and the financial performance of large firms. They conducted their analysis at both the middle and senior management team level, as well as at the board of directors level. Their findings demonstrated overall organisational effects, with limited influence of top management diversity composition on performance. Additionally, they observed a positive association between gender diversity in leadership roles and the financial performance of the company. Authors highlight the beneficial impact of gender leadership diversity composition on firm performance by arguing that these organisations have access to a larger pool of talented individuals, which enables them to hire more qualified applicants, irrespective of gender. A

meta-analysis of 140 studies showing a positive correlation between women on boards and firm financial performance, especially in countries with stronger shareholder protections (Post & Byron, 2015).

Diversity has the capacity to generate greater levels of creativity, innovation, and high-quality decision-making at both the individual and group levels (Erhardt et al., 2003). The inclusion of female representation on a board enhances its ability to effectively carry out its strategic function, since their experience frequently aligns closely with the specific requirements of the organisation. Regarding influence on strategic planning, women might possess a marginal edge over males. Women might therefore be able to assist the board in carrying out its strategic responsibility (Fondas, 2000). Burke (2000) presents compelling reasons for firms to incorporate highly skilled women into their board of directors. Overall, there is a deficit of skilled male directors in the market or within organisations. Hence, it is recommended for companies to broaden their recruitment efforts outside the conventional talent sources. This is because having women on the board can carry substantial symbolic importance, not just within the organisation, but also in establishing connections with external stakeholders. Additional studies emphasizes that diversity in workgroups can lead to greater creativity and innovation, though it also notes the importance of managing diversity effectively to avoid potential conflicts (Knippenberg & Schippers, 2007).

Dezso and Ross (2012) explore the relationship between gender diversity on corporate boards and its impact on firm performance, CEO turnover, and director compensation. Their study finds that CEO turnover is more sensitive to stock performance in firms with gender-diverse boards, and directors in these firms tend to receive more equity-based compensation. However, the overall effect of gender diversity on firm performance is negative. This negative effect is primarily observed in companies with fewer takeover defenses, suggesting that such firms may face greater challenges in integrating gender diversity effectively. The authors conclude that mandating gender quotas for board directors could potentially reduce firm value, particularly in well-governed firms, as the costs of diversity may outweigh the benefits in these contexts. Their findings highlight the nuanced and context-dependent nature of the relationship between board gender diversity and corporate outcomes.

However, the turnover is more strongly influenced by stock performance in companies with gender-diverse boards, and directors in such firms tend to receive greater equity-based compensation. However, on average, gender diversity has a negative impact on firm performance. This adverse effect is particularly pronounced in firms with weaker takeover defenses. The findings by (Adams & Ferreira, 2009) indicate that imposing gender quotas for board members may diminish firm value, especially in organizations with strong governance structures.

The aim of this paper is to evaluate the influence of board and top management gender composition on company financial performance. Board and top management gender composition is measured by the percentage of female representatives within these two company leadership bodies. Company financial performance is measured by revenue per employee. In addition, the financial performance of the company is examined in terms of its multiple characteristics. The structure of the paper is as follows: Section 2 describes data and methods; Section 3 presents and discusses the findings; and Section 4 explores conclusions.

2. Data and Methods

Data for this study were obtained from *TP Catalyst* database. This online database is developed primarily for arm's-length benchmarking analysis and contains substantial corporate ownership

data, including global coverage of enterprises around the world and detailed financials. The primary objective for defining selection criteria in the database was to obtain a sufficient sample of companies with available quantitative data in the form of financial statements, as well as qualitative data on board and top management gender composition and company characteristics. As a result, it was decided to focus on multinational corporations, which are required by legislation in most countries to publish their financials and other business data in an annual report. From a regional standpoint, the objective was not to focus on just one country or geographical region, but to include a sample of corporations from all around the world. Due to the large number of corporations in the database, that meet our selection criteria, specific countries were chosen to represent each geographical region of the world.

Using the approach, we retrieved data from the database for 722 corporations from 39 countries. Because each downloaded company profile from the database had an extensive amount of data, we performed screening, pre-processing, and clustering on the raw downloaded data to ensure that it could be effectively used in the subsequent stages of the research. Using pre-processed downloaded data, we quantified the board and top management gender composition of companies created categories

Top Management Female % and *Board Female %*) and classified companies according to defined company characteristic (categories *Public or Private*, *Employees Number*, *Geographical Region*, *Time on Market*, *Family Business*, *Ownership Capital Origin*). To measure company performance, we used the revenue per employee indicator (category *Company Performance*).

Utilizing the list of company leadership members, we determined the total number of male and female board and top management representatives for each company. As a result, we were able to calculate the percentage of male and female representatives in the board and top management. Based on these figures, we created the categories *Board Female %* and *Top Management Female %*, which measure the percentage of female representatives in these two leadership bodies of the company on a scale of 0% to 100%. A value of 0% represents board or top management teams with no female members, and a value of 100% is assigned to teams where all team members are only women. Based on the information about the country of residency of the companies, we categorized them into the *Geographical Region* category. For the purpose of classifying companies under *Family Business* category, we used data regarding company owners. If a company is owned by a physical person or family, it falls under this category and is categorized as a family business. To assign companies to *Public or Private* category, the categorization available directly in the database was used, which classifies companies as publicly traded companies on any stock exchange or private companies that are not traded on the stock exchange. *Employees Number* category was created using company data that was readily available in the database and represents the size of the company in terms of number of employees. We categorized companies within *Ownership Capital Origin* category by comparing the country of residence of the company and the country of residence of the owner. If the company owner's residence country corresponds with the company's residence country, the origin of the company ownership capital is considered as domestic, otherwise as foreign. To categorize companies according to the *Time on Market* criteria, the date of establishment of the company was used, which expresses how long the company has been operating on the market since its establishment.

Our study employed linear regression analysis to examine the effect of defined variables on company performance. The dependent variable in the present study is company performance, while the independent variables are leadership gender composition categories and identified company characteristics. The employed regression model's functional form is as follows:

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$$Y_i = \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \varepsilon_i$$

where:

x_1 – Top Management Female %; x_2 – Board Female %; x_3 – Geographical Region; x_4 – Family Business; x_5 – Public or Private; x_6 – Employees Number; x_7 – Ownership Capital Origin; x_8 – Time on Market ($x_1 – x_8$ are independent variables)

Y_i – Company Performance (dependent variable)

3. Results and Discussion

Linear regression is used to examine the relationship between the dependent variable (company performance) and the independent variables (board and top management gender composition, determined company characteristics). The employed linear regression model is considered appropriate for examining this kind of relationship since, as indicated by the ANOVA results, the model significance is less than alpha (0.05). The table below provides an overview of the ANOVA results.

Table 1: Overview of ANOVA Results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	3462643054.478	10	346264305.448	6.831	.000
Residual	36038762409.853	711	50687429.550		
Total	39501405464.331	721			

Source: author's calculations

Despite the fact that the used linear regression is statistically significant, it only explains 9% of the variability of the dependent variable. It is important to mention that other factors seem to influence the dependent variable *Company Performance*, but these are beyond the scope of this study. The following table provides a statistical summary of the model.

Table 2: Model Statistics Summary

	Value
R	.296
R Square	0.088
Adjusted R Square	0.075
Std. Error of the Estimate	7119.510485259680000
Change Statistics:	
R Square Change	0.088
F Change	6.831
df1	10
df2	711
Sig. F Change	0.000

Source: author's calculations

The regression results indicate that not all of the variables analysed have a statistically significant impact on company performance. The characteristics that do not have a substantial impact on company performance include *Geographical Region*, *Time on Market*, *Family Business* and *Ownership Capital Origin*. However, the firm's performance is influenced by factors such as the percentage of females on the board, the percentage of females in top management positions, whether the company is public or private, and the number of employees. Enhancing the gender composition of both the board and top management

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positively impacts company performance. Private enterprises demonstrated superior performance compared to public companies, as did organisations with fewer employees. The regression results are presented in Table 3. It is worth noting that the utilised model accounts for just 9% of the overall variability, hence the findings should be interpreted with caution.

Table 3: Linear Regression Model Summary

	B *	Std. Error *	Beta **	t	Sig.
(Constant)	591.472	2263.303		0.261	0.794
Board Female %	474.073	189.306	0.103	2.504	0.012
Top Management Female %	369.063	221.205	0.061	1.668	0.046
Public or Private	1856.351	662.027	0.121	2.804	0.005
Employees Number	-1321.626	252.314	-0.197	-5.238	0.000
Geographical Region	164.196	303.492	0.021	0.541	0.589
Time on Market	-272.967	205.293	-0.050	-1.330	0.184
Family Business	994.886	795.630	0.046	1.250	0.212
Ownership Capital Origin	496.093	717.755	0.027	0.691	0.490

* Unstandardized linear regression coefficients
** Standardized linear regression coefficients
Source: author's calculations

3.1 Discussion

Conducted research analyses the influence of gender composition in company leadership and other specific features on company performance. The results confirm that gender composition on the Board of Directors and Top Management Team is an essential element in boosting company performance. The positive influence of gender composition in the Board or Top Management aligns with other prior studies in this field (Smith, Smith, & Verner, 2006; Erhardt et al., 2003; …). Bonn (2004) also affirms a positive correlation between the proportion of female directors and company performance. The study conducted by Campbell & Minguez-Vera (2010) found that appointing female board representation is associated with a favourable response from the stock market, and having a diverse gender composition on the board has a favourable impact on the value of the firm. The study conducted by Ren & Wang (2011) examines the impact of gender composition in top management on the value of a company. The findings demonstrate a favourable relationship between gender diversity and firm value, particularly when female representatives in top management possess significant human or social capital.

The greater financial performance of private enterprises in comparison to public companies can be attributed to the element of flexibility. Private organisations have a simpler organisational structure, resulting in a less complex decision-making process and implementation of decisions compared to public companies. Private enterprises might leverage this organisational advantage to accelerate decision-making and promptly respond to market changes. As a result, privately held companies have an advantage in quickly adjusting to market changes, which can result in superior performance compared to publicly traded companies. This is due to the fact that decision-making and implementation processes in publicly traded companies are more complex, partially because of the various regulatory obligations they must adhere to.

The superior success of organisations with less employees, in contrast to those with a larger workforce, can be credited to the greater adaptability of smaller companies. Smaller enterprises typically operate on a lower scale of production and possess a less complex organisational framework, enabling them to promptly respond to unforeseen market circumstances and adjust more effectively to changes. This provides them an advantage in the marketplace, which

subsequently results in superior performance relative to companies with a greater workforce (typically associated with larger production, a complicated organisational structure, and more complex processes), which lack a comparable level of flexibility and consequently require more time to respond to unforeseen market fluctuations.

4. Conclusion

The research findings indicate that gender composition in the Board and Top Management has a significant impact on company performance. The increased representation of women in these two firm leadership bodies is positively impacting the organisation's performance. According to the findings, it can be concluded that companies with a smaller workforce and privately owned companies exhibit superior performance compared to companies with a larger workforce and publicly listed companies. The regression analysis reveals that not all the examined variables significantly influence company performance. Factors such as Geographical Region, Time on Market, Family Business, and Ownership Capital Origin show no substantial effect. On the other hand, variables like the percentage of women on the board, the percentage of women in top management roles, the company's status as public or private, and the number of employees significantly affect performance. Increasing gender diversity in both board and top management positively correlates with better company performance. Additionally, private companies tend to outperform public ones, and smaller organizations (with fewer employees) also show stronger performance. However, it is important to note that the model explains only 9% of the total variance, so the findings should be interpreted cautiously.

We encourage company policy makers to appoint female members to the Board of Directors and Top Management Team in order to achieve a more balanced gender composition in company leadership. This can potentially enhance the firm's performance. A notable constraint to consider is that this study was conducted specifically on multinational organisations, which means that the findings may not be applicable to other types of companies. Another constraint is the presence of additional significant factors that affect corporate performance, which are either unknown or not included in this research. Hence, it is necessary to apply caution when interpreting the offered findings. We propose conducting additional research to examine the relationship between gender composition in leadership and the performance of companies across various types of firms. Another recommendation is to assess the influence of different company characteristics on company operations and performance.

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The Model of Six Pillars – Evaluation of Customer Satisfaction

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Abstract

Paper's objective(s) and research background

The research in this article focuses on the support of customer loyalty in the conditions of the selected postal operator. The postal company is a representative of network service companies presenting an integral part of the economy in many countries. Many factors contribute to the success (or failure) of a business, while the customer satisfaction is being one of them. It is important to monitor this factor and work on its improvement so that customers become more loyal and eventually become "brand promoters".

Data/Methods

The Six Pillars Model is based on years of research to find the pattern of behaviour that influences the resulting experience and emotions. The essence of the six pillars lies in motivation, and therefore they are valid for both B2B and B2C assessment, and equally relevant segments for the psychologist and the employee experience. The original definitions of the standard experience, whether applied metrics (NPS or CSAT) did not provide an answer to the question why. While NPS shows whether customers like you, the six pillars reveal why they like you and what needs to be improved. Achieving excellent results in all six pillars improves the loyalty and advocacy index while predicting commercial success.

Results/Conclusions/Value added

Primary research - in the form of inquiries was used to determine the customer loyalty in the conditions of the selected postal operator, the resulting answers could be applied within the framework of the six-pillar model and afterwards the model should be evaluated.

In this article, the results of the given research are presented, proposals for improvements in a specific environment, as well as the methodology of using the six pillars model in practice.

Key words

Customer satisfaction, customer loyalty, six pillars model, postal operator, postal services

JEL Classification

D91, C52, C83

1. Introduction

Customer satisfaction is certainly an important factor in the success of today's business. In our article, the focus is directed on the evaluation of this parameter in a company providing postal services with a wide product portfolio, with a numerous network of branches throughout the country, when the customer fulfils his requirements personally at the service counters and is served by an employee of the company – Slovak Post, PLC (Slovak Post).

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One of the options for evaluating customer satisfaction is the implementation of a primary survey, where customers are asked about their experience with the evaluated company. However, to be able to determine the value of customer loyalty, in addition to the survey itself, a suitable methodology was also used for evaluating customer loyalty, and therefore in our research we combined a questionnaire survey with the method of evaluating customer satisfaction known as the Six-pillars model.

The Six-pillars model is usually used in practice to compare the success of brands in a competitive struggle, e.g. in one with the sector of the economy, when this model makes it possible to identify the leader in the given market from the point of view of customer satisfaction. However, since Slovak Post does not have significant competitors within the provided services to the population at post offices in Slovakia, the interest was focused on whether it is possible to use Six-pillars model to quantify the level of quality of this brand in the customers eyes even without the actual comparison. For such quantification, we used the results of a questionnaire survey of customer satisfaction, and thus the customers themselves became the evaluators.

1.1 Definition of the six-pillars model

Talking about the six-pillars model, below is a summary of the qualities experienced in an outstanding customer relationship, which allow organisations to connect with their customers in meaningful ways and as a result outperform their competitors. This model is based on an idea that there are six pillars of customer experience, each representing the basic characteristics needed to create positive experiences.

Developed by KPMG Nunwood of the UK (KPMG) following research involving more than one million customers across three continents, the system spotlights six key principles as the building blocks for customer experience success: personalization, integrity, expectations, resolution, time and effort, and empathy.

1. **Personalization** - A personalized approach is indeed essential in building customer loyalty – because it makes each of them feel seen. Suddenly they aren't just one of many in a faceless crowd. Instead, they feel like a valued partner, respected by the company. And these days, you can do better than just addressing them by name or sending a birthday gift voucher.
2. **Time and effort** - Our brain is a pretty power-hungry device and often, it subconsciously pushes us towards the path of the least resistance. What does it mean? That customers are not ready to offer up their time and effort as an extra payment for a service or a product. Instead, they will choose a business that can satisfy their needs, like placing an order or handling a request, in a quick, hassle-free way. In short, efficient processes are crucial to customer loyalty.
3. **Expectations** - Marketing, reputation, previous experience with competing brands – all these aspects affect customer expectations. As a brand, you should aim for more than simply fulfilling those expectations and preventing disappointment. You should focus on setting the bar higher, and that's where it gets tricky. Because promising something you can't deliver is never good. On the other hand, however, if you manage to exceed customer expectations, chances are that they will remember this and recommend the brand to others.
4. **Integrity** - Integrity means that you should practice what you preach. Keeping promises and sticking to your values are key in building customers' trust, and in the digital world full of risks, this applies even more. A trustworthy brand will protect the privacy and security of their customers, always using their personal data in accordance with

legislation and ethical standards; and to personalize their experience and save them some time and effort too, of course.

5. **Resolution** - When something does go wrong, every business should strive to find the most efficient solution and turn the customer's negative experience into one that ultimately leaves them satisfied. Technology can help identify weak points and potential issues before they even happen. Imagine a bank's website, with a customer lingering on the same screen or page for a while. This might be a good time to nudge them towards what they are probably looking for or refer them to your customer service chat before a problem does occur. Advanced online channels like chatbots and virtual assistants are available 24/7, able to resolve a large proportion of customer requests and turn a negative experience into a positive one thanks to their ability to respond immediately.
6. **Empathy** - Humanity and understanding are what make us more than just cells in a vast network. A brand that can empathize with customers' needs, show understanding, and remind them that it's still people behind the scenes will build lasting relationships. Technology knows all about us these days. It can talk to us and even react appropriately. But it cannot replace human warmth and sincere understanding.

KPMG assumes that there are six pillars of customer experience, each representing the basic characteristics needed to create positive experience and since customers perceive their experience, the pillars affect each other as well – so the best brands are great at all six of them. As part of its services, this company offers the possibility of self-evaluation of companies according to six pillars and conducts surveys that serve to compare brands within the relevant market. In the inter-company comparison, they assign a maximum value of 10 points in each pillar.

The model proposed by KPMG was an inspiration for us to carry out our own research focused on the field of providing postal services where we focused directly on the national postal operator (Slovak Post). The most of the population in the Slovak Republic has had some experience with it.

2. Data and Methods

The source of data in our research was a questionnaire survey carried out on a sample of 388 respondents and distributed through the social networks Facebook and Instagram. The questionnaire had a classic structure, in the beginning it contained identification questions, used for multi-criteria analysis of the results, and then, in meritorious questions, it focused on determining customer satisfaction and their experience with the postal operator in question. However, the chosen meritorious questions were formulated in such a way that the results from them could be implemented within the framework of the six-pillar model.

2.1 Primary research - questionnaire survey of customer satisfaction of Slovak Post

The aim of the questionnaire survey was to find out the preferences of customers when using postal operators and their experience in the case of using the services of Slovak Post. The questionnaire had 2 types of questions:

1. identification questions - determined the customer's gender (male/female), his age (determination of generation) and the highest level of education.
2. meritorious questions - these can be divided into two categories:
    a) questions to determine the preference for using postal companies,
    b) questions focused on Slovak Post and customers' experiences with this operator.

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Selected questions from part 2b) were subsequently used to evaluate postal operator in the six-pillar model. A relevant sample of respondents were those who used the counter services of Slovak Post more than once in the last six months, i.e. 350 respondents who evaluated their experience with this postal operator.

2.2 Implementation of 6M principles into outputs from primary research

To evaluate customer satisfaction and loyalty using the six-pillar model, the following questions from the questionnaire were selected for each pillar:

To evaluate the **Personalization pillar**, 3 questions from the questionnaire were relevant:

- in the first one, we asked about welcoming customers at the counter - here customers could choose 3 options (pleasant/neutral/unpleasant), which were further specified so that they could determine the correct rating. As success for this pillar, only those answers that marked the welcome as pleasant were evaluated,
- in the second, we asked about the suitability of the range of products that were offered to customers when their request was implemented - here customers could choose 4 options (none/relevant/irrelevant/can't evaluate), which were again specified in more detail with the aim of correct determination. Only those answers that marked the product offer as relevant were evaluated as success for this pillar, while those respondents who did not know how to evaluate the suitability of the offer were not included in the result,
- the last question asked if customers ever received a "gift - noticeable" when using the services at the counters. This question had a binary nature with the possibility of answering yes or no.

We considered all 3 questions to be equivalent from the point of view of the evaluation of this pillar, and therefore we determined the resulting evaluation as a simple arithmetic average of their success.

Table 1: Personalization pillar

Meritorious questions about	Number of successful responses	Success [%]	Overall success [%]
Welcome at the counter	107	30.57	**27.04**
Product offer	128	46.55	
Reward for the customer	14	4.00	

Source: author's calculations

When evaluating the **Time and Effort pillar**, respondents had to decide which of the following statements about SP they agree with, while they could choose several options or disagree with none of them:

- Respects the customer's time options (e.g. suitable opening hours)
- Removes bottlenecks that slow down product delivery
- It provides simple and clear instructions for using its products and services
- Dealing with mail requests is usually quick and easy
- If necessary, it will warn the customer about possible pitfalls in connection with the requested product

We considered each of the listed options to be equally important, and their success factored into the success of the resulting pillar as the sum of the partial success of each of them.

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Table 2: Time and Effort pillar

Calculation	Number of responses	Overall success [%]
the sum of successful responses	188 + 68 + 122 + 128 + 100 = 606	**34.63**
all relevant responses	350. 5 = 1750	

Source: author's calculations

The expectation pillar was evaluated from a single question in which the respondents had to determine to what extent the Slovak Post fulfils the expectations of customers in relation to the provided products. Here, respondents could choose one of four answers (above expectations, to the expected extent, did not meet expectations and I cannot determine), while only the first two options were evaluated as a success in the given pillar. In the calculation, we did not consider respondents who could not evaluate the satisfaction of their expectations, and thus the total number of relevant answers to the given question was reduced to 289.

Table 3: Expectation pillar

Fulfilling expectations	Number of responses	Partial success [%]	Success [%]
above expectations	24	8.30	**79.23**
to the expected extent	205	70.93	
did not meet expectations	60	20.76	

Source: author's calculations

The Integrity pillar, like a Time and Effort pillar, was evaluated as the sum of the success of statements about Slovak Post in case when respondents agreed with the following statements:

- Acts as a trusted postal operator
- It always gives me the information I need
- It always keeps what he promises
- It knows his products
- It pursues more than just profit
- It does not take social responsibility lightly
- I would recommend its products to my colleagues and friends

Table 4: Integrity pillar

Calculation	Number of responses	Overall success [%]
the sum of successful responses	220 + 136 + 39 + 119 + 21 + 56 + 69 = 660	**24.94**
all relevant responses	350. 7 = 2450	

Source: author's calculations

To evaluate the **Resolution pillar**, 3 follow-up questions were extracted from the questionnaire, where the first one was of a binary nature and reduced the number of relevant answers, focusing on those respondents who had some negative experience with Slovak Post. The number of respondents with a negative experience was 139. In the next question, we asked these respondents about their level of satisfaction with the solution to the situation, where the respondents could identify one of the following answers:

- It admitted its mistake, corrected the problem as quickly as possible and apologized
- It admitted the mistake and corrected the problem without an apology

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- It admitted the mistake, apologized, but did not solve the problem
- It ignored the problem and did not apologize

Only the first two answers were considered as a success in the evaluation. Subsequently, we asked these respondents in the third question whether they had submitted any written/formal complaint and to what extent they were satisfied with its resolution (extremely satisfied, satisfied, dissatisfied). Only respondents who filed a complaint (56 respondents) were evaluated here, while those who were satisfied and extremely satisfied with the handling of the complaint were considered successful in the Resolution pillar.

Table 5: Resolution pillar

Meritorious questions about	Number of successful responses	Success [%]	Overall success [%]
correcting the problem	45	32.37	**32.26**
processing of the complaint	18	32.14	

Source: author's calculations

To evaluate the Empathy pillar, the questions were used. The respondents had to indicate whether, in the case of a special request, they felt that the counter employees could empathize with their feelings, that they understood them and tried to accommodate them. All respondents who admitted that they had such a special request were 212. The total result of the Empathy pillar was therefore determined as the share of those who felt empathy from the counter employees and all those who had a special request where they expected empathy.

Table 6: Empathy pillar

Meritorious questions about	Number of successful responses	Success [%]
Empathy of counter employees	102	**48.11**

Source: author's calculations

3. Results and Discussion

The aim of the research was to determine the level of customer loyalty of the target postal operator – Slovak Post. The main method for determining this level was the model of six pillars in the conditions of the evaluated postal company – Slovak Post The evaluation was based on the questions from the questionnaire survey. Some pillars consisted of several questions aimed at identifying the characteristics defining the given pillar, others were represented by a single question that determined the level of customer satisfaction in the given area. We determined the resulting evaluation of the pillars in a percentage of their filling. Such an assessment is slightly different from the 0 to 10 points assessment used by KPMG when comparing competing companies. It can be converted to a given scale and interpreted. The resulting assessment is shown in Table 7.

The overall point gain of the Slovak Post is not great. Therefore, we can assume that compared to other postal operators operating in the Slovak market, it would not be the leader in the customer satisfaction. As we have already indicated, the conditions for providing services at post office boxes are difficult to compare with other postal operators who do not have a comparable network of brick-and-mortar service branches. Comparing with the competition in this case could be interesting rather in the context of comparing national postal operators in several selected countries.

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Table 7: Six-pillar model – results

Six pillars in the Slovak Post conditions			
Pillar	**Success [%]**	**Partial points**	**Total points**
1) Personalization	**27.04**	**3**	**4**
2) Time and Effort	**34.63**	**4**	
3) Expectation	**79.23**	**8**	
4) Integrity	**26.94**	**3**	
5) Resolution	**32.26**	**3**	
6) Empathy	**48.11**	**5**	

Source: author's calculations

However, from the point of view of fulfilling customer expectations, the results obtained in individual pillars are significant. They realistically indicate areas that have been lagging the pace of growth and changes in customer needs for a long time.

The area of personalization in the context as understood by the 6-pillar model is still difficult to solve in the conditions of service provision at post office counters, as customers often access the counters anonymously, and therefore the collection of personal data would only be possible if the customer identifies himself. The weak result of the given pillar was also influenced by the fact that many customers did not encounter the customer reward, which is an area where an opportunity for improvement is created for Slovak Post. If we evaluated this pillar in such a way that it is not within SP's power to provide rewards to anonymous customers at the counters, its success rate would increase from 27% to 39%. However, it would still not be sufficient, and therefore it is necessary to focus also on the area of welcoming customers, where we see the greatest scope for improving this pillar. After all, the postal services provided at the box office are still linked to the personal contact of two people, and the first common contact, including the initial greeting, strongly influences the customer experience.

The relatively weak assessment of the Time and Effort pillar in a broader context may also be due to the great expansion of postal operators providing package delivery, which more effectively take into account the time options of customers and with which the Slovak Post was apparently compared in this case. Despite the fact that these are not services directly comparable to those which are provided at post offices. Of course, post office opening hours will hardly compete with parcel shops with longer opening hours or parcel boxes available 24/7. On the other hand, with a deeper analysis, we can see that the biggest problem the customer sees is the removal of obstacles that slow down the provision of services. Slovak Post should focus on this area and try to be more flexible.

The most successful of the pillars - Expectations - is apparently influenced by the recent establishment of the brand in the Slovak market. Many customers know the brand and have an accurate idea of the services it provides. Therefore, the share of customers whose expectations were not met is relatively low. However, the challenge in this area is represented by customers whose expectations will be exceeded in the future and whose share in the survey was not large.

In the area of integrity, there is again an opportunity for a more significant comprehensive improvement of the position and perception of the brand. The claims that customers identified as the least fulfilled by Slovak Post concerned the fulfilment of promises and the pursuit of a higher goal than just profit.

Problem solving is undoubtedly a sensitive area of every business. Here, again we can see a poor level of fulfilling customer expectations in the Resolution pillar. If Slovak Post wants to

present itself as a reliable postal operator, it should work on this area, because only a small proportion of customers registered an apology when solving problems. An apology can be seen as a cornerstone of success in solving problems with customers, because it gives the customer the feeling that he is important to the company and that the company is interested in solving his problem (although it may not have been caused by Slovak Post).

About half of Slovak Post customers recorded empathy for special requests. This area strongly depends on the personality of the counter employees who provide services, but it is also possible to train these skills. The Empathy pillar is a big challenge for postal services provided at counters, as empathy can hardly be replaced by technology.

4. Conclusion

There exist a range of models which may be employed in researching the degree of satisfaction of postal service customers with the quality of service which they receive. Service quality itself has been clearly distinguished from customer satisfaction because the latter is personal and value dependant. Service quality in postal services must be managed and matched to changing customer expectations over time.

Our research was focused on postal services provided by Slovak Post at the counters. These services have many specifics and under the conditions of the Slovak Republic, they have no competitor in the postal services industry. Therefore, it was not possible to use the six-pillar methodology to compare the brand's success, as its authors did, but we used it to internally evaluate the Slovenská pošta brand from the perspective of its customers' experiences. This fact can be described as a limitation of the study from the perspective of the methodology used. Given the formulation of questions focused on customer experience at post counters, it was not possible to make a comparison within companies operating in the postal market. Nevertheless, our survey revealed many areas in which corrections, further analyses, and recommendations, so that this postal operator is once again ranked among the leaders in the provision of postal services in the perception of customers.

In future research, we would like to focus on using the six-pillar methodology in evaluating the loyalty of postal operators' customers. However, this focus will require necessary adjustments to the wording of the questionnaire questions. As a possible application of the presented research, we also have the opportunity to apply the presented methodology in the field of providing e-commerce services, focusing on evaluating the loyalty of clients using online courses and training aimed at improving Excel skills, which is being addressed by one of the authors of the article.

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FaceReader as a Tool for Implicit Comparison of Sensory Perception of Selected Dairy Products

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Abstract

Paper's objective(s) and research background

This paper explores the potential of FaceReader technology as a tool for implicitly comparing the sensory perception of dairy products. Traditional sensory evaluation methods often rely on explicit measures, which may be influenced by biases. FaceReader technology offers a non-invasive and real-time assessment of consumers' sensory experiences by analysing facial expressions. The integration of FaceReader technology into sensory evaluation assessment for dairy products presents opportunities for understanding implicit sensory preferences, assistance in product development and marketing strategies for improved consumer satisfaction.

Data/Methods

The aim of this study is to detect conscious, subconscious and unconscious consumer reactions when consuming a certain type of dairy products within using the biometrics and specifically the FaceReader as a tool for the implicit assessment of sensory perceptions. This paper presents the possibilities of using implicit tools in sensory evaluation of food and summarizes the basic knowledge in this field. The study describes and uses methods of examination, while comparing implicit and explicit perceptions of dairy products. In the given context, an online questionnaire is used as a classical data collection method, followed by blind testing and evaluation of the results using the innovative method FaceReader. It is a special platform which detects and processes six basic microemotions. It is used to obtain subconscious/unconscious feedback, as it allows online collection of implicit feedback using the software FaceReader 7.

Results/Conclusions/Value added

Today, marketers and sellers are facing the greatest challenge of how to attract attention of consumers. Every individual has a different perception of the products based on own subjective matters. This is why new marketing techniques and approaches are becoming increasingly popular in the marketing and shopping environment. Our research has shown that the results of blind testing do not completely match the answers from the questionnaire survey. Therefore, based on the results obtained, we can affirm that FaceReader as an innovative tool to examine consumer behaviour is very helpful in all spheres of business, as it helps to better understand consumers' behaviour in the shopping process and their motives, when it uncovers also subconscious and unconscious stimuli. Hence, it is important to complement classical forms of consumer behaviour research (like questionnaire, interview, etc.) with such innovative methods. Their use has great potential, as they not only bring a new perspective on the actual perception of consumers but also the possibility to work with more realistic data.

Key words

Consumer neuroscience, Sensory marketing, FaceReader, Consumer behaviour, Dairy products

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JEL Classification
M31, M39, Q13

1. Introduction

Today, marketers are facing the greatest challenge of how to attract consumers' attention. Every individual has different perception of the shopping environment based on own experience, beliefs and attitudes. The businesses need to work even harder to drive customer satisfaction and encourage spendings. It is why new marketing tools, techniques and approaches are becoming increasingly popular in the marketing environment, which focuses on examining consumer behaviour and the ways in which businesses can positively influence it.

Marketing, like every discipline, evolves over the years of practice and with the contribution of new knowledge. The trend today is marketing communication oriented simultaneously to multiple human senses, represented by the modern field of consumer neuroscience or neuromarketing. This uses neuroscience to detect the subconscious decision-making processes of consumers (see Berčík et al., 2018; Genco et al., 2013).

New methods are being developed to identify changing consumers' needs, to attract them, and to show them the advantages of particular product compared to competing product. The marketing industry, as well as other fields and industries, is increasingly facing the problem of visual and information overload. This is causing consumers to become more and more immune to traditional marketing activities, and to fall into a state of "perceptual blindness" (see more in Bredemeier & Simons, 2012; Brinson et al., 2018). Thus, it is now gradually difficult to attract customers at the point of sale, with this being usually the last opportunity to potentially change a person's decision to buy a product. Therefore, there is an increasing interest in targeting several senses simultaneously in order to influence buying behaviour (Berčík et al., 2021).

People act based on emotions. The choices we make, the actions we take, and the perceptions we have are all influenced by the emotions we are experiencing at any given moment. This fact was realized by many scientists, and they began to think about how to use it in marketing. It is important to understand what evokes emotions of people. Research has shown that senses can evoke significant memories, even from many years ago (Herz, 2016; Ledger, 2020; Miljković & Alčaković, 2010). For the marketers it is important to eliminate negative emotions and, conversely, to support the positive ones and thus motivate the consumer to the purchase process. The area where the influence of senses on consumer behaviour can be seen is a quickly developing trend in marketing, called sensory marketing.

Presented paper is focused on using FaceReader as an innovative tool to examine subconscious/unconscious customers´ perceptions and reactions in the consumption of dairy products. The aim is to focus on consumers' reactions when tasting different strawberry yoghurts, how they perceive the products by using this biometric method FaceReader software from the Dutch company Noldus. The aim of this research is also to find out the real consumer preferences in the examined products. As conclusion we will offer also some suggestions for improvement in practice, which can help businesses decide to use this type of research in their common practice.

1.1 The raising importance of sensory marketing

Sensory marketing has an increasing role. Sensory marketing (or sense marketing), can be understood in a general, as marketing that addresses the senses of consumers and affects their behaviour (Krishna, 2010, p. 2). It is a communication with consumers through sight, hearing,

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smell, touch, and taste. “This implies studying sensation and perception as ways that modify consumer behaviour” (Krishna, 2012, p. 333). So, the aim of sensory marketing is to influence perceptions, judgments, and behaviours of consumers through their senses. Brightness of light, loudness of voice, softness of fabric, smell of aroma samples at a market influence their feelings and behaviours (Erenkol, 2015, p. 2). More specifically, we agree that, sensory marketing at the point of sale addresses all the senses, to stimulate them and via this try to create a pleasant environment, so that the customer increases the purchase time in particular place (Jiménez-Marín, G., Bellido-Pérez, E. & López-Cortés, 2019).

Analysing the senses, we can say that the nose is being one of the most sensitive and emotional senses, with a great ability to associate certain aromas with specific situations. Neuromarketing related studies affirm that 75% of our emotions which are experienced during the day, are related to aromas and human can recognize up to 10 000 different aromas (see more in: Jiménez-Marín, 2016; Erenkol, 2015). They strongly influence the buying behaviour. As several researches indicate, while humans are only able to remember 50% of the things they have seen after three months, in the case of aromas it is up to 65% after one year (Mukherjee, 2015, p. 1294). Thus, we consider significantly important to pay attention to the smell and aromas in the marketing and its utilization in the business environment.

Sensory marketing is based on the influence of one or more human senses. It deliberately promotes several sensory perceptions and its means are typically smell, sound, taste or touch stimuli. Traditional means of communication mainly use visual and audio elements of communication. Thus, brands and products are known by their logos, design elements or typical sounds (Přikrylová et al., 2019). The role of sensory marketing today is primarily to convince consumers to prefer buying certain products and services, and in doing so, it uses the action of one or more of the senses. This type of marketing is based on consumer demands and preferences (Hultén et al., 2009; Randhir et al., 2016).

Sensory marketing is concerned with creating an atmosphere at the point of sale. It aims at influencing the consumer's senses (sight, taste, hearing, touch, smell) and arousing emotions that will influence their consumer behaviour and ideally guide them to buy the product or service (see also, Lee – O' Mahony, 2005).

Berčík et al. (2016) states that consumers perceive the store setting through all their senses. This perception can be defined as the process by which people organize, select and acquire information from the environment. At the same time, they point out that traditional forms of marketing are now becoming insufficient and are gradually being supplemented by new approaches and methods designed to monitor the consumer's neurological data. This is addressed by consumer neuroscience, i.e. neuromarketing, which is important in uncovering hidden consumer reactions and incorporating the relationships between consumers' internal feelings and external expressions and performances. Nowadays, individuals make more decisions through their emotions and senses, which means that subconscious and unconscious rather than conscious decision-making is dominant.

1.2 Consumer neuroscience and its impact on consumer behaviour

Neurology and marketing have recently come together in a wide range of research and have motivated a curiosity, as well as a desire for knowledge, leading to the birth of neuromarketing (Pop et al., 2009). Neuromarketing – or consumer neuroscience – is an emerging field in marketing that combines perspectives of marketing, neuroscience, economics, decision theory and psychology. Neuromarketing uses brain imaging technology to effectively disclose the underlying reasons for the behaviour of consumers and predict decision-making processes of consumers (Morin, 2011; Nilashi et al., 2020). N. Lee, A. J. Broderick and L. Chamberlain

(2007) define neuromarketing as "the application of neuroscientific methods to analyse and understand human behaviour in relation to markets and marketing exchanges" (Lee et al., 2007, p. 200). Neuromarketing is focusing on understanding the thoughts and behaviour of consumers to "transfer insights from neurology to research in consumer behaviour by applying neuroscientific methods to marketing relevant problems" (Miljković & Alčaković, 2010).

It is the science of understanding how consumers subconsciously define what they want. Neuromarketers draw out the emotions people attach to products and services to understand how they can influence consumer's decision-making process (Leigh, 2018). Neuromarketing allows to recognize consumer´s attitudes in detail and to identify the reasons behind some behavioural processes. Consumer neuroscience cannot clearly define whether the respondent likes a stimulus or not. However, by using different methods it can detect emotions, perceptions, memorability, and attention devoted to the stimulus, as well as the effect of environmental factors. Using this information, the effect of the stimulus can be recognized. Neuromarketing provides more accurate results and firms which use it are far more competitive than others and that is also a reason why it is at the forefront in the world of marketing (Berčík et al., 2014).

Up to 95% of our decisions during buying process take place in the subconscious mind (Zaltman, 2003), or unconsciously. Using neuromarketing, retail marketing thus uncovers what stimulates consumers to buy and, on the basis of this, forms strategies that motivate them to buy (Miljković & Alčaković, 2010).

2. Data and Methods

The study is aimed at utilizing biometric methods to obtain implicit feedback – specifically the FaceReader software – which was used and contributed in the consumer evaluation of selected dairy products. Our data was collected and processed using a questionnaire survey conducted in an online environment. In current world full of internal as well as external stimuli using just classical marketing methods like questionnaire – is not sufficient any more. These traditional methods shall be complemented with innovative neuromarketing tools, so that together they can reveal, as closely as possible, the true intentions and preferences of consumers, which might remain hidden if only traditional methods were used. Therefore, for obtaining the implicit reactions and responses of consumers in testing the selected dairy products – strawberry yoghurts – we used a biometric method FaceReader 7 software – a special platform that allows online collection of implicit feedback.

FaceReader is one of the spreading neuroscience tools that helps in marketing analysis of consumer perception and behaviour. It is a commercially available software program that can analyse seven basic facial expressions according to different emotional states: happiness, sadness, anger, surprise, fear, disgust and neutral expression (Yu and Ko, 2017). Several studies have also shown that the accuracy rate of the software in analysing emotions reaches 90% (Loijens & Krips, 2013). Thus, the emotional state analysed by the FaceReader software can show the emotions of the participants quite reliably and immediately (Yu & Ko, 2017).

When using FaceReader, the participant's face is recorded while watching some stimuli on the screen. "Then, the advanced computer program places a virtual grid consisting of 500 points on the recording of the participant's face. After that the advanced image processing algorithm calculates the points on the picture of the face (491 points/44 muscles) and as an outcome gives information about the different detected expressions of abovementioned emotions" (Maison & Pawłowska, 2017, p. 311). The analysis measures micro expressions to encode unconscious responses based on facial muscle activity using a camera and image processing software. Facial

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expressions have several unchanging features that can be identified as a common indicator of any mood. This analysis allows real-time measurement, it is highly subjective, and it is used as a complementary technique to other methods (Dincer, 2020).

The aim of using a special platform for remote collection of unconscious feedback was to obtain information about consumer preferences not only on a conscious but also on unconscious and subconscious level. The analysis of the recorded facial expressions of the respondents in the form of videos was realized by the mentioned somatic biometric method FaceReader from the Dutch company Noldus. The software measures the conformity of facial expressions at 30 frames a second, on a scale of 0–1, to those associated with six emotions: happiness, sadness, anger, fear, disgust, and surprise (Den Uyl & Van Kuilenburg, 2005; Terzis et al., 2010). It identifies the emotional feedback (valence, arousal) of the respondents based on the observable changes of the facial muscles with maximum accuracy. FaceReader identifies emotions as effectively as trained human observers (Lewinski et al., 2014; Terzis et al., 2010) and accurately classifies both intended and unintended emotions (Bijlstra & Dotsch, 2011).

The object of research is the detection of conscious and unconscious/subconscious consumer reactions in the consumption of dairy expressions using FaceReading, other methods were also used – questionnaire survey, blind testing using a questionnaire and statistical methods to evaluate the results. These statistical methods of assessing agreement based on comparison were used to compare the two sets of data to determine the degree of agreement between them. The questionnaire survey was carried out in an online environment. It was created using the Google Forms platform and released between February and March 2020. The number of respondents was 421 and included a total of 18 questions that focused on the respondents and their data, consumption of dairy products, their satisfaction with the occupancy of yoghurts on the Slovak market. The data were processed using Microsoft Excel 2007.

Blind testing was conducted using a questionnaire. It was created via Google Forms platform. It was carried out in the time period from 26.03.2020 to 02.04.2020 due to the outbreak of the COVID-19 pandemic this research was conducted in a home environment, despite the fact that the original plan was to conduct it in the Laboratory of consumer studies of the FEM SUA in Nitra with 20 respondents. In the end, the numbered must be lowered and 15 respondents took part in this blind testing. Before the actual testing, the respondents first filled in the initial part of the questionnaire with questions on gender, age, place of residence, economic activity, whether they consume dairy products, what kind of sour dairy products they consume, whether they consume yogurts and what kind of yogurts they consume.

3. Results and Discussion

3.1 Quantitative research – Questionnaire survey

The questionnaire survey consisted of three parts. In the first part, the questions were focused on the respondent and his/her data, in the second part on the consumption of dairy products and the third part dealt with the consumption and satisfaction of the respondents with the occupancy of yoghurt on the Slovak market.

The respondents who took part in the questionnaire survey make up a population of 421 persons. In terms of gender, the majority of respondents were female (352, representing 84%), while 69 (16%) were male. The age structure of the respondents was diverse: the largest group was 18-25 years old (137, 32%), followed by 26-33 years old (110, 26%), 34-40 years old (63, 15%), 41-47 years old (54, 13%), 56-65 years old (32, 8%), and the least represented age categories were 48-55 years old (15, 4%) and 66 years old and above (10, 2%). In terms of residence, the majority of respondents were from urban areas (296, 70%), while 125

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respondents (30%) were from rural areas. The highest number of respondents (118) indicated that their net household income was between 1001 – 1500 €, and only 12% (52) had a net household income of up to 580 €. We were further interested in questions related to the consumption of dairy products, with up to 93% of respondents confirming their consumption. Respondents cited yoghurt (374), acidophilus milks (179) and yoghurt milks (98) as the 3 most preferred acidophilus products, which can be a form of quick breakfast, snack or dinner, as well as their beneficial effect on digestive function. The remaining questions in the questionnaire survey focused on preferences for yoghurt, which was consumed by up to 96% of respondents. For the next question, respondents were again given the opportunity to select their three most preferred types of yoghurt, with classic cream yoghurt in first place (290 respondents), followed by yoghurt with probiotic ingredients (151 respondents) and Greek yoghurt in third place (149 respondents). More than half of the respondents (53%) consume yoghurt several times a week, 18% several times a month, 17% consume yoghurt once a week and 12% even every day, which may result in a boost to the immune system or digestive adjustment.

The most common reason for consuming yoghurts, according to the answers (fig. 1) given (44%), is their taste, while for 25% of people they are an essential part of their diet. The remaining 31% gave the reason for consumption as being related to the benefits for their health (nutritional value, health status or healthy diet). Among the selected factors packaging, brand, price, taste, nutritional value, country of origin or advertising, the taste of yoghurt (250 respondents), country of origin (116) and nutritional value (110) have the greatest influence on the respondents. Advertising (173) and packaging (110) are the least influential according to the number of responses.

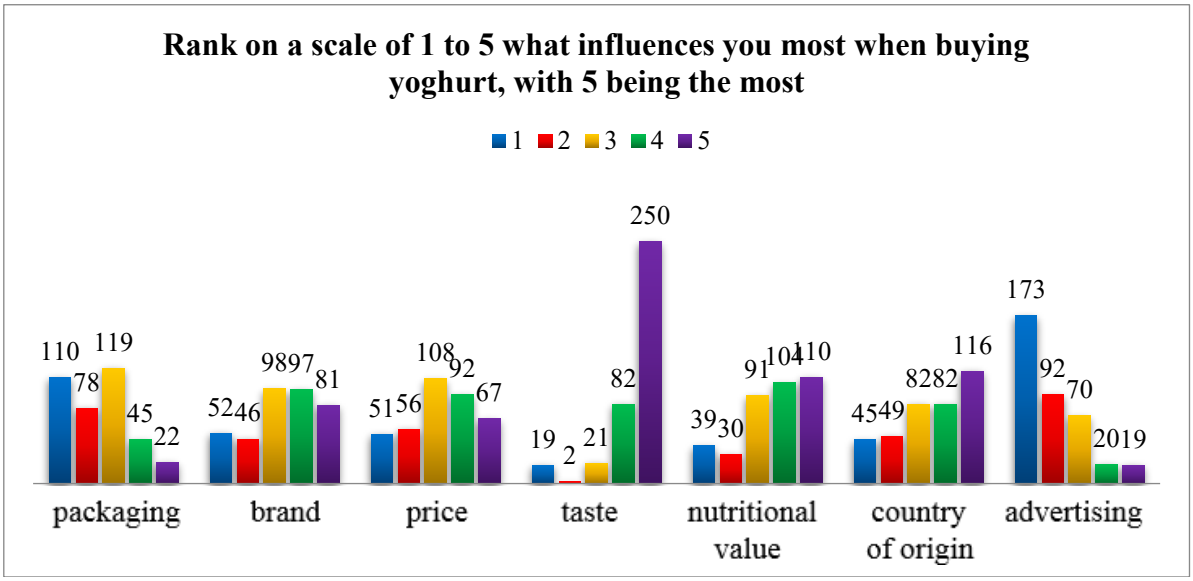

Figure 1: Impact on the purchase of yoghurt
Source: Own processing

An interesting finding is the influence of the brand and especially the price on the respondent, where up to 108 respondents chose to indicate the price and 98 respondents the brand as a factor that has a medium influence on them. Respondents prefer to buy yoghurt from hypermarkets (45%) and only 2% will focus on buying from a specialised dairy outlet, which may be due to the higher price of the products or the unavailability of such outlets. Nevertheless, up to 93% of respondents focus on local dairy products when shopping. The three most preferred brands are Zvolenská mliekareň (28%), AGRO Tami (26%) and Rajo (25%), which corresponds to the satisfaction of respondents (up to 96% expressed satisfaction with

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the offer of dairy products on the Slovak market). Also, based on the questionnaire survey, we can claim that at the same price, up to 63% would choose a product from the farm compared to choosing yoghurt from the dairy (fig. 2), which confirms us that our respondents prefer quality, freshness and a product without artificial additives or preservatives.

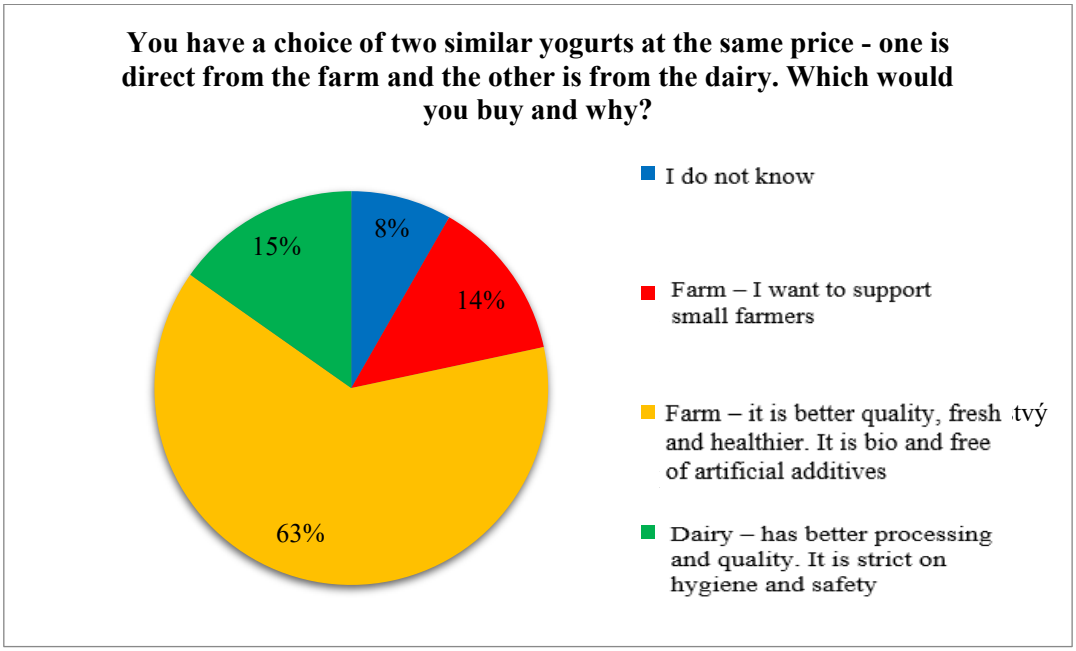

Figure 2: Selection of yoghurt at the same price, one from farm and one from dairy
Source: Own processing

3.2 Evaluation of qualitative research – blind testing using a questionnaire

Fifteen respondents participated in the blind testing, of which 9 were female (60%) and 6 were male (40%). The age structure of this sample was as follows: the 48-55 age category was the largest (5 respondents, 34%), followed by the 26-33 and 41-47 age categories (3 respondents each, 20%), and the 18-25 and 66+ age categories (2 respondents each, 13%). The residence of the respondents was fairly balanced: 7 persons (47%) were from urban areas and 8 persons (53%) from rural areas. Over 70% of respondents were economically active and all respondents consumed dairy products, with yoghurt being one of the top three favourite sour milk products for all respondents. For the blind testing strawberry-flavoured cream yoghurts from five different producers were selected. The selection of these samples was based on the variety of brands and the availability of the products on the Slovak market. The aim was to include products from well-known brands and less well-known brands in order to obtain a comprehensive view of consumers' perception and evaluation of yoghurt. These samples represented a wide range of products available on the market, from traditional local producers to private labels, which allowed for a comparison of their quality, taste characteristics and overall consumer perception. The respondents identified cream and low-fat yogurts as the most preferred types. The next task was for the respondents to evaluate the taste, aroma, colour, consistency, and proportion of strawberries on five samples based on sensory testing. Based on the data obtained, it can be assessed that in all characteristics, sample 5 ranked first and the worst ranked sample was sample 3. Based on the previous ratings, the respondents matched the names of the selected dairy products to the individual samples. The highest number of respondents indicated that sample No.1 belonged to the brand Bánovecký, MILSY a.s., sample No.2 was assigned by the same number of respondents to the brands Ňuňu, MALÝ GAZDA, s.r.o. and RAJO a.s. For sample No.3 and 4, the highest number of responses was attributed to Coop Jednota, AGRO TAMI, a.s. and the brand ZVOLENSKÁ MLIEKAREŇ, a.s. received

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the highest number of respondents for assignment to the last sample No.5, which was also the most popular among the respondents.



Figure 3: Blind testing of yoghurts
Source: Own processing

Based on blind testing, more than half (67%) of the respondents would buy sample No.5 and no respondent would be willing to buy sample No.3. When the samples were re-sensory evaluated based on taste, aroma, colour, consistency or proportion of strawberries, respondents were also provided with the revealed brands of each sample. Despite the influence of the yoghurt brand during the sample testing, the highest scores for all the above characteristics were given to sample 5 of Coop Jednota, AGRO TAMI, a.s. and, as in the previous testing, the last place was taken by sample 3 of the brand Ňuňu, MALÝ GAZDA. The second and third place goes to the Rajo and Zvolenský brands, respectively, which were exactly in the opposite order in the first testing, which is probably due to the brand influence. The fourth place belongs again to Bánovecký yoghurt as in the first testing. The most attractive packaging was chosen by the respondents for the yoghurt brand Ňuňu, MALÝ GAZDA, which is in a glass version with the possibility of further use. This was followed by Rajo, Bánovecký, Zvolenský and the last most popular sample was Coop Jednota, whose packaging design was in bold colours with poor quality graphics. Based on previous experience regarding the characteristics, brand or attractiveness of the packaging, most (47%) of the respondents would choose to buy Coop Jednota yoghurt (sample 5), 20% of the respondents would buy Zvolenský yoghurt (sample 1), 13% would buy Rajo (sample 2) and Bánovecký (sample 4), and 7% of the respondents would reach for the brand Ňuňu, MALÝ GAZDA (sample 4). The last and the strongest factor influencing the respondents' decision making when choosing yoghurt was the price, which caused that 33% of respondents would realistically be willing to buy yoghurt of Rajo and Bánovecký brand, 20% of respondents would choose Coop Jednota brand, 13% of respondents mentioned Zvolenský brand and not a single respondent would buy yoghurt of Ňuňu brand, MALÝ GAZDA. Compared to the other yogurts, it had the smallest package with the highest price, and scored the lowest in the feature-based evaluation. On the last question regarding the biggest influence on yogurt choice, up to 73% of respondents said taste, 13% were interested in nutritional value, and 7% of respondents would be influenced by brand and packaging, suggesting that consumers focus on what tastes good rather than the price of the product itself.

3.3 Facereader results

Emotional valence: (see fig. 4). In blind testing, respondents had approximately the same emotion for each sample, as there were not large differences between the measured values, and the results say that neutral emotion was the predominant emotion among the respondents. For the Zvolenský yoghurt sample, our respondents were the happiest, which may have been due to the creamy taste. Sample 3 (Ňuňu, MALÝ GAZDA) had the highest values for surprise and the lowest values for the emotion of happiness. The lowest values of disgust were for sample 5 (Coop Jednota) and respondents rated this sample as the tastiest. On the contrary, the most disgusted were for sample No. 2 (Rajo).

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When tested with the packaging, respondents were equally positive, and their neutral emotion was predominant. However, they had the best perception of sample 1 and the worst perception of samples 2 and 4 (highest negative values). Interestingly, the highest values of surprise and happiness were prevalent for sample 5 (Coop Jednota), as they did not expect the Coop Jednota private label yoghurt to taste the best.

After the measured values obtained with the Face reader software in both blind and wrapper testing, respondents were most positive about sample 1 (Zvolenský). In blind testing, they were negatively attuned to sample 5 (Coop Jednota) and, with minimal difference, to sample 3 (Ňuňu MALÝ GAZDA). Regarding testing with packaging, respondents were negatively tuned for sample No. 2 (Rajo).

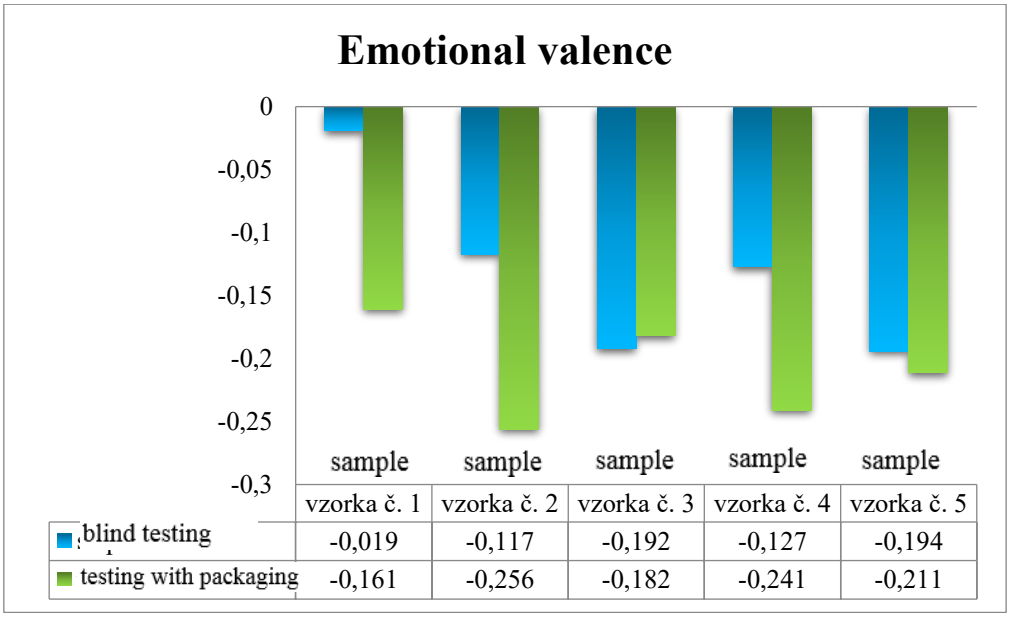

Figure 4: Emotional valence
Source: Own processing

Excitement: Based on the unconscious feedback, the highest activity was recorded for sample No. 1 (Yogurt Zvolenský) and sample No. 3 (Ňuňu, MALÝ GAZDA). On the contrary, the lowest was observed for sample No 5 (Coop Jednota private label yoghurt) and sample No 2 (Rajo). Thus, we can argue that the results are consistent with the packaging attractiveness assessment conducted during the blind testing, where respondents rated sample 5 (Coop Jednota) as the least attractive.

The highest arousal values (fig. 5) were for sample 1 (Zvolenský yoghurt), which may indicate that the level of arousal was retained from the past and the unchanged packaging of the product in question was just expected. Almost identical levels of arousal took place for sample 3 (Yoghurt Ňuňu, MALÝ GAZDA) as there was a high level of emotion where respondents liked the packaging of the product and ranked this packaging as the most attractive when assessing attractiveness.

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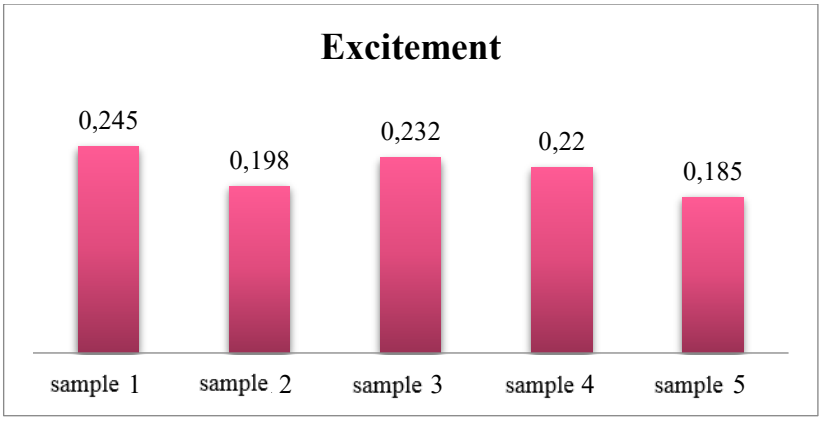

Figure 5: Arousal values
Source: Own processing

4. Conclusion

Despite rising numbers in the consumption of milk and dairy products in Slovakia, this consumption is still below the numbers recommended by the experts. The average Slovak consumes about 176 kg of milk and milk products per year, while experts recommend 220 kg. However, although consumption of drinking milk is stagnating, on the other hand, consumption of acid milk products is increasing. Slovaks like cream yoghurts the most, followed by cheese, and butter consumption is also growing.

Our research was aimed at identifying conscious and unconscious consumer reactions to the consumption of selected dairy products using the FaceReader biometric method, where we examined consumers' reactions when tasting selected brands of strawberry yoghurts.

The questionnaire survey was focused on consumers' preferences in buying yoghurt. The results of this questionnaire show that consumers are most influenced by taste and least influenced by packaging and advertising when making a purchase. Also, the data showed that consumers are more likely to focus on local brands. At the same time, up to ¾ of the respondents said that they would prefer yoghurt from a farm rather than from a milk factory, either because they support small farmers or because they think that these products are of better quality, without chemical and artificial additives or in terms of health safety.

Based on the data obtained, blind testing of individual yoghurt samples was carried out with the creation of video recordings of the face to examine the facial biometrics of consumers with FaceReader software. The obtained values (i.e., the subconscious and unconscious reactions of the respondents) were then compared with the results of the questionnaire. Here, respondents rated the taste, colour, aroma, consistency and proportion of strawberries. The results of the blind testing did not completely match the responses of the questionnaire survey, in which respondents indicated that they would reach for yoghurt from the farm rather than from the milk factory. Respondents least liked sample No. 3 Malý Gazda, which was a yoghurt from a small family-run business that is made by ripening in glass. However, they described the packaging as attractive as there is the possibility of further use of the packaging after consumption of the yoghurt. Respondents liked sample No. 5 – Coop Jednota brand yoghurt (produced by Agro tami, a.s. Nitra) the most. However, despite the best rated taste, it had the worst rated packaging.

Respondents were most positive about sample 1 – Zvolenský yoghurt, for both questionnaires. Negative attitudes were shown in blind testing for sample 5, Coop Jednota, and for sample 3, Malý Gazda. In the packaging test, a negative response was present for sample No 2 – Rajo yoghurt. For the packaging test, we evaluated the results of the arousal rate, which showed that

for the unconscious feedback, the highest level of arousal was for package No. 1, Zvolensky yoghurt, and also for package No. 3, Ňuňu Malý Gazda. The lowest level of attractiveness was recorded for package 5, Coop Jednota. These values are thus consistent with the results of the blind testing, where respondents were asked to consciously indicate which packaging was the most attractive.

Based on the presented findings, we would recommend the COOP Jednota Slovensko to change the packaging of its cream yoghurts in order to make the product look more premium and luxurious and to attract the demanding consumer, who cares about both look and quality. Since people do not know the taste of the yoghurt at first and see the unattractive packaging, they tend not to buy the product. They are more likely to prefer eye-catching packaging which may give the impression of higher quality than others and thus attract more customers in particular. This change could thus improve the sales of these products, which will bring higher sales for the retailer and raise customer satisfaction, who may also recommend the products further.

Our research has shown the importance and usefulness of FaceReader not only in marketing, sales, advertising or research agencies, but also in manufacturing in the creation of the products themselves, packaging or branding. As the competition is currently high, it is necessary to complement the conventional conscious feedback research tools with innovative tools revealing unconscious and subconscious feedback, which cannot be obtained by classical methods. Although these are more costly solutions, a real understanding of consumer behaviour can ultimately improve the economic results of retailers.

Acknowledgements

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The Employment Implications of Industry 4.0 in Slovakia

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Abstract
Research background
In light of the worldwide integration of value chains, we have chosen to delve deeper into this subject in order to analyse the correlation between employment and the latest developments in Industry 4.0. This complication represents a significant societal transformation, especially for manufacturing-dominant nations like Slovakia.
Objective of the paper
The objective of this study is to analyse and assess the effects of Industry 4.0 on the labour market in the Slovak Republic, in addition to examining its present and future trajectory.
Data/Methods
Statistical index analysis techniques are utilized to assess employment levels, enabling the determination of whether employment has witnessed a growth or decline. In order to evaluate the progress, the forecasting approach was implemented.
Results and Value Added
An indicator of the work's added value is the degree to which its subject matter is pertinent to critical national and international concerns that affect the populace of the country. The effective amalgamation of digitization trends and Industry 4.0 will significantly foster the advancement of knowledgeable communities and occupations.

Key words
Industry, IoT, globalization, Industry 4.0, employment, digitization

JEL Classification
A11; C10; O32

1. Introduction

The concepts of labour and employment are both well-known and significant. Policy and the labour market are components of employment. The contemporary world is constantly evolving. Eventually, everyone will embrace emerging technologies. Moreover, in the workplace and at home. Manufacturing and the workplace are permeated with technology and efficiency. The prevalence of Industry 4.0, the fourth industrial revolution, has increased. The region and the industrial sector will be altered by this transition. It impacts not only to daily lives but also the realms of commerce, education, scientific inquiry, and security. Industrial output serves as an indication of the fourth industrial revolution. Programmable automation and devices are predominantly employed for manual labour in large-scale manufacturing facilities, such as automotive plants (Su et al., 2022). The operation of an organization is reliant on the labour market. The government, merchants, and the general public are present. People obtain a livelihood, personal fulfilment, and social standing through employment. For production to run smoothly, the employer must have an adequate supply of high-quality labour. Further to ensuring employment, the state establishes and enforces market standards for newly hired personnel. (Hodder, 2020; Krizanova and Michulek, 2022).

The objective of this article is to identify, quantify, and analyse the employment implications of Industry 4.0 in the Slovak Republic. Additionally, a comprehensive overview of the pertinent literature and foundational concepts are presented in the paper. Employment is a frequently discussed topic; however, its relationship to Industry 4.0 is relatively under-discussed; consequently, the impact of Industry 4.0 on employment is even less understood, if not unknown..

2. Literature Review

Employment refers to the involvement of the working population in manufacturing, providing, or delivering goods, commodities, or services. It is a key metric for evaluating economic effectiveness, significantly influenced by human activity (Filippi et al., 2023). The labour market functions through the interplay of labour demand and supply, shaped by the prevailing economic framework (Teshabaeva and Kodirova, 2023; Gajdosikova et al., 2022). It serves as an integral component of the broader market system, encompassing all economic and social phenomena within a given time frame.

Employment metrics include absolute and relative indicators. The total employment figure reflects the number of employed individuals, while the unemployment rate serves as a relative measure of labour market conditions (Valaskova et al., 2022; Fana et al., 2020). The employment rate, denoting the percentage of the working-age population (15-64 years) gainfully employed, is a fundamental macroeconomic indicator (De Stefano et al., 2021). Similarly, the rate of economic activity indicates the percentage of productive-age individuals engaged in economic activities.

The Slovak Republic, like many other nations, aspires to full employment, defined as the level of employment corresponding to potential output and the natural unemployment rate. Full employment does not imply zero unemployment but represents a balance where all willing and able individuals can find work at prevailing wages. Employment policies are designed to reduce unemployment and provide assistance to the unemployed (Majd, 2020). Labour market policies, a subset of employment policies, aim to integrate citizens into the workforce and address labour market inefficiencies (Kolade and Owoseni, 2022).

Labour market policies are categorized as passive or active. Passive labour market policies, dating back to the 1920s, focus on mitigating the effects of unemployment through benefits such as unemployment insurance and early retirement pensions (Gallacher and Hossain, 2020). Active labour market policies, emerging in the 1970s, aim to improve employment prospects and labour market efficiency through measures like skill enhancement and job creation incentives (Dottori, 2021; Lăzăroiu et al., 2021). Under Act No. 5/2004 on Employment Services, Slovakia classifies active measures into two groups: assistance to improve employability and measures to promote job creation and retention (Arestis et al., 2020; Popescu, 2021).

Employment policy, a component of social policy, seeks to balance labour supply and demand, efficiently utilize labour resources, and protect workers' rights (Zhong et al., 2021; Lăzăroiu et al., 2021). Achieving these goals requires addressing labour market rigidities and preventing unemployment.

As this study focuses on the impacts of Industry 4.0, it is crucial to highlight its defining characteristics. Industry 4.0, driven by the Internet and autonomous networks, signifies the comprehensive automation of production processes through interconnected cyber-physical systems (Clayton and Kral, 2021; Skare et al., 2021; Ruttimann and Stockli, 2016). This transformation involves global networks and the integration of production facilities with digital

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systems, enhancing efficiency and innovation (Vuong and Mansori, 2021; Lawrence and Durana, 2021).

3. Data and Methods

The statistical technique of index analysis will be applied to the calculation and evaluation of employment growth in this project. In addition, an examination of the employment rate from 2007 to 2019 is furnished with the assistance of the calculation. The following years are not included as they were strongly affected by the COVID-19 pandemic and the outputs of the analysis would be significantly distorted. *The basic index* is an index whose postulate remains constant throughout the initial base period values. Variables: I – growth factor; y_t – the value of the indicator in the current period; y_0 – value of the indicator in the base period.

$$I = \frac{y_t}{y_0} \tag{1}$$

Where:

I – growth factor; y_t – the value of the indicator in the current period; y_0 – value of the indicator in the base period.

Chain index – it is a floating-basis index comprised of values from the period immediately prior to it.

$$Growth\ rate = \frac{y_t}{y_0} \cdot 100 = I \cdot 100\ (\%) \tag{2}$$

$$Rate\ of\ increase = \frac{y_t - y_0}{y_0} \cdot 100 = (I - 1) \cdot 100\ (\%) \tag{3}$$

Where:

I – growth factor; y_t – the value of the indicator in the current period; y_0 – value of the indicator in the base period.

A prognosis, as a broad term, refers to a scientifically validated prediction that ascertains the probable future course of action or the likelihood of additional progression of a specific phenomenon. By leveraging the forecast sheets feature in the data pane of the Excel software, authors generated their forecasts. The authors make the initial presumption that employment will decrease, specifically in the domain of industrial production, which is dominated by unskilled labour. These workers may be steadily replaced by machinery and automata as they are incorporated into the manufacturing process. The authors further posit that while employment levels will remain constant, personnel engaged in industrial production, such as belt production, will be replaced by staff tasked with the repair, maintenance, and programming of robots and machines. Utilizing the Internet portal of the Statistical Office of the Slovak Republic (SOSR), precise information regarding employment, the topic of this paper, was gathered.

Table 1: Millions of job positions created in the Slovak Republic between 2007 and 2019

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
2.36	2.43	2.37	2.32	2.32	2.33	2.33	2.36	2.42	2.50	2.53	2.57	2.58

Source: Author's compilation according to SOSR (2023)

The number of individuals who are employed in the Slovak Republic is presented in Table 1. The information spans the years 2007 to 2019 and is displayed in millions. Employment in the Slovak Republic has been increasing annually and in a gradual fashion. According to the most

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recent data available in this analysis, the number of employed individuals in the Slovak Republic was 2,583,636.

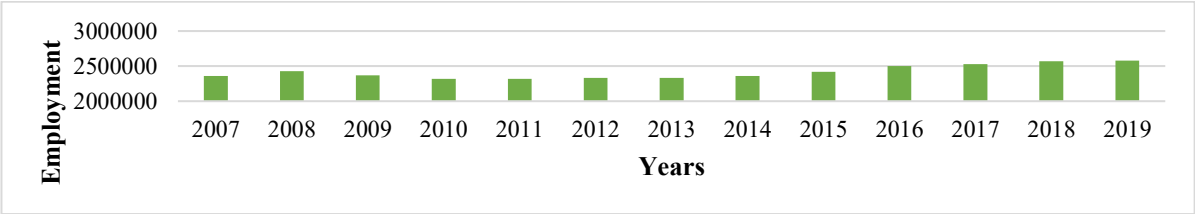

Figure 1: Employment in the Slovak Republic from 2007 to 2019

Source: Author's compilation according to SOSR (2023).

Employment in the Slovak Republic from 2007 to 2019 is illustrated more clearly in Figure 1. The year with the greatest employment rate will be 2019, whereas the year with the lowest employment rate was 2011. After declining from 2008 to 2012, the employment rate subsequently began to rise. The following segment of the project delves into the precise computation of the selected indices, in addition to the analysis of future progress that was previously alluded to.

4. Results and Discussion

The outcomes of chain index computations and an assessment of the employment climate in the Slovak Republic are presented in this section (Table 2).

Table 2: Employment growth rate in the Slovak Republic in %

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
X	103.24	97.21	97.21	99.91	100.59	100.01	101.45	102.58	102.81	101.55	101.42	100.66

Source: Author's compilation according to SOSR (2023)

The employment growth percentage in the Slovak Republic was ascertained by utilizing the chain index. Employment rose 3.24 percent in 2008 compared to 2007. Also unprecedented was the increase in employment. 2009 witnessed the largest annual decline in employment, at 6.14 percent, in comparison to 2008. A considerable proportion of long-term employees in the Slovak Republic fall within the age brackets of 35 to 39 years, 40 to 44 years, 45 to 49 years, and 50 to 54 years They are mature and able to contribute to society (Teshabaeva and Kodirova, 2023; Majid, 2020). Post-productive age is attained by individuals who continue to labour after the age of 55. Employability rates for those aged 55 to 59, 60 to 64, and 65 and older were as follows in 2019: 77.5%, 37%, and 4.6%, respectively. However, employment is uncommon among secondary school students aged 15 to 19; the lowest employment rate among those aged 65 and older, or pensioners. The quantification of employed individuals in the Slovak Republic, as well as the age distribution of that population, was ascertained via this analysis. On the basis of economic activities, the work subsequently divides employment into eleven categories. These are the following: 1. The domains of agriculture, forestry, and fisheries; 2. The construction industry; 3. Industrial production; 4. Mechanical industry; 5. Wholesale and retail; Motor vehicle and motorcycle repair; Transport and storage; Accommodation and catering services; and Wholesale and Retail; 6. Administrative and communication services; 7. Real estate-related activities; 8. Financial and insurance activities; 9. Professional, scientific, and technical activities; 10. Public administration 11. Extraordinary pursuits, entertainment, and leisure. Employment increased most in the following sectors during the analysed years: lodging and culinary services, transportation and storage, wholesale and retail trade, automobile and motorcycle repair, and transportation and storage. Conversely, throughout the period under

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review, employment declined in the agriculture, forestry, and fishing industries. Over the past three years, specifically in 2017, 2018, and 2019, the real estate sector has experienced a moderate upswing in employment. Given that the Slovak Republic is the leader in industrial production, it is logical to concentrate on this industry. As a consequence, the assignment also comprises a forecast of employment expansion in the industrial sector until 2025 (Table 3).

Table 3. Forecast of employment growth in industrial production through 2025

Years	Values	Prognosis	Lower confidence limit	Upper confidence limit
2007	516,446			
2008	537,783			
2009	479,617			
2010	461,458			
2011	479,849			
2012	476,495			
2013	469,496			
2014	479,094			
2015	490,670			
2016	508,899			
2017	528,786			
2018	537,824			
2019	536,755	536,755	536,755	536,755
2020		553,600	504,591	602,608
2021		559,432	490,159	628,705
2022		565,264	464,327	666,202
2023		571,097	430,502	711,691
2024		576,929	390,569	763,289
2025		582,761	345,540	819,983

Source: Author's compilation.

Prospects for employment in the industrial production sector would improve if employment conditioned in this economic sector persisted unchanged from 2019 to 2025. More than 582,000 individuals will be employed in industrial production by 2025, representing an increase of approximately 50,000 from 2019. Nevertheless, at this time, it is possible to lean toward the values indicated in the fourth column, which symbolize the minimum threshold of dependability. Therefore, it can be deduced that employment in industrial production will decline to around 345,000 by the year 2025.

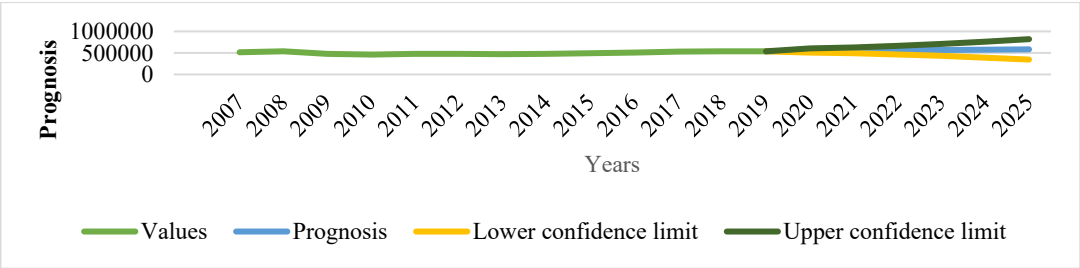

Figure 2. Employment expansion projections for industrial production through 2025

Source: Author's compilation.

The central preoccupation of Industry 4.0 is industrial production. Authors anticipated the progression of employment in industrial production. The industrial sector provides employment for more than 500,000 individuals. Current conditions indicate that the majority of industrial employees will be laid off. Thus, the purple line on the graph represents the lowest level of reliability. The brown line in the graph indicates that industrial production employment in the Slovak Republic will increase moderately through 2025 if the current scenario persists

until 2019. Competitive products from a nimble, sustainable, and loss-free value stream is the objective of Industry 4.0 (Belas et al., 2023). By connecting people, machines, objects, and systems, it is possible to achieve an increase in flexibility, robustness, and optimal deployment of resources (Kovacova et al., 2022). Industry 4.0 can thus be conceptualized as an assortment of digitization tools that facilitate the realization of lean manufacturing system objectives—achieving value flows that are agile, sustainable, and devoid of losses (Zhong et al., 2021).

While these advancements are promising, implementing digitization also introduces several risks. Violations of the draw principle, such as inaccurate monitoring of material supply to production lines and frequent adjustments to production schedules, can lead to inefficiencies. Moreover, rapid digitization may disproportionately impact employment, particularly for those with limited digital skills. In the Slovak Republic, employment trends have undergone significant fluctuations, creating uncertainties regarding the trajectory of industrial job retention.

Despite these challenges, authors like Vuong and Mansori (2021) emphasize the potential for populations to adapt through their innate knowledge, determination, and eagerness to embrace contemporary innovations. It is essential to approach upcoming industrial revolutions with understanding and strategic preparation, rather than fear. While some jobs will inevitably disappear, researchers have a responsibility to explore and leverage new opportunities that digitization offers, ensuring workforce welfare and the broader prosperity of humanity.

Furthermore, technological limitations necessitate human involvement in production processes, including decision-making based on observations and team discussions (Johnson and Nica, 2021). However, Industry 4.0 technologies can provide impartial insights and accurate data, enabling faster, better-informed decisions and fostering new job opportunities. Thus, the shift toward digitization, though complex, holds the promise of a balanced and progressive industrial landscape.

5. Conclusion

The sole remaining course of action is to assess the results in light of the collected and organized data. It is indisputable, based on the examined years, that employment is significantly impacted by both domestic and international events. The Slovak Republic is not an exception; the country's future trajectory has been demonstrated and determined over the past few years, which have been a trial for the population and the nation at large. The employment landscape in the Slovak Republic was significantly transformed with the advent of the home office a development primarily attributable to the COVID-19 crisis. The nature of this transition, whether positive or negative, is debatable, but technological progress and innovation are indispensable to its realization. A significant number of positions will be eliminated, while a substantial number of new positions will be created, as predicted. Hence, it is imperative to promptly and precisely adjust to these transformations in light of the correlation between digitization and Industry 4.0 and achieve a higher degree of psychological adaptation among the populace, an objective that should be instilled in the youth of today. Achieving nationwide and population-wide innovativeness can only be achieved through this approach, which emphasizes value addition and fosters an innovative mindset. It is not a fantasy, but an imperative, in order to prevent the country from falling behind its European Union neighbours. The value added to this work is a result of the theoretical processing and connection of current sources for the solved problem. While rare, this interconnectedness may occasionally be discernible.

Potential residents and employees can use the study's findings as an overview and guide for determining which aspects to prioritize and which to downplay in the future, if only due to the

need to implement digitalization in a variety of production processes and the ongoing trend toward digitalization. The study is subject to certain limitations, including its reliance on a small sample size and a restricted number of sources. However, upon careful examination, it is clear that the research is limited to the Slovak Republic. Conducting an analysis and comparison of multiple countries in the future may prove to be a challenge, especially with regard to the V4 countries, which constitute a sort of whole and share nearly identical historical and other factors. Furthermore, by incorporating a wider range of industries and populations, a more comprehensive and nuanced comprehension of this complex can be achieved.

Acknowledgements

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The Impact of the War in Ukraine on EU Foreign Trade

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Abstract
The ongoing conflict in Ukraine has reverberated far beyond its borders, impacting not only the lives of those directly involved but also influencing broader geopolitical dynamics and economic relationships. One significant aspect of this impact can be observed in the territory of European Union (EU) foreign trade. Russian invasion of Ukraine has introduced a complex set of challenges and implications for EU foreign trade policies, practices, and partnerships.
The paper utilizes autoregressive distributed lag (ARDL) technique to examine the geopolitical risk index (GPR) implications on commodity prices.
Thorough examining the impact of the war in Ukraine on EU foreign trade becomes crucial for understanding the interconnectedness of conflicts and trade dynamics. This paper examines how the conflict has influenced the EU's trade relations with Ukraine, its neighbouring countries, and other key trading partners. Additionally, it explores the measures taken by the EU to address the disruptions caused by the conflict and to safeguard its economic interests while upholding its values and commitments to peace and stability. The paper examines the impact on most traded agricultural commodities.
Overall, the past research suggests that the war in Ukraine has had a significant impact on EU agricultural trade, leading to disruptions, market instability, shifts in production patterns, and policy responses

Key words
Foreign trade, prices, Agricultural commodities, Time series analysis, ARDL model

JEL Classification
Q02, Q11, Q17

1. Introduction

The Russian aggression started in 2022 has had significant implications for the European Union's agricultural trade. Several studies have examined how this conflict has affected the EU's agricultural sector and its trade relationships. The Russian invasion of Ukraine has caused significant market disruptions in global trade, particularly affecting major importers of Ukrainian agricultural commodities. The impact of the conflict on the global economy, identifies key market disruptions in historical and geographical contexts, and highlights the interconnectedness between the war in Ukraine and world trade and GDP indices (Mariia & Yatsenko 2024). Further, the conflict in Ukraine has intensified discussions regarding the future of agriculture in the EU. Major agricultural producers are pushing for a review of targets and timelines for the green transition. On the other hand, environmental organizations are calling for an acceleration, citing the drawbacks of agriculture's reliance on imported fertilizers, fuel, and feed. Amid political and economic uncertainties, most Member States are scaling back their aspirations for environmentally friendly reforms in the agricultural sector (Szczepanik, M 2022).

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1.1 Trade Disruption and Market Instability

The conflict in Ukraine has led to disruptions in agricultural trade flows in the region. The uncertainty surrounding the situation has created market instability, affecting the EU's agricultural exports to and imports from Ukraine. This has resulted in challenges for EU farmers and agri-businesses in accessing Ukrainian markets and vice versa. Russia has established itself as the foremost global exporter of wheat and fertilizers, a position that underscores its significant influence in the agricultural sector. In a similar vein, Ukraine has emerged as a key player in the international market, boasting the title of the world's largest exporter of sunflower oil and ranking as the fourth largest exporter of corn. Together, these two nations jointly held a substantial combined export market share during the period spanning 2010 to 2020, with over 28% for wheat, 15% for corn, 66% for sunflower oil, and 16% for fertilizers (politico.eu).

The evolving landscape of these highly dynamic markets has witnessed remarkable growth in the export market shares of wheat and sunflower oil by Russia and Ukraine over the past two decades. During the 2000s, there was a notable resurgence in production, as depicted in Figure 1, which in turn led to a substantial increase in grain exports that continued to accelerate over the past decade. Specifically, between the agricultural years of 2013/14 and 2021/22, the yearly wheat exports experienced a remarkable growth rate of 10.0% per annum in Russia and 11.3% in Ukraine. In contrast, the rest of the world witnessed a more modest increase in wheat exports, averaging at just 2.3% annually during the same period. This disparity in export growth rates highlights the significant impact of production levels and export strategies in these key grain-producing regions compared to the global average.

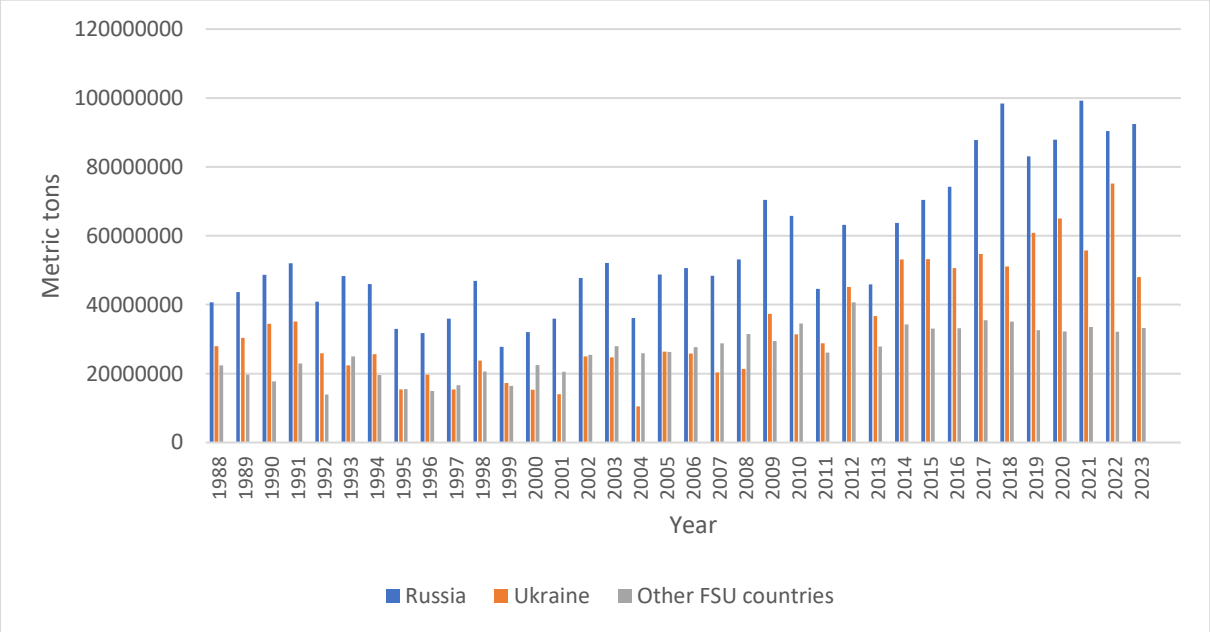

Figure 1: Wheat Production by Russia, Ukraine and Former Soviet Union

Source: USDA/FAS PSD database (2024)

This growth trajectory is particularly noteworthy, as the combined export market share for corn has surged by a factor of seven during this period. In contrast, the export of fertilizers has demonstrated a trend of relative stability, showcasing a resilient performance amidst the market fluctuations and changes.

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The symbiotic relationship between Russia and Ukraine in the realm of agricultural exports exemplifies their strategic positioning and adaptability in meeting global demands. As they continue to navigate the complexities of the international market, their collaborative efforts and individual strengths contribute significantly to shaping the dynamics of the global agricultural trade landscape.

2. Data and Methods

The main aim of this paper is to analyse the impact of geopolitical risks, particularly Russian aggression on Ukraine, on agri-food trade between Ukraine and the EU. Focus includes changes in trade volumes, patterns, and types of commodities traded. Research sets its partial objective as the effect of geopolitical risk on the price development of selected agricultural commodities.

We apply the autoregressive distributed lag (ARDL) technique to examine the geopolitical risk index (GPR) implications on commodity prices. The ARDL bound test methodology, introduced by Pesaran, Shin, and Smith in 2001, offers several advantages over traditional methods when examining relationships between variables in econometric analysis. Further, several similar studies have utilized ARDL model including (Hudecová & Rajčániová, 2023, Makalesi, 2024). Using the ARDL bounds testing approach, the presence of a long-run relationship is checked. The general form of the ARDL (p, q) model is as follows:

$$y_t = c_0 + \sum_{i=1}^{p} \phi y_{t-1} + \sum_{i=0}^{q} \beta_i x_{t-1} + u_t \quad (1)$$

where: y – dependent variable; c_0 – constant; x – independent variable; p – number of lags of the dependent variable; q – number of lags of each explanatory variable; u_t – white noise error.

Wheat, corn, and sunflower oil were identified as three of the most traded agricultural commodities between Ukraine and EU (World Economic Forum, 2022). Therefore, the paper will focus on impact on those commodities. 412 monthly observations from January 1990 to March 2024 were utilized in this study including first phase of Russian aggression on Crimea in February 2014 and second phase in February 2022. Commodity export volume and price data was acquired from Eurostat database. These two notable occurrences led to upheaval and disturbances in the worldwide agricultural commodity markets.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Corn	412	160.202	67.920	75.057	348.507
Sunflower oil	412	929.301	421.482	332.545	2536.617
Wheat	412	183.569	68.665	88.552	444.157
GPR	412	101.633	50.616	39.050	512.530

Source: Eurostat (2024), own calculation

3. Results and Discussion

3.1 Shifts in Production and Trade Patterns

The conflict has influenced the production and trade patterns of agricultural commodities in the EU. Due to the conflict and its impact on Ukraine's agricultural sector, there have been

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shifts in the production of key commodities such as wheat and sunflower oil within the EU. This has led to changes in export destinations for these products as well. By the end of February 2022, Ukraine had successfully shipped most of the wheat and barley harvested during the previous summer. However, a significant portion, approximately 40%-45%, of the corn harvested in the previous fall remained awaiting shipment. As a result of the suspension of Black Sea shipping, alternative transportation methods such as overland routes via rail, truck, and barge through countries including Poland, Hungary, Slovakia, and Romania were utilized to transport these remaining corn exports. This logistical adjustment allowed the exports to reach various destinations in Europe and facilitated transportation to Romania's Black Sea port of Constanta, ensuring continued trade flow despite the challenges posed by the disruption in maritime shipping routes (IFPRI, 2022).

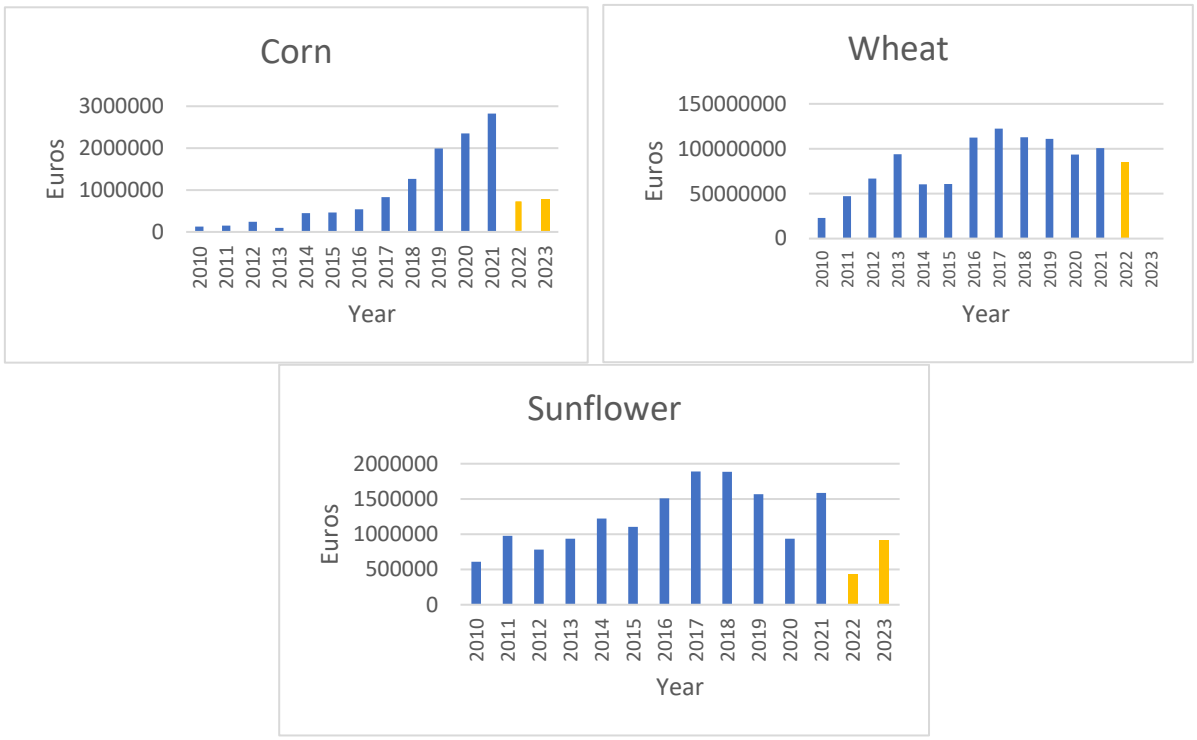

Figure 2: Development of Import from Ukraine to EU

Source: Eurostat database (2024)

As the graphs in Figure 2 show, Russia's invasion of Ukraine represented a significant shock in the development of imports of corn, wheat, and sunflower oil from Ukraine to the EU.

3.2 Price Volatility

The war in Ukraine has also contributed to price volatility in the agricultural markets. Uncertainty about the availability and prices of key agricultural commodities has affected the EU's trade relations with Ukraine and other countries in the region. As a result, EU farmers and traders have had to adapt to changing market dynamics and price fluctuations. The reduction in both production and exports of agricultural commodities has resulted in a notable shortage of various crops within the global market. This scarcity has, in turn, triggered a significant surge in the international prices of agricultural products, posing a critical threat of pushing a substantial number of individuals into conditions of hunger and poverty, especially in Low-Income Food-Deficit Countries (FAO, 2011). As highlighted in the World Bank's report dated

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June 20, 2023 there continues to be a prevalent issue of high domestic food price inflation on a global scale (Hassen & El Bilali, 2024). It is observed that, as of the specified date, inflation rates surpassed 5% in approximately 66.7% of low-income countries, 81.4% of lower-middle-income countries, and 77% of upper-middle-income countries, with a significant number of nations experiencing inflation rates in the double digits (Hebebrand & Laborde, 2022).

The escalating levels of price volatility are a cause for growing concern as they introduce heightened market uncertainties, which, in turn, influence production decisions and promote speculative activities within the agricultural sector. This scenario underscores the urgent need for strategic interventions and policies to address the challenges posed by the current state of the global agricultural market and its implications for food security and economic stability worldwide. For this reason, it was our intention to estimate what impact the geopolitical risk increased because of the war in Ukraine had on the development of the prices of wheat, corn and sunflower oil. Using the conventional unit root tests (Augmented Dickey-Fuller test and Phillips-Perron test) we ensured none the time series is integrated of order higher than 1. Using the ARDL Bounds test we found out, there is no evidence of a long run relationship between time series and we can only estimate the short run effects using ARDL in first differences. As seen from the results, the impact of geopolitical risk on world prices is not significant and the prices are driven by their lagged values. Introducing the dummy variable that takes value 0 until February 2022 and 1 after this date, did not show

Table 2: Short-term effects

	Coefficient	P>|t|	Coefficient	P>|t|	Coefficient	P>|t|
L1. Corn	0.249	***				
L1. Wheat			0.217	***		
L2. Wheat			-0.113	**		
L1. Sunflower oil					0.367	***
L1. GPR	0.001		0.004		0.186	
L2. GPR					0.092	
L3. GPR					0.279	
dummy1	176.054		208.524		154.959	
timedummy1	-0.448	*	-0.533		-0.425	
_cons	0.418		0.395		1.761	

3.3 Policy Responses

The EU has responded to the impact of the war in Ukraine on agricultural trade through various policy measures. These include trade agreements, tariff adjustments, and support programs for affected farmers. The EU's Common Agricultural Policy has also been adjusted to address the challenges faced by the agricultural sector in the wake of the conflict. Some of the responses were directly subsiding to repair the damages caused by aggression. As of June 2022, it was estimated direct losses to Ukraine's agricultural industry, encompassing damage to land, infrastructure, and machinery, at USD 4.3 billion (Kyiv School of Economics 2022).

New proposals are being made to ease environmental restrictions in response to immediate worries regarding the shortage in global food provisions and the potential repercussions for food security. Nations contemplating the implementation of such measures on a temporary basis must explore alternative strategies to address concerns related to food security (OECD, 2022).

3.4 Long-Term Implications

It is important to consider the long-term implications of the war in Ukraine on EU agricultural trade. The conflict has highlighted the vulnerabilities of the EU's agricultural sector to geopolitical events and conflicts in neighbouring regions. Understanding these implications is

crucial for developing more resilient agricultural trade policies and strategies in the future. EU could provide subsidies or financial support to help reduce the cost of fertilizers for farmers in vulnerable developing countries. This could make fertilizers more affordable and accessible, thus increasing agricultural productivity. Further, EU could invest in training programs and capacity-building initiatives to help farmers in vulnerable developing countries improve their agricultural practices, including the efficient use of fertilizers. This could help farmers increase their yield and income (Zachmann, 2022).

4. Conclusion

Overall, the past research suggests that the war in Ukraine has had a significant impact on EU agricultural trade, leading to disruptions, market instability, shifts in production patterns, and policy responses. The highest impact was observed on wheat imports, as Ukraine is a major supplier, resulting in supply chain challenges and price fluctuations. These disruptions have prompted the EU to explore alternative sources and reinforce internal production capabilities.
Moreover, the conflict has accelerated the need for the EU to reassess its trade dependencies and consider more resilient agricultural policies. There have been initiatives aimed at boosting sustainability and self-sufficiency within the EU, which may redefine future agricultural strategies.
The European Union has addressed the effects of the war in Ukraine on agricultural trade by implementing a range of policy measures. These measures consist of trade agreements, modifications to tariffs, and assistance programs for farmers who have been impacted. Additionally, the EU's Common Agricultural Policy has been revised to tackle the difficulties encountered by the agricultural sector as a result of the conflict.
Further research is needed to explore the lasting effects of this conflict on the EU's agricultural sector. This includes understanding the broader geopolitical implications and how they might influence agricultural policy and trade agreements. Additionally, identifying potential strategies for mitigating the impact on trade relationships in the region is crucial. This could involve diversifying trade partners, investing in technology to enhance productivity, and developing more robust risk management frameworks to better withstand future disruptions. Such efforts will be essential in ensuring the stability and sustainability of the EU's agricultural sector in the face of ongoing global challenges.

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Assessing Food Security in Europe: Unravelling Challenges and Vulnerabilities

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Abstract

Paper's objective and research background: The main objective of the presented paper is assessing current food security situation among European countries. To achieve it was necessary first to produce an objective indicator for evaluation food security level in Europe. It is assumed that the overall level of food security in Europe will be good with some disparities across regions. In process of development of consistent food security indicator for specific European conditions was applied food security definition according to FAO, with four pillars: Availability, Access, Stability and Utility. Final indicator was based on 12 variables representing these four pillars.

Data/Methods: From the list of all available indicators in the food security section of FAOstat could be used only 9 variables, which were supplemented by 3 variables from World bank database to ensure equal number of indicators in every pillar: Average dietary energy supply adequacy, Prevalence of moderate or severe food insecurity in the total population, Food Production Index (WB), Gross domestic product per capita, Gini index (WB), Consumer price index (WB), Political stability and absence of violence/terrorism, Per capita food supply variability, Coefficient of variation of habitual caloric consumption distribution, Minimum dietary energy requirement, Incidence of caloric losses at retail distribution level, Percentage of population using safely managed sanitation services. All variables were obtained for 38 European countries in year 2021 which was the latest available period. The reason for the smaller number of selected indicators was that variables included in FAOstat database were focused more on developing countries and their values were not available for European region or had very small variability in developed countries. To produce composite food security indicator with objective weights in European conditions was used Data envelopment analysis with dummy input. Advantage of this approach is, that overall level of indicator is based on current situation and countries are benchmarked at European level.

Results/Conclusions/Value added: The added value of presented paper has more dimensions. First, the paper suggests a methodological framework based on data envelopment analysis for creating objective composite indicators usable for measuring and identification of food security issues in European countries. The paper also shows evaluation of food security and its disparities among European countries in 2021. Which was year when COVID 19 pandemic spread across Europe. Paper offers deeper insight into food security conditions in European countries in this period. Best performing countries were Luxembourg, Switzerland, Belgium, Ireland, and Austria. On the other hand, the most problematic countries are Belarus, Montenegro, Albania, North Macedonia, and Ukraine.

Key words Food Security, Data envelopment analysis, FS Indicators, Dummy input

JEL Classification C44, C10, Q01, Q50, R10

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1. Introduction

Current scientific papers offer various approaches to definitions of food security and its pillars, its quantification and insight into the current situation in the world. The first time this term was used was at the World Food Conference in 1974. At that time, it was focused mainly on price stability and availability of food. Later in 1983 this concept was extended by FAO (Food and Agriculture Organization) by a pillar connected with physical access to food. But in general, there existed still various attitudes to food security and some of them were linked primarily to food sufficiency (Matkovski et. al. 2020). The most frequently used definition of food security was formulated at the World Food Summit in 1996. It states that food security at the individual, household, state, regional and world level is achieved, when all people always have a physical and economic approach with enough safe and adequate food to satisfy their needs and different preferences for active and healthy life. Food security concept based on four dimensions: stability, accessibility, access, and use were introduced at The World Food Summit of 2009 and is still used by FAO. Currently can be found in literature more than 200 definition of food security and its determinants (Kumar and Sharma, 2022).

1.1 Related works

Food security measuring is a complex problem which should not be simplified into dichotomous variable indicating security or insecurity. There may occur situations when someone got into food insecure situation although do not experience immediate hunger, in contrast with others who could be in desperate position which is emphasized by Webb et al. (2006). This should be considered also in development of food security indicators, which should make a difference between transitory and chronic food insecurity (Cafiero 2013).

Various agencies use different indicators to assess food security and as highlighted by Carletto et al. (2013) there is a lack of consensus about it. Aggregation of indicators at global level can offer just general information about situation in country and hide issues related to endangered segments of households and group of individuals. In addressing food help it is therefore very important to focus on groups and individuals in direct danger of food insecurity. Except aggregated indicators at global level plays therefore important role also primary data collected from households and individuals (Poudel and Gopinath 2021). The most frequently used measures based on primary data are Consumption score developed by World Food Program based on the frequency of different food groups consumption by household, Household dietary diversity score developed by United States Agency for International Development based on number of unique foods consumed by household and The Coping Strategy Index which assess how household copes with food shortages.

On the other hand, Jacobs et al. (2004) highlights the important role of composite indicators at national level for evaluation of summary performance and identification of policy priorities. The most frequently used measures used at the national level are: Global Food Security index proposed by The Economist Intelligence Unit, prevalence of undernourishment used by FAO, Global Hunger Index developed by the International Food Policy Research Institute (IFPRI), the Global Poverty index developed in collaboration with Oxford University, The Hunger Reduction Commitment Index. According to many authors there exists between these measures a significant level of variability (Pangaribowo et. al. (2013), Poudel and Gopinath 2021, Pérez-Escamilla et al. 2017, Pingali 2016).

Global Food Security index (GFSI) which belongs between indicators used the most often in scientific papers was critically reviewed by Chen et al. (2019), Izraelov and Silber (2019), Maričič et al. (2016) and Thomas et al. (2017). Authors agree that GFSI is suitable for evaluation of food security at national level, however all claims that its subjective weighting scheme is biased. The result is that despite the solid methodology and reliable data GFSI focused more on food security determinants than its outcomes. More complex study of

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composite indicators conducted by Nardo et al. (2005) and Saisana et al. (2005) suggests that weighting scheme of composite indicators should be based on objective statistical methods, such as Data envelopment analysis (DEA) or Principal components analysis. Alternative can be also to use equal weights, or to derive weights based on variability or correlation matrix of input indicators. DEA technique of deriving objective weighting scheme for composite indicators is used also in papers by Lovell and Pastor (1999), Kao (2010), Liu et al. (2011), and Blancas et al. (2013). Authors used special type of DEA without explicit inputs or outputs. This method was used also by Chen et al. (2019) for reassessment of Global Food Security index.
The main objective of the presented paper is to evaluate food security situation in European countries in 2021. In order to achieve the main objective was formulated following partial objectives:

- Construction of an objective indicator for evaluation food security level in Europe
- to characterize its food security situation of food security in Europe
- Identify possible food security disparities in European region.
- Identify the weakest regions and opportunities to improve food security situation within region.

It is expected that overall food security situation in European region will be good, but its nature and character will be different across regions with various properties.

2. Data and Methods

The first step in the analysis was determination of variables which could be used to evaluate actual food security situation in Europe and to construct composite indicator according to definition of food security by FAO in four pillars: availability, access, stability, and utility. The intention was to use the largest possible number of variables. All indicators should have nonzero variability in European countries and should be available for year 2021. From the list of all available indicators in the food security section of FAOstat met previously mentioned requirements only 9 variables, which were supplemented by 3 variables from World bank database to ensure equal number of indicators in every pillar. (Food production index in pillar Availability, Consumer price index and Gini index in pillar Access). List of analyzed variables can be found in table 1. All variables were obtained for 38 European countries in period of year 2021 The reason for the smaller number of selected indicators was that variables included in FAOstat database were focused more on developing countries and their values were not available for European region or had very small variability in developed countries. Missing values were extrapolated or interpolated to maximize the number of observations available for analysis.

Tab. 1 List of variables used to create composite food security index.

Pillar	Variable	Units of measuring	Source
Availability	Average dietary energy supply adequacy	percent, 3-year average	FAOstat
	Prevalence of moderate or severe food insecurity in the total population	Percent, 3-year average	FAOstat
	Food Production Index	index variable 2014-2016=100	World Bank
Access	Gross domestic product per capita	Ppp constant 2017 international $	FAOstat
	Gini index	index value: index of 0 represents perfect equality, 100 implies perfect inequality.	World Bank
	Consumer price index	2010=100	World Bank

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Stability	Political stability and absence of violence/terrorism	Index (-2,5 weak; 2,5 strong)	FAOstat
	Per capita food supply variability	kcal/cap/day	FAOstat
	Coefficient of variation of habitual caloric consumption distribution	Real number	FAOstat
Utility	Minimum dietary energy requirement	kcal/cap/day	FAOstat
	Incidence of caloric losses at retail distribution level	percent	FAOstat
	Percentage of population using safely managed sanitation services	percent	FAOstat

Source: Author´s work based on data from FAOstat and World Bank

Variables were analysed using descriptive statistics according to Achymský and Achymská (2023) and further processed in order to obtain composite indicator with consistent ranking. It was necessary to normalize all input variables according to process described by Kao (2010) and Chen et al (2019). Variables where higher values are better were normalized according to function 1. This was applied to most analysed variables.

$$Y = \frac{y - \min(y)}{\max(y) - \min(y)} \quad 1.$$

Variables, where smaller values mean better result, such as prevalence of moderate or severe food insecurity in the total population, consumer price index, per capita food supply variability, coefficient of variation of habitual caloric consumption, Gini index and incidence of caloric losses at retail distribution level were normalized according to equation 2.

$$Y = \frac{\max(y) - y}{\max(y) - \min(y)} \quad 2.$$

In both equations are min and max the smallest and the highest values among 38 countries for each variable.

A composite indicator of food security was created with Data envelopment analysis. Standard DEA is a method to measure efficiency of transformation of inputs into outputs for every DMU. Lovell and Pastor (1999), Kao (2010), Liu et al. (2011), and Blancas et al. (2013) and Chen et al. (2019) suggested that DEA can be applied also in situation without explicit inputs or outputs to generate objective weights for composite indicators. The constructed indicator will be given in contrast to the Global food security index, where weights are set subjectively by the panel of experts. In the case of composite indicator would be suitable to use hierarchical DEA following structure in of individual pillars of food security as proposed by Chen et al. (2019). In this case, it was not possible due to the few available indicators in each pillar. For construction of composite food security indicator basic DEA for aggregating indicators was used.

Let yi (i=1,2,...M) be the indicator for each DMU j (j=1,2,...N). As proposed by Kao (2010), input-oriented DEA can be used to generate objective weights for composite indicator for j-th DMU by assuming input equal to one (dummy input). Then objective function has form:

$$Max\ \theta_j = \sum_{i=1}^{M} u_{ij}\, y_{ij} \quad i = 1,2,\dots M \quad j = 1,2,\dots N \quad 3.$$

Subject to

$$\sum_{i=1}^{M} u_{ij}\, y_{ij} \leq 1\ ,\ i = 1,2,\dots M \quad j = 1,2,\dots N \quad 4.$$

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Where θ is the value of composite food security index, u is the weight for variable I and country j, and y is value of variable i and country j.
According to equations 1 and 2 will be weights generated objectively without external influence the way, it will maximize value of indicator for each DMU (country in this case) and constrain will ensure, that index for all other countries will be less or equal than one (Ramathan 2006). This formulation also means that the food security index for each country will depend on the performance of all other analyzed countries in the current year. For this reason, calculation of food security composite index included data for all 38 European countries available at FAOstat (equation 4 means 38 constraints, one for every country).
According to the assumption of simple additive weighting scheme was included also constraint that sum of weights should be equal to one, formulated in equation 5.

$$\sum_{i=1}^{M} u_{ij} = 1 \quad i = 1,2,\dots M \quad j = 1,2,\dots N \qquad 5.$$

To avoid zero weights for some indicators (especially for small indicator values in maximization function) it was necessary to add constraint to restrict maximum and minimum value of weight. According to some authors these values could be decided by expert opinion. The goal of this paper was to determine objective weights, so it was applied scheme suggested by Chen (2019) based on average weight without subjective element (equations 6 and 7).

$$Lb = \frac{1}{(number\ of\ indicators\ in\ composite\ index)} - 50\% \qquad 6.$$

$$Ub = \frac{1}{(number\ of\ indicators\ in\ composite\ index)} + 50\% \qquad 7.$$

Constrain for the nonzero weight of indicator has form:

$$Lb \leq u_{ij} \leq Ub \quad i = 1,2,\dots M \quad j = 1,2,\dots N \qquad 8.$$

Where Lb is lower bound for indicator weight, Ub is upper bound for indicator weight and uij is the weight of variable i and country j. In presented case with 12 indicators included in composite index was minimum weight equal to 0.0417 and maximum weight to 0.125. This means that minimum weight of one food security pillar could be 0.125 and maximum weight 0.375.
Every value of produced composite index was solution of maximization problem with 40 constraints. This was solved for 38 European countries for the period 2021.The indicator only considered the performance in European countries, so the result of every country in the current year depends on the performance of all other European countries in the analyzed period. Indicator can take values between 0 and 1. Value closer to 1 means better food security performance. Despite using DEA, the estimated value of indicator is not efficiency and no country reached value equal to 1.

3. Results and Discussion

The main objective of conducted analysis was to evaluate food security situation in European region and its individual pillars in 2021. For this purpose, was selected 12 variables, which describes situations in four pillars of food security: availability, accessibility, stability, and utility. There can be assumed, that overall food security situation in developed European region will be good, but purpose of this study is identification of weakest regions and pillars with smallest achieved levels. Table 1 shows descriptive statistics of input variables used in composite index for assessment of food security situation. Study use food security definition suggested by FAO, so the most of variables were selected from FAOstat database.

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First complication of this research was, that this database consisted mostly of variables suitable more for assessment of developing countries. This means, that food security evaluation in European region requires different approach compared to evaluation of developing countries, due to different sources of food insecurity, and different performance of countries. If we would satisfy with evaluation of all European countries as food secure, then it would be difficult to identify regions, which needs help and to determine the main problems of European region in this field. For this reason, was necessary to use different approach and set higher benchmark for analysed European countries. To set more rigorous benchmark for European countries was not removed from the analysis values, which could be normally considered as outliers (e.g. Luxembourg). Still, it is important to note that overall food security situation in European region can be evaluated as food secure compared to the rest of the world, but purpose of this study is to help to determine its weakest spots and regions. Evaluated period of 2021 was also significantly influenced by pandemic situation.

Table 1 Descriptive statistics of variables used in composite index in 2021

	Mean	Median	Standard Deviation	Coeff. Of variation	Kurtosis	Skewness	Minimum	Maximum
ADEnsupply	127.53	126.00	11.95	9%	-1.01	0.07	106.00	148.00
Insecurity	32.33	31.70	4.82	15%	-0.84	0.42	24.80	42.80
FPI	91.64	94.00	17.79	19%	2.60	0.89	61.43	153.55
GDP	30210.70	27035.68	19858.65	66%	2.75	1.25	6441.46	101143.15
Gini	9.97	8.75	6.41	64%	10.33	2.69	3.70	38.80
CPI	73.49	81.30	16.69	23%	1.32	-1.49	25.86	92.66
Stability	0.56	0.67	0.64	114%	-0.43	-0.38	-0.95	1.64
Fsvariability	57.84	53.50	39.39	68%	10.21	2.54	6.00	235.00
Cvhabitual	0.21	0.20	0.01	5%	7.86	2.20	0.19	0.25
MDEreq	1932.82	1935.50	22.93	1%	0.12	-0.33	1870.00	1974.00
CalLoss	2.06	2.09	0.21	10%	1.19	-0.90	1.50	2.44
Sanitation	66.22	75.85	26.21	40%	-0.93	-0.54	12.90	99.00

Source: Author´s work

Except overall level of variables is important also their variability and distribution of values among countries, when evaluating their situation. The largest differences between countries measured by coefficient of variation were recorded in variable political stability and absence of violence with value 114%. This suggests large heterogeneity in region. Large values of coefficient of variation were recorded also in food supply variability, gross domestic product, and Gini coefficient, which could be influenced by different impact of covid pandemic on situation in individual countries.

It is interesting, that distribution of the most variables had positive skewness, which suggests, that value in the most countries is smaller than average. Only four variables had negatively skewed distribution: Average dietary energy supply, Prevalence of food insecurity, Political stability and absence of violence and Percentage of population using safely managed sanitation services. This means, that only in these four variables had majority of analysed countries values higher than mean. But this can be perceived positively only in case of three of them, as the higher values of prevalence of food insecurity mean negative development in country.

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Figures 1 to 4 shows situation in European region in relation to individual pillars of food security. Distribution of values in maps can help to determine weakest regions. As the best evaluated countries in the first pillar of food security accessing availability of food in the country were Ireland and Belgium. On the other side of ranking were identified Malta, Bulgaria, Croatia, and Greece. Figure 1 shows, that based on indicators evaluating food availability can be Europe divided into two basic groups. Despite of good overall availability of food in Europe, can be found countries with worse performance compared to the rest of the Europe in the Northern part, and Southern part. To ensure good food security situation is important not only good availability of food, but also its accessibility in relation to socio-economic conditions.

Pillar accessibility can be interpreted as affordability of food in population, and evaluates income, its distribution and price level. The worst situation was identified in Ukraine, Belarus, and Albania. On the other side, according to expectations were at the top of the ranking according to accessibility pillar identified Luxembourg, Switzerland, Ireland, and Germany. Figure 2 shows spatial distribution of countries results in accessibility pillar. There is obvious weak region identified in the Eastern and South-eastern part of Europe.

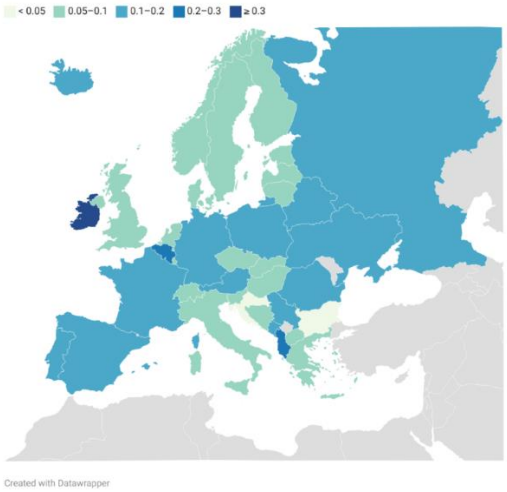

Figure 1 Pillar availability

Source: Author´s work

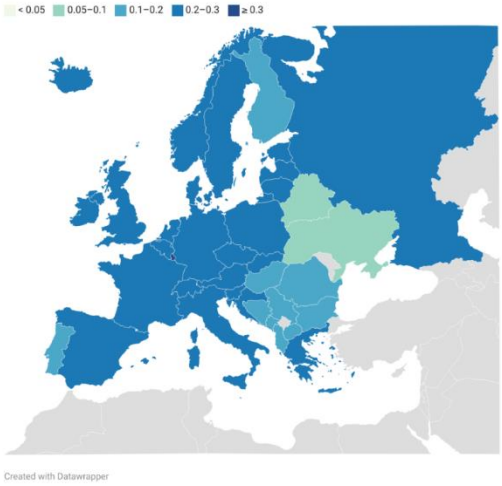

Figure 2 Pillar Accessibility

Source: Author´s work

Except availability and accessibility of food is important also stability of food security situation. This could refer to stability of food supply and accessibility of food, but also it can refer to overall economic and political stability in countries. Stability of food security is getting more and more influenced by climate change, which is actual challenge for further research and future policy makers. In the analysed period of 2021 was stability of food security situation in regions significantly influenced by pandemic situation, which had impact on research results.

This does not include impact of war conflict in Ukraine, which escalated in 2022. The worst evaluation in stability ranking was recorded in Montenegro, North Macedonia, Netherlands, France, and Slovakia. On the other side of ranking was identified Finland, Portugal, Bulgaria, and Switzerland. Figure 3 shows evaluation of countries stability in European region. Despite of some surprising results, it should be noted that recorded results include not only stability of political situation but also variability of food supply and habitual caloric consumption.

As the last pillar of food security was evaluated utility, which is pillar connected with efficient using of food. In conducted analysis it was presented by food losses at retail level, safely

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managed sanitation, and energy requirements. The worst results in the analysed sample reached Montenegro, Albania, and Russian Federation, which is obvious also in figure 4 showing spatial distribution of utility pillar values across Europe. In the map can be identified dark spot in the central Europe which consists of Hungary, Czech Republic, and Slovakia, which achieved good results. Slovakia is also leader of utility ranking followed by Luxembourg, Hungary and Netherlands.

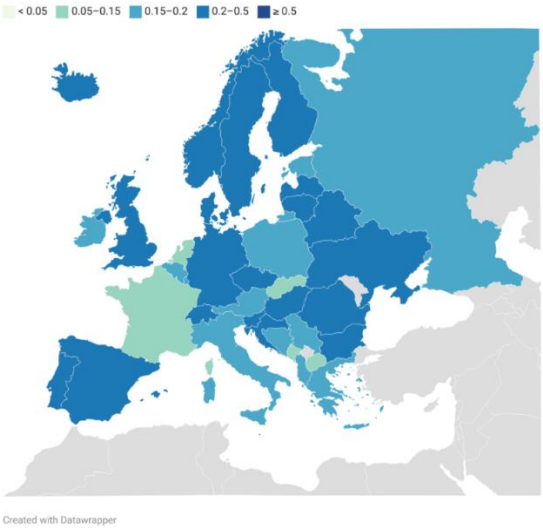

Figure 3 Pillar Stability

Source: Author´s work

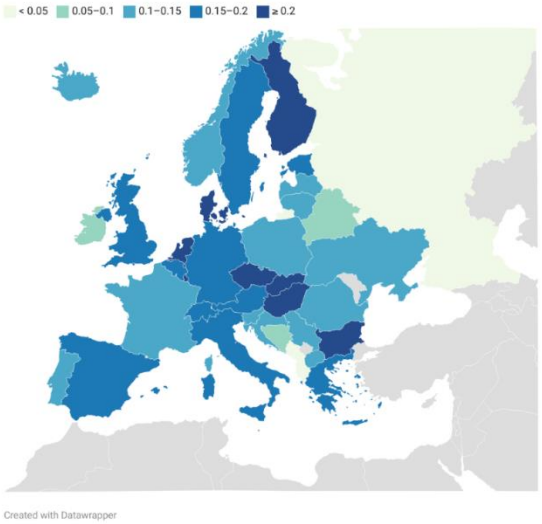

Figure 4 Pillar Utility

Source: Author´s work

Conclusion of all above presented results can be overall evaluation of food security situation in European region. This can be concluded as good compared to the rest of the world, but in the figures can be identified obvious disparities across the analysed countries.

Figure 5 shows evaluation of overall situation of food security in European countries according to values of constructed composite index, which weights were determined by data envelopment analysis. Countries with the best food security situation were Luxembourg, Switzerland, Belgium, and Austria. This result is in accordance with expectations. More interesting are countries on the other side of ranking. As the countries with the worst food security situation in Europe were evaluated Ukraine, North Macedonia, Albania, Montenegro, Belarus, Serbia and Croatia. It should be emphasized, that indicator values and ranking was based on comparison of food security situation in European countries, where the best performing countries were used as benchmark.

This can help to identify weaker spots on the map of Europe in relation to food security situation in individual countries. Results shown in the map of Europe in figure 5 identify possible food security problems in the Eastern part and Southeastern part of Europe. On the other hand, strong food security pillar of Europe consists of countries in the central part which continues also to Scandinavian part of Europe. If these results would be interpreted in context of events which happened after the year 2021, then it would be concluded probably further deterioration of food security situation in the Eastern part of the region.

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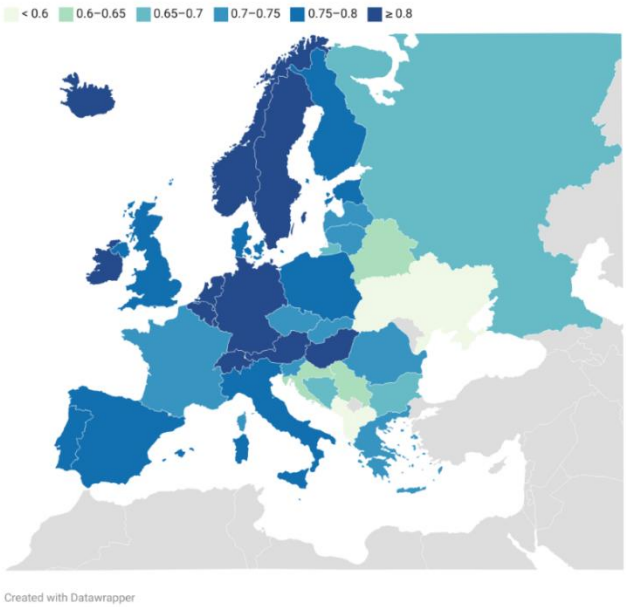

Figure 5 Overall evaluation of food security in European countries

Source: Author´s work

4. Conclusion

Presented paper evaluates overall food security situation in Europe according to constructed composite indicators, which uses weights derived from data envelopment analysis. Results therefore shows also benchmarking of food security situation in individual pillars across European countries. According to results of conducted analysis can be concluded, that the regions with the worst food security situation were identified in the Eastern and Southeastern part of the Europe. Presented analysis was performed for year 2021, which was the latest available period, when data was retrieved. Presented results was significantly influenced by pandemic situation in analysed year, which had significant impact especially on pillar evaluating stability of food security situation.

Results of presented paper agrees with Bjorch and Kjaernes (2016) which concluded alarming lack of knowledge about European food insecurity. Cooper et al. (2020) in their text mining study concluded, that most of the papers in the field of food security were focused on economic policy and global issues, which highlights added value of analysis in presented paper which was focused primarily on European region. Food security is usually related only with developing part of the world, but presented results shows, that there is still space also for improving food security situation in developed European region. Methodology applied in this paper to produce composite indicator was based on DEA analysis, which considered four basic pillars of food security as defined by FAO. In contrast with the view of Clapp et al. (2022) who suggested extension of food security to definition to six dimensions, results presented in this paper and its comparison with GFSI showed that current four dimensions are sufficient. Producing even more complex indicators with six dimensions could cause smaller weight of availability and quality of food in such measure.

Analysis shows, that there could be still used traditional interpretation of strong west and weak east. However, presented results of food security performance identified strong European food security axis in the central part which continues to North. On the other hand, results identified also weak food security situation in the Eastern and Southeastern part of Europe. This could have two different sources of food insecurity. One is related especially to countries with transitional economies and especially eastern part is influenced by instable situation in Ukraine.

As the further challenges for European food security in recent future will be impact of war conflict in the Ukraine and Russian-Ukraine relationships. But except this strong social economic factor will be European food security strongly challenged also by climate change and severe and unstable weather conditions as its consequence. In relation with other environmental factors there can be identified a lot of opportunities for further food security research related to both scientific auditorium and policy makers.
Results o presented paper offer valuable insight into food security situation in European region. However, they also raised questions for further research of European food security. Evaluation of food security in Europe based on suitable composite indicator is still opened topic with various dimensions and aspects which should be considered. Important question is also which variables should be used for its construction and what number should be suitable. DEA method used in presented paper is just one possibility and its advantages and disadvantages are shown in presented results, however, there are other option, or modifications of DEA. Various aspects of food security and methods for its investigation could be subject for further research works.

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Trends in the Honey Market: Consumption Patterns of Honey and Consumer Acceptance of Flavoured Honeys

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Abstract

Paper's objective(s) and research background

The honey market is influenced by changing consumer behaviour, emerging trends, and honey enriched by various additions. Following these factors, the aim of the paper is to explore consumption patterns related to honey, with a focus on preferences and reasons for consumption. Additionally, the paper examines consumer acceptance of new honeys enriched with additions, using flavoured honeys as an example.

Data/Methods

The consumer study is based on primary data obtained by a questionnaire survey combined with sensory testing conducted in Slovakia in 2022 on a sample of 249 participants. The survey aimed to identify consumer behaviour and assess the sensory aspects (colour, aroma, taste) of five flavoured honeys: honey with cinnamon, honey with pomegranate, honey with mint, honey with ginger, and honey with chocolate. Various statistical methods were used to identify consumer attitudes and preferences towards honey and potential additives.

Results/Conclusions/Value added

Results showed that 36.1% of participants consume honey regularly several times a week, 27.3% of consumers consume honey 1-2 times per week, and 36.5% of consumers tend to consume honey only 1-2 times per month and during the winter season or illness. Key motives for consumption are taste and health benefits and consumers prefer honey from local beekeepers, with a liquid consistency, single species, and varieties such as agave, linden, and honeydew. The study indicated that 78% of Slovak consumers are aware of flavoured honeys, but only 53% had consumed them. The most preferred additives and flavours in honeys are cinnamon, ginger, chocolate, propolis, nuts, cocoa, sea buckthorn and pollen. Sensory evaluation of colour of flavoured honeys pointed out that honey with ginger is the most attractive, followed by honey with mint and honey with pomegranate. Additionally, with regard to aroma, consumers prefer honey with ginger, pomegranate and cinnamon. Regarding taste, results indicated that honey with mint, ginger, and pomegranate are the most preferred. The study also revealed a willingness of consumers to consume honey with mint, ginger, and pomegranate. The findings offer valuable insights for scientific research because consumer study combined with sensory analysis can be beneficial for further research in the field of new honeys enriched with health-promoting substances. Food companies may implement the findings in creating of marketing strategies and developing new flavoured honeys. Additionally, results are useful for policymakers in enhancing food policy and promoting public health.

Key words
honey, consumer, flavoured honey, preference, sensory testing
JEL Classification
M30; M31; M39; Q13

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1. Introduction

The utilization of honey, a by-product of the digestion of floral nectar by bees, has started 8000 years ago (Eteraf-Oskouei & Najafi, 2013; Kenjerić, Mandić, Primorac, Bubalo, and Perl, 2007). Honey can be used as a natural sweetener, nutritional product, or as a therapeutic agent in traditional and alternative medicine (Samarghandian, Farkhondeh, and Samini, 2017). Honey contains more than 200 compounds with antimicrobial, antioxidant, anti-inflammatory, and anticancer activities (Samarghandian et al. 2017). Nevertheless, the global average honey consumption is only 250-300 grams per person (Vida & Feketéné Ferenczi, 2023), which is lower than the consumption of honey in European countries where the average is 0.60 kg per person in 2020 (Palmieri, Stefanoni, Latterini, and Pari, 2022). In comparison average annual consumption in Slovakia in 2020 was 1.2 kg per person which is equivalent to Austria (1.32 kg per person) (FAO, 2019; Statistical Office of the Slovak Republic, 2024). Currently, the honey market is evolving due to changing consumer tastes and emerging trends, which are altering how honey consumption is perceived (Román, Sánchez-Siles, and Siegrist, 2017). Consumers are more and more oriented towards healthy food with focus on functional food rich in vitamins, minerals, proteins, lipids, carbohydrates, and other important components for the human well-being (Doyon & Labrecque, 2008; Ali & Rahut, 2019). According to Šedík, Pocol, and Ivanišová (2020) there is a growing trend in popularity of flavoured honeys. Honey can be enriched with health promoting substances contained in various fruits e.g. chokeberry (Miłek, Grabek-Lejko, Stępień, Sidor, Mołoń, and Dżugan, 2021), mulberry (Tomczyk, Miłek, Sidor, Kapusta, Litwińczuk, Puchalski, and Dżugan,2019), blackberry, raspberry (Grabek-Lejko, Miłek, Sidor, Puchalski, and Dżugan, 2022); herbs (lavender, lemon balm leaves, ginger, peppermint, cinnamon, turmeric, cardamon) (Muharemagić, Šabanović, Mustedanagić, Jašić, Aličić, and Čačić-Kenjerić, 2016; Dżugan, Sowa, Kwaśniewska, Wesołowska, and Czernicka, 2017; Wilczyńska, Newerli-Guz, and Szweda, 2017; Marni, Firdaus, Wahyuningsih, Soares, Raharja, and Savitri, 2023); cocoa (Šedík, Horská, Ivanišová, Kačániová, and Krasnodębski, 2019); phenolic compounds e.g. rutin and quercetin (Đorđević, Nedić, Pavlović, Milojković-Opsenica, Tešić, and Gašić, 2022); royal jelly, pollen, propolis (Muharemagić et al. 2016), and many more. Based on the above, the consumption of flavoured honey may be acceptable for consumers who consume functional foods and foods that offer health benefits. Šedík et al. (2020) emphasize that flavoured honey is becoming increasingly popular among consumers due to its new, original taste and easy spreadability, as well as the possibility of using it as a spread, thus replacing other foods. Honey with chocolate or fruit, can be an attractive alternative for consumers as a suitable replacement for sweet spreads or jams (Šedík et al. 2020; Šedík, Hudecová, and Predanócyová, 2023; Miłek et al. 2021). In the context of the mentioned, the sale and promotion of flavoured honey may also attract consumers who prefer natural products with a unique character and flavour profile.

Following the above, it is important to consider the prospective direction of the honey market and understand the current behaviour of honey consumers, as well as the potential consumer acceptability of new types of honey enriched with health-promoting substances. The aim of the paper is to identify consumer preferences regarding the consumption of honey and flavoured honey with an emphasis on investigating consumer preferences in the evaluation of sensory attributes of samples of selected flavoured honeys. The presented study will provide relevant information obtained from a survey conducted on a sample of 249 honey consumers. The results of the study can be useful for honey producers in the development of new honeys enriched with substances beneficial to health, as well as in the creation of marketing strategies for the launching and selling of new products on the market, and they will provide consumers with information about the possibility of consuming flavoured honeys with the aim of supporting their consumption. In the context of the above and the aim of the paper, the following research questions were formulated:

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- What are the preferences of Slovak consumers in honey consumption?
- How do Slovak consumers evaluate the individual sensory attributes of the examined honey samples?

2. Data and Methods

The consumer study is based on a survey aimed at honey consumers, the aim of which is to identify the behaviour of consumers when consuming honey and flavoured honey, as well as to determine the consumer acceptability of selected samples of flavoured honey by evaluating sensory attributes. The study was conducted in person during a public event aimed at promoting honey and regional products in June 2022 in the Nitra region on a sample of 249 honey consumers. Respondents were divided according to selected socio-demographic characteristics, namely gender (men 39.0%; women 61.0%), age (under 35 years 24.9%; 36-45 years 30.5%; 46-55 years 20.5%, more over 56 years 24.1%), number of members in the household (1-2 members 40.6; 3 members 24.1%; 4 members 25.7%; 5 members and more 9.6%), education (primary or secondary school 39.0%; university 61.0 %), economic situation (employee 60.2%; entrepreneur 9.6%; pensioner 17.4%; student 7.2%; maternity leave 4.4%; unemployed 1.2 %); and place of residence (city 71.9%, countryside 28.1%).

The first part of the survey was focused on general questions concerning the consumption of honey and flavoured honey. Consumers determined the frequency of honey consumption, while the influence of individual socio-demographic variables was investigated using the Chi-square test of independence. Furthermore, consumers determined the preference of the consumed honeys, with an emphasis on honey type, honey consistency, or honey origin. The mentioned attributes were evaluated on a scale from 1 to 7, with 1 representing no preference and 7 representing a high preference. Subsequently, consumers also evaluated selected reasons for honey consumption on a scale from 1 to 7, where 1 represented an insignificant reason and 7 significant reason. Regarding the reasons for consumption, the differences in their importance were investigated by implementation of the Friedman test and the post-hoc test Nemenyi method. The survey was also aimed at consumer awareness of the existence of flavoured honey, as well as previous experience with the consumption of honey enriched with health-promoting substances.

Another part of the study was focused on the evaluation of sensory attributes, namely colour, aroma, and taste. Five honey samples were evaluated, namely honey with ginger, honey with pomegranate, honey with mint, honey with cinnamon, and honey with chocolate. Consumers evaluated the samples without prior knowledge of the flavour of the honey. The Friedman test and the Nemenyi method were used for the statistical evaluation of the obtained data and for showing the differences in the evaluation of honeys.

For statistical data analysis, a significance level of 0.05 was set and statistical methods were implemented using XLSTAT 2022.4.1 and IBM SPSS 28 statistical software.

3. Results and Discussion

The results of the study showed that 36.1% of consumers consume honey every day or at least 3 times a week, 27.3% of consumers consume honey 1-2 times a week, and 36.5% of consumers consume honey only occasionally, 1-2 times a month, or during illness or winter. In the context of the frequency of honey consumption, the influence of socio-demographic variables was also investigated. The results obtained using the Chi-square of independence showed that the frequency of honey consumption is not influenced by gender (p=0.143), economic status (p=

0.112), place of residence (p=0.089), or the number of members in the household (p=0.625). On the other hand, it is important to emphasize that age (p=0.00019) and education (p=0.010) are key determinants of the frequency of honey consumption, and it was found that the older generation and consumers without higher education consume honey more often.

The survey was also focused on the key reasons for honey consumption. Based on the survey results and means, it can be concluded that the most important reasons for consuming honey are taste (mean=6.0), health aspect (mean=5.7), immunity support (mean=5.7), and antioxidant effects (mean=5.0). Furthermore, differences in the evaluation of reasons for consumption were identified by implementing the Friedman test (p<0.0001) and Nemenyi method. The applied Nemenyi method is graphically shown in the Figure 1.

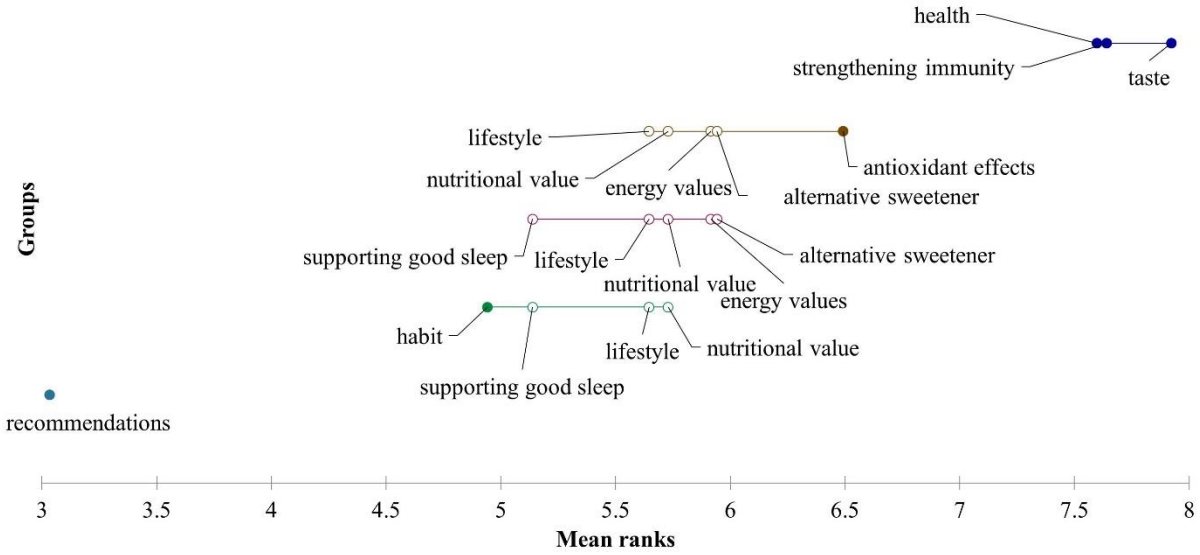

Figure 1: Key reasons for honey consumption
Source: own research

In terms of preferences for honey consumption, we examined different specifics, including type of honey, innovativeness, origin, place of purchase, and consistency. The results of the research showed that single-species agave honey, honeydew (forest) honey, or linden honey are the most preferred types of honey. Regarding country of origin, honeys of Slovak origin obtained directly from beekeepers are the most purchased. From the point of view of consistency, Slovak consumers most prefer liquid honeys or pasted (creamed) honeys. The preference for new types of flavoured honeys is not yet widespread among Slovak consumers. On the other hand, it is important to note that up to 78.3% of Slovak consumers are aware of the existence of flavoured honey, and even more than half of the consumers involved in the survey have already consumed flavoured honey. The most popular honey flavours are cinnamon, ginger, chocolate, propolis, nuts, cocoa, royal jelly, and pollen.

The second part of the research was aimed at consumer evaluation of sensory attributes of selected honey samples (Figure 2). The first attribute was the honey colour. Based on the survey results and means, it can be concluded that the best rated was honey with ginger [A] (mean=3.6), honey with mint [C] (mean=3.3), and honey with pomegranate [B] (mean=3.3). On the contrary, the worst evaluated colour was colour of honey with chocolate [E] (mean=2.1). The Friedman test and the subsequent Nemenyi method revealed differences in the evaluation of the colours of individual honey samples, while no statistically significant differences were identified between samples A, C, and B. The second investigated sensory attribute was the aroma of selected honey samples. The results indicated that the aroma of

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honey with ginger [A] (mean=3.4), honey with pomegranate [B] (mean=3.4), honey with mint [C] (mean=3.1), and honey with cinnamon [D] (mean=3.1) were evaluated very positively. The worst evaluated was the aroma of honey with chocolate [E] (mean=2.0). The Friedman test and the Nemenyi method revealed statistically significant differences between samples A, B, C, D, and sample E. The last evaluated attribute was the taste of honey, and the results showed that the best evaluated was the taste of honey with mint [C] (mean=3.4) and the worst rated was the taste of honey with chocolate [E] (mean=1.9). The Friedman test revealed differences in taste ratings, and the Nemenyi method identified statistically significant differences between sample C and sample D, as well as between samples A, B, C, D, and sample E.

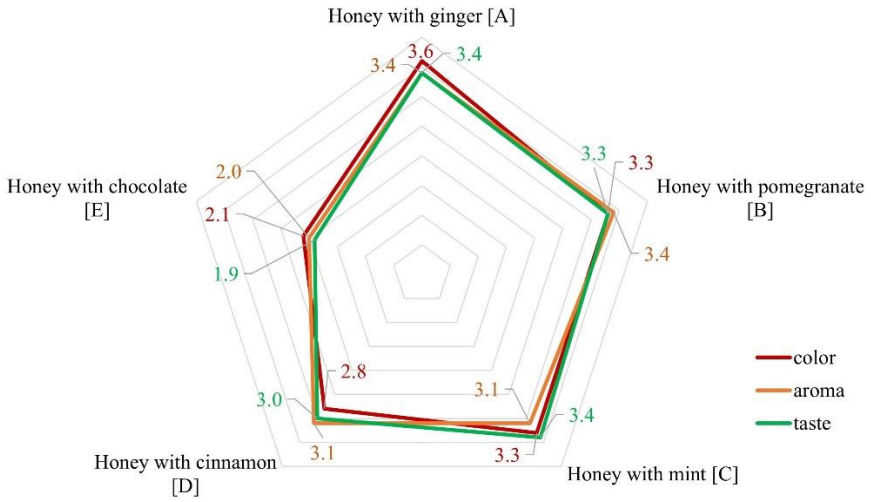

Figure 2: Consumer evaluation of sensory attributes of different samples of flavoured honey
Source: own research

Furthermore, a comprehensive evaluation of all the sensory attributes of all examined samples of flavoured honey was also analysed. The implementation of the Friedman test (p<0.0001) indicated differences between the assessment of sensory attributes of individual honey samples. Applying the Nemenyi method, we identified which sensory attributes of which samples have statistically proven differences in evaluation (Table 1). The results showed that among all the sensory attributes and all the examined samples, the colour of honey with ginger, the taste of honey with mint, the taste of honey with ginger, the aroma of honey with ginger, the aroma of honey with pomegranate, and the taste of honey with pomegranate were highly positively evaluated. On the contrary, all sensory attributes of honey with chocolate, as well as the colour and taste of honey with cinnamon were negatively evaluated by Slovak consumers.

Table 1: Consumer evaluation of sensory attributes of flavoured honey samples

Sample	Sum of ranks	Mean of ranks	Groups		
taste [E]	1165.500	4.681	A		
aroma [E]	1240.000	4.980	A		
colour [E]	1327.500	5.331	A		
colour [D]	1843.500	7.404		B	
taste [D]	2036.500	8.179		B	C
aroma [C]	2056.500	8.259		B	C
aroma [D]	2076.500	8.339		B	C D
colour [B]	2175.500	8.737		B	C D
colour [C]	2177.500	8.745		B	C D
taste [B]	2190.000	8.795			C D

aroma [B]	2269.500	9.114	C	D
aroma [A]	2274.500	9.135	C	D
taste [A]	2311.000	9.281	C	D
taste [C]	2332.000	9.365	C	D
colour [A]	2404.000	9.655		D

Source: own research

Based on the sensory evaluation of the attributes of the honey samples, consumers determined their preference for consumption. The research results and means showed that consumers would choose honey with ginger (mean=3.6) or honey with mint (mean=3.5), followed by honey with pomegranate (mean=3.2), and honey with cinnamon (mean=3.0). On the other hand, the least preferred for purchase and consumption was honey with chocolate (mean=1.7).

In our study we investigated the honey consumption preferences. Our results indicate that frequency of honey consumption is affected by age and education where older and more educated consumers tend to consume honey more frequently. Similarly, study conducted by Kopała, Balcerak, and Kuźnicka (2019) confirmed higher consumption of honey by the older consumers. The influence of age, education, and occupation on honey consumption was also confirmed in the study by Pocol and Bolboacă (2013). Age plays a crucial role in the honey consumption. Overall young consumers tend to consume honey less frequently (Majewska, Kowalska, and Łapińska, 2012; Żak, 2017). In this study we also focused on key reasons for honey consumption. The results show that taste and health aspects had the biggest influence. Comparably, Kleisiari, Kleftodimos, and Vlontzos (2023) identified the health effect as the main reason for honey consumption. Results of our study indicate strong preferences for liquid and single-species honey, which is consistent with study performed by Šedík, Hudecová, and Predanócyová (2023). However, the young generation preferred the multi-species honeys. Based on our study awareness of flavoured honeys existence in Slovakia is more than 2/3 of consumers. In addition, more than 50% of Slovak consumers have already tried the flavoured honeys. However, according to study by Elsadibah, Apriantini, and Cyrilla ENSD (2023) only less than 10% of consumers have already tried honey with additions, while focusing on the Jakarta population. Šedík et al. (2023) focused on different generations flavoured honey consumption where consumers over 50 years old have the knowledge about enriched honeys while the young consumers have very little information about it. According to the consumer study of enriched honey preferences by Šedík, et al. (2023) the following additions were evaluated as the most preferred: pollen, propolis, royal jelly, forest fruit, cinnamon, and ginger. On the other hand, additions of spirulina, exotic fruits, coconut, chilli, grapes, and cocoa were not very preferred. Our study focused also on the sensory analysis of 5 selected flavoured honeys. According to our results the honey with ginger was evaluated as the best in colour and aroma attributes, while honey with mint was evaluated as the best in taste, followed by the honey with cinnamon. On the contrary honey with chocolate was evaluated as the worst and least acceptable for colour, aroma, and taste attributes. Results of the study by Wilczyńska, Newerli-Guz, and Szweda (2017) revealed positive significant effect of cinnamon addition on taste and smell of evaluated honey. Šedík, Pocol, and Ivanišová (2020) also identified honey with cinnamon as the most accepted in colour, aroma, and taste attributes. However, our study identified negative effect of cinnamon addition on taste in comparison with ginger, pomegranate, and mint additions. Identifying and understanding of the consumer acceptance of new products in terms of sensory attributes is the key factor in development and innovations (Głuchowski, Czarniecka-Skubina, Kostyra, Wasiak-Zys, and Bylinka, 2021).

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4. Conclusion

Honey is not one of the most attractive foods for consumers around the world. Research conducted in Slovakia showed that only a third of consumers are heavy consumers of honey, and more than half of consumers consume honey only moderately or occasionally. To increase honey consumption, various measures are taken, and producers try to adapt their offer to the changing demands of the market and the needs of consumers. One of the possibilities to support honey consumption is the production and consumption of flavoured honeys, which can be more interesting compared to traditional honeys. However, the results of the conducted survey showed that so far only a third of Slovak consumers have previous experience of consuming flavoured honeys, and the most preferred are honeys with cinnamon, ginger, chocolate, propolis, nuts, cocoa, royal jelly, and pollen. Consumer evaluation of sensory attributes revealed that consumers highly positively evaluate the colour, taste, and aroma of honey with ginger, the taste of honey with mint, and the aroma and taste of honey with pomegranate.

The consumer study combined with the sensory evaluation of the attributes of selected flavoured honeys enriches current science with new knowledge, which can be a suitable basis for the implementation of other activities related to the investigation of the acceptability of the consumption of honeys enriched with health-promoting substances and the acceptance of flavoured honey as a substitute for other products, such as jams and chocolate spreads. The results of the study have also practical implications. Honey producers and food companies can use the results to produce honeys with innovative flavours. Developing flavoured honeys according to sensory preferences, such as honey with ginger or cinnamon, could diversify product offerings and attract new consumer segments. Moreover, flavoured honeys can be marketed as healthier alternatives to traditional sweet spreads, such as jams and chocolate spreads. Producers should also consider emphasizing the health-promoting attributes of flavoured honeys, such as the inclusion of propolis or royal jelly, to appeal to health-conscious consumers. With a future perspective, it is important to monitor the development of changing consumer demands and acceptance of new honey flavours. The results are also beneficial for policymakers, who can use them to increase consumer awareness of trends in the honey market and new honey flavours, as well as to support producers who have decided to develop innovative and healthy flavoured honeys. Despite the valuable contributions of the study to both scientific knowledge and practical applications, it has several limitations. The primary limitation is its focus solely on Slovak consumers, which may limit the ability to generalize the findings to other countries or regions with different culinary preferences or market conditions. Additionally, the study relies on self-reported data. To address these limitations, future research could expand to explore the acceptance of flavoured honey in various countries to identify regional differences. Furthermore, incorporating broader cross-cultural comparisons and using blind tastings or experimental methods would provide a more objective validation of consumer preferences.

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Sustainable Consumption and its Influence on Behavioral Changes in Food Waste Management

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Abstract

Paper's objective(s) and research background

The paper aims to find out how consumer behavior is changing in the context of the sustainable development of society. How sustainable consumption is perceived by individuals in meeting their needs. The product on which consumption behavior is observed and has become the focus of the authors' interest is food, particularly food waste. The paper identifies the factors that are considered to be critical in terms of sustainable consumption when consumers purchase food and require behavioral change. The paper also seeks to find ways of achieving behavioral changes in meeting the needs of the individual that are consistent with the needs of society as a whole. The subject of food management is mainly concerned with food waste and the identification of effective methods of education for sustainable consumption and zero food waste.

Data/Methods

The questionnaire survey was conducted among 759 respondents from the Slovak Republic (February - April 2023). Descriptive statistics and the PCA method of factor analysis were used to process the collected data, which allows to identificate artificial hypothetical variables (determinants) from a large number of factors acting on consumers, which show a significant share in the variability of the set of sustainable consumption. The χ^2 test was used to test the effect of selected socio-economic characteristics on the frequency of wastage.

Results/Conclusions/Value added

The 23 factors related to the causes of waste to reduce waste were reduced to 4 determinants of household perceptions of food waste. The price and quality of food still play a very important role in household food management. The results will allow us to compare similar surveys carried out in the Czech Republic.

Key words

sustainable consumption, food waste, change in consumer behavior, determinants of sustainable consumption, perception of food waste

JEL Classification

M310, J130, O350

1. Introduction

There is an urgent need in our society to intervene in the current consumerist lifestyle and patterns of consumption behavior. Sustainability is a concern from a social, economic, and technological perspective. Society is aware of the need to appeal for responsible and balanced

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satisfaction of its needs not only from the perspective of the individual but also from the perspective of society as a whole. Consumer behavior is crucial for sustainable development and the preservation of life on Earth (Lubowiecki-Vikuk, Dąbrowskaa, & Machnik, 2021). The necessity of understanding consumer behavior is indicated by the large number of studies that deal with its research. Purvis, Mao, and Robinson (2019) define three key dimensions of sustainability: environmental sustainability, economic sustainability, and social sustainability. These dimensions are interdependent and interact with each other. Francis and Sarangi (2022) state that sustainable consumption is based on a decision-making process that takes into account the social responsibility of the consumer, which is particularly evident in the younger generation, in addition to individual needs and wants (First Insight and The Baker Retailing Center, 2021; Orea-Giner & Fusté-Forné, 2023). Different studies arrive at different determinants of sustainable consumption. However, they all decide on the need to understand consumer behavior. The behaviorist approach to understanding behavior, represented by its founder Ryle (2002), gave it a broader philosophical foundation and reflected it in the way it approaches consumer behavior research. However, it is still a behaviorism based on the objectivity of the observed behavior, which avoids any subjectivism as much as possible. The cognitive approach to understanding consumer behavior views consumer behavior as a series of need-satisfaction activities whose outcome depends on intellectual functions and information processing. This approach is mainly based on general theories of consumer behavior, which emphasize the acquisition and processing of information. In general, the chain of causes common to cognitive approaches is as follows: information - attitude - intention - purchase. The different steps of this process interact with each other and other mental processes are also involved in which information is transformed into attitudinal and directional structures that influence the choice of brand, store, firm, etc. (Howard, 1983; Bettman, 1979; Hansen, 1976). The theory of planned behavior (TBP model) assumes three determinants of behavior (Ajzen, 1991). The first is the attitude towards the behavior, which is determined by the consumer's evaluation of the importance of the intention, the second is a social factor known as the subjective norm, involving thinking about the behavior of others, and finally, the third determinant of intention is the degree of perceived behavioral control. Secondi, Principato, and Laureti (2015) in their research showed that there is a significant relationship between attitude and food waste behavior. This model has been criticized by some researchers (Normanen, 2013) for not ignoring non-cognitive determinants in predicting behavior. In this regard, many researchers agree that emotions affect intention and behavior (Quested Marsh, Stunell, & Parry, 2013; Graham-Rowe, Jessop, & Sparks, 2014). For the same reason, authors (Baumeister, Vohs, & Tice, 2007; Soorani & Ahmadvand, 2019; Wang, 2006) have focused their experiments on the study of guilt and how guilt affects food waste. The understanding of consumption behavior, especially in relation to food, has shown that none of the previously preferred behavioral models is closed; models are open to other determinants if these are selected based on behavior from different observation contexts and help to increase the variance in the model. Currently, this need for knowledge not only from sustainable consumption but also from sustainable production is relevant in the context of food handling. Therefore, the authors also address this issue in the present paper.

2. Data and Methods

A questionnaire survey (February-March, 2023) is conducted to analyze consumer behavior with a focus on food waste in the context of sustainable consumption. 759 respondents from the Slovak Republic participated in the survey. The distribution of respondents by socio-demographic characteristics is shown in **Table 1**.

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Table 7: Characteristics of the sample

Categories		n_i	p_i
Gender	Female	471	61.97
	Male	288	37.89
Generation	Gen Z	567	74.61
	Millennials	40	0.52
	Gen X	42	5.53
	Boomers II	62	8.47
	Boomers I	39	5.33
Education	Basic	14	1.84
	Secondary	581	76.45
	Higher	164	21.58
Economic activity	Employed	248	33.88
	Self-employed	77	10.52
	Senior	28	3.83
	Unemployed	406	55.46
Degree of urbanization	City/town	324	42.63
	Village	435	57.24

Source: Google Forms, own processing

The definition available at (Pew Research Center, 2019) is used to characterize the generation. Boomers I (birth year 1946-1954, or 69-77 years); Boomers II (birth year 1955-1964, or 59-68 years); Generation X (birth year 1965-1980, or 43-58 years); Millennials (birth year 1981-1996, or 27-42 years); and Generation Z (birth year 1997-2012, or 11-26 years). The content questions in the questionnaire relate to the respondents' attitudes towards sustainability issues, motives when buying food, and food waste. The variable that reflects the importance and influence of the factors in the position of the dependent variable is "frequency of wastage". The χ^2 test is used to express the influence of socio-demographic characteristics on the frequency of wastage. A paired t-test is used to assess the effect of price changes. The main focus of the investigation is to observe the influence and importance of factors in the perception of sustainable consumption and shopping and food waste. Factor analysis is applied to reduce 22 Factors influencing food purchasing and consequently food wastage. Factor analysis allows the reduction of these factors from a larger number to a smaller number of artificial hypothetical variables (determinants). The suitability of using FA is verified by KMO and Bartletts' test. The Extraction Method: Principal components analysis (PCA) and Varimax Rotation Method with Kaiser Normalization, converged in 6 iterations, is used. The individual factors, their significance, and the newly created determinants are presented in **Table 5**.

3. Results and Discussion

A questionnaire survey conducted in February-March 2023 among 759 respondents in the Slovak Republic showed that most respondents associate the concept of sustainable consumption and environmental protection mainly with food waste and waste sorting. In this context, the respondents were able to respond to the issue of food waste in more detail, and for example, it was found that 55% of respondents try to use surplus food in another way (donate, use it to prepare another meal), 15% say they do not have surplus food and 30% of respondents admit that they throw away food. The frequency of wastage is consistent with these behavioral results. The following Figure 1 shows which foods are most frequently wasted. Ready meals are the most wasted, followed by bread, dairy products, fruit, and vegetables. For some foods, the length of their shelf life (cheese, potatoes, eggs), and for others the price of the product (meat, fish) determines the frequency of waste. Both reasons lead to lower wastage. On the

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other hand, the short shelf-life of the food or its sustainability (ready meals, fruit, vegetables) leads to a higher frequency of waste.

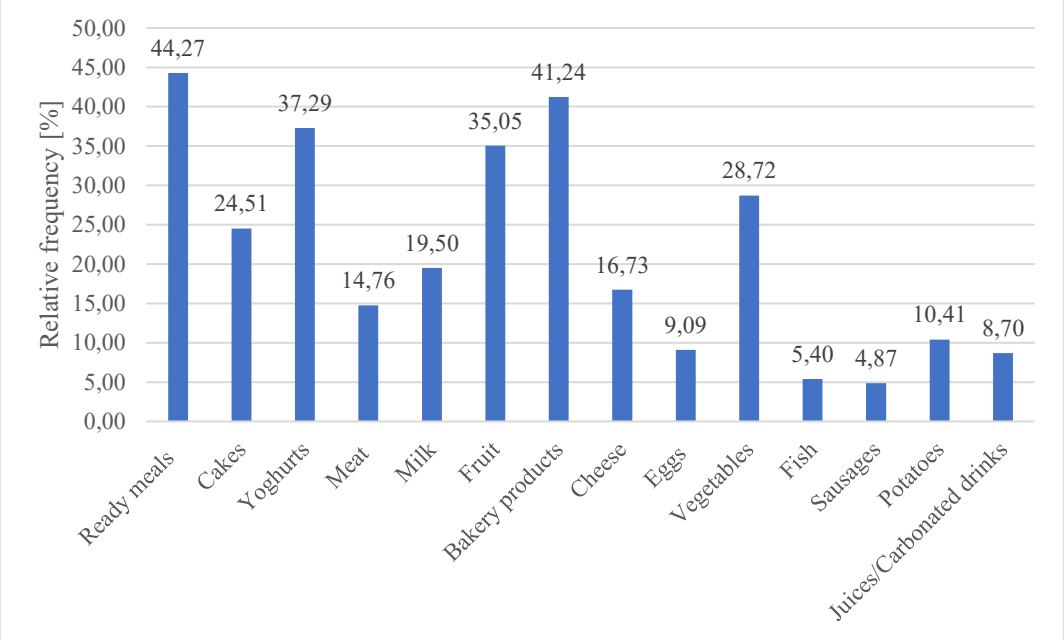

Figure 1: Structure of wasted food

Source: Google Forms, own processing

The survey also revealed how food is purchased. The majority of households (about 70%) buy food in larger purchases with varying lengths of intervals (monthly or weekly), 12% buy food as needed, 3% buy food daily, and 15% do not indicate any dominant method of purchase. This information is also relevant for retailers and their product rotation strategy.

The influence of food price on wastage was monitored by respondents expressing their opinion on the extent to which the amount of wasted food is a reflection of its price, and whether price can significantly influence the amount of wasted food. 50% of respondents expressed that price has little influence on the amount of wasted food, about 40% acknowledged a medium influence and only 10% acknowledged a large influence.

When the question was asked again in a different context, whether a sharp increase in prices during an energy crisis and high inflation would have an impact on waste, and when the answers were evaluated with a paired t-test to test the conclusiveness of the difference of opinion, a different result was reached. Considering the calculated value of the test criterion and the *p-value* < *0.001*, it can be concluded that price had a conclusive effect on the amount of wasted food in a negative direction i.e. an increase in food prices led to a decrease in the frequency of wastage (**Table 2**).

Table 8: Paired t-test to assess the relationship between price and amount of wastage immediately before and after the price increase

t	df	Value of p
-6.621	758	< 0.001

Source: IBM SPSS, own processing

The survey results also revealed the influence of respondents' socio-demographic characteristics on food shopping and handling. The χ^2 test used to test the influence of each socio-demographic characteristic on the frequency of wastage, the results of which are

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presented in **Table 3**. The results show that only the effect of the number of children in the household was verified as conclusive.

Table 9: Results of Pearson χ^2

Characteristics	Pearson χ^2	df	Value of p
Method of purchase	33.045	16	0.007
Place of residence	11.376	4	0.023
Number of children in the household	39.101	12	<0.001
Education	12.491	6	0.130

Source: IBM SPSS, own processing

Table 10: Components (first 5 components)

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1 *Forms of Purchasing (FoP)*	8.978	39.033	39.033	7.573	32.925	32.925
2 *Method of Production and Forms of Processing (MoP)*	2.854	12.407	51.440	3.122	13.575	46.500
3 *Price and Taste (PaT)*	1.895	8.238	59.678	2.233	9.709	56.209
4 *Ready Meals (RM)*	1.226	5.328	65.006	2.023	8.797	65.006
5	0.869	3.778	68.784			

Source: IBM SPSS, own processing

Efforts to reduce food waste are linked to the sustainability of life on earth from a global perspective. Country strategies need to be much more focused on education for sustainability, respecting anticipated changes in people's diets, health care, and healthy lifestyles, but also the whole value chain of food production and consumption and management options, including waste. A prerequisite for the development of a successful strategy is the understanding of the approach to the issue of waste by the individual, or how the issue of waste is perceived by the individual Hazuchová, Antošová, and Stávková (2020). This knowledge can be used to guide the application of appropriate tools to achieve a change in attitudes towards waste and consequently reduce food waste. The effectiveness of interventions aimed at preventing food waste at consumption stages is addressed in (Morávková, Veselá, & Kubíčková, 2022; Kubíčková, Veselá, & Kormaňáková, 2021).

The main objective of the authors of this paper is to identify, in the context of sustainable consumption and sustainable production, the consumer-determined factors that are critical to achieving behavioral change related to food waste. Therefore, respondents were asked 22 questions from which their answers in the form of a 10-point scale revealed the strength of influence of each factor on food purchasing and subsequent handling, including food waste. These were classic factors influencing food purchasing such as price, quality, processing method, and place of food production, but also questions more detailed about the frequency of waste, structure of wasted food, causes of waste, etc. An overview of all the factors k studied is presented in **Table 5**. Factor analysis was used to quantify the impact of perceptions of individual factors affecting food purchasing and subsequently food waste.

KMO = 0.932 and Bartletts' test = 10713.305; $p < 0.001$ verified that factor analysis is appropriate and the prerequisites for this analysis are met. From the values in the **Table 4**, it is clear that the 4 hypothesized variables (determinants) created explain 65% of the variability

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in the observed factors that influence food handling behavior and subsequent wastage. This value is sufficient to confirm the results. The **Table 5** then shows which factors are part of each hypothetical variable and helps to verbalize them.

Table 11: Rotated Component Matrix

	Component			
	1 *(FoP)*	2 *(MoP)*	3 *(PaT)*	4 *(RM)*
Impulse purchase	**0.847**	0.091	0.039	0.119
Unplanned shopping	**0.843**	0.087	0.041	0.154
A purchase influenced by a promotion	**0.839**	0.144	0.003	0.103
Low food prices	**0.833**	0.086	0.055	0.146
No cooking ideas	**0.832**	0.158	-0.116	0.078
Lack of cooking skills	**0.799**	0.190	-0.189	0.039
Low-quality products	**0.771**	0.181	-0.037	0.132
Unsuitable storage conditions	**0.765**	0.186	-0.130	0.133
Too big packaging	**0.761**	0.160	0.039	0.200
Too much food bought	**0.705**	0.110	0.032	0.365
Too large portions of food	**0.621**	0.208	-0.090	0.364
Regional origin and its support	0.146	**0.832**	0.007	0.130
Trad. or eco. Breeding/cultivation	0.249	**0.808**	0.013	-0.001
Farming method (e.g. free range eggs)	0.027	**0.804**	0.045	0.138
Degree of processing	0.223	**0.651**	0.141	0.077
Type of packaging (recyclable)	0.232	0.592	0.212	-0.144
Price	-0.022	0.061	**0.768**	-0.021
Discount	0.113	-0.027	**0.747**	-0.191
Taste	-0.214	0.125	**0.733**	0.213
Quality	-0.093	0.233	**0.610**	0.248
Food spoilage	0.300	0.013	0.014	**0.757**
Best before date	0.370	0.071	0.144	**0.727**
Preparing too much food	0.540	0.151	0.034	**0.547**

Source: IBM SPSS, own processing

The first hypothetical variable entitled *"Forms of Purchasing"* includes the largest number of observed factors and also contributes the most to the overall variability (32%) and refers mainly to factors such as impulsive and ill-considered purchasing, large packaging of goods, large purchases, lack of ideas on how to modify food, poor storage conditions, etc. The second determinant, *"Method of Production and Forms of Processing"* is quite reserved and indicates the importance of organic production of the product, the way the animals are raised, and, of course, the technology used in processing the products. The influence of this determinant is expressed as a 14 % share. The third determinant, *"Price and Taste"*, relates mainly to price and the use of discounts, possibly linked to the taste of the food. It influences 10 % of the variability. The last determinant created is labeled *"Ready Meals"* and includes the influence and importance of the sustainability of ready meals, their potential for rapid deterioration, and sustainability dates. It influences 9 % of the variability. For producers and retailers, these findings imply the need for action on how food is purchased, the technology of growing, rearing, and processing, the impact of price and price promotions on food purchasing and handling and finally, separate attention must be paid to ready meals.

4. Conclusion

Several conclusions and recommendations can be drawn from the extensive questionnaire survey on the issue of consumption behavior in the context of sustainable development concerning food and the results presented in the previous chapter of the paper, by educating and enlightening individuals to achieve a fundamental change in people's awareness of sustainable development in society, to improve awareness and knowledge about sustainable production and sustainable consumption. Seek appropriate forms of education for different age groups of the population. Involve all educational institutions, and especially the family in this process. Understanding which factors most influence consumers and their decision-making process when buying food. Advising retailers to choose an appropriate, consumer-friendly way of selling food, to innovate the structure of products with a preference for regional and organically grown and processed products and healthy food. Advise producers to focus on the production of healthy food, both organically grown and processed. Innovate the structure of the food offer to consider healthy lifestyles and health care. The identified determinants related to food waste *("Forms of Purchasing"*, *"Method of Production and Forms of Processing"*, *"Price and Taste"*, and *"Ready Meals"*) can be used in the construction of the model according to the theory of verification of the theory of planned behavior (TPB) as additional determinants of real sustainable behavior. For these determinants, the strength of their influence can then be verified. These results have the limitation of non-representativeness of the research sample, therefore the results cannot be generalized to the whole population of the Slovak Republic.

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Green Bond as the Instrument to Finance Carbon Neutrality

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Abstract

One of the obligations included in the European Green Deal (European Commotion [EC], 2019) is that the EU will achieve carbon neutrality by 2050. To ensure this goal, it is necessary to obtain and subsequently allocate sufficient financial resources. One of the options for providing/ensuring enough resources is the so-called green bond. Green bonds are used to finance projects with a positive environmental impact, especially in the field of renewable energy and energy efficiency.

Paper's objective(s) and research background: Therefore, the main objective of this article is to characterize green bonds at the general level, and the second one is to describe their differences in yield compared to conventional (non-green) bonds at the theoretical level. The third objective is to evaluate the development of green bond issues based on the available data from the Climate Bonds Initiative for the period of 2014 to 2023 with focus on the amount of the issued bond in developed and emerging countries, as well as according to the use of proceeds like energy, buildings, transport or land use.

Data/Methods:

Within the aim to provide the Comprehensive Analysis of green bonds in a broader sense, the Conceptual Analysis was used, which is aimed at understanding the conceptual boundaries and semantics related to the object of research. The article used data from the free Climate Bonds Initiative website from 2014 to 2023. Based on the non-parametric Kruskal-Wallis test, we investigated whether there are statistically significant differences between the regions of Europe, Asia-Pacific and North America in the structure of issued bonds according to the use of proceeds for the entire period under review.

Results/Conclusions/Value added: The results show that the green bonds belong to debt sources of financing without the possibility for their holders to participate directly in the management of the company that issued these bonds. Investors were often willing to buy these green bonds at higher prices compared to standard bonds, so their yield was lower and therefore more advantageous to the issuers themselves. This often resulted in the misuse of the term "green bond", and we speak about the so-called greenwashing. Therefore, there are currently several initiatives at the international level to determine the standards, so that it will be possible to clearly classify the bonds as "green" or "non-green".

Key words

green bonds, yield of a bond, greenwashing, green bond standards

JEL Classification

Q50, Q01, Q14, O16, G12

1. Introduction

A commitment contained in the European Green Deal (EC, 2019) is the EU's goal of becoming carbon neutral by 2050. Businesses must adopt more environmentally friendly projects and

modify their operational procedures. The United Nations, through the Paris Agreement, demands that companies maintain the temperature by integrating ESG policies into their long-term planning. One of the member nations' concerns is financing those initiatives, thus they talk about how to make funding for environmentally friendly projects better (United Nations Framework Convention on Climate Change [UNFCCC], 2015). The main goal of low-carbon finance is to provide money for long-term, sustainable projects that generate low-carbon emissions (Zhang et al., 2019). A substantial amount of money must be obtained and then set aside in order to guarantee this goal. The "green bond" is one way to guarantee or supply adequate resources. As per the Green Bond Principles (GBP, 2018), a green bond is "any bond instrument where the proceeds will be exclusively applied to finance or re-finance, in part or in full, new and /or existing eligible green projects." Green bonds provide funds to support environmentally conscious initiatives and contribute to long-term sustainable development. Green bond proceeds are mostly utilised for financing green technology. These technologies are sometimes referred to as green ventures. These initiatives are mainly in their early stage and not economically feasible (Sachs et al., 2019) opposite from conventional (brown) bonds in this regard. Like conventional fixed income instruments, companies have the option to issue green bonds in order to raise funds for their worthwhile investments. In addition, green bonds are designed to provide a favourable environmental impact, such as mitigating CO2 emissions and averting pollution (Tang & Zhang, 2020).

Issue of green bonds incurs certain expenses, and investors exhibit reluctance to engage in these bonds due to the precarious nature of projects linked with green bonds (Bhutta et al., 2022). Ehlers and Pecker (2017) highlighted the necessity of favourable market conditions for the expansion of green bonds. Both issuers and investors should be content with the profitability and security of such security.

The procedure of issuing green bonds can be arduous and expensive for new issuers. (Tang & Zhang, 2020). Nevertheless, these authors examine three plausible origins for the positive return on this green bond announcement, which could enhance the value of a company in the short term.

1. The "financing cost" channel: Socially responsible funds or investors with a green mandate may choose to hold green bonds in order to increase their Environmental, Social, and Governance (ESG) ratings. Consequently, these investors have the ability to increase the value of the bond, resulting in green bond issuers enjoying reduced borrowing costs. This, in turn, leads to a favourable response from the stock market.
2. The "investor attention" mechanism: by designating their green bonds, corporations may get greater media coverage, which in turn can capture the interest of investors and enhance the visibility of the issuing firms. This heightened visibility can possibly result in increased demand for their shares and a wider pool of investors.
3. The "firm fundamental" channel: Green bonds showcase a business's commitment to sustainable development, and investing in these initiatives might prove advantageous for enterprises in the long term, perhaps aiding their resilience in challenging circumstances.

It is necessary to be aware of the basic relationship between the market price and the yield of bonds, and it is true that if the price on the market rises, it means that investors must pay more for such a bond, thereby reducing their yield to maturity (if we assume, for example, a fixed coupon yield for the bond). Yields in classic term structure models are only influenced by three factors: interest rate, default risk, and the anticipated loss in case of failure. (Liu et al., 2009). The study conducted by Elton et al. (2001) yielded two significant conclusions. The first, both interest income and capital gains from bonds are taxable, so taxes should be a significant factor

in determining business profit and the second there is evidence of a consistent risk premium linked to common characteristics in the returns of corporate bonds.

The relatively new green bond market provides the question for investors, if this new category of assets also has appealing risk-return characteristics in comparison to traditional (non-green) bonds (Hachenberg & Schiereck, 2018). These authors tested hypothesis, that „Green bonds trade tighter than non-green bonds “, what means that the inclusion of a green component in the bond serves as an added benefit for the investor, resulting in more demand and hence justifying a higher price of a green bond. Investing in green bonds offers several advantages to the investor. Unlike traditional bonds, he has the ability to track the specific allocation of his funds and select projects that meet his ecological criteria. Sustainable investors have a restricted selection of products. Green bonds provide investors with an extra investment opportunity. Therefore, it is logical to predict that investors would be inclined to tolerate a narrower difference in yield for green bonds compared to traditional, non-green bonds. However, the investor faces the danger of "greenwashing”. They compared some green bonds with the “similar” non-green bonds (similar in terms of issuer, ranking, currency, maturity, and coupon, i.e., fixed, or floating). Greenwashing refers to the deceptive communication of sustainable projects to be funded through the issuance of green bonds, without implementing them. This misleading information misrepresents the level of environmental and/or social commitment of the public or corporate issuer (Berensmann et al., 2018). On 10 November 2022, the European Parliament approved a new Corporate Sustainability Reporting Directive, called the CSRD, which replaces the current Non-Financial Reporting Directive (NFRD). CSRD brings new requirements for the disclosure of non-financial data for a wider range of companies. This new CSRD directive entered into force on 5 January 2023 and will affect around 50,000 companies across the European Union. Member states are obliged to incorporate the directive into their national legislation by July 6, 2024. In addition, they must gradually take measures to ensure compliance with all obligations arising from CSRD for individual companies. (Dzuroska, 2023).

To address the issue of heterogeneity across bonds, as discussed by Gordon and Viscione (1984), they used utilising matched pairings. Prior bond investigations have utilised matched pairings. Maul and Schiereck (2017) offer a thorough summary of the utilisation of matched pairs in bond event investigations. They paired each green bond with two similar non-green bonds: one with a shorter duration and the other with a longer duration. For non-green bonds to be deemed similar, they must satisfy the following criteria:

1. The bonds must be issued by the same entity as the green bond.
2. The bonds must have the same raking as the green bond.
3. The bonds must be in the same currency as the green bond.
4. The bonds must not have any special features such as being callable, puttable, convertible, having dual currency or dual coupon, having step up/down coupon, or being index linked.
5. The bonds must be either fixed or floating, depending on the type of green bonds.
6. The minimum size of the bond issuance must be at least 150 million U.S. dollars or its equivalent.
7. The bonds must be either secured or unsecured, depending on the characteristics of the green bonds.

Their results show, on average, green bonds do not trade at considerably lower spreads than non-green bonds. Nevertheless, the economic disparities were most apparent and statistically significant for single A-rated bonds, as green bonds were traded 3.88 basis points (4.87%) lower than identical non-green bonds. Green bonds rated AA and BBB trade at narrower

spreads compared to their non-green counterparts, but they did not observe any statistically significant differences. While the cost of issuing green bonds is higher compared to non-green bonds, the pricing disparity between green and non-green bonds for rating classes AA, A, and BBB has the potential to compensate for additional expenses incurred by the issuer (certification etc.). Upon further analysis of the price differentials, their findings suggest that the factors of maturity, volume, and currency did not have a major impact. Instead, the industries that had notable influence are government-related and financial issuers, together with the presence of an ESG issuer rating. Green bonds issued by the government had somewhat higher trading spreads compared to similar bonds that were not environmentally friendly. Conversely, green bonds issued by financial institutions had lower trading spreads than non-green bonds.

Olivier (2019) utilised a matching approach, followed by a two-step regression procedure, to estimate the difference in yield between a green bond and a hypothetical conventional bond from July 2013 to December 2017. The findings indicate a small negative premium: the yield of a green bond is lower than that of a non-green bond. He demonstrated that the negative premium was particularly prominent for financial and low-rated bonds. The findings highlight that investors' pro-environmental preferences have a little effect on bond prices. This, however, does not yet discourage investors from backing the growth of the green bond market. The matching method, sometimes referred to as a model-free approach or direct approach, is a valuable methodology for assessing the specificity of a financial instrument. The process involves identifying a pair of instruments that have similar qualities, except for the specific trait that we are interested in studying its impacts (Oliver, 2017). Febi et al. (2018) examined the impact of the liquidity premium on the differences in yield amongst green bonds. They stated, that the green bonds market may face liquidity difficulties due to its relatively low trading volume and the lack of clarity on its financial stability.

2. Data and Methods

Hence, the primary aim of this paper is to provide a comprehensive analysis of green bonds in a broad sense, while the secondary purpose is to elucidate their yield disparities in relation to conventional bonds (non-green) from a theoretical standpoint. For the filling this goals we used a Conceptual Analysis, which is focused on understanding the conceptual boundaries and semantics associated with the research object. Overall, semantics associated with a research object help shape the understanding and discourse surrounding that object within the academic community and beyond.

The third objective was to assess the growth of green bond issuance amount using data from the Climate Bonds Initiative free websites database between 2014 and 2023. The database of the Green Bond Initiative functions as a comprehensive repository of information about the issuing of green bonds and associated environmental initiatives. The system carefully records information on issuers, bond attributes, project categories, and environmental effect measurements. The strong and durable structure of this framework enables the conduct of empirical research and policy assessments, providing vital insights into the changing field of green finance. Data were analysed based on:

1. the total global amount issued green bonds in billion USD according to the regions;
2. the total global amount issued green bonds in billion USD according to the type of market (emerging, supranational and developed);
3. the total global amount issued green bonds in billion USD according to the use of proceeds;
4. the cumulative amount of green bonds in billion USD issued between 2014 and 2023 in Europe;

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5. the total global amount issued green bonds in billion USD according to the use of proceeds in Europe.

Based on the non-parametric Kruskal-Wallis Test, we determined whether there are statistically significant differences between the regions of Europe, Asia-Pacific and North America in the structure of issued bonds according to use of proceeds for the entire monitoring period, that is, not for the monitored period. The aim was to find out if there are different priority areas for obtaining the necessary resources through the issue of green bonds in these regions. For the calculation of the Kruskal-Wallis test we used statical software Statgraphics Centurion. The Kruskal-Wallis Test examines the null hypothesis that the medians in each of our three regions are equal.

Kruskal-Wallis Test Formula

The test statistic *H* is calculated as:

$$H = \frac{12}{N\,(N+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3\,(N+1) \qquad (1)$$

Where:
- k = number of groups (in this case, Europe, Asia-Pacific, and North America)
- N = total number of observations across all groups
- n_i = number of observations in group i
- R_i= sum of the ranks for group i
- The data from all the regions were initially merged and sorted in ascending order.

3. Results and Discussion

The volume of issued bonds climbed significantly from 37.8 billion USD in 2014 to 725.9 billion USD in 2023, representing a remarkable rise of 1 820.4%. Figure 1 displays the total volumes of issued green bonds categorised by region in billions USD. When comparing the amount of the issuance between 2023 and 2022, which was USD 649 billion, there was a year-on-year growth of over 12%. Europe has the highest average representation of 45.6% in terms of structure, followed by the Asia-Pacific area with an average presence of 27.2%. North America ranks third with an average participation of 20.5%. Asia-Pacific area has surpassed North America in terms of the number of green bond issuance for last years. Specifically in year 2014, the Asia-Pacific region accounted for 4.2% of the total volume of green bond issues, while North America accounted for 19.6%. In 2023, the Asia-Pacific area had reached a 37% share, while the North America region only accounted for 11%.

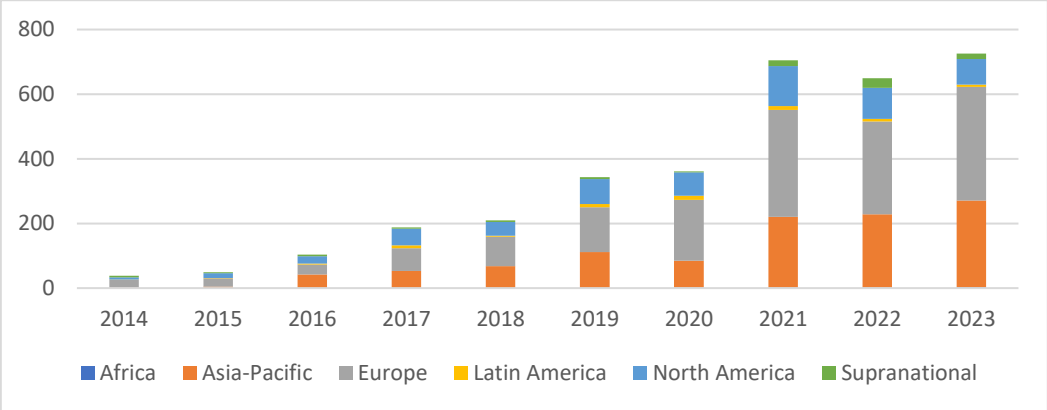

Figure 1: The total global amount issued green bonds in billion USD according to the regions

Source: Climate Bonds Initiative, own processing

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The presented data encompasses information on developed, emerging and supranational markets. In the context of the Green Bond Initiative, the term supranational market pertains to the issuance of bonds by international organisations such as the World Bank or European Investment Bank. Emerging markets denote nations undergoing fast industrialization and experiencing substantial economic expansion. Developed markets generally pertain to nations that possess sophisticated economies and well-established financial systems. Table 1 clearly indicates that developed market had the highest amount of issued green bonds over the whole monitored period. But we also observe that the share of emissions in countries from emerging markets has been increasing in recent years, primarily at the expense of emissions from supranational organisations.

Table 1: The total global amount issued green bonds in billion USD according to the type of market

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Emerging	0.8	3.7	42.4	52.7	54.9	94.8	76.6	183	199.2	225.1
Supranational	10	8.6	10.3	9.6	13.4	14.9	14.9	33.6	46.4	32.3
Developed	27.2	36.7	50.5	125.4	141.4	233.7	269.3	488.3	403.3	468.6

Source: Climate Bonds Initiative, own processing

The Green Bond Initiative distinguishes nine categories in terms of the use of financial resources obtained from the issuance of green bonds. Three of them (Energy, Buildings and Transport) accounted for the largest share over the entire period, which was over 80%. However, in recent years this share has decreased in favour of smaller categories, as more issuers finance a wider range of projects. Amounts in billion dollars are listed in Table 2. "Unspecified A&R" refer to "Unspecified Adaptation and Resilience," indicating projects that aim to enhance resilience to climate change impacts and adapt to changing environmental conditions but are not specified in detail within the table.

Table 2: The total global amount issued green bonds in billion USD according to the use of proceeds

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Energy	18.3	23.8	33.2	53	53.7	87.6	105.4	206.7	166.5	206.5
Buildings	7.7	8.7	18.1	47.5	48.3	82.4	84.2	169.6	126.7	107.7
Transport	4.2	6	12.7	23.9	30.7	53.1	67.8	97.9	95.8	126.8
Water	2.9	4	10.7	20	20.4	25	18.4	35.9	35	32.5
Waste	1.2	1.6	4.4	6.1	7.6	10	7.9	25.2	24.6	29.8
Land Use	1.5	0.6	1.7	5.3	7.3	9	15.3	30.4	27.5	37.1
Industry		0.7	0.1	0.2	0.8	1.9	1.4	7.9	4.3	11.3
ICT[1]					0.1	1.9	1.5	5.2	6.6	13.3
Unspecified A&R	1.2	1	3.9	3.5	3.5	2.6	2.4	11.8	20.1	22.6
Total	**37**	**46.4**	**84.8**	**159.5**	**172.4**	**273.5**	**304.3**	**590.6**	**507.1**	**587.6**

Source: Climate Bonds Initiative, own processing
[1]Information and Communication Technology*

It is interesting that the Green Bonds Initiative also divided countries into developed and emerging countries in Europe, too. It ranks among developed countries (UK, Norway, France, Sweden, Germany, Netherlands, Spain, Austria, Italy, Switzerland, Denmark, Belgium,

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Ireland, Finland, Luxembourg, Portugal, Cyprus, Guernsey, and Jersey. The emerging countries include Slovakia, Czech Republic, Poland, Hungary, and 16 other states, like Estonia, Latvia, Lithuania, Slovenia, Iceland, Russia, Greece, Ukraine, Georgia, Armenia, Serbia, Romania, Albania, Macedonia, Malta, and Montenegro.

From Figure 2, we can observe that the largest amount of issued green bonds among developed countries was in Germany, France and the Netherlands. From emerging countries, there were Poland, Hungary and Greece. The Czech Republic ranked 4th and Slovakia just 7th ahead of Romania.

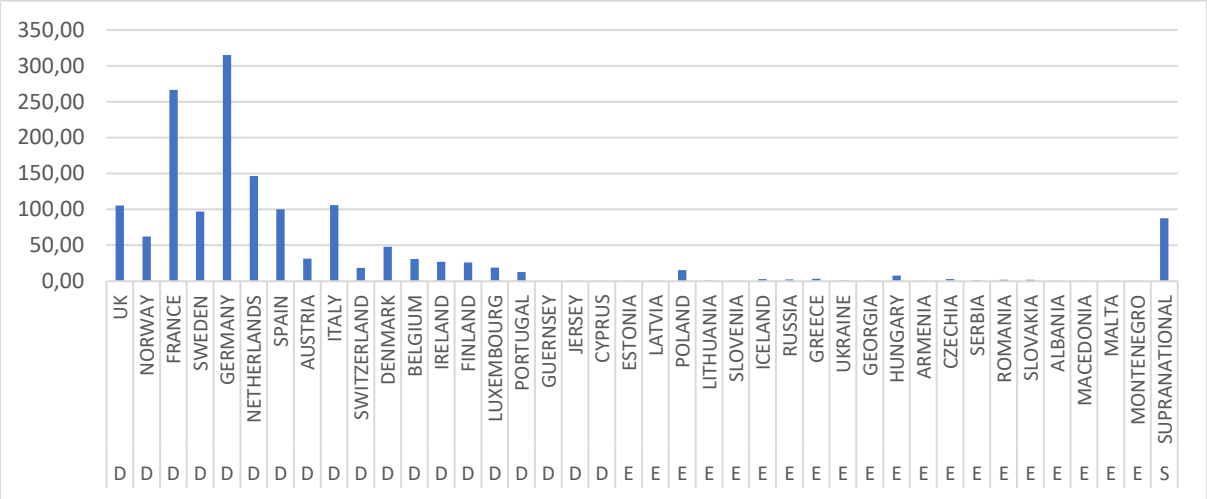

Figure 2: The cumulative amount of green bonds issued between 2014 and 2023 in Europe in in billion USD

Source: Climate Bonds Initiative, own processing

D – developed countries, E – emerging countries, S - supranational

In the next part, we will only look at developments in the amount of green bonds issued in Europe from the point of view of the use of proceeds without the supranational organisations. Similarly, from a global point of view, three sectors have prevailed, namely Energy, Buildings and Transport. However, the share of the Energy sector recorded the largest decrease in shares of the total issue of green bonds. In 2014, this sector accounted for up to 61.2% of the total volume, but in 2023 it was just under 30%. The building sector maintained an almost similar share in the total volume of emissions, with a share between 15% and 29%. The Transport sector has significantly increased its share from the original 4.9% in 2014 to 20 % in 2023. In terms of Land Use, we also observe a significant increase from 4.4% to 8.4%. Figure 3 shows these development trends in terms of structure.

Table 3: The total global amount issued green bonds in billion USD according to the use of proceeds in Europe without the supranational institutions

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Energy	11.2	10.2	14.6	24.9	22.3	40.4	56.8	92.4	79.7	85.8
Buildings	2.8	4.7	5.9	17.1	17.1	35	40.9	85.8	64.2	69.6
Transport	0.9	2.1	2.3	7.7	13.9	24.8	37.6	49.2	40.9	59
Water	1.2	1.1	1.3	3.8	4.7	7.1	5.4	13.2	10.8	15.2
Waste	0.8	1	0.4	2.5	3.5	4.2	3.9	15.3	9.6	17.3
Land Use	0.8	0.2	0.5	3.1	4.1	5.9	13.1	22.8	18.2	24.9
Industry				0.1		0.6	0.6	6	3	7.9
ICT[1]					0.1	1.5	1.2	1.9	1.6	3.2
Unspecified										
A&R	0.6	0.8	0.9	1.1	2	1.4	1.9	4.7	5.9	11.9
Total	**18.3**	**20.1**	**25.9**	**60.3**	**67.7**	**121**	**161**	**291.3**	**233.9**	**294.8**

Source: Climate Bonds Initiative, own processing

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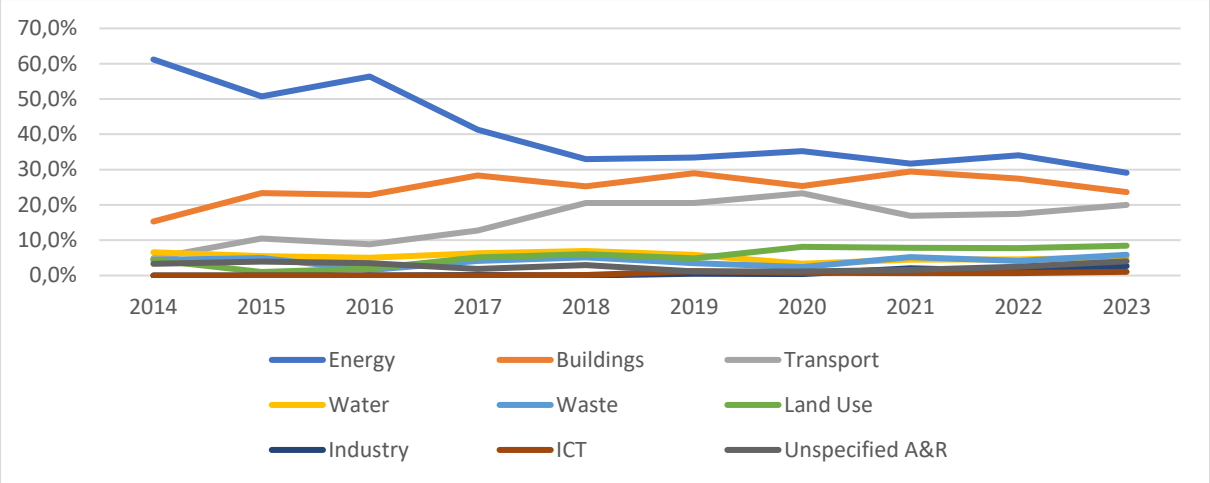

Figure 3: The development trend in structure of the use of proceed in Europe in percentage between years 2014 and 2023

Source: Climate Bonds Initiative, own processing

In the last part of paper, we conducted a non-parametric Kruskal-Wallis Test to assess if there are statistically significant variations in the structure of issued bonds across the regions of Europe, Asia-Pacific, and North America, specifically in terms of the use of proceeds. This analysis was performed for the entire monitoring period. We used only issuers from emerging a developed countries and excluded the supranational organisations from the regions. The objective was to determine if there are distinct areas of importance for acquiring the required resources through the issuance of green bonds in these regions. We utilised the statistical programme STATSGRAPHICS Centurion to perform the Kruskal-Wallis Test.

Table 3: The total amount issued green bonds in billion USD for the monitoring period in chosen regions and percentage according to the use of proceeds

Year	Europe	Asia-Pacific	North America	Europe	Asia-Pacific	North America
Energy	438.3	288.4	136.7	33.86%	40.30%	26.63%
Buildings	343.1	112.9	201.5	26.50%	15.77%	39.26%
Transport	238.4	165.9	71.2	18.41%	23.18%	13.87%
Water	63.8	59.4	66	4.93%	8.30%	12.86%
Waste	58.5	40.9	12.2	4.52%	5.71%	2,38%
Land Use	93.6	23	6.6	7.23%	3.21%	1.29%
Industry	18.2	4.2	4.3	1.41%	0.59%	0.84%
ICT[1]	9.5	6.5	6.7	0.73%	0.91%	1.31%
Unspecified A&R	31.2	14.5	8.1	2.41%	2.03%	1.58%
Total	**1294.6**	**715.7**	**513.3**	**100%**	**100%**	**100%**

Source: Climate Bonds Initiative, own processing

The Kruskal-Wallis Test examines the null hypothesis that the medians in each of our three regions are equal. The data from all the regions were initially merged and sorted in ascending order. The average rank was calculated for the data in each region (Figure 3). The Test statistic of this test was equal to 0.151675. Given that the P-value was 0.926967 what is larger than 0.05, there is between these three regions no statistically significant difference seen among the medians at the 95.0% confidence level. The only significant difference can be observed in the North America region, where the Buildings dominated according to the use of proceeds.

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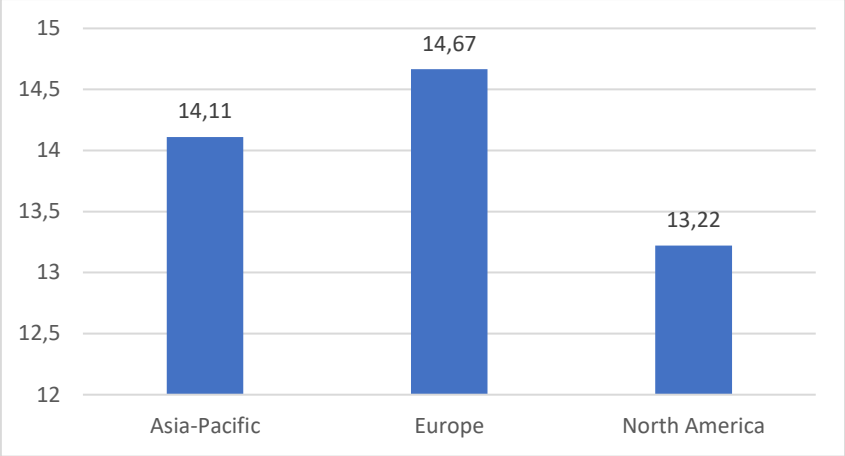

Figure 4: Average Rank of Kruskal-Wallis Test

Source: Table 3, own processing

4. Conclusion

A green bond is a type of bond that is used solely to fund or refinance approved green projects, whether they are new or existing. Green bonds offer financial resources to promote environmentally conscious projects and help to the achievement of long-term sustainable development goals. The investment in the green project has a higher level of risk compared to other typical projects, and the potential return on these projects is more unpredictable. Issue of green bonds incurs certain higher expenses because financed projects must meet demanding certification. Consequently, there exists a significant disparity between the need for funding and the actual accessibility of financial resources for environmentally friendly initiatives. Green bonds are financial products that can bridge the gap between the demand for funds and the need to address ecological degradation. This is also confirmed by the data from the Green Bonds Initiative, where the amount of issued green bonds increased every year according to the regions or the use of proceeds. In recent years the share of the three biggest categories (Energy, Buildings and Transport) has decreased in favour of smaller categories, as more issuers finance a wider range of projects. In Europe the Energy sector recorded the largest decrease in shares of the total issue of green bonds. In Europe the Transport sector has significantly increased its share from the original 4.9% in 2014 to 20 % in 2023 and in terms of Land Use, we also observed a significant increase from 4.4% to 8.4%. In the three regions (Europe, Asia-Pacific and North America) there weren't significant differences in percentage structure according to the use of proceeds the green bonds in tested overall period. In conclusion, we can conclude that green bonds are an important instrument for financing carbon neutrality, while it is necessary to continue the standardization of the parameters that must be met by green bonds in order to avoid green-washing.

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Consumer Behaviour in the Meat Consumption - Current Situation and Prediction until 2027

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Abstract
Nutrition and food policy are part of the economic policy of every developed country and are understood as complex educational, economic, legislative, and technical measures aimed at achieving the required level of food consumption. The basic model of recommended food consumption allowances in kg per inhabitant per year has been valid in Slovakia since 2000 and is based on recommended nutritional allowances. The paper aims to evaluate the consumer behaviour and level of consumption of selected types of food, compare it with the Recommended Dietary Allowance (RDA), and predict consumption until 2027. In the analysis, we realise that consumers decide rationally or irrationally when making their decisions. Based on this, we focused on individual types of meat, namely pork, poultry, beef, veal, and fish. We drew secondary data on food consumption in 2017-2022 from the publications of the Statistical Office of the Slovak Republic. We calculated the prediction of food consumption in the years 2023 - 2027 using the Exponential Smoothing (ETS) algorithm. Predicted values are a continuation of historical values at the specified target date.
Furthermore, analysis, synthesis, comparison and trend function methods were used. When comparing the actual consumption with the recommended consumption of individual food in 2022, we found excessive pork consumption (16.8 kg more than RDA) and poultry meat (9.5 kg more than ODSP). Recommended daily allowances do not reach beef and veal (11.4 kg less than RDA) and fish meat (0.3 kg less than RDA). The prediction of the future level of consumption assumes an increase in the average annual consumption of all types of meat, namely pork to the level of 44.3 kg, poultry to 27.1 kg, beef and veal to 7.0 kg, and fish to 6.2 kg. The above implies the need to reduce the level of consumption of pork and poultry and increase the level of consumption of beef and veal. When buying meat, the average consumer decides primarily rationally, based on price or shorter time required for preparation, and irrationally, considering the tradition or habits. Educated consumers, especially, buy more rationally and try to direct their consumption towards the required level of consumption of the given food group.

Key words
Consumer Behaviour, Meat, Consumption, Current Situation, Prediction, Irrationality.

JEL Classification
M29, M39, M59

1. Introduction

The significant changes in society brought about by the year 1990 significantly impacted the formation of Slovak agrarian and nutrition policy. Until 1990, agriculture was a strongly

preferred sector of the national economy. The fundamental changes brought about by transforming a centrally managed economy into a market one caused a radical change in the economic conditions for agricultural production and, thus, agrarian and nutrition policy. The main goals of the agrarian and nutrition policy include ensuring the country's food security, healthy nutrition, and population nutritional sufficiency. It should also be an effort to achieve the highest possible self-sufficiency in food production.

Nutrition and food policy is a complex set of educational, economic, technical, and legislative measures intended to improve the project of nutritional needs and forecast food consumption and nutritional requirements (FAO, WHO, 1974).

The existence of long-term energy overconsumption in nutrition and its imbalance in the representation of nutrients and protective factors in our population creates risk conditions due to non-infectious diseases, especially cardiovascular and oncological diseases, obesity and diabetes mellitus. In the case of the mentioned diseases, proper nutrition guidance is one of the basic components of all tasks and goals in their primary prevention (WHO, 2000).

Agrarian and food policy forms an important part of economic policy in all countries with advanced economies. Even if agriculture is not as significant a carrier of economic growth as industry, strengthening their mutual ties can contribute to its higher growth dynamics. Mutual compliance enables the growth of both sections. In addition, agriculture plays an important role in the fulfilment of socioeconomic goals (Kuzma, 1995).

All developed countries of the world carry out nutrition and food policies. These policies aim to direct food consumption in the desired direction while current scientific knowledge about healthy nutrition is applied. It is most often applied at the national level, but it can also be implemented at the level of smaller groups (children, young families, pensioners, etc.). Nutrition and food policy is usually implemented through official recommendations for food consumption. It is the same in Slovak conditions.

Meat has been a part of human nutrition for several thousand years. Currently, there is a double view of its role in the diet. On the one hand, it is a key factor in reducing the occurrence of malnutrition in developing countries; on the other hand, its excessive consumption in developed countries is linked to the occurrence of non-infectious diseases of mass occurrence, e.g. obesity, cardiovascular diseases or cancer (Chlebo et al., 2020).

Improper nutrition and lack of physical activity are the most important lifestyle risk factors involved in the development of chronic non-infectious diseases. They act for several years to decades before reaching the symptoms of the disease. According to the WHO, it is possible to prevent ischemic heart disease by 80%, type 2 diabetes by 90% and tumours by 30% with proper nutrition, adequate physical activity, and not smoking. SR belongs to the European countries with a high prevalence of adult obesity, the highest incidence of malignant neoplasms, with almost twice the mortality from cardiovascular diseases compared to the European countries with the lowest mortality (Golian, 2017).

Consumer behaviour is determined by many personal, social, psychological, economic, and situational factors. The most important factors when buying food include product freshness, quality, experience with the product and price ***(Nagyová et al. 2012).***

Several studies (Ruby et al., 2016; Miguel et al., 2021; Kilian & Hamm, 2021; Hungara et al., 2022; Paslakis et al., 2020) have been conducted on consumer perception, consumption and purchasing behaviour which investigated various factors such as consumer attitudes towards this type of diet, opinions on health and nutrition, ethical concerns, taste preferences and market availability of food products; now a gap is opening up creating a new phenomenon where it is necessary to find out how consumers decide to change their lifestyle and approach to life and most importantly why.

Consumer psychology studies have shown (Kahneman &Tversky, 1979; Bagozzi, Gopinath & Nyer, 1999; Krishna & Raghubir, 1999; Clegg, 2000; Clark, 2008; Barsalou, 2008; Krishna,

Lwin & Morrin, 2010; Krishna & Schwarz, 2014; Thaler, 2016; Serenčéš & Lazorčáková, 2017; Lincényi & Bulanda, 2023 and others) that consumers base their purchasing decisions on feelings and emotions, not on logic. Only then does he rationalise or try to rationalise his decisions? This means that the better we can reach potential customers on an emotional level, the greater the chance to influence their behaviour towards sustainable consumption (Rybanská et al., 2020).

2. Data and Methods

The goal of the paper was to evaluate the level of consumption and compare it with the Recommended Dietary Allowance (RDA) of selected types of meat and predict the level of consumption until 2027 with an emphasis on the rationality and irrationality of consumers when creating preferences in their purchasing and consumer behaviour. Pork, poultry, beef, veal and fish were selected. Information on actual food consumption in 2016-2022 was drawn from the Statistical Office of the Slovak Republic. The future level of food consumption prediction in the years 2023 - 2027 was made with the Microsoft Excel program using the FORECAST function. ETS. This function calculates the future value based on the existing (historical) values using the AAA version of the exponential smoothing algorithm (ETS). Forecast values are a continuation of historical values at the specified target date. Furthermore, analysis, synthesis, comparison and trend function methods were used.

3. Results and Discussion

Meat is an important component of our daily diet. The consumer prefers it mainly for its sensory properties. Meat is a rich source of essential nutrients. As a part of food, meat contributes significantly to saturating the body with nutrients. Meat has a high nutritional density. This is one of the ways to express the nutritional value of food. Nutritional density is the ratio of nutrient content to energy content in a unit of food weight. Meat and meat products are good sources of easily digestible proteins, lipids, iron, zinc, selenium and vitamins A and B (Chlebo et al., 2020).

The latest research on pork, its nutritional benefits, and its impact on health proved that pork contains quality protein, B vitamins, and minerals, but high consumption may be associated with chronic disease risk (Vicente & Pereira, 2024).

The situation in Slovakia is marked by overconsumption of this meat.The actual consumption of pork meat (years 2017 - 2022) and the consumption prediction until 2027 is shown in Figure 1. Pork meat shows the highest level of consumption for a long time, which significantly exceeds the recommended amount of consumption. In 2017, the level of consumption was 13.7 kg (per person per year) higher than the Recommended Dietary Allowance (RDA); in 2022, it was up to 16.8 kg. The forecast assumes an increase in consumption in 2027 to 44.3 kg.) they have always had non-perishable food at home to stock up on (53.16% of respondents). They do not buy larger quantities of food to be on the safe side (46.47% of respondents).

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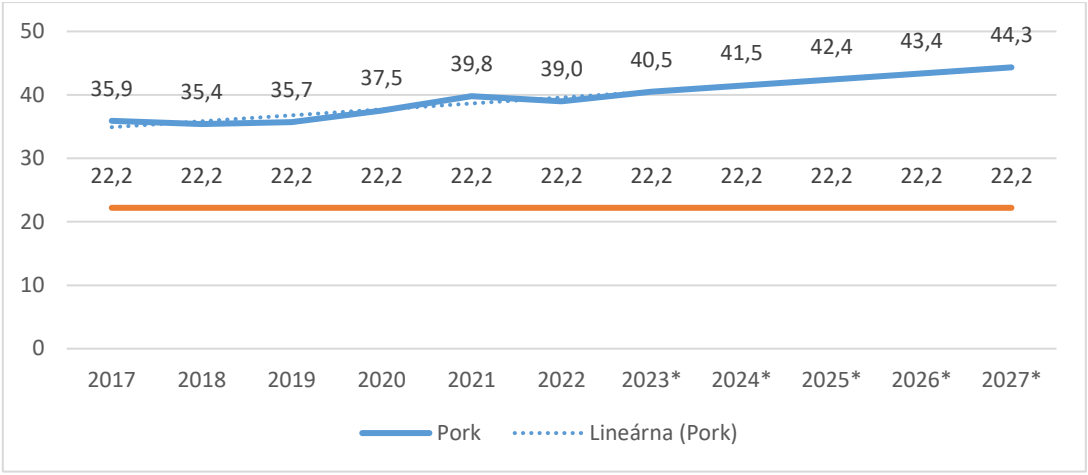

Figure 1: Consumption and prediction of pork consumption per person per year

Source: Statistical Office of the Slovak Republic, processed by the authors

The consumption of poultry meat in 2017-2022 and the prediction of consumption until 2027 are shown in Figure 2. The recommended amount of consumption is 15.0 kg per person per year. The consumption of poultry meat in the entire period exceeds the stated value. The lowest level of consumption was observed in 2017 (20.2 kg) and the highest in 2019 (26.9 kg).

The consumption of poultry meat in Slovakia for 2023 was more than 130,000 tons of poultry. However, Slovakia produced just over 77,000 tons of poultry meat last year. Due to the low domestic production, a third of the consumption is missing from the Slovak market every year, so in reality, there is a shortage of around 50,000 tons of imported goods. At the same time, consumption is increasing slightly year-on-year, related to the revival of the gastro sector and the fact that poultry meat is more affordable and healthier than pork or beef (The News Agency of the Slovak Republic, 2024).

The prediction of future consumption assumes a slight increase, which in 2027 should be at 27.1 kg per person per year (Figure 2).

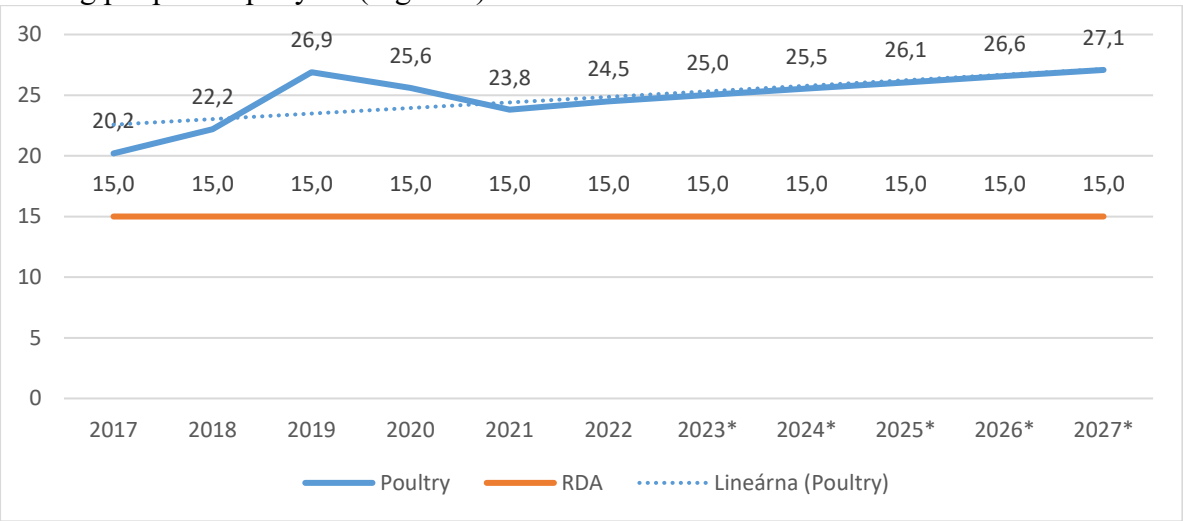

Figure 2: Consumption and prediction of poultry consumption per person per year

Source: Statistical Office of the Slovak Republic, processed by the authors

The consumption of beef and veal in 2017 - 2022 and the prediction of consumption in 2023 - 2027 are shown in Figure 3. It is clear from the figure that the actual consumption of beef and veal is significantly lower than RDA. In 2017, consumption was 12.2 kg lower than RDA, then

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consumption increased slightly, and in 2022, it was 11.4 kg lower than RDA. The consumption forecast assumes a slight increase in consumption to 7.0 kg in 2027.

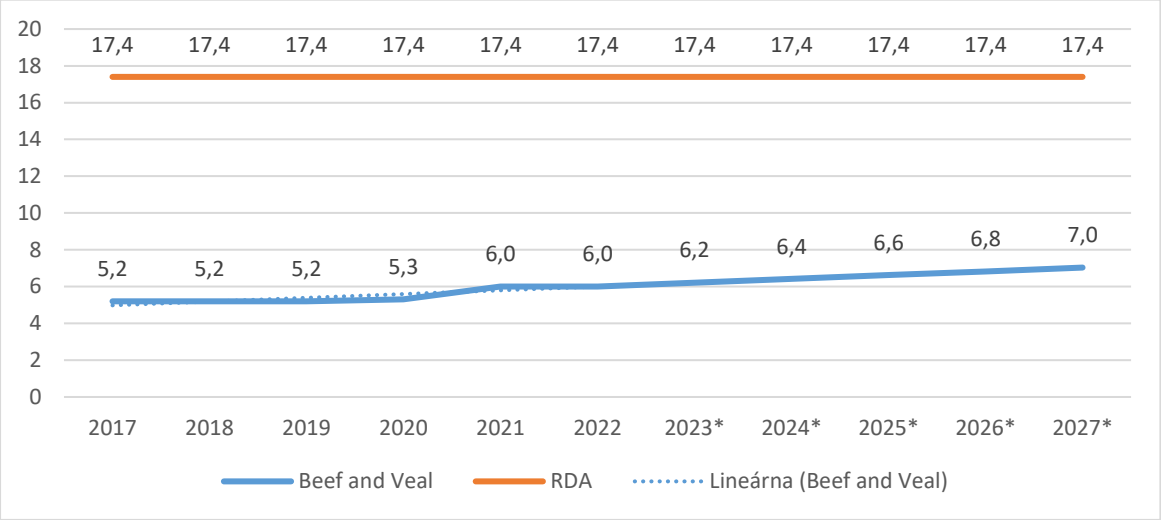

Figure 3: Consumption and prediction of beef and veal consumption per person per year

Source: Statistical Office of the Slovak Republic, processed by the authors

Based on the scientific evidence available today, it can be concluded that high consumption of red meat, especially processed meat, is associated with an increased risk of several serious chronic diseases and premature mortality. In addition, the production of red meat also represents an environmental burden. Therefore, some European countries have already integrated these two problems into the new national dietary guidelines and recommended limiting the consumption of red meat (Gonzáles et al., 2020).

Figure 4 shows the consumption and prediction of fish consumption compared to RDA. Fish consumption ranges from 5.5 kg to 5.9 kg. In 2022, fish consumption was 5.7 kg - 0.3 kg lower than RDA. Despite this, a slight increase in fish consumption has been recorded in recent years, which may be a consequence of increasing awareness of the health benefits of fish consumption and the availability of different types of fish on the market. The consumption forecast assumes a slight increase in fish consumption above the RDA level (6.2 kg) in 2027.

International health organizations contribute to the increase of fish as a source-3 and the improvement of dietary habits. This could change the overall consumption. To increase fish consumption, as recommended by international health organizations and dietary guidelines, there is a need to understand better what drives consumers to fish consumption behavior. Consumer health-orientation and social influences are better drivers to increase fish consumption frequency, compared to socio-economic characteristics. Given the health advantages of higher fish consumption, government initiatives should support fish food industry marketing strategies (Samoggia & Castellini, 2018).

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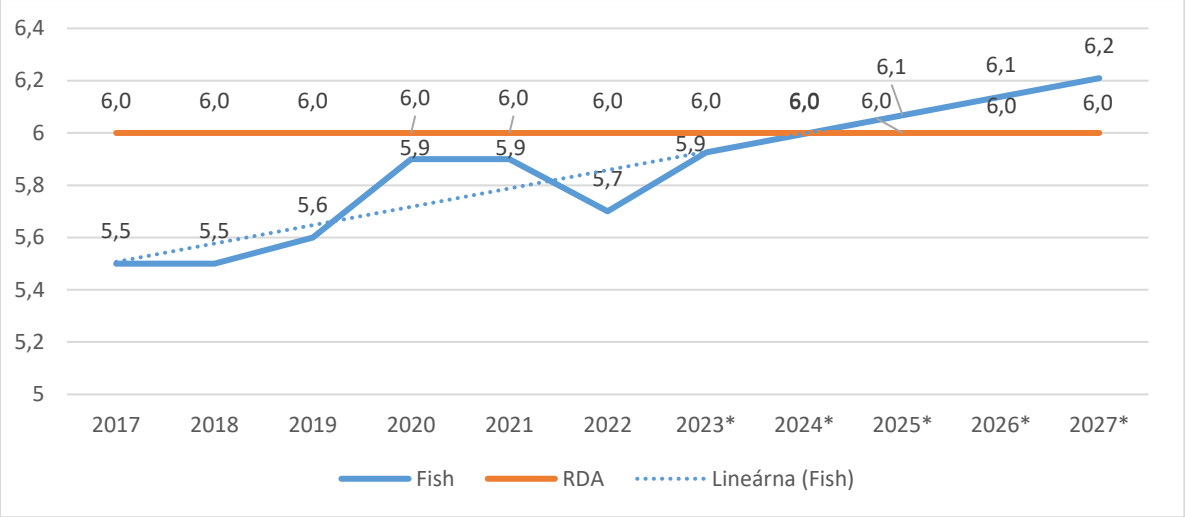

Figure 4: Consumption and prediction of fish consumption per person per year

Source: Statistical Office of the Slovak Republic, processed by the authors

Dietary guidelines for food groups (Food-based Dietary Guidelines, FBDGs) are scientifically based specific advice and principles on proper eating and appropriate nutrition to prevent all forms of malnutrition and maintain good nutritional status and human health (FAO, 2021). From monitoring the national databases of FBDGs, which were carried out in 90 countries of the world, certain recommendations emerge that are uniform for all countries: consuming a variety of foods, consuming more vegetables, fruits and legumes, consuming less sugar, fat and salt (WHO, 2015).

Meat is the main source of protein, but it also contains a certain amount of fat, a very small amount of carbohydrates and micronutrients, the most important of which are iron and vitamin B12. The fat content in meat and meat products ranges from 8 to 20% (Ahmad et al., 2018).

There are three types of macronutrients: proteins, fats and carbohydrates. Limiting animal food (proteins and fats) shifts consumption towards the one remaining macronutrient – carbohydrates. A breakfast without eggs and bacon (fat and protein) becomes a breakfast with cereal or fruit (carbs). Dinner without meat means pasta, rice or potatoes. Many experts now state that in the second half of the 20th century, such a dietary change occurred, negatively affecting health. The path to wholesome, highly unprocessed food is full of animal foods. Meat has been the main food throughout human history, but to our detriment, we have forgotten this history (Teicholzová, 2016).

Meat is of great importance in human nutrition, although excessive intake is not recommended from a health point of view. From a nutritional point of view, beef and veal, lean pork, chicken, rabbit and turkey meat are the most valuable. Since 1990, there has been a decrease in meat consumption in our country; the most significant decrease is in beef and veal (80%). On the contrary, poultry and fish consumption increased (Hybenová, Kajaba, 2021).

Pork is one of the most used types of meat in Slovakia. Its popularity is not due to tradition but its sensory properties. From an energy point of view, it is one of the foods with a high energy value; it is recommended to reduce its consumption and replace it mainly with beef or poultry meat, especially because of the high content of fat and cholesterol (Chlebo et al.).

Published analyses of food consumption in Slovakia show that the eating habits of the inhabitants are not in line with healthy eating (Kubicová et al., 2019).

Rationality in consumer behaviour and the creation of consumer preferences should be based on the principles of healthy eating. On the other hand, the irrationality of consumers manifests itself in this area as well, as emotions, the current state of the consumer, or other subjective factors influence purchasing decisions. The resulting decision is the result of both rationality

and irrationality, which significantly impact the purchasing behaviour and decision-making of consumers at the threshold of the 3rd millennium.

4. Conclusion

Determining the recommended amounts of food consumption is an important part of every developed country's food and nutrition policy. RDA represents a basic criterion for evaluating the level of consumption of individual food groups and should determine the direction in which the consumption of the given group should go. The basic RDA model has been valid in Slovakia since 2000, and the recommended consumption of individual food groups is expressed in kilograms per person per year. In this paper, we analyzed the level of consumption, compared it with RDA, and calculated the prediction of the future consumption of pork, beef, veal, poultry, and fish. The pork consumption per person exceeds RDA (22.2 kg) for a long time. In 2017, consumption was higher by 13.7 kg (62%) than RDA, and in 2022 by 16.8 kg (75%). The consumption forecast assumes an increase in consumption to 44.3 kg. Increasing consumption and overconsumption are also observed in poultry meat. In 2022, actual consumption was 9.5 kg (63%) higher than RDA. The prediction of future consumption predicts an increase of up to 27.1 kg. Fish consumption is lower by 0.3 kg (5%) than RDA. The consumption forecast assumes an increase in fish consumption to 6.2 kg in 2027. The highest difference between actual consumption and RDA is observed for beef and veal. Despite a slight increase in consumption in 2021, the level of consumption in 2022 was 11.4 kg (65%) lower than RDA. To improve the population's health status, it is inevitable that the consumption of beef, veal, and fish will increase, and pork and poultry consumption will be reduced. The total meat consumption in bone value was 71 kg per person in 2022, which is 13.7 kg more than RDA.

It can be concluded that meat is an important part of the Slovakian population's diet. Current trends indicate excessive consumption of pork and poultry, which significantly exceeds the recommended dietary allowances (RDA). On the contrary, beef, veal, and fish meat consumption remains below the recommended values, which points to the need to change eating habits to achieve a more balanced consumption. Predictions indicate a further increase in meat consumption by 2027, which may have health and environmental consequences. In order to ensure a healthier population and a more sustainable approach to nutrition, it is necessary to support the increase in the consumption of beef, veal, and fish meat while limiting the excessive consumption of pork and poultry meat. This goal can be achieved through educating consumers, increasing their nutritional literacy, and implementing effective nutrition policy measures.

Increasing nutrition and health literacy is the goal of the EU and individual member countries. A person must be more responsible for his consumption and health, especially following a healthy lifestyle. It is therefore necessary to constantly raise awareness in this area, to educate the consumer, and, above all, to explain to him how and by which factors he can influence his health. The rationality and irrationality of consumer behavior play a key role in food choice decisions, with educated consumers tending to make decisions more in line with the principles of healthy eating as both rationality and irrationality influence consumers, but only educated consumers are influenced by rational reasons when purchasing. The implementation of the nutrition policy should consist precisely of the successful introduction of scientific knowledge about nutrition into practical measures aimed at improving the population's health status.

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Evaluation of the Efficiency of Planting an Energy Plantation of Fast-Growing Trees

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Abstract
The topic of the research is based on the possibility of using land that does not meet the conditions for growing crops for the food industry to plant an energy plantation. The aim of the paper is to create and evaluate the investment plan for the establishment of an energy plantation of fast-growing willow using model technology. The model is constructed in an Excel spreadsheet and is quantified with data from similarly implemented projects as well as from other available sources. Using the net present value (NPV) criterion, the deterministic efficiencies of individual variants of investment plans are compared in the conditions of a 5 and a 4-year harvesting cycle with the purchase of a wood chipper and the sale of final wood chips and without the purchase of a wood chipper and the sale of wood for further processing. Based on the obtained results, we can conclude that with a 5-year wood harvesting cycle, 40% share of the subsidy and 20% share of equity in the costs of establishing a stand and purchasing a chipper, the investment plan in the scope of 20 ha is effective with an NPV value of € 6 453. In the case subsidies fell below 32%, it would be ineffective. A similar project in the scope of 10 ha would be effective with subsidies of more than 66%, while the scope of 5 ha with more than 89% of subsidies. Without the possibility of subsidies, the project is successful only with an area of 33 ha and with high loans not only for the establishment of a stand and the purchase of a chipper, but also for bridging loans - a total loan of € 184 412. Better results would be achieved with a 4-year wood harvesting cycle, where without subsidies it is sufficient 23 ha of cultivation areas. For 20 ha, subsidies are necessary at least about 8%, while for 10 ha at least 52% would be needed and for 5 ha 80%.
In the case of variants without the purchase of a woodchipper with a 5-year wood harvesting cycle, 40% shares of subsidy and 20% shares of equity in terms of the costs of establishing a stand, an investment plan with 5 ha of land with an NPV value of €623 is already effective. Without the possibility of subsidies, at least 7 ha of cultivation areas with a total loan of € 23 025. In the case of a 4-year cycle, the minimum area is 4 ha in order for the project to be effective without subsidies with an NPV value of € 322.

Key words
fast-growing trees, investment plan, harvesting cycle, wood chips, net present value

JEL Classification
A10, C30, D25, G31

1. Introduction

In the conditions of the Slovak Republic, there are also soils whose quality is not suitable for the cultivation of competitive crops for the food industry, as well as soils that are contaminated, or soils that are waterlogged or threatened by erosion. Such types of soil can be effectively used for the establishment of energy plantations of fast-growing trees, which serve not only for the production of energy wood chips, but also contribute to the revitalization of the soil and

can also improve the economic results of business entities. The aim of the paper is the creation and evaluation of the investment plan for the establishment of an energy plantation of fast-growing willow using model technology.

The territory of Slovakia is among the countries that have potential in renewable energy sources. Within its total area, the Slovak Republic has 47% of agricultural land and 41% of forest land, which creates prerequisites for the use of renewable energy sources (Fáber, 2012). However, their current use in the technical potential of Slovakia is very low. In Slovakia's overall potential in renewable energy sources, biomass of plant or animal origin predominates. The potential of biomass was recently estimated at approximately 33 400 GWh. Energy plantations of trees and herbs can also be an important source, since according to the data of the Research Institute of Soil Science and Soil Protection, the total area of suitable areas for their cultivation is 369 088 ha.

Fast-growing trees are trees with a short period of wood production in the desired quantity and quality, the weight gain of which is clearly higher than the average weight gain of other trees. Fast-growing trees in Slovakia include, for example, willows, agates, maples and some poplars. They are moisture-loving trees, whose renewability is manifested primarily due to the youthfulness of the stump. With a 3-year fallow period, the growth will grow from a 5 cm size to a fallow size of 7 meters. We can collect such energy growth in two ways, directly as wood chips or long rods that are left to dry directly in the field. The rods are gathered by ordinary sawing 10 cm above the ground (Žilavý, 2013).

In the article by Aronsson, Rosenqvist, and Dimitriou (2014), the overall aim of the present study was to quantify the yield response of short-rotation willow coppice plantations grown in Sweden to different rates of nitrogen fertilization and to evaluate the economics of fertilization based on the results obtained. The yield results were then used for calculating the revenue obtained given different fertilization strategies and cost/price situations, which in turn indicated if and in what rates fertilization is to be recommended under different scenarios for commercial plantations. The impact of nitrogen fertilization on the yield of plantations planted with willow plants of bred varieties was positive resulting in yield increases which were generally higher with higher fertilization intensity. However, it was not always the most intensive nitrogen fertilizations rates that were most favourable in terms of economy, and old unbred varieties are not recommended to be fertilized with nitrogen at all.

Jensen, Keddy, and Sidders (2021) illustrate with the achieved results, that at current trading prices for carbon credits and market prices of woodchips, expected rates of return on investment for short rotation woody crops (SRWC) were relatively low, despite a positive net present value ($400/ha for 20 year planting cycle without carbon credits). However, higher future carbon prices, a well-developed market for buying and selling carbon credits, as well as adapted policy including additional government sponsored programs for carbon credits, could make SRWC more attractive and dramatically change the economics of afforestation in the future.

An important criterion for evaluating the investment intention of planting an energy plantation of fast-growing trees is that the investment intention is economically acceptable. In terms of accuracy, two approaches are considered as among the best in evaluating the investment objectives: The Net Present Value (NPV) and The Internal Rate of Return (IRR). The advantages and potential problems faced while using such approaches are treated for example by Northcott (1992), Lumby (1996), Žižlavský (2014). Xu (2015), Hopkinson (2016). The suitability of the NPV method was confirmed by Brandes, Plastina, and Heaton (2018) when evaluating the efficiency of the production of ordinary bioenergy crops. They looked at which landscape area could be more profitable to switch to energy grass production than growing

corn and soybeans. Technical-economic analysis of biofuel production using the NPV criterion was applied by Ingle, Chandel, and Da Silva (2020) and provided organizations with the basis for deciding which projects to continue and how to optimize them. Similarly, Chandel et. al. (2019) used NPV, which in this case acquired negative values, to evaluate the investment intention of fermenting waste mass into biofuels. However, going forward, they anticipate that R&D efforts focused on innovation can lead to cost reductions and a positive NPV. Eehart, Patel, and Faaij (2015) analysed production returns using NPV methodology, including sensitivity analysis to determine the effects of changes in financial parameters, inputs, chemicals and market prices. The study Dong et al. (2023) highlights the profitability of geothermal projects by developing a techno-economic coupling model for economic evaluation of Closed-loop geothermal systems based on net present value.

Tian, Gan, and Lu (2023) applied both traditional net present value (NPV) and real options methods to evaluate the investment in vertical agroforestry system composed of fast-growing and high-yield poplar trees and underwood button mushroom which has been increasingly adopted in Shandong, China. Regarding the investment options, they considered and evaluated the option to delay, option to expand, as well as option to abandon the investment using a binomial option-pricing model with the assumption that the button mushroom price would follow a multiplicative binomial process. They calculated option values were significantly greater than the NPVs, suggesting that the investment in this agroforestry system would be considered more favourable financially if it is evaluated using the real options method than the NPV approach that ignored the uncertainty and managerial flexibility.

Applications of model techniques in investment decision-making also with risk taken into consideration via a simulation model can be found in the articles in different fields: like in agriculture: Repiský (2006), Repiský (2019), or in co - generation plants: Colantoni at al. (2021), as well as in gold mining: Franco-Sepulveda, Campuzano, and Pineda (2017).

2. Data and Methods

The process of creation and evaluation of the investment plan for the establishment of an energy plantation of fast-growing willow is done as follows:

1. The construction model of the investment plan for planting an energy plantation and processing wood with the purchase of own chipper and without the purchase of a wood chipper.
2. The deterministic assessment of the efficiency of investment projects based on criteria of NPV and quantification of the impact of different financing options on the efficiency of the investment plan in the conditions of a 5 and a 4-year harvesting cycle with the purchase of a wood chipper and the sale of final wood chips and without the purchase of a wood chipper and the sale of wood for further processing.

The presented multi-period model simulating a twenty five-year period is created in a Microsoft Excel spreadsheet.. The deterministic evaluation of the efficiency is on the basis of the net present value criterion (Lumby, 1996, Eerhart et al. 2015, Brandes et al. 2018, Chandel et. al. 2019, Ingle at al. 2020).

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+i)^t} - I_0 , \qquad (1)$$

where: NPV – Net Present Value;
i – discount rate;

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$1/(1+i)^t$ – discounted factor at time t;
I_0 – initial investment costs;
n – number of years of investment;
CF_t – Cash Flow from the investment in different years.

The lifetime amount of the initial investment must provide for the reimbursement of the cash expense, the desired rate of return expressed by the interest rate and should increase the cash flow, thereby contributing to the increase in market value. The company achieves the status if the net present value is positive.

Model is made up of the following interconnected parts: input decisions, cost estimation: capital, variable, fixed, estimation of production, depreciation, financing of the investment, loan, repayment scheduling, projected annual income statement and projected cash flow. Initial decisions relate primarily to the width and length plot of land, clip i.e. distance between rows (1.5 m), distance in a row (0.7 m) and distance in a two-row clip (0.7 m), annual harvest cycle and method of financial coverage of investment costs. In the other parts of the model, the user only enters the actual unit prices and all other calculations are made automatically through defined relationships. All work operations and their associated costs are rigorously quantified in the model. The input data were obtained from real data from similar implemented projects of establishing energy plantations and professional literature.

3. Results and Discussion

Based on the model solution, it is possible to simulate different scenarios and quantify their net present value of NPV. Variant solutions are created using different areas of the energy plantation, different wood harvesting cycles, different ways of financial coverage of the investment, i.e. different level of subsidies and the ratio of own and foreign capital.

Table 1: NPV with a 5-year harvesting cycle, 20% equity shares in the costs of setting up a plantation and purchasing own chipper

Area	NPV	Subs.	Loan for investment cost + bridgings loan (€ in the given year)									Total loan
ha	(€)	(%)	1	2	3	4	5	7	9	11	13	(€)
33	455	0%	12 068	8 528	12 528	78 144	5 144	12 000	21 000	22 000	13 000	184 412
25	18 172	40%	10 208	6 556	9 556	31 314	3 994	1 000	7 000	3 000	0	72 628
25	1 532	20%	10 208	6 556	9 556	54 154	3 994	9 000	16 000	15 000	8 000	132 468
20	6 453	40%	8 037	5 315	8 315	33 592	3 272	4 000	10 000	9 000	3 000	84 531
20	29	32%	8 037	5 315	8 315	42 592	3 272	7 000	14 000	13 000	8 000	109 531
10	2 678	70%	4 707	2 846	3 846	13 032	1 832	1 000	7 000	4 000	1 000	39 263
10	20	66%	4 707	2 846	3 846	16 592	1 832	3 000	8 000	6 000	5 000	51 823
5	988	90%	2 546	1 616	2 616	1 074	1 114	1 000	5 000	2 000	0	16 966
5	492	89%	2 546	1 616	2 616	1 634	1 114	1 000	5 000	2 000	2 000	19 526

Source: author's calculations

Table 1 provides information on the value of NPV in the conditions of a 5-year harvesting cycle with the purchase of a wood chipper and the sale of final wood chips with different levels of subsidies of investment costs and rest of financing investment costs would be in the ratio of 20:80 own capital and foreign capital in the first five years. In addition, bridging loans are also needed to cover financial obligations during the lifetime of the investment. Commercial loans are with an assumption of a 3.5% interest rate and a 10-year repayment period. With the annual

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harvest of 1/5 of the total area of the plantation, with an expected annual yield of 60 t/ha, the realization price per ton of €55 and the purchase price of the chipper €65 000. NPV to the equity is calculated in a way that from the net cash flow in the individual years is deducted the investor's own investment and consequently is the cash flow discounts to the present value with a discount rate of 4%. In addition, the cumulative cash flow must reach positive values in order for the company to be able to pay its obligations in each time period.

In the case of the impossibility of obtaining subsidies, the marginal value of the plantation area for the project to be effective is 33 ha with investment costs €109 266 and with a total need of credit resources of €184 412 over 13 years and own resources of €21 853 during the first five years. If it is possible to get a 20% subsidy, the marginal value is 25 ha with a subsidy of €19 800 and a total need of credit resources of €132 468 and own resources of €15 867 during the first five years. Of course, if subsidies are increased to 40% at 25 ha, the project will be more efficient and will reach an NPV value of €18 172 and will require only €72 628 in credit resources and €11 907 own resources. In the case of smaller cultivation areas of 10 ha or 5 ha, the marginal value of subsidies would have to be 66% respectively 89% for the project to be acceptable from the NPV point of view, with a subsidy of €52 800 respectively €65 600 and a total need for credit resources of €51 823 or €19 526 and own resources €5 456 or €1 638 during the first five years.

With the proposed solutions, it is possible to calculate the turning point and other input parameters of the model. For example with 40% subsidies and an area of 25 ha, wood production at zero NPV is approximately 52 t/ha. If the production of wood material falls below the mentioned limit, the project would be unacceptable with the unchanged values of the other parameters. For example the realization price for the sale of wood chips should not fall below 49 €/t in order for the project to be acceptable with the unchanged values of the other parameters. Obviously, assuming other scenarios, these values would change.

Table 2: NPV with a 4-year harvesting cycle, 20% equity shares in the costs of setting up a plantation and purchasing own chipper

Area	NPV	Subs.	Loan for investment cost + bridgings loans (€ in the given year)									Total loan
ha	(€)	(%)	1	2	3	4	5	7	9	11	13	(€)
25	42 191	40%	11 410	7 565	35 165	4 642	0	0	0	0	0	58 782
25	8 888	0%	11 410	7 565	70 845	11 642	2 000	8 000	16 000	16 000	0	143 462
23	2 845	0%	10 838	6 981	69 239	14 300	1 000	11 000	18 000	19 000	1 000	151 358
20	26 296	40%	8 996	6 120	34 664	4 790	0	0	0	0	0	54 570
20	266	8%	8 996	6 120	62 424	10 790	3 000	10 000	17 000	21 000	0	139 330
10	5 640	60%	5 184	3 246	21 038	4 090	2 000	2 000	5 000	4 000	0	46 558
10	-17	52%	5 184	3 246	26 158	5 090	4 000	5 000	8 000	9 000	2 000	67 678
5	12	80%	2 783	1 814	8 910	5 243	1 000	2 000	4 000	4 000	2 000	31 750
5	-609	79%	2 783	1 814	9 470	5 243	1 000	3 000	4 000	4 000	3 000	34 310

Source: author's calculations

If it were possible to shorten the wood harvesting cycle by one year, better economic results can be expected. The output values shown in Table 2 document that in the case of a 4-year wood harvesting cycle, in conditions without the possibility of a subsidy, 23 ha of cultivation areas will suffice with investment costs €96 679 and a total need of credit resources of €151 358 over 13 years and own resources of €19 339 during the first five years.

Compared to the 5-year harvesting cycle with an unchanged acreage of 25 ha, unchanged subsidies of 40%, the NPV will reach a value higher by €24 019 (€42,191 - €18 172) and the

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total need for credit resources will decrease by €13 846 (€58 782 - € 72 628) mainly due to the reduction in the need for bridging loans. Under the assumption of 20% subsidies with an unchanged area of 25 ha, the NPV will change by €24 816 (€26 348 - €1 532) and the total need for credit resources will decrease even more significantly than with higher subsidies, specifically by €48 846 (€83 622 - €132 468). Similar conclusions also follow from the comparison of the results of the 4 and 5-year harvesting cycle with a plantation area of 20 ha. For example, assuming 40% subsidies, the NPV will increase by €19 843 (€26 296 - €6 453) and the total need for credit resources will decrease by €29 961 (€54 570 - €84 531). For smaller plots of land of 10 ha and 5 ha, the marginal values of subsidies will decrease by 14% (52% - 66%) and by 9% (80% - 89%), while the requirements for credit resources will increase by €15 855 (€67 678 - €51 823) respectively by €12 224 (€31 750 - €19 526).

Table 3: NPV with a 5-year harvesting cycle, 20% equity shares in the costs of setting up a plantation and without the purchase of a wood chipper

Area	NPV	Subs.	Loan for establishing a plantation + bridging loans (€ for the relevant year)									Total loan
ha	(€)	(%)	1	2	3	4	5	7	9	11	13	(€)
20	20 551	40%	8 037	5 315	8 315	0	3 272	0	0	0	0	24 939
20	12 950	0%	8 037	5 315	11 315	3 272	3 272	1 000	3 000	0	0	35 211
10	7 326	40%	4 707	2 846	3 846	0	1 832	0	0	0	0	13 231
10	3 085	0%	4 707	2 846	5 846	1 832	2 832	2 000	3 000	2 000	0	25 063
5	623	40%	2 546	1 616	2 616	0	1 114	1 000	1 000	1 000	0	10 892
5	-14	30%	2 546	1 616	2 616	0	1 114	2 000	2 000	2 000	0	13 892
7	136	0%	4 009	2 107	4 107	1 401	2 401	2 000	3 000	4 000	0	23 025

Source: author's calculations

Table 3 shows the NPV values of variant solutions for investment plans in the conditions of a 5-year harvesting cycle without the purchase of a wood chipper and the sale of wood for further processing. Project is also acceptable without subsidies in the case of cultivation areas larger than 7 ha. Assuming 20 ha, the NPV value would reach €12 950 with the need for credit resources €35 211 over 13 years and own resources €5 553 during the first five years with investment costs of €27 765. In the case of 7 ha, the NPV value would be close to zero €136 with the need for credit resources €23 025 and own resources €2 255 with investment costs of €11 265. Assuming a 20% subsidy, the marginal value of the plantation area for the project to be effective is 5.8 ha with a subsidy of €1 950 and a total need of credit resources of €17 544 and own resources of €1 636 with investment costs of €9 708. With 40% subsidies, the investment plan is effective even for a 5 ha plantation with an NPV value of €623.

Compared to the 5-year harvesting cycle with the purchase of a wood chipper and the sale of final wood chips and without the purchase of a wood chipper and the sale of wood for further processing, the NPV variants without the purchase of a wood chipper achieve much better values. If it is possible to directly sell wood for further processing for example under specific conditions, with subsidies of 40% and 20 ha of plantation, the NPV value is €14 098 higher in this variant (€20 551 - €6 453). Even the variant with 10 ha with the same input parameters would achieve a higher NPV value by €873 compared to the variant with a 20 ha plantation with the purchase of a wood chipper (€7 326 - €6 453).

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Table 4: NPV with a 4-year harvesting cycle, 20% equity shares in the costs of setting up a plantation and without the purchase of a wood chipper

Area	NPV	Subs.	Loan for establishing a plantation + bridging loans (€ for the relevant year)									Total loan
ha	(€)	(%)	1	2	3	4	5	7	9	11	13	(€)
20	35 866	40%	8 996	6 120	0	3 790	0	0	0	0	0	18 906
20	27 581	0%	8 996	6 120	9 344	3 790	0	0	0	0	0	28 250
10	15 129	40%	5 184	3 246	0	2 090	0	0	0	0	0	10 520
10	10 573	0%	5 184	3 246	5 358	2 090	0	0	0	0	0	15 878
5	4 703	40%	3 783	1 814	0	1 243	0	0	0	0	0	6 840
5	2 060	0%	3 783	1 814	2 870	1 243	0	1 000	2 000	0	0	12 710
4	322	0%	3 506	1 531	1 575	1 074	1 000	1 000	3 000	1 000	0	13 686
3,8	-40	0%	3 450	1 473	1 516	1 040	1 000	1 000	3 000	1 000	2 000	15 479

Source: author's calculations

Of course, if it were possible to shorten the harvesting cycle to 4 years, better results can be expected compared to the 5-year cycle. Assuming 40% subsidies, the value of NPV at 20 ha and other parameters unchanged would be €15 315 higher (€35 866 - €20 551), at 10 ha by €7 803 (€15 129 - €7 326) and at 5 ha by €4 080 (€4 703 - €623).

Similarly, as it was in the case of a comparison of a 5-year harvesting cycle with the purchase of a wood chipper and without the purchase of a wood chipper, and in the case of a 4-year harvesting cycle, the NPV variants without the purchase of a wood chipper achieves better values. For example, with subsidies of 40% and 20 ha of plantation, the NPV value is €9 570 higher in this variant (€35 866 - €26 296).

When planting fast-growing trees, each specific region, even each plot, may require different agrotechnical operations as well as different types of suitable trees when planting fast-growing trees. A concrete business entity can choose a different intensity of production, which of course will affect the amount of costs and the amount of expected production. All these aspects are satisfied by the model solution. In addition, the decision-making body can change strategies in investment financing and the credit area, but also in the extent of cultivation areas, in the wood harvesting cycle, and to monitor the immediate impact of these changes on the resulting efficiency indicators of the investment plan scenarios and identify the most suitable variant of the solution.

Currently, various newly bred varieties are available, which reach more than 80 t of wood from one hectare in four years with a lifespan allowing 6 harvests. In addition to production benefits, fast- growing trees plantations can have a positive effect on the surrounding landscape and human environment, e.g. for soil regeneration, increasing the country's biodiversity, stabilizing the hydrological regime. They can even act as sewage treatment plants and can also use sewage, urea, etc. as a source of nitrogen. Burning wood alone does not greatly burden the environment with excessive production of carbon dioxide. When burned, approximately the same amount of carbon dioxide is produced as the tree consumes for its growth. However, during cultivation, agrotechnical procedures must be strictly observed, especially treatment in the year of planting, only in this way is it possible to achieve the expected harvest with the expected economic effect.

4. Conclusion

The aim of the paper was to create and evaluate the investment plan for the establishment of an energy plantation of fast-growing willow using a multi-period balance model. Based on the model solution, it is possible to simulate different scenarios and quantify their net present value. Variant solutions are created using different areas of the energy plantation, different wood harvesting cycles, different ways of financial coverage of the investment, i.e. different level of subsidies and the ratio of own and foreign capital.

Under the conditions of a 5-year harvesting cycle with the purchase of a chipper and sale of final chips, 40% subsidy shares and 20% property shares for the costs of establishing a plantation and purchasing a chipper, the investment plan in the range of 20 ha is effective with an NPV value of €6 453. In the case of a drop in subsidies below 32%, it would be ineffective. A similar project in the scope of 10 ha would be effective with subsidies of more than 66%, in the scope of 5 ha more than 89% of subsidies. Without the possibility of subsidies, the project is successful only with an area of 33 ha and with investment costs €109 266 and with a total need of credit resources of €184 412 over 13 years and own resources of €21 853 during the first five years. Better results would be achieved with a 4-year wood harvesting cycle, where without subsidies it is sufficient 23 ha of cultivation areas with investment costs €96 679 and a total need of credit resources of €151 358 over 13 years and own resources of €19 339 during the first five years. At 20 ha, subsidies would have to be at least 8%, at 10 ha at least 52% and at 5 ha 80%. Compared to a 4-year and 5-year harvesting cycle with an unchanged acreage of 25 ha, unchanged subsidies of 40%, the NPV will reach a value higher by €24 019 and the total need for credit resources will decrease by €13 846 mainly due to the reduction in the need for bridging loans. For smaller plots of land of 10 ha and 5 ha, the marginal values of subsidies will decrease by 14% and by 9%, respectively, while the requirements for credit resources will increase by €15 855 respectively by €12 224.

In the case of variants without the purchase of a woodchipper with a 5-year wood harvesting cycle, 40% subsidy shares and 20% equity shares in the costs of establishing a stand, an investment plan with 5 ha of land with an NPV value of €623 is already effective. Without the possibility of subsidies, at least 7 ha of cultivation areas with a total loan of € 23 025. In the case of a 4-year cycle, the minimum area is 4 ha in order for the project to be effective without subsidies with an NPV value of € 322. Of course, if it were possible to shorten the harvesting cycle to 4 years, better results can be expected compared to the 5-year cycle. Assuming 40% subsidies, the value of NPV at 20 ha and other parameters unchanged would be €15 315 higher, at 10 ha by €7 803 and at 5 ha by €4 080 higher.

The achieved results provide the decision-making entity with an idea of what it would have to be, e.g. the area of the energy plantation with which harvesting cycle under certain conditions of financial coverage of the investment with or without the possibility of subsidizing. Alternatively, what would have to be the minimum amount of subsidies for the given area of the plantation so that the investment plan is acceptable from the point of view of NPV. What is important, however, is that with the help of the given model solution, the decision-making subject can identify the most suitable variant of the solution for the planting of an energetic plantation of fast-growing trees in the specific conditions of his business environment.

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Human Capital and Economic Growth: Regional Differences in the Visegrad Countries

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Abstract

Paper's objective(s) and research background

Human capital is among the factors positively contributing to the economic development and progress of countries. Nurturing human capital – along with favourable policies to forge a countries' environment - is key for governments and a priority in the centre of their agenda. The literature suggests that high levels of human capital are likely to determine high economic growth (e.g., by coming up with more innovations). Proxies for human capital are education and health. For instance, expenditures in education or policies promoting lifelong learning (a mix of formal and informal activities that lead to ample knowledge and that occur throughout life). In addition, health contributes to the growth of human capital, and so ultimately, to the economic development of a country/region. Indeed, when citizens are in good health, they can spend their time in productive activities. The aim of the present paper is twofold: to construct an index that allows the comparison of regions of the Visegrad countries considering selected indicators of human capital and economic development and identify clusters of regions based on its components.

Data/Methods

To reach the aim, a composite indicator for each region (NUTS 2) of the Visegrad countries was created. Thereafter, by the means of a clustered analysis, group of regions were identified according to their innovation performance. The data were obtained from EUROSTAT (last update for most of the variables is 2021). The indicator includes proxies of human capital (individuals completed tertiary education and number of beds in the hospital per hundred thousand inhabitants) and innovation. Afterwards, a cluster analysis identified the clusters.

Results/Conclusions/Value added

This paper contributes to the literature of regional economic development. With a single number it is possible to identify which regions of the Visegrad member countries perform better in terms of human capital. It was found that two main different performance groups of regions exist and the *institutions* component is the one discriminating those groups. We advocate for the enhancement of institutional quality in the group composed of eastern Slovakia and eastern Hungary.

Key words

Human capital, economic growth, institutions, regional differences, innovation, Visegrad countries.

JEL classification

030, 034, E24

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1. Introduction

In the late twentieth century, scholars have started to study the role of institutions in economic growth and development, firstly focusing solely on national level, then extending research on regional level. Their importance in shaping a territory and determining economic growth make them critical in a national innovation system. Indeed, institutions influence the ability of economic players to interact in a certain location, impact employment, productivity, and local economic growth, among other economic aspects [34]. Institutions can be categorized in two broad types: regional and national and there exist an interdependence between them as the former are aided or hinder in the establishment of effective regional innovation systems [32]. While national institutions are responsible for governing and regulating the country overall, what North [28] calls "rules of the game", regional ones focus on the specificities of a limited territory. Regional institutions are those that directly condition the innovation performance of their territory being them responsible for regulating learning processes, supporting the formation of mutual trust and facilitating the transmission of knowledge between innovation players, help to provide the framework and incentives that lower transaction costs and increase the viability of economic activity development [32][35].

Those institutions favouring economic growth possess the property of quality and inclusiveness ([32] [36] [18] [40], [41]). They remove obstacles that hinder innovation, progress and simplify the patent registration process, facilitating the dissemination of ideas among researchers, sharing existing knowledge, ensuring property rights enforcement, and decreasing uncertainty for new ventures. Inclusiveness occurs when most of the population participates in economic activities, thus are encouraged to effectively use their abilities and skills [2]. Genuine democracy - example of quality and inclusive institution - is crucial to a nation's ability to flourish [23] and it promotes high levels of innovative activity (e.g.[12]).
Institutional quality can explain the divergent economic trajectories of regions across practically any facet of the economy [36]. Note that simply increasing education and health expenditure is not enough. For example, analysing Sub-Saharan area, Ogundari & Awokuse [29], suggested that quality of education is more relevant than the amount invested in it. Having good institutions is a necessary but not sufficient condition for nurturing human capital. Policies and government's strategies must target ways to retain talents, be appealing to migrants offering favourable conditions like removal of bureaucratic barriers and social egalitarianism (pwC, 2012 cited in [24]). At regional level, several authors have debated that the impact of innovative efforts on regional growth is not "mechanic" but it depends critically on how they interact with a number of local and non-local elements, including the accumulation of human capital [8].

Institutions are basically ideas originated by human capital, which in turn is to some extent stimulated by institutions that shelter intellectual property [17]. Generally, human capital has a strong impact on institutions as it contributes to their development and enhancement [17] as they make up those institutions active in the innovation ecosystem [20]. It plays a critical role to promote economic institutions of better quality [17], is a solid measure of innovation [6] and crucial contributor to a nation's overall growth and innovation [3]. It is viewed as a part of an input that determine the knowledge-based, technological and economic outcome of innovation [26]. According to Diebolt & Hippe [11] and to Kwan & Chiu [24], the accumulation of human capital can lead to an increase in the number of creative goods, knowledge creation, and entrepreneurs and in which would indirectly promote economic development through the direct impact on innovation. Besides, such an accumulation contributes to shaping efficient policies, less violence and more political stability [19].

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Human capital is the set of innate abilities and characteristics that individuals possess and the knowledge and skills acquired, talents, abilities and training [7] [9], it is accumulated over time. Since education is essential to producing the highly trained labor required for job creation, economic growth, and societal and individual success in a knowledge economy, it is frequently seen as a more significant source of human capital accumulation [30]. However, health is a critical component as well because it increases physical and mental capabilities to foster worker productivity: thus, it is a cardinal part of human capital [5]. These dimensions are interrelated. Among various benefits of it, Sianesi and Reenen [38]found that the educational dimension tends to enhance health levels of individuals (cited in [42]). Considering the above and because of its nature, human capital is complex and multidimensional [29] thus a thorough way to measure it would take into account both education and health dimensions. This is known as indicator-based approach and it is the one used to calculate the World Bank's Human Capital Index [1].

2. Data and Methods

The aim of this paper is to emphasize the main differences of regions of the Visegrad countries, namely Czech Republic, Hungary, Poland and Slovakia in terms of human capital development and economic indicators that are determinant for the innovation performance of a region. The choice of choosing these regions is justified. Their countries have similar economies, share a common history and geographic ties. From a total of 37 NUTS 2 regions, we selected 33 regions (Tab.1). The excluded regions were HU11 Budapest, HU12 Pest, PL91 Warszawski stołeczny and PL92 Mazowiecki regionalny due to missing data.

Table 1: NUTS 2 Regions of Visegrad

Poland	**Czechia**	**Hungary**	**Slovakia**
Malopolskie	Praha	Budapest	Bratislavský kraj
Slaskie	Střední Cechy	Pest	Západné Slovensko
Wielkopolskie	Jihozápad	Közép-Dunántúl	Stredné Slovensko
Zachodniopomorskie	Severozápad	Nyugat-Dunántúl	Východné Slovensko
Lubuskie	Severovýchod	Dél-Dunántúl	
Dolnoslaskie	Jihovýchod	Észak-Magyarország	
Opolskie	Střední Morava	Észak-Alföld	
Kujawsko-Pomorskie	Moravskoslezsko	Dél-Alföld	
Warminsko-Mazurskie			
Pomorskie			
Lódzkie			
Swietokrzyskie			
Lubelskie			
Podkarpackie			
Podlaskie			
Warszawski stoleczny			
Mazowiecki regionalny			

Source: authors' elaboration

Considering the RIS report, different innovation performance groups exist within the Visegrad countries, between emerging and moderate type. Thus, using a cluster analysis, we may be able to find diverse clusters and *if* there are groups with similar characteristics, an ANOVA test can detect whether any dimensions of the index statistically differ. Formally:
Hypothesis H1: There will be different clusters of regions with similar characteristics.
In order to achieve the aim and test H1, the proxies of the dimensions of human capital and economic performance were defined. Thus, we firstly normalized the variables to get the same

scale, then we computed the indexes. Differently from a study at national level, many measures are not available at regional level, such as digital skills, which is indirectly calculated at this level (see e.g. [14]) or they are not up to date. As a consequence, the variables that can be used are limited. Examining how human capital contributes to cross-country differences in economic growth needs a measure produced in an equivalent way across countries and over time [26]. EUROSTAT database, Regional Innovation Scoreboard (RIS) and QoG Institute's EU Regional Dataset (EURD) provide harmonized data [27]; hence comparisons can be made. The Regional Innovation Scoreboard (RIS) is an annually published report that relies on a set of 21 indicators capturing regional innovation performance to assess European NUTS 2 regions. EURD is a dataset that quantifies institutional quality at regional level in EU on diverse measures. The variables are reported in Table 2 below. Unless specified, the year for which the variables were analysed is 2021.

Tab. 2: Variables used to construct the index

Variable	Description	Source
Bedsxthou	Available beds in hospitals by NUTS 2 region (every 1000)	EUROSTAT
GERDreg	Gross Domestic expenditure on R&D at NUTS 2 level	EUROSTAT
Lifelonglrn	Participation rate in education and training (last 4 weeks) by NUTS 2 regions	EUROSTAT
Terteduc	Percentage of people that completed tertiary education by NUTS 2 regions	EUROSTAT
acadoutput	Scientific publications among the top-10% most cited publications worldwide as percentage of total scientific publications of the country.	European Com. (2023)
abobadsk	Individuals that have above basic overall digital skills.	European Com. (2023)
GDPmill	Gross Domestic Product (Million Euros)	EUROSTAT
Eqi_score	Final score of European Quality Index calculated for NUTS 2 regions (2017).	QoG
PCTreg	PCT patent applications per billion GDP (in Purchasing Power standards)	European Com. (2023)

Source: authors' elaboration.

Some notes about the choices of the variables.

- *Abobadsk*: the need for digital skills, to be able to "participate actively in the Digital Decade and to reinforce our collective resilience as a society" [13], has become more and more important.
- *Eqi_score*: the latest available figure is 2017. This four-year time lag can allow to see the effects of policies and institutional changes.
- *PCTreg*: Output measure of innovation performance. With patents, the level of innovation can be evaluated [4] and compared.
- *GDPmill*: Regional output, providing indication for production in a region.
- *GERDreg*: R&D yield novel knowledge that enhance an organization's and the nation's overall production [37].
- *Bedsxthou*: proxy for health. It is an appropriate measure because primary deficiencies of hospitals (e.g., delays in emergency room admissions, early patient discharges, early patient transfers from intensive care units, and delays in patient transfers between units) are caused by bed availability ([25], [21] cited in[31]).
- *Terteduc*: proxy for education. Availability of high-skilled workforce with diverse backgrounds aged 25-34.
- *Acadoutput*: proxy for university quality contributing to the human capital.
- *Lifelonglrn*: comprises any kind of learning activities done on an ongoing basis.

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2.1 Construction of the performance index and cluster analysis

In order to construct the index, a common range was calculated for each component. We opted for a 0-100 range. Thus, we summed up together measures representing education (*Lifelonglrn, Acadoutput, Terteduc, Abobadsk*) and innovation performance (*GDPmill, GERDreg, PCTreg*). *Bedsxthou* was the component used as a proxy for health and *Eqi_score* for institutional quality.

This technique is used for the identification of subgroups in a dataset with no need for "a-priori labelling [10]. Before running a k-means clustering, we opted to use a hierarchical method (Ward-distance) to identify the number of groups. Thus, an ANOVA test was conducted.

3. Results and Discussion

With the built index we were able to rank the V4 countries and make some considerations about their innovation performance and the elements favouring it.

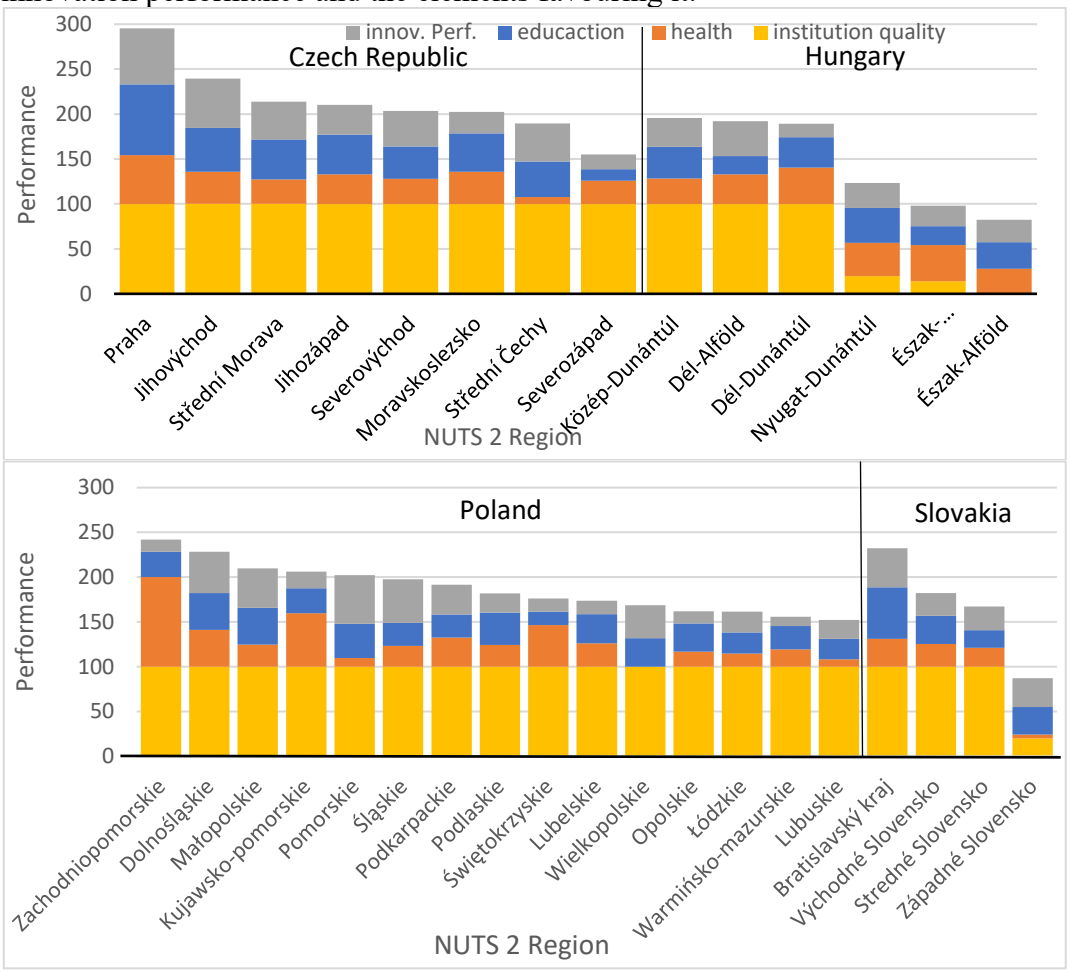

Fig.1: Performance of Visegrad regions
Source: authors' elaboration

Figure 1 presents the indexes calculated for each region and their subcomponents whereas Beginning the discussion with the computed index, it is to highlight that the 75th percentile for the Visegrad regions is 207.85, which implies that only 25% of the regions' index is greater than this threshold and whereby the capital regions, namely Prague (Czechia) and Bratislava (Slovakia) and the close region to Budapest (Hungary) lie. Prague region is the best with respect to the 33 regions for all components as it totals 295.36, a true outlier. The second region is in Poland, namely, Zachodnipomorskie (index = 241.96), the third is Jihovýchod (index = 239.48)

in Czech Republic and the fourth Bratislava with an index of 232.19. In the 25th percentile equal to 161.71 we see that eastern regions of Hungary (Észak-Alföld and Észak-Magyarország) and Slovakia (Západné Slovensko) underperform with respect to the rest of the sample. Their score is below 100.

Analysing the institutional quality component, the scores are similar in the regions, with the exception of Nyugat-Dunántúl, Észak-Magyarország, Észak-Alföld and Západné Slovensko, which is sensibly lower than the average in the sample. We stressed the importance of institutional quality in the introduction. If these institutions are bettered, it is likely that human capital and innovation performance can increase due to their driver to remove obstacles to and improve innovation propensity of a country [2]. The basic policy of the central government must be adjusted by local administrations to the particular requirements of the territory they administer. Resources for structural reforms may come from EU funds. Therefore, it is key to have a more effective bureaucratic structure, thus regional expenditure of EU funds can increase.

For the innovation performance pillar, the top regions are somewhat the same first ranked identified by the overall index with the Czech regions of Praha (62.2) and Jihovýchod (54.8) and the Polish regions of Pomorskie (54.3) and Śląskie (48.74) in top positions. Bratislava region is only the seventh in this pillar. The other Slovak regions surprisingly do not occupy the very last positions among the V4s even though, historically, Bratislava's R&D expenditure (subpillar) is equal to half of the total R&D Slovak expenditure [39]. In the latest places, the majority are Polish: Opolskie, Warmińsko-mazurskie, Lubelskie and Zachodniopomorskie, an unexpectedly modest result for the latter region since all other components are consistent with respect to similar regions, according to the ranking.

Health component varies considerably in Poland with very high values in the region of Zachodniopomorskie and the highest number of beds available among the V4 (1,195) and the lowest number of beds available in the V4 (428.61). Kujawsko-pomorskie (Poland) is the second highest (886.91 of available beds). Last places are occupied Zapadné Slovensko (460.64), Střední Čechy (486.92) and Lubuskie (493.31). The capital regions differ substantially with Prague's beds availability of 844.64 (third among V4) and Bratislava with 668.50 (only 15th). In Hungary and in Czech Republic (except Střední Čechy and Prague), the average number of beds are similar and even Észak-Alföld region has a score close the median number of beds (17th position with 641.93) comparable to Bratislava's.

5 Czech regions occupy the first positions in the education component (at least in top 13). Praha region is the best in education (78.95), while Jihovýchod (48.99), Střední Morava (44.823), Jihozápad (44.14) and Moravskoslezsko (42.79) are the third, fourth and sixth positions among the 33 regions of the sample. To complete the ranking, Bratislava is the second for education (57.53). Other regions ranked in the top positions are Polish Małopolskie (seventh with 41.1) Dolnośląskie (eighth with 40.9) and the Hungarian Nyugat-Dunántúl (38.78). In last positions we found several regions from Hungary: Severozápad with a modest 12.63 (33rd) and Dél-Alföld (20.54: 30th). Stredné Slovensko is 31st (19.58) and Polish region of Świętokrzyskie (14.88: 32nd). Lastly, differently from other components, in Slovakia great differences were found between Bratislava and central Slovakia (Východné Slovensko), not with the east (Západné Slovensko is 20th in the general rank and third in Slovakia). There is a need for reforms of the school system aimed at providing advanced digital skills and improving lifelong learning figures by the governments in those lagging regions.

Figure 2 shows the results of the hierarchical clustering method. We found two main broad groups. The regions of Západné Slovensko, Észak-Alföld, Nyugat-Dunántúl and Észak-Magyarország belong to a different cluster than the rest of the V4 regions.

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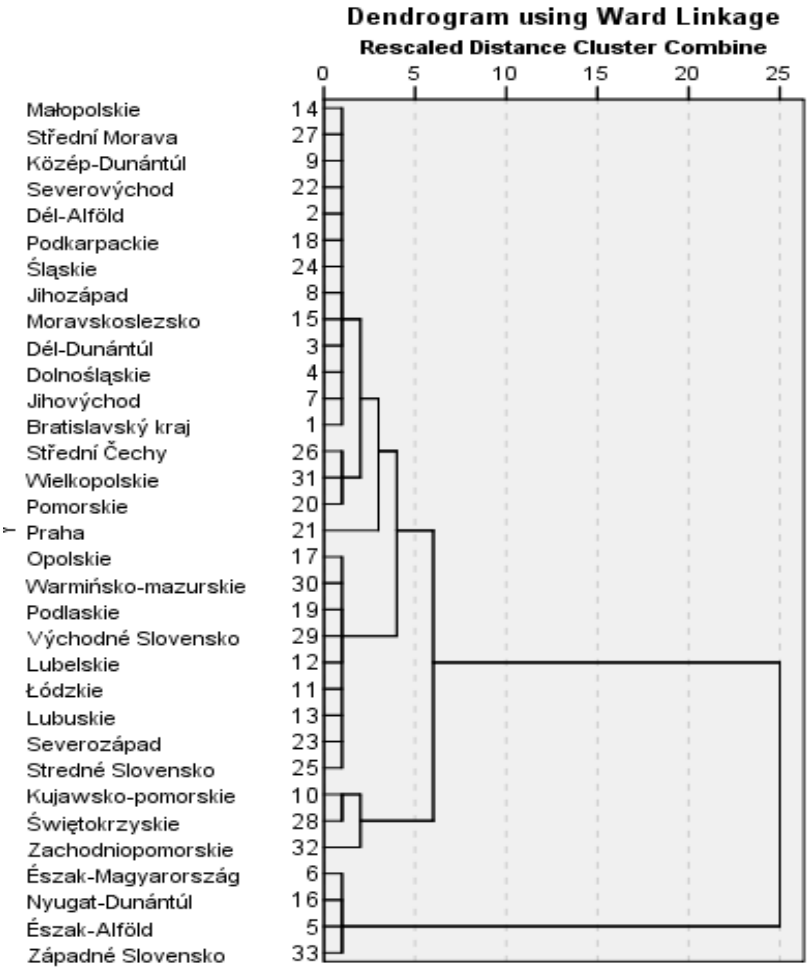

Fig. 2: Hierarchical analysis: deandrogram
Source: Authors' elaboration

In the k-means analysis, an ANOVA test was able to identify institutions as the only statistically significant dissimilar component (sig. .000 less than p-value of .05). According to this result, we should not reject the hypothesis H1: there are different groups of regions according to their diverse performance. Particularly, the discriminant component is institutions.

As we observed, regional discrepancies exist, particularly between the underperforming regions of eastern Slovakia and eastern Hungary and the other regions of the V4. Such discrepancy is persistent and widening [22], raising concerns on the measures and policies until now enacted by the Slovak and Hungarian governments. In 2023, as the latest RIS report shows, improvements are still required and disparities hold with a mixed performance among the V4. *Catching-up region initiative* in Slovakia (to know more [43]) and *Territorial and Settlement Development Operational Programme Plus* (TOP Plus) in Hungary (see [16] can financially aid the countries to reduce the gap between regions and contribute to their development. Moreover and more in general in the Visegrad, we advocate for an integrated planning at regional level, such that a systematic process can be ensured thus encouraging the proactive participation of regional stakeholders.

4. Conclusion

This article stressed the importance of human capital (health and education), innovation related indicators (patents, GDP and GERD expenditure) and the institutional quality to the innovation performance and economic growth of a region (or country). The scope of the analysis was the regional NUTS 2 of Visegrad countries. Capital regions and in particular Prague region outperform the other regions as the constructed index suggests. Regions of Západné Slovensko, Észak-Alföld, Nyugat-Dunántúl and Észak-Magyarország lag behind the rest of the sample especially in terms of health infrastructure and institutional quality. The latter was confirmed to be a significant component in determining such performance variations with ANOVA test. Persistent regional gaps require targeted policies and initiatives, such as catch-up region initiatives and integrated planning, to address discrepancies and foster balanced development across the Visegrad countries.

This study presents some limitations for several objective and subjective drawbacks of the methodology used. Aggregation bias and particularly the lack of weights for building the index can lead to oversimplification and to influenced conclusions by certain components. In addition, the index may rank the regions differently using diverse measures. For what regards the cluster analysis, the main drawback is subjectivity: how many clusters should be included? Thus, future research can include more clusters in the k-means analysis.

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Gold and Inflation: a Critical Examination of Wealth Preservation by Investing in Gold

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Abstract

Paper's objective(s) and research background

This article discusses the relationship between Slovakia's inflation rate and the market price of gold. Almost 23-year span is examined, starting from January 2000 and ending on August 2023. The paper points to gold's capacity to protect wealth against inflation-related asset depreciation.

Data/Methods

Numerous parameters, including the average yearly return and the difference in the Slovak currency's purchasing power, were computed in order to get at the results. Additionally, correlation analysis was applied. The World Bank and the Slovak Republic's Statistical Office's websites provided the data.

Results/Conclusions/Value added

A very weak but statistically significant indirect correlation is shown between Slovakia's inflation rate and gold prices (value of -0.18), and strong indirect correlation (value of -0.845) between the market price of gold and the buying power of the national currency. Throughout the examined time, Slovakia's average annual inflation rate was just 4.23%, but the average arithmetic annual return for gold was 9.71%. Based on these findings as well, it is feasible to claim that gold in Slovakia during the past two decades has successfully served as an inflation hedge and contributed to the preservation of wealth.

Key words

Gold, inflation, investing

JEL Classification

E22; E31; G11

1. Introduction

One of the most well-known metals in the world is gold. It has been utilized for ages by people as a tool for pricing and value storage. This might be one of the reasons, why many authors and investors believe it to be among safe investments in the long term (Kral & Olszanska, 2020; Fauzi, et al., 2017; Zhu, 2019). Some authors even claim that in order to reduce the risk, it is advisable to diversify portfolio with other precious metals such as silver and platinum (Akhtaruzzaman, et al., 2024).

The high rate of inflation represents a large-scale problem, not only for the individual but also for the entire economy (Iyke & Ho, 2019). The fundamental characteristic of an inflation-hedging asset ought to be the relationship between its market value and inflation. Naturally, price fluctuations might cause reactions to lag behind inflation, which could drastically lower correlation coefficient estimates. For this reason, multiple correlations with the shift of various time series and graphic analysis will be used. Since many investors are of the opinion that gold

will protect funds only in the long term, a period of more than 20 years will be analyzed and returns will be compared with inflation.

In this paper, we seek to confirm the safety of gold investments in terms of their capacity to protect assets against inflation-related depreciation. An often overlooked fact is that inflation is not the same problem everywhere on earth, so people in different parts of the world will need protection against inflation to different degrees. In some parts of the world, investors invest more, for example, in protection against natural disasters (Chamrada, 2023). Unlike previous research, in this work we analyze the connection between the price of gold and inflation in Slovakia, therefore the results are mainly aimed at Slovak investors.

This article is divided into the following parts: in the literature review part, the reader can familiarize himself with important works dealing with related issues, in the data and methods part, data sources are listed, the methods used are described, and in the results and discussion part, the results of the work are analyzed and compared with the results of other authors, and the summary section summarizes the results of this article, describes its weaknesses and suggests future research.

1.1 Literature review

Throughout the 20th century, articles on gold and investing had previously been written. Frankel (1935), who detailed a potential 1907 investment in a gold mining business in the Witwatersrand mountain region of southern Africa, wrote one of the first and most significant studies in the field. Articles from this era focused more on investing in businesses, such gold mining, than they did on investing in gold as a whole. Later on, though, things were different. Important publications that addressed investing directly in gold as a commodity started to appear gradually (Lyon et al., 1953; Barker, 1974; Lehmannhaupt, 1976). At the same time, these investments started to be contrasted with stock investments. The fact that it was illegal to possess or invest in gold in many areas of the world throughout the 20th century is one of the reasons why there haven't been many publications regarding gold investment as such.

Many authors are currently writing about gold investment. Baur et al. (2020) compared the applications of fundamental investment strategies like buy and hold or market timing. The analysis was done over a 20-year period because gold investment is advised to be done over the long term. Lei and his co-authors (2023) conducted a recent investigation into investing in precious metals as a safe haven for Environmental, Social, and Governance (ESG) stocks. Through the use of precious metals in the portfolio, the work offers potential strategies for lowering risk. Potrykus (2023) has recently written a substantial work on the search for price bubbles in the market. Author used the GSADF test to determine the periods defined as price bubbles in the three markets studied, i. e. the investment wine market, precious metal market and national stock market indices of G-7 countries. The results obtained enabled the calculation of the values of the phi correlation coefficients, which served the research objective of assessing the co-occurrence of price bubbles in the markets analysed. The research period adopted in the study was December 2003 to March 2022, and the data were examined at a monthly frequency. Again, the analyzed period was in the range of approximately 20 years.

Abaidoo et al. (2022) discussed the relationship between inflation and commodities prices. They examined inflation in emerging economies over a 20-year period using panel data, and they discovered positive associations between inflation and a number of commodities. To examine the link between the price of gold and the rate of inflation and ascertain how responsively the inflation rate is to shocks in the price of gold, Oloko et al. (2021) created the Fractional Cointegrating Vector Autoregressive (FCVAR) model. Their analyses were conducted between January 2001 and December 2019. The authors have taken into

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consideration the phenomenon of nation heterogeneity, which arises from differences in a country's income, development, and monetary policy framework. Their findings imply that the impact of the gold price shock has a long-lasting effect on developing nations' inflation rates and a brief influence on developed countries' inflation rates. Throughout the past decade, the idea of "digital gold"—which is most frequently associated with Bitcoin, the most well-known cryptocurrency at the moment—has gained prominence. About the relationship between digital gold and inflation, or the similarities between Bitcoin and gold, multiple authors have written interesting articles (Blau, et al. 2021; Matkovskyy & Jalan, 2021; Smales, 2023).

2. Data and Methods

This paper endeavors to verify the relationship between inflation and gold's market price as well as assess gold's capability of securing assets from inflation-induced depreciation. The findings of our analyses, which were conducted on the Slovak market, are especially meant for Slovak investors who are thinking about diversifying their portfolio with precious metals—typically gold—in order to preserve their assets. It is important to remember that, even though the eurozone's member states share a single currency, the rates of inflation vary among them. Belas & Rahman (2023) also pointed out possible differences in risks resulting from differences in countries. Because of this, we cannot anticipate a strong correlation between Slovakia's inflation and the price of gold, which is unified worldwide. Instead, it will be crucial to confirm whether the correlation that has been shown is random or statistically significant.

The analysis period ranges from January 2000 to August 2023, which is the latest data accessible at the time the work was written. A relatively large period of time is analyzed, which can capture long-term effects, but it should not be forgotten that markets are dynamic and changes in prices can also be due to factors with short-term effects, which can be difficult to detect in long-term analysis (Kliestik, 2023). Data on inflation were obtained from the website of the Statistical Office of the Slovak Republic (2024). The data includes monthly values of the annual inflation rate in Slovakia. Monthly data on gold market prices in USD per one troy ounce were obtained from the World Bank website (2023), from which other characteristics were subsequently calculated, such as annual arithmetic returns, average and median prices, and others.

To estimate the findings and perhaps even verify any errors in the data, it is important to look at the graphs showing the development of the variables throughout the monitored period even before beginning the actual investigation. Figures 1 and 2 show the development of the market price of gold and the year-on-year inflation rate on a monthly basis in Slovakia during the monitored period.

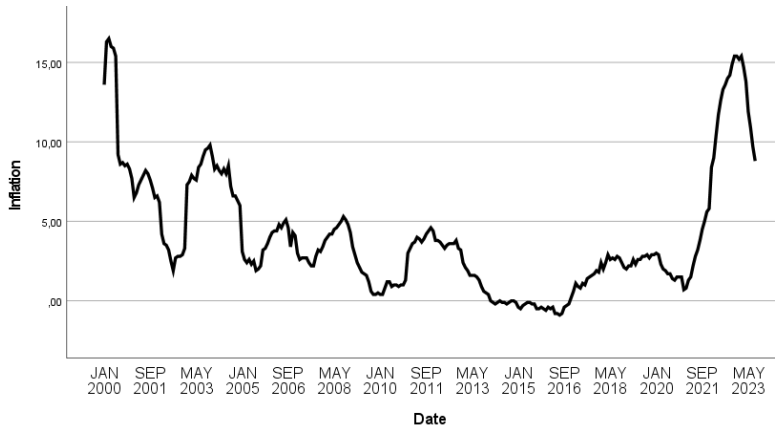

Figure 1: Annual inflation rate in Slovakia.
Source: own elaboration, based on Statistical Office of the Slovak Republic (2024).

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Figure 2: Development of market price of gold
Source: own elaboration based on World Bank (2023).

The data show that inflation is very variable over time, making it challenging to identify trends. Due to two notable spikes at the beginning and end of the observed period it appears to be slightly declining, but this is not entirely evident. In contrast, there have only been a few minor declines in the price of gold, which is largely on an upward trend. Initial research has already made it evident that there is unlikely to be a significant connection between the variables, however, an indirect and weak correlation (one variable tends to rise while the other declines slightly over time) may be predicted. For gold investors, this is not a particularly satisfying conclusion because increasing the market price during an inflationary period is required to safeguard the property against inflation. Correlations were also computed for the gold variables delayed in time by 1, 2, 3, 6, 12 and 24 months, as the reaction to a change in the price of gold that might lag after a change in the inflation rate.
Based on the results of this analysis, we decided to expand the correlation analysis, while we also analyzed the correlations between the purchasing power of the currency in Slovakia and the price of gold. January 2000 was chosen as the starting year, when the original analysis began. Subsequently, the purchasing power of the Slovak currency was always recalculated as of January of the following year based on the respective value of interannual inflation and the previous value of the purchasing power of the currency. With this procedure, we came to the fact that in January 2023, the Slovak currency had only 42.8% of its original purchasing power from January 2000.

The purchasing power of the currency was calculated according to the following formula:

$$PP_t = \frac{PP_{t-1}}{1+I} \quad (1)$$

Where:

- PP = purchasing power
- I = inflation rate

3. Results and Discussion

The results of all correlation analyzes even with a lag of gold values are shown in the following table.

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Pearson Correlation	Inflation	Gold	Gold Lag 2	Gold Lag 3	Gold Lag 6	Gold Lag 12	Gold Lag 24
Inflation	1	-.175**	-.152*	-.138*	-0.097	-0.05	-0.019
Purchasing power	-	-.845**	-	-	-	-	-

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Source: own elaboration.

The results of the correlation analysis confirmed a statistically significant indirect dependence at the 1% level of significance. Although the correlation between gold prices and inflation was very weak (the strongest correlation had a Pearson coefficient value of -0.18), this result confirmed that the connection is not random. We thus made the decision to investigate the relationship between the price of gold and the purchasing power of the currency in Slovakia. One additional intriguing feature can be noticed in Figure 1, despite the fact that the inflation trend is a bit challenging to identify due to its values being quite unpredictable. Only very briefly did inflation numbers drop to negative numbers. If we were to examine the development of the euro's purchasing power in Slovakia, we would undoubtedly observe a downward-trending curve.

A correlation analysis between the yearly market prices of gold and the purchasing power of the Slovak currency for each year was then conducted. The results indicated that the correlation coefficient was -0.845. The statistical significance of this result at the 1% significance level attests to the systematic rather than random nature of this connection. This indirect relationship is really strong. Based on this outcome, we may conclude that throughout the past 23 years, Slovakia has verified the idea that the price of gold increases as the value of the currency decreases, thereby serving as a reliable inflation hedge. Simultaneously, the average annual rate of inflation may be compared, revealing a value of 4.23%, while the average arithmetic annual return of the market price of gold throughout the examined period was 9.71%.

Carpantier (2021) carried out comparable research. However, he examined the stability of gold's purchasing power in his studies. Gold's increasing market price at times of higher inflation contributes to its relatively steady buying power. In contrast, the author of this article examines the buying power of several commodities and discovers more favourable options than gold. Ghazali et al. (2015) looked for a link between gold prices and inflation in Malaysia. Considering the subject of the analysis, they chose a relatively short period, about 10 years, since most analyses of a similar type have a scope of around 20 years. In their work, they found no significant correlation between inflation and the price of gold. In our work, the connection was statistically significant, but the coefficient indicated a very weak indirect connection. More interesting results were achieved only after replacing the variable inflation with the variable purchasing power of the currency. The reason may be that inflation may show relatively stable values, for example around 4%, but the purchasing power of the currency will have a downward trend all the time. Reboredo (2013) came up with an interesting and substantial result, supplementing our results, who investigated whether gold can compensate for inflation caused by rising energy prices, especially oil. He found that with inflation caused precisely by the rise in oil prices, gold does not effectively perform the role of a protector against asset depreciation. It is important to keep this fact in mind when investing in gold. However, according to Mititean & Sărmaș (2023) and Balcerzak et al. (2023) the market prices of energy and energy commodities are influenced by many institutions to a greater extent than in the case of precious metals, which can bring opportunities but also risks. We therefore recommend diversifying

your portfolio not only with precious metals but also with commodities such as oil. The link between the price of gold and inflation throughout various time periods was compared by Xu et al. (2021). They noted changes over time as they examined the relationship between the factors throughout time spans ranging from one month to fifteen years. In our work, we did not perform analysis with different time scales, only delayed values of the gold price were tested, but they did not show a higher correlation with inflation. In order to guard against inflation, we advise long-term investments in gold as it retains its buying value over time. However, because gold carries a larger risk in the short run, speculative investments may benefit more from it.

4. Conclusion

We examined gold's capacity to protect wealth against inflation-induced depreciation in this article. An analysis was conducted covering nearly 23 years, from January 2000 to August 2023. Because the gold prices were examined in light of Slovakia's inflation and price developments, the conclusions are primarily targeted at Slovak investors. Therefore, the outcome may differ for various nations. We discovered a very strong indirect correlation between the market price of gold and the purchasing power of the Slovakian currency, as well as a very weak but statistically significant correlation between Slovakia's inflation and gold prices. The results of this research are beneficial primarily for investors in Slovakia, but also for ordinary people who are considering wealth protection by investing in gold.

The study's drawback is that it just accounts for Slovakia's inflation, which means that its findings might not apply to other countries. It also does not make reference to various conditions at various times. Not to mention, the research's shortcoming is that it merely relied on the "buy and hold" concept without accounting for the timing of gold purchases or sales. The research's limitations also offer ideas for further investigation. – e.g. geographic expansion of the analysis, expansion or shortening of the analyzed period, creation of a prediction model of price development.

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The Impact of the Military Conflict in Ukraine on Slovak Agrifood Trade

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Abstract

Paper's objective(s) and research background: The article aims to assess the effects of the war in Ukraine on the Slovak agrifood trade. The war in Ukraine is associated with several macroeconomic consequences for Slovakia and other countries in agritrade. Many entities in the agri-food sector are affected by this impact. The active involvement of the Slovak Republic was reflected in a massive increase in the value of agricultural imports from Ukraine, while our agricultural exports increased much more moderately.

Data/Methods: In the contribution, we used the classification of the Ministry of Agriculture and Rural Development of the Slovak Republic, which defines agri-food foreign trade as the sum of the first 24 chapters of the customs nomenclature. Data on agri-food foreign trade and data on the production of selected agricultural commodities in the Slovak Republic for 2016 - 2023 were used from databases published by Eurostat. We used the Lafay index to evaluate the competitiveness of Slovak agri-food products in the Ukrainian market.

Results/Conclusions/Value added: In our contribution, we focused on the extent to which imports from Ukraine limited the sale of Slovak cereals and oilseeds and, at the same time, the extent to which the income of Slovak farmers was negatively affected due to the drop in prices of agricultural commodities. The European Union actively assisted with the sale of Ukrainian agricultural commodities. Corridors through the Danube and railway corridors through Slovakia, Poland, and Hungary were opened. The import of cheaper cereals and oilseeds, further strengthened by the exemption of imports from import duties, gradually increased the protests of our farmers against these imports. These protests resulted in a ban on importing Ukrainian grain and oilseeds from Ukraine to Slovakia from May 2023. The main argument was that cheap imports from Ukraine limit sales of Slovak agricultural commodities on domestic and foreign markets. The analysis proved that imports from Ukraine did not threaten Slovak producers of agricultural commodities.

Keywords

agrifood trade, grain, oilseeds, export, import, price

JEL Classification

E60, F10, F15

1. Introduction

The employment in agriculture has shortened from 26 % to 12 % for the period of 1999-2021 but at the same time value added by agrarians raised to 17454 mln USD from 4668 mln USD. Reduction of livestock from 1990 to 2021 was combined with rise of some kinds of its production. The number of animals in total in 1990 year equaled to 37 mln heads and in 2021 year it was 8.4 mln heads. Meat in slaughter weight accounted as 115 kg from head in 1990 and 274 kg from head in 2021 year. Considering that at the beginning of studied period the number of cows was 8.5 mln heads and to the end it slumped to 1.5 mln head, volume of milk changed tendency from 2.9 to 5.2 ton from one cow. As a result, Ukraine increased export of

agriculture production. Thus, in 1999 the fraction of food in merchandise export was on the level of 12 % but in 2021 it soared to 40 %. (Dmytriieva & Sviatets, 2023).

The authors analysed the export structure of Ukraine for 2022 and found that the second position in the structure was sunflower oil. The next positions are com and wheat. A significant share of exports was food and agricultural products - $28 billion. The military events in Ukraine in 2022 disrupted the supply chains of agricultural products, both to the EU countries and the countries of the world, which caused to some extent the crisis phenomena of the world economy and the rise in prices of critical consumer goods. That is, to summarize, considering the statistics of Ukraine for the year 2022, the main trading partners were the EU countries. (Buiak, Harmatiy, Fedyshyn & Pryshliak, 2023).

The war in Ukraine exposed another apparent flaw of the current form of globalization: geopolitical instability and the strategic dependence on specific countries with uncertain diplomatic stances. Rather than just on GVC resilience in general, the focus was now also explicitly on some critical inputs and raw materials sourced from one or very few countries, and on technological leadership. (Giovannetti, Marvasi & Ricchiuti, 2023)

Research showed that although this conflict will affect the majority of the economies, however, the most affected economies are in Europe and Africa. It is advisable for these adversely affected economies to explore and find alternative food supply chain partners and solutions in other regions of the world (Jagtap et al., 2022).

Results indicate a major re-direction of trade towards the EU and away from Russia in the years preceding the 2022 Russian Invasion. Ukrainian export shares of agro-food and manufacturing products to the EU have grown by approximately 104% and 84%, respectively, since 2014. Over the same period, export shares of these products to Russia fell by 93% and 55%. Long-term redirect ion of trade requires exporters in Ukraine to find new buyers for their goods and requires Ukrainian buyers to identify new sellers for their imports. For example, the redirection of trade to the EU in the agro-food, manufacturing and ‘other goods' export sectors may signal that Ukraine had already become more resilient to Russian retaliatory measures. Reforms may incentivise and facilitate new investments in agriculture and other sectors, potentially increasing output and bringing more goods into compliance with EU regulations and standards. (Boyko, Nes & Schaefer, 2023).

The implementation of the Association Agreement did not have a significant downward impact on domestic prices for agri-food products in Ukraine. The lowering of the tariff protection of the domestic market did not significantly influence the domestic production of agri-food products, which remained stable, except for the production of grape wines, which decreased during 2016-2020. Due to the implementation of the Association Agreement, the EU has increased its share in the import of agri-food products to Ukraine. However, for some commodity groups, there was both an absolute and relative decrease in imports. This happened due to competition from other importers, as well as due to import substitution processes (Ostashko et al., 2022).

We found that the EU-Ukraine “deep” trade agenda is marked by medium effectiveness, with strongest concerns, attributed to corruption, weak rule of law and strong oligarchic influence. Although the EU-Ukraine trade liberalization led to the notable increase in the EU’s share in both Ukrainian exports and imports. Ukraine still suffers from negative economic externalities due to the abrupt reorientation from the Russia’s and CIS countries’ markets to the Western ones. Alongside this, the weaknesses in trade terms include low levels of Ukraine’s services’ exports to the EU and EU-Ukraine investment cooperation. In political terms, the “deep” trade agenda expectedly boosted EU’s trade power in Ukraine, yet it is still prone to uncertainties,

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such as Russia's multiaspect pressure on Ukraine, the persistence of frequently informal Ukraine-Russia bilateral links and the unclear future of the EaP (Rabinovych, 2022).

2. Data and Methods

Our article aims to evaluate the effects of the war conflict in Ukraine on the development of mutual agri-food foreign trade between the Slovak Republic and Ukraine. In the contribution, we used the classification of the Ministry of Agriculture and Rural Development of the Slovak Republic (MPRV SR, 2023), which defines agri-food foreign trade as the sum of the first 24 chapters of the customs nomenclature (HS 01-24). Data on agri-food foreign trade and the production of selected agricultural commodities in the Slovak Republic for 2016 - 2023 were used from databases published by Eurostat (Eurostat, 2024; Eurostat, 2024a). To evaluate the competitiveness of Slovak agri-food products in the Ukrainian market, we used the Lafay index (LFI) (Lafay, 1992).

$$LFI_j^i = \frac{X_j^i - M_j^i}{X_j^i + M_j^i} - \frac{\sum_{j=1}^{N}(X_j^i - M_j^i)}{\sum_{j=1}^{N}(X_j^i + M_j^i)} * \frac{X_j^i + M_j^i}{\sum_{j=1}^{N}(X_j^i + M_j^i)} * 100 \quad (1)$$

where:
Xij - export of country "i" in commodity group "j"
Mij - import of country "i" in commodity group "j"
N - number of analysed commodity groups,
whereas the sum of the LFI index for all analysed commodity groups is equal to zero,

$$\sum_{j=1}^{N} LFI_j^i = 0. \quad (2)$$

- A positive LFI index indicates the comparative advantage of a commodity or commodity aggregation.
- A negative value of the LFI index signals that specialisation and, therefore, a comparative advantage do not exist (Zaghini, 2005).

3. Results and Discussion

The unleashing of Russia's military aggression against Ukraine in February 2022 significantly destabilized the world markets for agricultural commodities, as both warring parties are among the world's leading exporters, mainly cereals and oilseeds. The blockade of shipping in the Black Sea at the beginning of the war made exporting agricultural commodities from Ukraine to the Middle East and North African countries impossible. The European Union tried not only to avert the impending famine by diplomatic means but also by opening corridors for shipping along the Danube and by strengthening rail transport through Slovakia, Poland, and Hungary. To simplify the transit of Ukrainian agricultural commodities further to third countries, the European Union exempted these imports from import duties. Duty-free imports reduced the import price of cereals and oilseeds from Ukraine even more significantly, and business entities used them in the European Union member countries to import them to the EU common market. Against importing cheap commodities from Ukraine, especially in EU member countries in Eastern Europe, a wave of protests arose from farmers who could not compete with such imports on price. As a result of protests by farmers in Slovakia, the government of the Slovak Republic in April 2023 approved a ban on importing selected agri-food products, mainly cereals and oilseeds, from Ukraine (MPRV SR, 2023a). In the fall of 2023, the government of

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the Slovak Republic once again extended and expanded the ban on importing food from Ukraine to include natural honey, wheat flour, malt, sugar and breadcrumbs (MPRV SR, 2023b).

Table 1: Slovak agri-food import from Ukraine (in th. EUR)

Code	Item name	2016	2017	2018	2019	2020	2021	2022	2023
01	live animals	0	1	0	0	0	0	21	0
02	meat and edible meat offal	895	11 041	17 946	10 384	591	1 046	0	34 682
03	fish and shellfish	0	0	0	0	0	174	300	400
04	milk, eggs, honey, and products	1 197	765	735	1 299	1 551	1 861	3 794	780
05	products of animal origin	10	12	20	7	7	0	0	5
06	live plants and floricultural products	0	0	44	66	49	60	36	66
07	edible vegetables, roots, and tubers	6	45	89	102	181	43	292	270
08	edible fruits and nuts	564	1 109	378	579	827	1 142	419	821
09	coffee, tea, and spices	0	0	0	0	10	3	3	51
10	grain	95	9	8	1 117	541	137	126 640	72 040
11	mill products, malt, starches	106	1 208	657	373	58	821	912	1 902
12	oil seeds and fruits, straw, fodder	449	789	818	1 241	1 702	2 021	97 901	22 386
13	shellac, rubber, resin	0	0	3	3	1	1	0	0
14	vegetable knitting materials	6	4	8	0	0	2	135	45
15	animal and vegetable fats	1 309	2 851	3 505	2 561	4 905	14 055	15 249	12 399
16	meat and fish preparations	2	0	0	33	0	4	0	200
17	sugar and confectionery	0	14	36	87	69	96	1 016	1 453
18	cocoa and cocoa preparations	54	20	1	281	521	646	110	3
19	preparations of cereals, milk	47	239	1 464	456	452	1 112	754	1 545
20	preparat. of vegetables, fruits, plants	30	41	74	99	65	1	0	95
21	various food preparations	21	13	254	465	661	497	186	381
22	drinks, spirits, and vinegar	20	77	291	43	1 865	10 129	5 034	8 510
23	residues and waste, feed	39	8	5	86	6	56	459	2 669
24	tobacco, substitutes	0	0	11	7	0	0	0	0
01-24	agri-food products	4 849	18 245	26 348	19 288	14 064	33 906	253 263	160 705

Source: Eurostat (2024), own calculation

Table 1 shows the enormous increase in the value of imports of agri-food products from Ukraine to Slovakia. The value of imports grew continuously. From 2016 to 2021, the value of agri-food imports increased sixfold (+699.2%). During this period, our imports consisted mainly of fats and oils, beverages, meat, and offal. As a result of Russia's military aggression in Ukraine, the value of Slovak imports of agricultural and food products from Ukraine increased year-on-year in 2022 by up to 219.4 million. EUR, i.e. by 747.0%. The commodity structure of imports has also changed radically. In 2022, up to 50.0% of total agricultural imports were cereals, mainly wheat and corn, another 38.7% were oilseeds, mainly sunflower, and 6.0% were fats and oils, mainly sunflower oil. The ban on the import of cereals and oilseeds from May 2023 caused a year-on-year to decrease in the value of agricultural imports in 2023 by up to 92.6 million. EUR, i.e. by 36.5%. Despite the ban on imports, in the first 4 months of 2023, cereals and oilseeds were imported to us for a total of 94.4 million. EUR, which represents 58.8. % of total agricultural imports for the entire year 2023. During the year 2023, the import of cereals and oilseeds was replaced to a significant extent by the import of meat and offal.

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Table 2: Slovak agri-food export to Ukraine (in th. EUR)

Code	Item name	2016	2017	2018	2019	2020	2021	2022	2023
01	live animals	1 092	431	923	629	1 300	2 803	2 813	2 614
02	meat and edible meat offal	16	43	55	134	7	62	83	143
03	fish and shellfish	0	0	0	0	45	14	0	0
04	milk, eggs, honey, and products	4 164	4 177	4 384	7 528	9 866	4 117	2 926	4 420
05	products of animal origin	0	0	0	0	0	0	0	5
06	live plants and floricultural products	0	11	3	9	7	20	0	4
07	edible vegetables, roots, and tubers	18	1	11	258	14	46	117	13
08	edible fruits and nuts	1 552	1 694	372	36	31	59	807	315
09	coffee, tea, and spices	0	16	20	107	157	60	53	1
10	grain	102	18	42	25	0	104	56	114
11	mill products, malt, starches	110	110	120	154	105	194	325	1 125
12	oil seeds and fruits, straw, fodder	31	158	220	187	161	318	307	349
13	shellac, rubber, resin	0	0	0	0	9	35	2	1
14	vegetable knitting materials	0	0	0	0	0	0	0	0
15	animal and vegetable fats	302	627	289	250	246	370	479	130
16	meat and fish preparations	82	92	57	110	5	0	215	0
17	sugar and confectionery	170	287	185	354	307	503	225	155
18	cocoa and cocoa preparations	38	37	95	162	482	676	470	407
19	preparations of cereals, milk	468	695	821	1 413	2 205	905	448	734
20	preparat. of vegetables, fruits, plants	114	177	154	154	166	156	430	365
21	various food preparations	2 160	1 948	1 923	2 274	1 860	2 814	8 749	11 923
22	drinks, spirits, and vinegar	3 854	6 518	2 797	2 012	4 716	6 362	7 029	10 030
23	residues and waste, feed	37	25	33	38	86	65	74	113
24	tobacco, substitutes	11	28	36	28	41	19	44	134
01-24	agri-food products	14 321	17 095	12 541	15 862	21 814	19 703	25 653	33 095

Source: Eurostat (2024), own calculation

Slovak agri-food exports show the same growing trend but significantly lower dynamics (Table 2). In 2021, we exported agri-food products to Ukraine with a total value of 19.7 million. EUR, i.e. by 5.4 million EUR (+37.6%) more than in 2016. Beverages, dairy products, other food products and live animals dominated the commodity structure. The commodity structure of our exports did not change even during the war conflict in Ukraine, but the value of exports gradually increased. In 2022, the Slovak agricultural and food product exports to Ukraine reached 25.7 million. EUR (30.2% more year-on-year) and in 2023 even up to 33.1 million. EUR (year-on-year increase of 29.0%). In 2023, other food products comprised 36.0% of the total export value, beverages 30.3. %, dairy products 13.4% and live animals 7.9%.

The Lafay index reveals the influence of the different growth dynamics of the value of exports and imports on the development of the comparative advantages of the Slovak Republic vis-à-vis Ukraine (Table 3). In 2022 and 2023, our comparative disadvantage against Ukrainian grain increased dramatically. We also note a similar, although not as dramatic, increase in our comparative disadvantage with oilseeds. On the contrary, we have seen a paradoxically significant reduction in our comparative disadvantage in the recent case of fats and oils.

Table 3: Lafay's index for the most imported product groups from Ukraine to Slovakia

Code	Item name	2016	2017	2018	2019	2020	2021	2022	2023
10	grain	-0.472	0.030	0.133	-2.792	-1.833	0.057	-8.315	-12.598
12	oil seeds and fruits	-3.416	-1.697	-0.592	-2.604	-5.417	-2.020	-6.257	-3.646
15	animal and veget. fats	-9.402	-5.974	-4.806	-5.795	-16.085	-18.399	-0.693	-2.074

Source: Eurostat (2024), own calculation

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The significant increase in the volume of imports from Ukraine can also be demonstrated by its share in the total agricultural imports of the Slovak Republic (Table 4). Until 2021, cereal imports from Ukraine to Slovakia represented a maximum of 2% of our total imports. However, its share has increased to almost 60% in the past two years, or 50%. This means that grain from Ukraine replaced their import from EU member countries to a significant extent. We are also observing a similar development in oilseeds. Until 2021, practically no oilseeds were imported from Ukraine to Slovakia. However, in 2022, they already accounted for almost 70% of our total imports and in 2023, despite the ban on their import since May, almost 33%. Regarding fats and oils, the share of Ukraine in their total import is not so dramatic and is at 4%. This is due to our low level of self-sufficiency and the related dependence on importing vegetable and animal fats and oils from abroad.

Table 4: The share of imports from Ukraine of selected commodity groups in their total imports into the Slovak Republic (in %)

Code	Item name	2016	2017	2018	2019	2020	2021	2022	2023
10	grain	0.25	0.02	0.01	2.19	1.74	0.18	58.31	49.28
12	oil seeds and fruits	0.36	0.65	0.56	1.40	1.24	0.95	69.31	32.89
15	animal and veget. fats	0.73	2.02	2.34	1.91	3.09	5.59	3.60	4.44

Source: Eurostat (2024), own calculation

The main argument for imposing a ban on importing cereals and oilseeds from Ukraine to Slovakia was that it significantly limits the sale of our products on the domestic market and the common EU market. Table 5 shows the share of import and export volume of selected commodities in their total production in the Slovak Republic. Until 2021, the volume of wheat imports was 1% of the total domestic production. In 2022, thanks to wheat from Ukraine, the share of imports increased to 4.3%, and in 2023, it reached 2.0% of our domestic production.

Table : The share of import and export of selected agricultural commodities in their total production in the Slovak Republic (in %)

		2016	2017	2018	2019	2020	2021	2022	2023
wheat	import	0.63	1.43	1.18	1.65	0.74	0.78	4.31	1.99
	export	60.69	63.21	48.08	42.91	59.58	58.03	58.71	63.64
maize	import	6.94	8.75	10.64	6.34	5.41	9.58	88.98	43.39
	export	19.78	56.74	21.23	27.81	37.67	37.07	164.13	54.57
rape seeds	import	16.97	17.35	11.54	4.69	2.08	8.28	29.03	8.58
	export	45.43	43.95	58.36	57.52	49.82	61.14	61.76	61.56
sunflower seed	import	13.50	19.35	20.98	39.98	31.33	22.75	27.70	26.88
	export	3.28	5.90	6.46	12.26	8.09	15.59	8.45	8.46

Source: Eurostat (2024; 2024a), own calculation

Despite the mentioned increase, importing wheat from Ukraine did not limit the sale of Slovak wheat on the domestic market. It is evident from the share of wheat export volume in domestic production that wheat imports from Ukraine did not limit our wheat sales abroad. On the contrary, it slightly accelerated our wheat export abroad. A similar situation exists in the development of the Slovak corn trade. The extreme values in 2022 are due to low production due to drought. For this reason, the import of corn from Ukraine enabled us to eliminate the shortfall of domestic production and, at the same time, supported our exports abroad. Imports from Ukraine did not significantly limit sales and export possibilities for Slovak oilseeds. In 2022 and 2023, we exported more than 61% of the domestic rapeseed production and almost 9% of the sunflower production.

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Markets with agricultural commodities responded to the Russian invasion of Ukraine by significantly increasing their prices, which was also reflected in significantly higher import and export prices (Figure 1, 2). From 2016 until June 2022, the price of wheat exported abroad gradually increased. In June 2022, it reached its maximum of 423 EUR/t. In May 2022, we imported wheat from Ukraine to Slovakia for the first time, and until August 2022, its import price copied the price for which Slovakia sold wheat to its foreign partners. From September 2022 to May 2023, when we imposed a ban on imports, the difference between the price at which we imported wheat from Ukraine and the price at which we exported it abroad increased steadily. During the entire period, our export price was from 27.3% to 86.0% higher than imports from Ukraine. Cheap grain from Ukraine is gradually pushing down our export price as well. Nevertheless, in 2023, we exported wheat for 270.8 EUR/t on average, i.e. 12.4% more expensive than in 2021 and even 39.2% more expensive than in 2016-2021. According to Eurostat data, we imported corn from Ukraine to Slovakia, except for sporadic cases from March 2022 to June 2023. It is evident from Figure 1 that the import of cheap corn pushed down its price for export abroad.

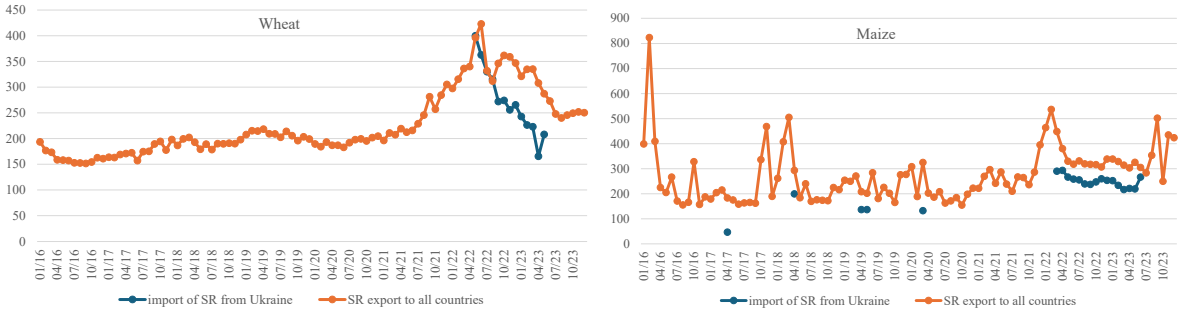

Figure 1: Comparison of the price of importing wheat and maize from Ukraine and the price of their export from the Slovak Republic (in EUR/t)

Source: Eurostat (2024), own calculation

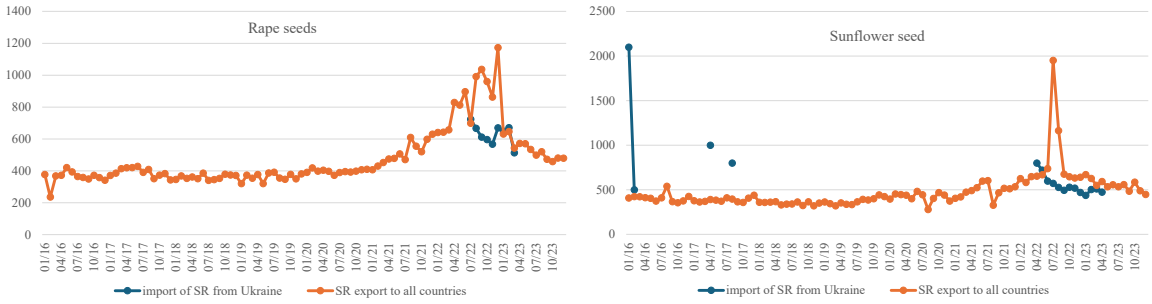

Figure 2: Comparison of the price of importing rape seeds and sunflower seeds from Ukraine and the price of their export from the Slovak Republic (in EUR/t)

Source: Eurostat (2024), own calculation

Despite this, we could place corn on foreign markets at a price higher by 14.4% to 54.6% compared to corn from Ukraine. In 2023, the average export price of corn from Slovakia reached 337.6 EUR/t, i.e. up to 25.8% higher than in 2021 and up to 47.0% higher than in 2016-2021. Significant price differences are also noted for oilseeds. Rapeseed was imported to Slovakia from Ukraine for only 9 months, from July 2022 to March 2023. The import of cheaper rapeseed did not limit the sale of our production. In 2022, we exported rapeseed 50-75% more expensive than Ukrainian rapeseed imported to the Slovak market. In the first quarter of 2023, import and export prices have equalised. A similar situation existed in the case of sunflowers, which we imported to Slovakia from Ukraine from April 2022 to April 2023. In

July and August 2022, we recorded an extreme when we exported sunflowers almost 2.5 times, or 1.2 times more expensive than the price of Ukrainian sunflowers. Despite the significant drop in the export price of sunflower in the following period, we sold it in 2023 for an average of 562.7 EUR/t, i.e. 14.0% more expensive than in 2021 and up to 40.4% more expensive than in the period 2016-2021.

4. Conclusion

The unleashing of Russia's military aggression against Ukraine in February 2022 significantly destabilised world agricultural commodity markets. The Russian Federation and Ukraine are among the world's largest exporters of cereals and oilseeds. The blockade of Ukraine's seaports in the Black Sea temporarily prevented the supply of agricultural commodities to the Middle East and North African countries. The European Union actively assisted with the sale of Ukrainian agricultural commodities. Corridors through the Danube and railway corridors through Slovakia, Poland, and Hungary were opened. The active involvement of the Slovak Republic was reflected in a massive increase in the value of agricultural imports from Ukraine, while our agricultural exports increased much more moderately. The import of cheaper cereals and oilseeds, further strengthened by the exemption of imports from import duties, gradually increased the protests of our farmers against these imports. These protests resulted in a ban on importing Ukrainian grain and oilseeds from Ukraine to Slovakia from May 2023. The main argument was that cheap imports from Ukraine limit sales of Slovak agricultural commodities on domestic and foreign markets. In our contribution, we focused on the extent to which imports from Ukraine limited the sale of Slovak cereals and oilseeds and, at the same time, the extent to which the income of Slovak farmers was negatively affected due to the drop in prices of agricultural commodities. The analysis showed that importing grain and oilseeds from Ukraine did not limit our export potential; on the contrary, it slightly increased it. At the same time, we concluded that cheaper imports from Ukraine did not limit the income of Slovak farmers from plant commodities that are important to us. Although after the extreme increase in the prices of cereals and oilseeds in 2022, in 2023, we saw a rather steep decline in them, the sale prices of Slovak cereals and oilseeds on foreign markets were on average 10-26% higher than in the last pre-war year of 2021.

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Differences between the Readiness of CSR Reporting of a Local Companies and Subsidiary of a Multinational Companies in the Czech Republic

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Abstract

Paper's objective(s) and research background

This study examines the extent to which a parent company's headquarters influences the CSR activities of its subsidiaries in the Czech Republic. In the context of current non-financial reporting obligations, the question of the influence of foreign multinationals on their subsidiaries is an interesting aspect.

Data/Methods

The authors of the paper seek to answer this question, complements the shortcomings of previous studies. Could these subsidiaries actually have some advantage in reporting CSR activities compared to local companies with no links to foreign companies? A questionnaire survey among 80 companies based in the Czech Republic was conducted between 2023.

Results/Conclusions/Value added

This study provides empirical evidence that subsidiaries with links mainly to parent companies in economically developed countries perceive their readiness better than local companies without foreign capital links. Our findings have implications for multinational executives and policymakers.

Key words
Readiness, discrepancies, subsidiary, reporting, CSR, Czech companies,

JEL Classification: M14; O52

1. Introduction

Multinational corporations (MNCs) have become increasingly significant in the economic development of various countries, and their environmental approach and efficiency have a considerable impact on sustainability and conservation of resources in the host location. Furthermore, MNCs are also playing an increasingly important role in environmental strategy and performance, substantially shaping sustainability and resource conservation in their home country. A significant body of research has been dedicated to the CSR of MNCs in the context of environmental issues (see Hall et al., 2010; Meek et al., 2010). However, it should be noted that local companies and subsidiaries of multinationals may have different standards and requirements for CSR reporting, which may lead to differences in their approach and readiness. The availability of resources and capacity for CSR reporting is often greater in subsidiaries of MNCs than in local firms, which may influence their propensity and readiness to engage in this area. However, different corporate cultures and values may also play a significant role in their approach to CSR activities and stakeholder reporting. The regulatory environment in which

local companies and subsidiaries of multinational corporations operate may also influence it. Furthermore, the question of whether subsidiaries of MNCs are subject to heightened scrutiny and transparency from their parent companies has been posited.The fundamental question that this study seeks to address is as follows: Do these subsidiaries possess any distinct advantage in reporting CSR activities when compared to local companies lacking foreign links? The expansion of corporate social, environmental and economic responsibility (CSR) reporting has been significant over the last decade. The European Union is the most active region in the world in terms of sustainability reporting, predominantly on a voluntary basis.The majority of empirical research related to sustainability reporting in Europe has been carried out in Western European countries, with a smaller number of studies focusing on sustainability reporting in Central and Eastern Europe. (Horvath et al, 2017). Reporting of sustainability activities by subsidiaries in Central and Eastern Europe (CEE) is an emerging area of interest, reflecting the region's developing engagement with global sustainability standards.While a growing body of research on sustainability reporting in Western Europe exists, studies focusing on CEE are less widespread, highlighting a gap in the understanding of how subsidiaries in the region disclose their sustainability efforts. The Corporate Sustainability Reporting Directive (CSRD) is a significant catalyst for sustainability reporting in CEE, as evidenced by the adoption of these standards by companies in Bulgaria, for instance, with the aim of enhancing transparency and accountability (Petrova, 2024).In the chemical industry, a pivotal sector within CEE, there is a discernible endeavour to disclose progress towards the CSR. Nevertheless, the quality and extent of reporting varies considerably, with many companies failing to clearly articulate their CSR goals and achievements (Nichita et al., 2020).There is considerable variation in the quality and methodology of sustainability reporting across CEE countries. This inconsistency is partly due to gaps in expertise and guidelines that affect the reliability and comprehensiveness of reporting (Petrova, 2024). Subsidiaries of MNCs may be better prepared for CSR reporting due to the influence of their parent companies' global standards (Szanto, 2019).Subsidiaries tend to integrate CSR more systematically into their core business strategies, driven by the need to align with global corporate policies and maintain a consistent brand image across markets (Fuchs, 2022).Despite their apparent readiness, subsidiaries face challenges such as balancing global corporate norms with local expectations. They frequently employ strategies such as negotiating with headquarters for resources and tailoring CSR initiatives to local needs (Szanto, 2019).However, the evolving business environment and rising stakeholder expectations are likely to lead to improved CSR reporting practices at local companies over time (Przytula et al., 2019).These dynamics suggest a gradual convergence towards more comprehensive and strategic CSR reporting across local and multinational entities in the country. The development of sustainability frameworks in CEE countries signifies a substantial opportunity for these regions to enhance their contribution to global sustainability initiatives. As these countries continue to align with the UN Sustainable Development Goals, they can leverage their distinct geopolitical location and emerging economic structures to assume a pivotal role in global sustainability initiatives. This assertion is reinforced by the progress achieved by certain CEE countries, despite the challenges posed by geopolitical risks and historical environmental degradation. The integration of multinational enterprises and their subsidiaries into these frameworks has the potential to further bolster the region's contribution to global sustainability. The sustainability levels in Central and Eastern European countries vary, with the Balkan countries exhibiting high potential for sustainable development despite their current lower levels of sustainability. This suggests a significant opportunity for growth and the adoption of improved sustainability practices across the region (Huang, 2023). European Union regulatory frameworks, including the European Green Deal, furnish CEE countries with a strategic framework to align their policies with broader European sustainability goals, thereby potentially augmenting their global sustainability impact (Fernandez et al., 2021). Furthermore,

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it has been demonstrated that countries with higher levels of geopolitical risk tend to exhibit lower sustainability performance, thereby indicating that the mitigation of these risks could enhance sustainability outcomes (Huang, 2023).

2. Data and Methods

The survey was conducted on a sample of 80 Czech companies. 40 of them were local companies with no connection to the parent company abroad and a 40 were subsidiaries of a multinational company or companies otherwise connected to an international headquarters. The main aim was to describe the differences in readiness for CSR reporting of chosen variables between them. There are strata stretching distinct characteristics in the sample due to the diversity of firms in terms of size, legal form, and other attributes. A group of Czech interviewers with training conducted the questionnaire-based survey in 2023. After data adjustments, the sample size was reduced to 80 businesses. The questionnaire included one main sorting characteristic, the type of company (1 – subsidiaries of a multinational company and 2 – local companies with no connection to the parent company abroad). The series of variables connected with the readiness of CSR reporting were questioned and answered in the study in the form of the Lickert scale (1. Very strongly, 2. Strongly, 3. On average, 4. Weakly, 5. Not at all.)

Using the factors that were looked at, a hypothesis was formed:

H0: There is no difference in readiness for CSR reporting between local companies with no connection to the parent company abroad and subsidiaries of a multinational company or companies otherwise connected to an international headquarters.

Ha: There is a difference in readiness for CSR reporting between local companies with no connection to the parent company abroad and subsidiaries of a multinational company or companies otherwise connected to an international headquarters.

The data were analysed using XL stat., statistical software. Firstly, Cronbach's Alpha was computed using for the reliability of the data (Leontitsis & Pagge, 2007). The result was a value of 0.964, indicating a high degree of dependability for the used model and its eligibility for additional statistical analysis. In addition, to determine whether the data distribution was normal, the Shapiro-Wilk test of normality (Shapiro & Wilk, 1972) was run. The Mann-Whitney U Test (McKnight & Najab, 2010) was used to find statistically significant differences between companies because of the non-normal distribution of the data was discovered using previous Shapiro-Wilk test.

Mann-Whitney formula:.

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1 \qquad U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

Where: $n1$ is the size of sample 1 and $n2$ is the size of sample 2, and $R1$ is the adjusted rank-sum for sample 1 and $R2$ is the adjusted rank-sum of sample 2.

This model does not require further post hoc testing because it just uses two groups of observed variables. The study's sample, which comprises only 80 monitored organizations overall, is its main limitation. Finding statistically significant variances in the particular topic of reporting CSR activities was found to be achievable by keeping track of the same number of monitored businesses.

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3. Results and Discussion

The issue of the influence of multinational companies on their subsidiaries is quite extensive. A sub-focus on a narrower area concerning the topic of MNCs' influence on subsidiaries in CSR activities (Campbell et al., 2012, Durand and Jacqueminet, 2015, Marano and Kostova , 2016, Tashman et al, 2019), however, their implementation and reporting is already under-researched.Our paper is situated in this research gap and builds on existing studies that have already addressed the topic, but in a different setting than the Czech Republic (Holtbrügge and Dögl, 2012, Tatoglu et al., 2014, Zhou, Hou and Wang, 2024). MNE subsidiaries operate in a complex legitimate environment that includes the home and host country institutional environment and the internal institutional environment within the MNE (Kostova and Roth, 2002), therefore it is important to observe how the CSR influence of MNEs is reflected in the behaviour of subsidiaries.

After Shapiro-Wilk test showed p values of < 0, 0001, which means a data does not follow a normal distribution, a non-parametric test was chosen to be performed. The test that enables the comparison of two independent samples is the Mann-Whitney test and the hypotheses stated were:

H0: There is no difference in readiness for CSR reporting between local companies with no connection to the parent company abroad and subsidiaries of a multinational company or companies otherwise connected to an international headquarters.

Ha: There is a difference in readiness for CSR reporting between local companies with no connection to the parent company abroad and subsidiaries of a multinational company or companies otherwise connected to an international headquarters.

As the computed p-value is lower than the significance level alpha=0, 05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.

It is evident that the null hypothesis is rejected for the 7 variables (table 1.). We can conclude that there are notable differences in readiness of CSR reporting between local companies with no connection to headquarters and subsidiaries connected to headquarter companies.

These differences were seen for the variables of:

A.[Directive on non-financial reporting, which currently applies to large public interest companies with 0 to 500 employees]

B.[EU setting environmental targets for companies with over 250 employees]

E.[Environmental activities]

G.[Economic activities]

I.[Activities connected with the conflict in Ukraine]

K.[Diversity (gender, race, etc.)]

L.[Fighting corruption and bribery]

Table 1. Mann-Whitney test of Readiness for reporting chosen variables between local company and subsidiary of a multinational company:

Variable\Test	Mann-Whitney
A.[Directive on non-financial reporting, which currently applies to large public interest companies with 0 to 500 employees]	**0.014***
B.[EU setting environmental targets for companies with over 250 employees]	**0.023***
C.[Regulation on corporate sustainability reporting from 250 employees valid from 2025 (for the year 23/24)]	0.145
D.[CSR in general]	0.052
E.[Environmental activities]	**0.036***
F.[Social activities]	0.060
G.[Economic activities]	**0.038***
H.[Activities related to COVID-19]	0.140

I.[Activities connected with the conflict in Ukraine]	**0.015***
J. [Activities associated with energy crisis]	0.066
K.[Diversity (gender, race, etc.)]	**0.004***
L.[Fighting corruption and bribery]	**0.031***

Source: author's calculations
Note: * Indicates a significance level of 0.05. Grouping Variable: Company type, n = 80.

The biggest difference is seen in the readiness of CSR reporting connected with the variable K. [Diversity (gender, race, etc.)], where subsidiaries of a multinational company was better prepared for reporting (mean of 2.5) as the local companies (3.3 mean). The smallest but still significant difference was related to the reporting connected with the variable G. [Economic activities], but with the same better preparedness for subsidiary than local companies. The rest of the significant variables resulted also in advantage for the subsidiary companies. This confirms our assumptions that subsidiaries actually have some advantage in reporting CSR activities compared to local companies with no links to foreign companies.

Table 2. Summary statistics of Readiness for reporting chosen variables of a local company and subsidiary of a multinational company:

Variable	Obs	Obs. with missing data	Obs. without missing data	Min.	Max.	Mean	Std. deviation
A.[Directive on non-financial reporting, which currently applies to large public interest companies with 0 to 500 employees] | 1	40	0	40	1	5	2.8	1.083
A.[Directive on non-financial reporting, which currently applies to large public interest companies with 0 to 500 employees] | 2	40	0	40	1	5	3.5	1.154
B.[EU setting environmental targets for companies with over 250 employees] | 1	40	0	40	1	4	2.8	0.893
B.[EU setting environmental targets for companies with over 250 employees] | 2	40	0	40	1	5	3.5	1.218
C.[Regulation on corporate sustainability reporting from 250 employees valid from 2025 (for the year 23/24)] | 1	40	0	40	1	4	2.9	0.931
C-[Regulation on corporate sustainability reporting from 250 employees valid from 2025 (for the year 23/24)] | 2	40	0	40	1	5	3.2	1.23
D.[CSR in general] | 1	40	0	40	1	4	2.5	0.961
D.[CSR in general] | 2	40	0	40	1	5	2.9	1.187
E.[Environmental activities] | 1	40	0	40	1	5	2.7	1.305
E.[Environmental activities] | 2	40	0	40	1	5	3.3	1.127
F.[Social activities] | 1	40	0	40	1	4	2.6	1.062
F.[Social activities] | 2	40	0	40	1	5	3	1.038
G.[Economic activities] | 1	40	0	40	1	4	2.5	1.038
G.[Economic activities] | 2	40	0	40	1	5	3	1.038
H.[Activities related to COVID-19] | 1	40	0	40	1	5	2.8	1.165
H.[Activities related to COVID-19] | 2	40	0	40	1	5	3.1	1.01
I.[Activities connected with the conflict in Ukraine] | 1	40	0	40	1	5	2.7	1.104
I.[Activities connected with the conflict in Ukraine] | 2	40	0	40	1	5	3.4	1.102
J.[Activities associated with energy crisis] | 1	40	0	40	1	5	2.7	1.071

J.[Activities associated with energy crisis] | 2	40	0	40	1	5	3.1	1.099
K.[Diversity (gender, race, etc.)] | 1	40	0	40	1	4	2.5	1.035
K.[Diversity (gender, race, etc.)] | 2	40	0	40	1	5	3.3	1.018
L.[Fighting corruption and bribery] | 1	40	0	40	1	5	2.7	1.05
L.[Fighting corruption and bribery] | 2	40	0	40	1	5	3.3	1.018

Source: author's calculations

The rest of the variables resulted with no differences, which means that all the companies are ready for the reporting connected with variables (C, D, F, H, and J) in the same way (table1). Both samples of companies are ready for CSR reporting to the same average extent connected with 3 variables, specifically : C Regulation on corporate sustainability reporting from 250 employees valid from 2025 (for the year 23/24)], H. Activities related to COVID-19 and J. Activities associated with energy crisis, which we can see from the means in table 2. For the readiness of CSR reporting in general (D) and Social activities (F) they are comparably ready as well and their answers were between strongly and on average.

Zhou et al. (2024) examined how foreign subsidiaries of multinational companies respond to internal requirements of the parent company and external requirements of host and domestic institutions to determine their environmental footprint. Using a sample of U.S. MNC subsidiaries operating in China, they verified that the subsidiaries' environmental footprint is negatively related to the parent company's environmental performance. These findings are consistent with the findings of our study, i.e., the influence of the parent company on the subsidiary's approach to CSR activities. In their study, Aguilera-Caracuel et al. 2014 show that institutional distance between home and host countries affects the standardization of environmental performance of multinational companies, which is measured by air discharge data from headquarters and subsidiaries. Consistent with the findings of this study, our study highlights the influence of MNCs on the attitude in responsible behavior of subsidiaries.

The findings underscore the growing influence of the EU's regulatory landscape on CSR reporting. The Corporate Sustainability Reporting Directive (CSRD) is a key driver, mandating comprehensive sustainability disclosures for a wider range of companies. This increased regulatory scrutiny incentivizes subsidiaries of multinational corporations, often with established global standards and internal controls, to prioritize and enhance their CSR reporting.

4. Conclusion

Multinational enterprises (MNEs) can play a critical role in promoting sustainability by developing global strategies that incorporate actions by local subsidiaries. This process necessitates a harmonisation of global corporate objectives with local market requirements and stakeholder expectations (Elg & Ghauri, 2023). The purpose of the study was to compare local businesses without any connection to a global headquarters and subsidiaries of multinational corporations in terms of their preparedness for Corporate Social Responsibility (CSR) reporting. The study included a questionnaire-based methodology and statistical analysis to evaluate multiple variables associated with the preparedness of CSR reports, and it involved 80 Czech enterprises. Because of the data's non-normal distribution, the Mann-Whitney test was used, and the results showed a significant difference in these two categories of organizations' preparedness for CSR reporting. Across a number of variables, including environmental activities, economic activities, and anti-corruption measures, subsidiaries of multinational corporations demonstrated superior preparedness for CSR reporting, as evidenced by the rejection of the null hypothesis.

An analysis of the two types of organizations' preparedness for reporting on many variables, including COVID-19 activities, requirements on sustainability reporting, and energy crisis activities, revealed no discernible differences. Overall, subsidiaries of multinational

corporations showed a distinct advantage in numerous important categories, even while both types of businesses showed comparable levels of preparedness for CSR reporting in several areas. The structure of the relationship between headquarters and subsidiaries is critical to the implementation of the SDGs at the subsidiary level (Zhou et al., 2024). For multinational executives, these findings highlight the importance of sharing best practices and resources across subsidiaries to ensure consistent and high-quality CSR reporting. Empowering subsidiaries to tailor global CSR strategies to local contexts and stakeholder expectations while ensuring compliance with EU regulations. Continuously assessing the effectiveness of CSR initiatives at the subsidiary level and making necessary adjustments to align with evolving regulatory and stakeholder demands. Effective linkages between headquarters and subsidiaries have been shown to enhance sustainable development outcomes, with FDI motives playing a moderating role (Zhou et al., 2024). MNEs are required to customise their sustainability strategies to local conditions and ensure that subsidiaries can address specific local gaps in sustainability goals while maintaining alignment with global corporate objectives (Liu & Rao-Nicholson, 2021). Participation in global sustainability initiatives has been shown to offer CEE countries access to new markets, investments and innovative solutions, thereby increasing their competitive advantage and sustainability impact (Soloveva et al., 2024). To enhance CSR readiness, local Czech companies should integrate CSR into their core business strategy, set clear and measurable CSR goals, invest in employee training on CSR principles and reporting, develop robust systems for tracking environmental, social, and governance performance, appoint a dedicated team or individual to oversee CSR initiatives, analyze CSR reports from leading companies to identify best practices, engage with industry associations for resources and networking opportunities, seek guidance from consulting firms or sustainability experts, actively engage with employees, customers, and the community, establish transparent communication channels to share CSR progress, utilize government support programs and online resources, conduct regular internal and external reviews of CSR performance, stay informed of evolving regulations and best practices, and embrace innovative approaches to CSR, such as integrating sustainability into product design. By taking these steps, local companies can enhance their CSR readiness, improve their environmental and social impact, and gain a competitive advantage in the market.

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Navigating Talent Management: Effective Strategies and Best Practices through Corporate Case Study

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Abstract

Paper's objective(s) and research background

This article aims to examine in detail effective talent management strategies and practices through a case study in a corporate environment, serving as the main objective. Additionally, the article seeks to provide a detailed look at a company that is systematically investing in the development of its human resources and successfully implementing high-level talent management. Furthermore, it aims to identify and analyze best practices and approaches in detail, ultimately offering practical recommendations and inspiration for other companies to effectively implement and improve their talent management processes.

Data/Methods

In this article we use qualitative approach, which takes an in-depth look at the collection and analysis of information through a case study in selected company. The main focus is on primary data collection, gathered through a specially guided interview with the human resources manager. This interview took place on February 10, 2024, and followed a structured question strategy specifically designed to cover all key aspects of talent management. In addition, the use of observation and careful analysis of available secondary sources such as company reports and databases are also important, contributing to a broader and deeper understanding of talent management issues in specific organisations.

Results/Conclusions/Value added

The case study revealed that systematic investment in talent management enhances employee retention and organizational performance. Key findings include a structured talent identification process using performance evaluations and leadership assessments, a multi-tiered development program with mentoring and job rotation, and a strong focus on internal talent mobility for succession planning. Additionally, a performance-based retention strategy combining financial and career growth incentives helps reduce turnover. These insights highlight best practices that can guide other companies in optimizing their talent management strategies.

Key words

Talent management, Case study, Strategy, Human resources, Performance Development, Qualitative approach, Recommendations

JEL Classification :

M12 Personnel management
M53 Training
M54 Labor management

1. Introduction

The significance of talent as a strategic asset became apparent when a McKinsey & Co. study revealed that, for the next two decades, talented people—intelligent, sophisticated businesspeople who possess technology literacy, global expertise, and operational agility—will be the most valuable corporate resource. Additionally, the supply of talent will decline as

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demand for it increases. The largest issue in human resources is the competition across businesses for the limited quantity of talent (Makela et al., 2010).

Talented personnel must be attracted, developed, and retained through distinctive techniques. If organisations are interested in reaching their strategic goals. Therefore, an organization's primary competency is talent, and managing it will undoubtedly make it possible for it to remain competitive (Huselid et al., 2005).

Talent management is an integrated process that includes a number of specified practices that contribute to the success of an organization (Iles et al. , 2010).

The most important step of talent management is the first phase, namely talent identification (Vallée, 2023). It is important for the company to identify and assess if and which employees will produce quality results in the future (Máté et al., 2016). Talent should meet high standards, deliver high values and demonstrate high performance in three areas which are namely commitment, aspiration and capability. A person who is perceived as a talent should strive for the best results, have the highest goals, motivation and also aspiration, this characteristic leads them to move to key positions (Mensah, 2015).

To attract talent, a business should present itself as an attractive, success-oriented employer with a strong corporate and company culture in which employees can continually grow. Talent can be obtained from two sources:

- internal company resources,

- external sources (Koubek, 2007).

According to Hronik (2007), there are 6 methods of how a company can acquire talent through internal sourcing namely project participation, appraisal system, 360-degree feedback, development centre, potential measurement and nomination. The company can also attract talent from outside the company's own ranks and it is from external sources, these are mostly university students or graduates from universities. There are programs for these talents where companies try to identify talented students or graduates, so called trainee programs (Koller, 2023).

Talent development is an organizational process where employees go through a development process where they acquire new skills, abilities and prepare themselves for career advancement in a way that is consistent with the company's mission. How to maximize and develop talent potential is a fundamental question in talent development. Greater self-actualization and better identification with the corporate culture result from talent education and development (Joniakova et al., 2016). It is a process that is long-term, it is not enough to start its implementation only when solutions are sought to the problems that have already arisen, it is important to realize that it is important for the company to have employees who can not only solve these problems but predict them in the first place (Kachňáková et al., 2013). There are several development programs that can be divided into 2 basic groups namely, specific development programs in the workplace and development programs outside the workplace (Al-Dalahmeh, 2020).

The next phase of talent management is the talent retention phase, since the company has already spent a lot of resources on talent acquisition and development in the previous phases, this phase is critical, it is very important that the company makes sufficient efforts to retain such talent and stabilize them, it is important to create an attractive work environment that will ensure that instead of leaving to the competitors, talented employees will remain loyal to the company. To achieve this goal, the company must behave ethically, reward their performance, achievements fairly and also provide sufficient recognition (Chitu and Russo, 2020).

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Horváthová (2011) defined the factors that a company must meet to become an attractive employer, these are providing career advancement, personal growth and education, offering fair and quality working conditions, offering well-paid and interesting work, respecting also the employee's personal life and showing respect and feeling appreciated. Tobias (2007) indicates, that underutilizing employees' talents is the main reason for work dissatisfaction. The author claims that in order for talent to be satisfied, its egoistic requirements must be satisfied. This is the main focus of talent management in companies with high performance among employees.

Oladapo (2014) in his study highlights the challenge faced by businesses to replace experienced and talented employees when they retire. To ensure that there is no shortage of talent in the company, management must come up with effective and robust strategies to identify, attract, develop and most importantly retain talent in the company. Long-term stability is key for companies because they need effective talent management techniques to compete in the marketplace and prevent crises, layoffs, and talent attrition. In particular, the study concludes that the effective implementation of talent management is always a competitive advantage for organizations over organizations that do not place as much emphasis on talent management. Implementing talent management also has a very positive impact on talent retention in an organization.

2. Data and Methods

The paper focuses on a case study in the area of talent management process. Within the case study we focused on the different phases that talent management includes. We focused on a particular company Procter & Gamble. This study aims to examine the prevailing practices and strategies employed by Procter & Gamble in talent management through structured interviews conducted with key personnel within the company. The first interviewee was human resource manager, responsible for overseeing talent management practices within the organization. Additionally, an interview was conducted with the country manager of Procter & Gamble, to gain insights into the strategic direction and organizational objectives pertaining to talent management.

The case study contained a total of 16 questions which were divided into 4 areas, talent identification, talent acquisition, talent development and talent retention. Each area contained a total of 4 questions which were used to find out all the important information about the talent management process within company Procter and Gamble. Questions were prepared and presented to both interviewees to solicit their perspectives on talent management practices within Procter & Gamble. These questions were designed to comprehensively explore various aspects of talent management, including identification, recruitment, developmnet and retention of talents.

The responses provided by respondents were analyzed to identify prevailing talent management practices within Procter & Gamble. By comparing and contrasting their insights, key themes and patterns emerged, shedding light on the organization's approach to talent management.

Drawing upon the findings of the interviews, this study aims to offer practical recommendations and actionable insights for companies. These recommendations will be based on identified best practices within Procter & Gamble and aligned with industry standards and emerging trends in talent management.

3. Results and Discussion

The first area we focused is talent identification, based on the interviews we found that within Procter & Gamble talent is defined as individuals who demonstrate exceptional skills,

capabilities, and potential to achieve outstanding performance within their role or area of expertise. A talented individual at P&G is someone who is capable of:
Delivering excellent results in their work and contributing to the success of the company.
Demonstrating initiative, entrepreneurship, and the ability to innovate.
Effectively communicating and collaborating within a team.
Quickly adapting to changing conditions and performing successfully in new environments.
Exhibiting strong leadership and managerial skills, if relevant to their role.
Sharing the company's values and showing commitment to their personal development and the company's success.
Based on findings, talent is a key factor in P&G's ability to achieve competitive advantage and maintain its leading position in the market. Therefore, it is important for any company to place high priority on identifying talented individuals who bring added value and innovation to the organization. The importance of talent management is also evident from the following definitions, according to Stevens (2008) talent management plays a key role in influencing the entire organization and according to Krishnan and Scullion (2017) talent management is defined as the systematic attraction, identification, development, engagement, retention and deployment of those individuals who have high potential that creates value for the organization. Talent management also has a very large impact on organizational performance by minimizing recruitment costs (Boon et al., 2011), and its application within a company opens up enormous potential for competitive advantage for the business (Schuler et al., 2011). We found out that company assess candidates based on specific criteria aligned with the needs of organization, including education, experience, skills, and values. Additionally, they utilize competency frameworks and various assessment methods such as interviews, psychometric tests, and performance evaluations to identify individuals with the potential to excel within the company, which can be used in every company for identification of talent. Based on answers provided, we found out, that diverse workforce is crucial for company to respond quicker and more creatively to business opportunities.
The second area we focused on is talent attraction. Procter and Gamble attracts talents through a combination of proactive recruitment strategies and compelling employer branding. Company actively engage with potential candidates through university recruitment events, career fairs, and online platforms. Strong reputation as a leading global employer, coupled with competitive compensation packages and opportunities for career advancement, helps them attract top talent from diverse backgrounds. When we analyzed these answers, we found out that for talent attraction the public relations, how people perceive a particular company, brand is also extremely important. Garvin (2001) claims that, particularly in the current global era, having a diverse workforce with a range of talents from different cultural backgrounds, genders, ages, and lifestyles allows an organisation to respond to business opportunities more quickly and creatively. This has to be one of the major organisational goals to be achieved.
The third area we focused on is talent development. Procter and Gamble are committed to the continuous development of talents. They offer a range of development programs, including leadership development initiatives, rotational programs, mentorship opportunities, and education assistance programs. These initiatives aim to enhance the skills, knowledge, and capabilities of talents, empowering them to reach their full potential and contribute to the success of organization. According to Walner (2000) putting trust in an employee's talent entails assigning them crucial organisational responsibilities since talent's managers are confident they can handle the work. According to the author, talented people find this motivating and it strengthens their sense of worth as individuals.
The last area we focused on is talent retention. We found out that retaining talented employees is a priority for Procter & Gamble, they foster a supportive and inclusive work environment that values diversity, innovation, and collaboration. Additionally, they offer competitive

compensation and benefits packages, opportunities for career growth and advancement, and recognition programs to reward outstanding performance, thanks to all this company creates a motivation for their employees. According to Leigh (2004) motivation and ability are the primary drivers of performance and can be enhanced through talent management. According to the author, companies who have implemented a talent management system see talent development as an impulse for their own growth.They also provide ongoing feedback and opportunities for employees to voice their opinions and contribute to decision-making processes. By investing in the well-being and professional development of their employees, they strive to ensure their long-term engagement and retention within the company.

Oladapo (2014) in his study highlights that company must come up with effective talent management strategies to identify, attract, develop and most importantly retain talent in the company to efectively replaced talented employees. At Procter & Gamble succession planning is a critical element of the human resource management strategy that helps the company avoid situations where there is a shortage of qualified and talented employees due to retirements or other reasons. To avoid a shortage of qualified employees they apply several practices :

Identifying critical positions and functions in the organization, that are strategic to achieving business objectives. These positions may include management leaders, key professionals and other key employees.

The company regularly assesses the state of its succession pipeline and identifies potential gaps or areas where there could be a talent shortage in the future. This process includes analyzing the age structure of the workforce, estimating retirements, assessing the competencies and potential of existing employees, and identifying candidates with the potential for succession into key positions.

Company strives to identify and develop internal talents, that have the potential for exciting roles in the future. This includes providing opportunities for career growth and development, rotations between different departments and functional areas, as well as mentoring and leadership programs.

In addition to developing internal talent, company also recruits external candidates who can contribute to succession planning for key positions. The company actively recruits talented individuals who have the necessary experience and skills to successfully perform key roles.

Moreover company is investing in strategies to transfer knowledge and experience from current employees to new talented people joining the company. This can include training programs, mentoring, and the creation of knowledge bases that enable new employees to quickly orient themselves and work effectively.

4. Conclusion

The insights gleaned from the case study, in which we were studying talent management practices in the company Procter and Gamble, offer valuable recommendations for organizations seeking to improve their own approaches in this critical area. As we have observed, talent management is an integrated process, that includes several specified practices, that contribute to the success of an organization. These practices are workforce planning, attracting talented employees, developing and training these talented employees and last but not least retaining them (Iles et al. , 2010).

As the first area, we observed the talent identification. Based on the findigs, we would like to offer recommendations for companies. For assesing candidates, companies should asses them based on specific criteria aligned with the needs of organization, including education, experience, skills, and values. Additionally, they should utilize competency frameworks and various assessment methods such as interviews, psychometric tests, and performance evaluations to identify individuals with the potential to excel within the company. We found out, that diverse workforce is crucial for company to respond quicker and more creatively to

business opportunities, so companies should take this into account and focus on a more diverse workforce.

As the second area, we observed the talent attraction. In today's business world, it is very important for companies to find the right people to join their teams. Drawing insights from Procter & Gamble's practices, several recommendations emerge for other companies seeking to bolster their talent acquisition efforts. Firstly, companies should adopt proactive recruitment strategies that encompass a diverse array of channels. Engaging with potential candidates through university recruitment events, career fairs, and online platforms enables organizations to cast a wide net and connect with talent across various demographics and geographic locations. Furthermore, cultivating a compelling employer brand is essential for attracting top-tier talent. A strong reputation as a leading global employer, coupled with competitive compensation packages and opportunities for career advancement, serves as a magnet for prospective employees. Companies should leverage their unique value propositions and organizational culture to differentiate themselves in the competitive talent market. Additionally, embracing diversity and inclusion initiatives is crucial for talent attraction in the contemporary global era. Garvin (2001) emphasizes the importance of having a diverse workforce with talents from different cultural backgrounds, genders, ages, and lifestyles. This diversity not only enhances creativity and innovation but also enables organizations to respond more quickly and effectively to evolving business opportunities. In conclusion, talent attraction is a multifaceted endeavor that requires a strategic blend of recruitment tactics, employer branding efforts, public relations initiatives, and diversity initiatives. By adopting a holistic approach inspired by Procter & Gamble's practices, companies can enhance their ability to attract top talent and drive organizational success in today's dynamic business environment.

As the third area, we observed the talent development. According to our findings the motivation to improve and develop as a person is crucial for talents. According to Walner (2000), when companies trust their employees with important tasks, it shows they believe in their abilities. This can be really motivating for talented people and make them feel valued.

Based on our case study we can offer valuable recommendations for companies on how to develop their talents. One way to train talented employees is to provide them with sufficient quality personal development programmes such as leadership training, rotational programs where they can try different roles, mentorship opportunities or week colleges where they have intensive trainings focused on the skills for specific positions.

When companies are investing in programs to develop their employees' talents, they are not only helping them grow but also boosting their confidence and sense of worth.

As the last area we focused on is talent retention. We would like to provide some recommendations for companies aiming to improve talent retention. Firstly, creating a supportive and inclusive work environment is crucial. Companies should foster a culture that values diversity, encourages innovation, and promotes collaboration among employees. This creates a sense of belonging and loyalty among staff, making them more likely to stay with the company. Secondly, offering competitive compensation and benefits packages is essential. Employees need to feel adequately rewarded for their contributions to the company's success. Additionally, providing opportunities for career growth and advancement demonstrates a commitment to employees' long-term development and encourages them to stay and progress within the organization. Furthermore, recognition programs play a significant role in motivating employees and reinforcing their sense of value. Acknowledging outstanding performance through awards, bonuses, or other forms of recognition boosts morale and encourages continued excellence.

According to Leigh (2004), motivation and ability are key drivers of performance, and talent management practices can enhance both. Implementing a comprehensive talent management system allows companies to identify, develop, and retain top talent effectively, driving

organizational growth and success. Moreover, providing ongoing feedback and opportunities for employees to voice their opinions fosters a culture of transparency and employee engagement. Employees who feel heard and valued are more likely to remain committed to the company in the long term. In conclusion, by prioritizing a supportive work environment, competitive compensation, recognition programs, talent management practices, and employee feedback mechanisms, companies can enhance talent retention and ensure the long-term engagement and commitment of their employees.

In conclusion, the insights derived from Procter & Gamble's talent management practices provide valuable guidance for organizations seeking to enhance their own approaches in this critical area. By prioritizing trust, empowerment, diversity, and continuous development, companies can create a supportive and inclusive work environment where employees thrive and contribute to long-term success.

While this study provides valuable insights into talent management strategies based on a case study of Procter & Gamble, certain limitations must be acknowledged. The findings and recommendations are derived from a single case study, which raises concerns regarding their generalizability. Although P&G serves as a strong example of talent management excellence, its practices may not be universally applicable across industries, company sizes, or organizational structures. Different firms may have varying resources, cultures, and strategic priorities that influence the effectiveness of these recommendations. Future research could enhance the robustness of these findings by incorporating comparative case studies or empirical data from multiple organizations. This would provide a broader perspective on how different companies approach talent management and allow for more widely applicable recommendations.

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Artificial Intelligence in Enterprises: A Comparative Analysis of Slovakia and EU Member States

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Abstract

Paper's objective(s) and research background

Digital transformation and artificial intelligence (AI) affect various areas of people's professional and private lives. Even enterprises cannot avoid this situation. It is worth examining what the real state of AI use by enterprises is. The aim of this paper is to examine the use of AI technologies by enterprises located in Slovakia and in other EU member states.

Data/Methods

The examination was conducted based on data on the use of AI technologies by enterprises in the years 2021 and 2023. More specifically, the paper focuses on the comparison of the use of AI technologies in Slovakia and other EU member states in general and then also in terms of the size class of enterprises (small, medium, large). Specific types of AI technologies used by enterprises were also a subject of interest.

Results/Conclusions/Value added

The results show that there is not big increase in the use of at least one AI technology by EU enterprises in 2023 (8% of enterprises) compared to 2021 (7.6% of enterprises). In the case of enterprises in Slovakia, there is an increase in the use of at least one AI technology from 5.2% of enterprises in 2021 to 7.0% of enterprises in 2023. Also, the results point to the fact that small and medium-sized enterprises implement AI technologies to a lesser extent than large enterprises. This applies to the average of the EU member states and specifically also to Slovakia. AI technologies that automate various workflows or help in decision-making are among the most used by enterprises, but it must be noted that there are only minor differences in the use of AI technologies by enterprises.

Key words

Artificial intelligence, enterprises, business, Slovakia, EU member states

1. Introduction

Digital technologies are an integral part of our lives and are changing the way the people operate in their professional and personal spheres. Digital transformation is gradually taking place in various areas of life and professions. This also applies to enterprises. Digital transformation can be defined as the integration of new technologies into all areas of a company. This technological integration will ultimately imply a need to transform traditional business models (Forradellas & Gallastegui, 2021). Artificial intelligence (AI) also has its share in this. One of the goals of European Union (EU) for the digital transformation of business by 2030 is that 75% of EU companies should use cloud computing services, perform big data analysis, or use artificial intelligence (Eurostat, 2023a). Nowadays, AI has high popularity, it has high impact on business, and it penetrates various areas, not excluding enterprises.

AI equips machines with the ability to analyse data from their environment and take decisions and actions with some degree of autonomy to achieve specific goals (Eurostat, 2023a). AI can be understood as the simulation of human intelligence by machines (Forradellas & Gallastegui,

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2021). AI can be also defined as a set of technologies that simulate human cognitive functions (Mikalef, Fjørtoft & Torvatn, 2019) normally associated with the human brain, including perceiving, reasoning, learning, evolving with experience, self-correction, solving problems, and interacting with the environment (Forradellas & Gallastegui, 2021).

AI refers to intelligent systems which can quickly analyse large amounts of data and draw relevant conclusions from them. AI systems can be software-based (e.g. image recognition software, virtual assistants, speech, and face recognition systems) or embedded in devices (e.g. autonomous robots, self-driving vehicles, drones) (Eurostat, 2023b). AI research focuses on areas and technologies such as:

- *Machine learning (e.g. deep learning)* – Technologies enabling systems to analyse data, learn from them and improve over time without being explicitly programmed. It involves the development of models that can identify patterns and make predictions or decisions based on new information. These models are trained using large datasets and thanks to that they can better perform automated tasks.
- *Computer vision* – Technologies includes image processing and image recognition. Such systems can analyse and interpret digital pictures and videos and recognise the objects contained in them.
- *Natural language processing* – Technologies that can understand human language and generate it too. Therefore, the terms natural language generation and speech recognition are also used in this context. It is the ability of a machine to understand human language in written or spoken form, identify words and sentences in it and convert them into a machine-readable format.
- *Robotics* – Technologies facilitating machine mobility through autonomous decision-making derived from environmental observation.

AI is developing rapidly, and thanks to the above-mentioned technologies, it can find wide use in enterprises and bring various benefits to them. The surge in AI's impact on businesses stems from its capacity to process extensive data sets, deliver valuable insights, and boost operational efficiency and productivity. With the ability of artificial intelligence and machine learning to process and explore huge data sets quickly and comprehensively, they surpass human abilities in speed and scope in this activity. Consequently, AI can unveil patterns, behaviours, and trends that might elude human analysts initially, aiding in forecasting future outcomes through the analysis of historical data. Holtel (2016) stated that data-driven enterprises will outperform those that do not exploit data. Ruiz-Real et al. (2021) adds that the process of digitalization and the transformation that Industry 4.0 is generating in the expectations and consumption habits of clients, together with the huge amount of data that needs to be analysed, classified, and structured, leads us to think that many of the high-level technical tasks that are currently carried out by specialized personnel will be left to AI.

AI finds applications across various departments within companies and can be integrated into diverse organizational processes. For example, the following uses are usually listed in publications:

- *Process automation* - AI can help automate repetitive routine tasks. As a result, AI can enable the human workforce to disengage from time-consuming tasks to perform other activities that require more creative skills and critical thinking (Mikalef, Fjørtoft & Torvatn, 2019). It also increases the time available to concentrate employees on more meaningful and demanding tasks (Sipola, Saunila & Ukko, 2023). Automation also contributes to reducing the error rate of employees.
- *Customer relationship management and service support* - AI makes it possible to target all customer segments in a fully personalized way. Applications include recommender

systems, virtual assistants, chatbots and voice bots (Forradellas & Gallastegui, 2021). Chatbots have seen increasing use by companies to support customer service (Wang, Lin, & Shao, 2022). AI in this form finds use in answering questions that costumers send to the organization (Buntak, Kovacic & Mutavdzija, 2021). It is also an advantage that such chatbot is available non-stop for customers.

- *Decision-making process support* – Thanks to the ability to analyse large amounts of data, AI becomes the basis for the decision-making process support (Buntak, Kovacic & Mutavdzija, 2021). Quickly extracted information from large datasets contributes to faster, better decision-making (Sipola, Saunila & Ukko, 2023).
- *Marketing* – AI can be applied to identify unique personas of customers, and to offer tailored-made marketing campaigns, or even special offers and services (Mikalef, Fjørtoft & Torvatn, 2019)
- *Forecasting* – AI can use data from the past to predict the future – enabling businesses to plan more effectively and prepare various scenarios.

In addition to the advantages, various challenges associated with the implementation of AI in enterprises are also mentioned. Kitsios and Kamariotou (2021) stated that while the AI technology offers great potential to solve difficulties, challenges remain implicated in practical implementation and lack of expertise in the strategic usage of AI to create business value. Buntak, Kovacic & Mutavdzija (2021) also point out that when AI is implemented in the organization there is also risk of decreasing need for the human labor. On the other hand, there is also possibility for creating new workplaces related to the use of AI. Finally, it is stated that AI is great opportunity for all organizations and possibility for organizations to gain a competitive advantage too.

Considering the above, it is worth examining what the real state of AI use by enterprises is. The aim of this paper is to examine the use of AI technologies by enterprises located in Slovakia and in EU member states. In this context, the following research questions were set:

RQ1: What is the percentage of enterprises in Slovakia compared to enterprises in EU member states using at least one AI technology?

RQ2: What is the percentage of enterprises in Slovakia compared to enterprises in EU member states using at least one AI technology in terms of their size class?

RQ3: What is the percentage of enterprises located in EU member states (all member states including Slovakia) using specific AI technologies?

2. Data and Methods

The data on the use of AI technologies by enterprises were used to answer the set research questions. The data used in this paper were obtained from the online database of the Statistical Office of the European Union from the EU survey on ICT usage and e-commerce in enterprises (Eurostat, 2023c). It is an annual survey. The data from the EU survey were collected for the years 2021 and 2023. The enterprises located in EU member states (currently 27 states) were examined in the survey. The survey explores various areas of ICT usage including artificial intelligence, which is specifically the focus of this paper.

The collected data were analysed according to set research questions in following three ways:

1. Enterprises located in EU which uses at least one of the AI technologies in comparison to enterprises located in Slovakia – Relates to RQ1. In this way, comparison is focused on enterprises using AI technologies which are in Slovakia

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compared to enterprises located in EU Member States and to EU average. Enterprises with at least 10 employees are examined.

2. Enterprise size classes – Relates to RQ2. The characteristics according to which enterprises could be distinguished into specific size classes may be different and opinions on the determination of criteria for this purpose may therefore differ. Among such characteristics, it is possible to include market share, the complexity of the organizational structure, annual turnover, or the number of employees. Enterprises can thus be divided according to their size into micro enterprises, small enterprises, medium enterprises, and large enterprises. In this comparative analysis, three classes of enterprise size are distinguished based on their number of employees:

- small enterprises (from 10 to 49 employees),
- medium enterprises (from 50 to 249 employees)
- and large enterprises (at least 250 employees or more).

3. Average value of enterprises located in EU compered by type of AI technology they use and by their size class – Relates to RQ3. Artificial intelligence is used in various areas, as we mentioned in the previous chapter. From this point of view, the ways of using AI technologies in enterprises are categorized and the categories are listed in Table 1 together with the abbreviations assigned to individual categories. These abbreviations are subsequently used further in the text. Enterprises with at least 10 employees are examined in this way of analysis.

Table 12 Categories of AI technologies with their abbreviations

Categories abbreviations	Description of categories of AI technologies
TPA	AI technologies automating different workflows or assisting in decision making (AI based software robotic process automation).
TTM	AI technologies performing analysis of written language (text mining).
TML	AI technologies related to machine learning (e.g. deep learning) for data analysis.
TSR	AI technologies converting spoken language into machine-readable format (speech recognition).
TIR	AI technologies identifying objects or persons based on images (image recognition, image processing).
TNLG	AI technologies generating written or spoken language (natural language generation).
TAR	AI technologies enabling physical movement of machines via autonomous decisions based on observation of their surroundings and taking autonomous decisions.

The data were compared in terms of these three views and evaluated. Based on the evaluation, it was then possible to answer the set research questions. A time factor was included in each of these three methods too. So, the comparison was also made on the basis of the years in which the data were collected (2021 and 2023) and the increase or decrease in the number of enterprises using AI technologies were monitored.

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3. Results and Discussion

The results can be divided according to the established research questions.

RQ1: What is the percentage of enterprises in Slovakia compared to enterprises in EU member states using at least one AI technology?

From the results presented in Figure 1, it can be observed that the percentage share of enterprises located in EU member states which use at least one AI technology is on average 7.6% in 2021 and 8.0% in 2023. The results show that there is just small but not big increase in the use of at least one AI technology by EU enterprises in 2023 compared to 2021. In the case of enterprises in Slovakia, there is an increase in the use of at least one AI technology from 5.2% of enterprises in 2021 to 7.0% of enterprises in 2023. Thus, Slovakia moved from 17th place to 15th place among EU member states in the use of at least one AI technology by enterprises. Within the V4 countries, Slovakia has the largest percentage of enterprises using at least one AI technology. It is also possible to observe that in 2021 only 8 out of 27 (approximately 30%) EU member states are those whose percentage of enterprises using at least one AI technology is greater than or equal to 10%. In 2023, the number is already bigger, although it is still the minority - 10 out of 27 (approximately 37%) of the EU member states. According to the results, the EU member state in which the largest percentage of enterprises use at least one AI technology is Denmark, even in 2021 and 2023. Romania is the EU member state in which, by contrast, the smallest percentage of enterprises use at least one AI technology, even in 2021 and 2023. In most EU member states, we can observe an increase in the percentage of enterprises using at least one AI technology in 2023 compared to 2021, except for six EU member states (Croatia, Denmark, Finland, France, Italy, Slovenia).

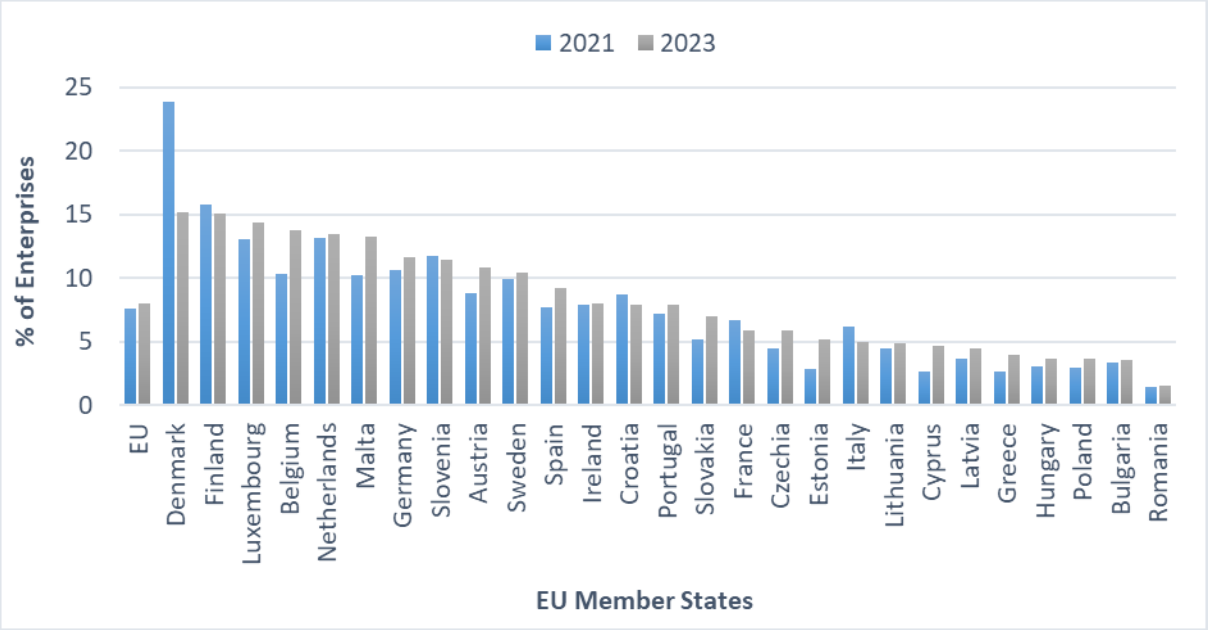

Figure 1 Enterprises which use at least one of the AI technologies with at least 10 persons employed and located in EU member states

The implementation of AI in enterprises can be influenced by several factors. As one of these factors Canhoto & Clear (2020) mention the inability to identify and manage risk which can lead some managers to delay the adoption of AI technologies and thus prevent them from realizing their potential. Enterprises must identify use-cases in which AI can create value, as well as decisions that can be supported or executed automatically. Furthermore, the organization will need to be transformed to be able to integrate AI-based systems into their human workforce (Kerzel, 2021). Therefore, the challenge is also how AI will affect the

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implementation of activities in the enterprise. All employees will be affected, their way of working, the way they make decisions, or do predictions and forecasts (Holtel, 2016). Xiong, Xia & Wang (2020) also state that to develop AI, firms need to get strong funding support. In addition to the financial complexity, other challenges of AI implementation in enterprises may include the technical complexity of the implementation, connection with existing systems, mistrust of AI technologies, lack of information, the need for employee training, or possibly other legal or ethical reasons.

RQ2: What is the percentage of enterprises in Slovakia compared to enterprises in EU member states using at least one AI technology in terms of their size class?

The largest share in the use of at least one AI technology in terms of enterprise size is represented by large enterprises in the case of the average of enterprises located in EU member states (28.4% in 2021, 30.4% in 2023) as well as in the case of enterprises located in Slovakia (19.4% in 2021, 21.9% in 2023) (Figure 2). The second largest percentage of enterprises that use at least one AI technology falls under the medium size class of enterprises. Small enterprises have the smallest percentage share of using at least one AI technology. For all size classes of enterprises, an increase in the percentage share measured in 2023 compared to 2021 can be observed. It is also possible to observe that not only on average, enterprises in Slovakia have a smaller percentage share than enterprises in the EU, but this also applies to each size class.

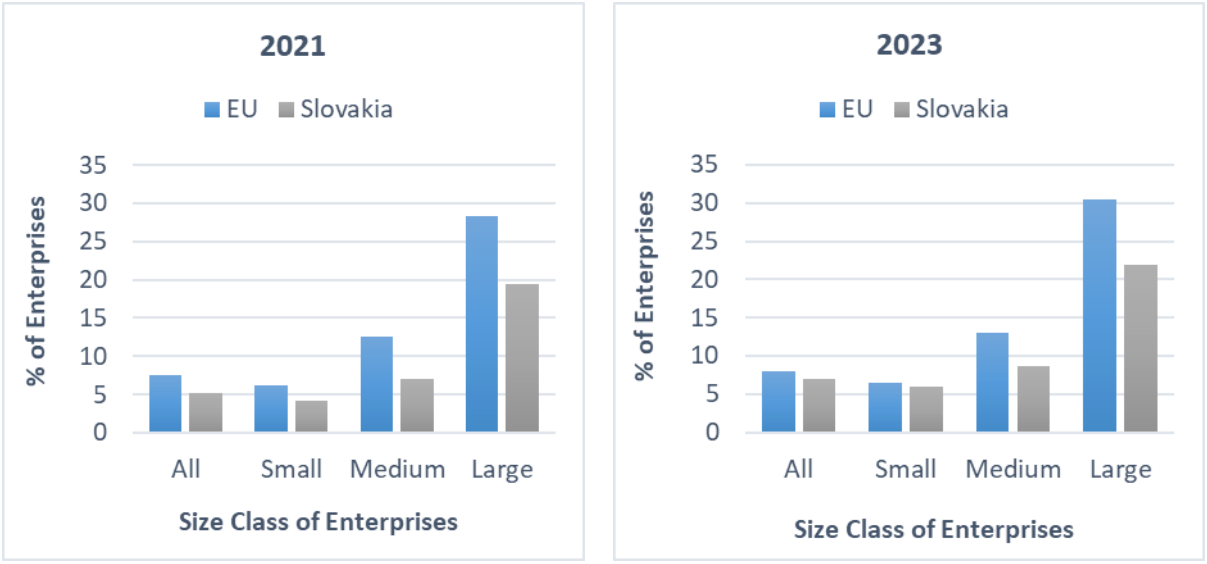

Figure 2 Comparison of the percentage of enterprises using at least one AI technology according to their size class in 2021 (left) and 2023 (right)

Small and medium enterprises may be slower to implement AI technologies than large enterprises for several reasons. It can also be related to the digitization of their processes and digital transformation of the enterprise. The enterprise for the use of the AI must conduct digital transformation of business (Buntak, Kovacic & Mutavdzija, 2021). Bettoni et al. (2021) stated that digitalisation includes innumerable elements and aspects that require models that are too complex to be easily applied by small and medium enterprises. Other reasons for slower implementation may also include the challenges associated with AI implementation, which are mentioned in the answer to RQ1. These challenges can be even greater in the case of small and medium-sized enterprises, such as smaller financial resources than large enterprises have, concerns about maintenance costs, less expertise knowledge, or a preference for longer-

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established methods. Also, some industries are more suitable for the implementation of AI than others (for example, it finds use in financial sector rather than in retail).

RQ3: What is the percentage of enterprises located in EU member states (all member states including Slovakia) using specific AI technologies?

The results point to a low use of specific AI technologies by enterprises located in EU member states (Figure 3). For this reason, it is possible to observe only small differences (in the interval of 1 to 2%) in the percentage of enterprises in the use of individual AI technologies. The situation is similar when comparing the use of individual AI technologies in 2021 and 2023. In the case of the average of all enterprises located in EU member states and with at least ten employees, TPA technologies are used the most (3% of enterprises) and TAR technologies are used the least (approximately 1% of enterprises).

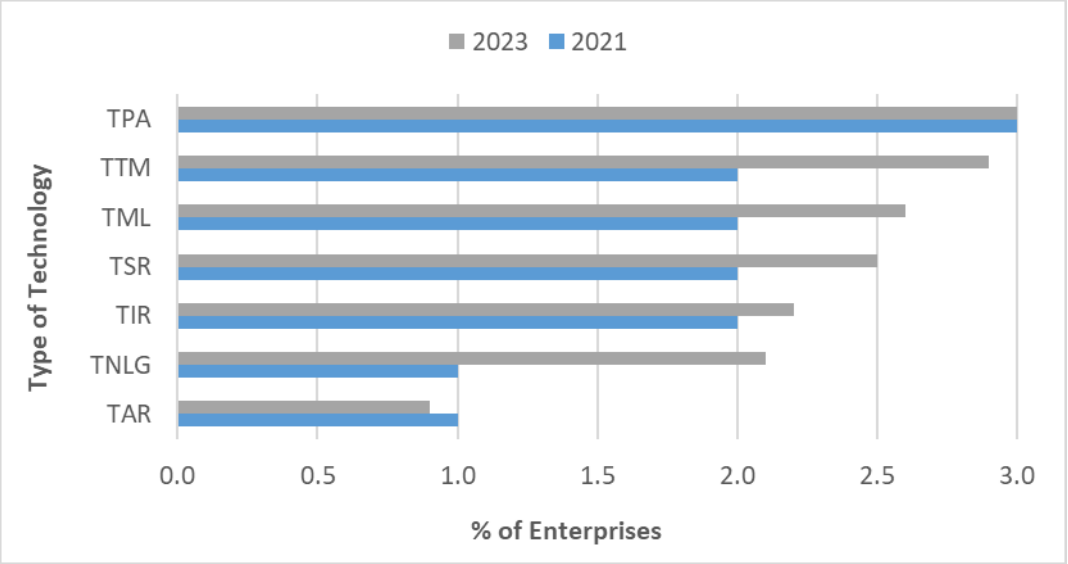

Figure 3 Enterprises with at least 10 persons employed compared according to the type of technology used

When looking more specifically at the use of individual AI technologies from the point of view of the size class of the enterprise, it is possible to observe the largest percentage share of large enterprises in the use of all types of AI technologies. Likewise, small enterprises have the smallest percentage share in the use of all types of technology. It applies to 2021 (Figure 4) and 2023 as well (Figure 5). When examining the increase or decrease in the percentage share of enterprises by comparing the years 2021 and 2023, in the case of small and medium-sized enterprises, it is possible to observe only a small increase or decrease (maximum 0.8%) in the use of individual AI technology. In the case of large enterprises, it is possible to observe an increase in the percentage of enterprises in the case of each type of AI technology - the increase was a maximum of 2.7% in the case of TNLG technology.

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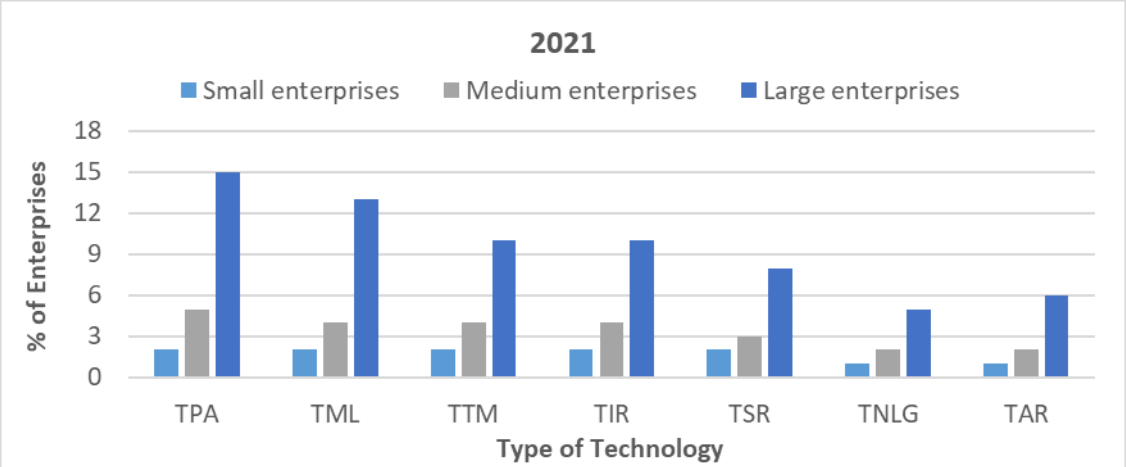

Figure 4 Enterprises divided by size class and compared according to AI technology used in 2021

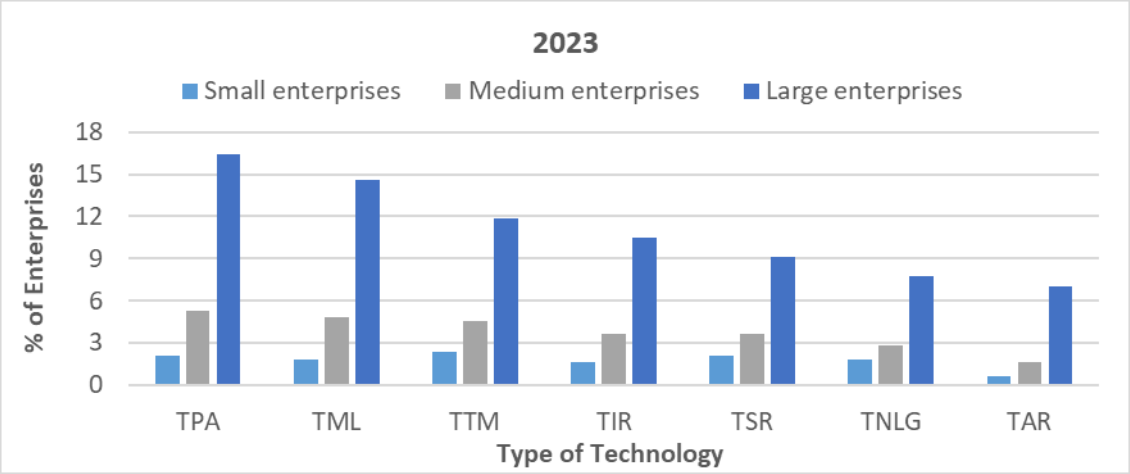

Figure 1 Enterprises divided by size class and compared according to AI technology used in 2023

Which technology is used more and which less can be influenced by the focus of the company and its resulting needs. Another influence may be the current state of technology development and its availability, which creates a greater/less possibility of applying the technology in practice. Also, different technologies may require different costs for their implementation, which may also be one of the factors influencing the use of technology. Over time and the development of AI technologies, the preferences of companies can also change.

4. Conclusion

From the results, it can be concluded that, on average, the use of AI technologies by companies in EU member states, including Slovakia, is not high. In most EU member states, the percentage of companies using at least one AI technology does not even exceed 10%. However, it is possible to observe an increase from year 2021 to 2023 in the use of AI technologies by enterprises, but this is only a modest increase. There are multiple internal and external factors and challenges that enterprises must face when implementing AI technologies into their processes. These factors can have an even more significant impact when we talk about small and medium-sized enterprises and cause slower implementation of AI technologies by small and medium-sized enterprises. This is also confirmed by the results, which show that there is a greater percentage of large enterprises using AI technologies than it is in small and medium-sized enterprises. Considering the trends in the use of ICT in various spheres of society and

progress in the development of AI, it is also possible to assume a growing share of enterprises using AI in their processes. Therefore, a more detailed examination of the causes and conditions for the development of enterprises in the field of using AI technologies in EU member states could be interesting for future work. The use of AI in enterprises also requires careful investigation in the long term and an examination of the benefits as well as the threats that may result from it.

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State Aid Distribution and Risk Management in Agriculture

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Abstract:
This paper uses individual farm data on state aid in agriculture to evaluate the distribution of state support for the period 2018 to 2022.
Every state aid to farmers needs to be notified by European commission to prevent overcompensation and to guarantee competitiveness of all Member states (MS). Otherwise, rich MS can support farmers with higher compensations which can decrease the competitiveness of farmers in other MS.
In Slovakia, the amount of state aid differs across farms due to the farm structure, which is dominated by large farms. Total amount of state aid to farmers increased significantly from 4.35 mil. EUR in 2018 to 104.15 mil. EUR in 2022. Support was paid to farmers via 12 state aid schemes in form of environmental taxes compensations, participation on exhibitions, damages on crop and animal production, insurance premium subsidies and others.
The state aid is supporting mainly large farms in Slovakia. 92% of the total state aid was received by beneficiaries – legal persons. Only 8% of the financial support was paid to small farmers – natural persons. The state aid is unequally distributed in Slovakia. We analyzed 2 state aid schemes: i) Insurance premium compensations and ii) Green diesel compensations using Lorenz curve and Gini coefficient. Both do show high level of inequality. 50% of all beneficiaries within each scheme receive only 8.59% of the total state aid in case of Insurance premium compensation and only 5.29% of the total state aid in case of Green diesel. Based on results of state aid concentration and inequality we recommend setting limits on volume of state aid per beneficiary.

Key words
State aid, support distribution, Lorenz curve, insurance premium

JEL Classification
D31, Q18

1.Introduction

Agriculture is the largest provider of food supplies and plays a vital role in delivering essential ecosystem services (Viana et al., 2022). However, efforts to boost productivity and yields have historically led to environmental degradation, reduced biodiversity, and diminished ecosystem services, with particularly severe impacts on vulnerable populations (Rehman et al., 2022).
The Common Agricultural Policy (CAP) and state aid measures are critical for ensuring agricultural sustainability and competitiveness. The CAP provides direct payments, rural development programs, and market support to increase farmers' incomes and encourage environmental stewardship. Severini and Tantari (2015) examine the distributional effects of CAP direct payments, highlighting their influence on income inequality among farmers. Moreover, state aid enables member states to offer financial assistance during crises, such as price fluctuations or climate-related challenges, thereby supporting farm viability and food

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security. State aid also functions as a fiscal policy tool to promote economic growth in the agricultural sector, especially during periods of economic instability (Podsiadło, 2021).

1.1 State Aid in EU agriculture

State aid in the European Union (EU) is prohibited under Article 107 of the "Treaty on the Functioning of the European Union" (TFEU) which defines it as any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favoring certain undertakings or the production of certain goods.

Despite the general prohibition of State aid, in some circumstances government interventions are necessary for a well-functioning economy. Therefore, there are exemptions that apply also specifically for agricultural sector. The EU´s Agricultural State aid rules consist of the following:

1.1.1 Agricultural block exemption regulation (ABER)

ABER refers to Commission Regulation (EU) 2022/2472 of 14 December 2022 declaring certain categories of aid in the agricultural and forestry sectors and in rural areas compatible with the internal market in application of Articles 107 and 108 of TFEU which replaced the previous Regulation (EU) 702/2014 from year 2014. The revision was necessary to align with the new Common Agricultural Policy and European Green Deal. It declares specific categories of aid compatible with EU State aid rules and exempts them from the requirement of prior notification to and approval by the European Commission. It applies until 31st December 2029 ("State Aid - Agricultural", 2023).

The categories for the aid include: SMEs (micro, small and medium-sized enterprises) involved in primary agricultural production, processing and marketing of agricultural products, environmental protection like agri-environmental-climate measures, conservation of cultural and natural heritage of farms and forests, repairs to damage from natural disasters, research &development in agriculture and forestry, forestry, SMEs in rural areas. The new categories of revised ABER include e.g. aid to prevent or compensate damage caused by protected animals, aid in favour of environmental management commitments or aid for cooperation in the agricultural and forestry sectors (European Commission, 2022).

1.1.2 Agricultural Guidelines

Agricultural guidelines refer to Communication from the Commission – Guidelines for State aid in the agricultural and forestry sectors and in rural areas 2022/C 485/01 which outlines the criteria the EU applies when assessing whether agricultural state aid can be considered as compatible with internal market and meets conditions of Article 107 TFEU. The revised Agricultural Guidelines applicable from January 2023 introduce the changes like an enlarged scope of measures targeting animal diseases and plant pests, allowing for aid to be granted for emerging animal diseases and certain invasive alien species or new incentives for farmers to commit to schemes under which they respect stricter environmental standards than what is required by law ("Guidelines For State Aid", 2023).

1.1.3 Small-scale (de minimis) aid for farming

De minimis aid refers to small amounts of national state aid which are exempted from EU state aid notification requirements. The beneficiary must be a business active in the primary production of agricultural products ("Small Scale", 2021). EU Member State can grant aid up to 20 000 EUR per farm over 3 fiscal years (with possibility to increase to 25 000 EUR per farm) as outlined by Regulation (EU) No 1408/2013 on small-scale (de minimis) aid for farming and amending Regulation (EU) 2019/316 which applies until 31st December 2027.

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In the literature, there are several papers examining regulations governing EU state in agriculture and its challenges and limitations (Wieliczko, 2018, Janku, 2015, Janku, 2017), but studies cover the previous CAP programming period and status-quo before introduction of European Green Deal. With regards to most recent studies in the context of European Green Deal, e.g. Georgieva and Blagoeva (2023) analyzed the tax relief for fuels used in agricultural production in Bulgaria while highlighting the inefficiency of fossil fuel subsidies and the need for reform and aiming to identify the proper alternative mechanisms to create a more stable, secure, and sustainable agricultural sector.

1.2 Agricultural State Aid in the EU in the context of Russia's war against Ukraine

War in Ukraine has caused serious disturbance to EU economy. As a result, Temporary Crisis Framework (TCF) was adopted on 23rd March 2022 to enable Member States to use the flexibility foreseen under State aid rules to support the economy. In 2023 the current Temporary Crisis and Transition Framework (TCTF) was adopted in order to further support the measures in sectors which are key for the transition to a net-zero economy (European Commission, 2023).

With regards to agricultural sector, limited amounts of aid were increased up to €280,000 and €335,000 in the agriculture, and fisheries and aquaculture sectors respectively. Currently the European Commission (EC) is consulting Member States on a limited prolongation for the primary agricultural sector of the TCTF section (European Commission, 2024).

2. Data and methods

We use the individual data on state aid and minimum support granted to farmers and other beneficiaries over the period 2018-2022 from the database of Agricultural paying agency. The state aid and minimum aid was granted to beneficiaries via 12 schemes. We analyse the volume, number of beneficiaries and the state aid distribution using Lorenz curve and Gini coefficient. The Gini coefficient is a widely used statistical measure for assessing income inequality, including within the agricultural sector. A study examining farm household income in Hungary used the decomposition of Gini coefficients by income sources to evaluate the effects of policy shifts from market-based to government support on income inequality (Fertö et al., 2022). Similarly, research on Italian farm households employed the Gini coefficient to investigate how off-farm income sources and CAP direct payments affect income distribution, revealing that both types of income help reduce income concentration (Severini & Tantari, 2014).
We use Gini coefficient to measure the inequality of support. A Gini coefficient ranges from 0 to 1. Value 0 reflects perfect equality in state aid distribution, where each beneficiary would receive equal payment, while a Gini coefficient of 1 (or 100%) reflects maximal inequality in state aid distribution. The Gini coefficient is equal to the area below the line of perfect equality minus the area below the Lorenz curve, divided by the area below the line of perfect equality. The mean absolute difference is the average absolute difference of all pairs of items of the state aid beneficiaries, and the relative mean absolute difference is the mean absolute difference divided by the average. If xi is the state aid to beneficiary i, and there are n beneficiaries, then the Gini coefficient G is given by:

$$G = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}|x_i - x_j|}{2\sum_{i=1}^{n}\sum_{j=1}^{n}x_j} \qquad (1)$$

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3. Results

State aid farm support in Slovakia

Farmers in all EU member states (MS) are besides the Common Agricultural Policy (CAP) also supported by state and minimum aid. State and minimum aid to farmers and food producers in Slovakia was increasing during the period 2018-2022. Volume was low in 2018 and 2019 and increased in 2020 to 37.82 mil. EUR, in 2021 to 44. 61 mil. EUR and in 2022 to 104.15 mil. EUR (Table 1).

Table 1: Development of state and minimum aid in Slovakia (in mil. EUR)

	2018	2019	2020	2021	2022
Total aid amount	4.35	1.99	37.82	44.61	104.15

Source: APA, open data, own processing

Aid is paid through state and minimum aid schemes. In the period 2018-2022, a total of 192.92 mil. EUR was paid to farmers in Slovakia using 12 schemes. Most of the financial support was paid through the scheme Green diesel, Drought, Insurance premium compensation and support for non-production functions of the forest (Table 2).

Table 2: Purpose of state and minimum aid schemes in Slovakia in 2018-2022 (in mil. EUR)

Type of state aid	2018	2019	2020	2021	2022	TOTAL
1. Drought compensation	0.00	0.00	0.00	0.00	41.68	**41.68**
2. Green diesel (compensation of environmental taxes)	0.00	0.00	25.72	25.92	32.03	**83.67**
3. Breeding value of animals (control and assessment)	1.20	1.20	1.20	1.60	2.00	**7.20**
4. Disposal of dead livestock	0.00	0.00	2.00	3.13	1.70	**6.83**
5. Non-productive functions of forests	2.30	0.00	3.00	5.99	5.99	**17,28**
6. Support of the food sector as a result of Russia's aggression	0.00	0.00	0.00	0.00	9.86	**9.86**
7. Insurance premiums in agricultural primary production	0.00	0.00	5.00	6.00	8.00	**19.00**
8. Employment of disadvantaged employees	0.05	0.00	0.12	0.21	0.00	**0.38**
9. Damage caused by animal diseases and reimbursement of eradication costs	0.00	0.18	0.14	0.80	1.72	**2.85**
10. Participation of breeders and growers in exhibitions	0.11	0.11	0.03	0.12	0.15	**0.50**
11. Participation of processors in exhibitions	0.30	0.00	0.12	0.14	0.15	**0.71**
12. Support of recognized breeding organizations	0.40	0.50	0.50	0.70	0.87	**2.97**
TOTAL	**4.35**	**1.98**	**37.82**	**44.61**	**104.15**	**192.92**

Source: APA, open data , own processing

The number of farmers and other beneficiaries supported by state aid is increasing. In total, 192 beneficiaries were supported in 2018, 20 in 2019, 2674 in 2020, 3023 in 2021 and 4211 beneficiaries in 2022 (Table 3).

Table 3:Total number of beneficiaries supported by state and minimum aid in Slovakia

	2018	2019	2020	2021	2022
Total number of beneficiaries	192	20	2 674	3 023	4 211

Source: APA, open data, own processing

The number of beneficiaries supported under individual schemes is shown in the table below (Table 4). Some entities were also supported within several support schemes. Therefore, the total number of supported entities is not identical to the sum of supported entities within the individual schemes below. Most entities are supported by Green diesel.

Table 4: Number of subsidies paid within individual state and minimum aid schemes

Type of state aid	2018	2019	2020	2021	2022	TOTAL
1. Drought compensation					2 367	**2 367**
2. Green diesel (compensation of environmental taxes)			2 225	2 498	2 697	**7 420**
3 Breeding value of animals (control and assessment)	3	3	3	3	3	**15**
4. Disposal of dead livestock			1	2	1	**4**
5. Non-productive functions of forests	127		174	181	283	**765**

6. Support of the food sector as a result of Russia's aggression					302	**302**
7. Insurance premiums in agricultural primary production			821	920	1 039	**2 780**
8. Employment of disadvantaged employees	8		21	20		**49**
9. Damage caused by animal diseases and reimbursement of eradication costs		2	10	7	7	**26**
10. Participation of breeders and growers in exhibitions	7	7	4	7	7	**32**
11. Participation of processors in exhibitions	48		14	7	20	**89**
12. Support of recognized breeding organizations	8	9	9	9	9	**44**
TOTAL	**201**	**21**	**3 282**	**3 654**	**6 735**	**13 893**

Source: APA, open data , own processing

As in the case of CAP, also in the case of state aid, large farms receive most of the financial support in Slovakia. These are mainly legal entities, i.e. limited liability companies, cooperatives or joint stock companies. Tin total over the period 2018-2022, legal entities (large farms) received up to 92% of the funds. Small individual farmers received only 8% of the total support. The reason for this situation is, in addition to the size structure of the farms, the absence of capping of state aid per farm. Small farmers had a higher than 8% share only in state aid in form of drought compensations in 2022, in support of Green diesel, insurance premiums and employment of disadvantaged workers. In some supports, legal entities have a share of up to 98% or more on the volume (Table 5).

Table 5: The share of natural and legal persons in the amounts paid

Type of state aid	Natural persons (mil. EUR)	Legal entities (mil. EUR)	TOTAL (mil. EUR)	Share Natural persons (in%)	Share Legal Entities (in %)
1. Drought compensation	4.82	36.85	41.68	12%	88%
2. Green diesel (compensation of environmental taxes)	7.69	75.98	83.67	9%	91%
3 Breeding value of animals (control and assessment)	0.00	7.20	7.20	0%	100%
4. Disposal of dead livestock	0.00	6.83	6.83	0%	100%
5. Non-productive functions of forests	0.37	16.91	17,28	2%	98%
6. Support of the food sector as a result of Russia's aggression	0.23	9.62	9.86	2%	98%
7. Insurance premiums in agricultural primary production	1.83	17,17	19.00	10%	90%
8. Employment of disadvantaged employees	0.06	0.31	0.38	16%	84%
9. Damage caused by animal diseases and reimbursement of eradication costs	0.10	2.75	2.85	4%	96%
10. Participation of breeders and growers in exhibitions	0.00	0.50	0.50	0%	100%
11. Participation of processors in exhibitions	0.01	0.70	0.71	1%	99%
12. Support of recognized breeding organizations	0.00	2.97	2.97	0%	100%
Total	**15,12**	**177.80**	**192.92**	**8%**	**92%**

Source: APA, open data, own processing

Further we analyze the distribution of support within i) Insurance premium compensation and ii) Green diesel compensation.

Insurance premium compensation: Price, production and income risk of farmers is growing due to climate change and recently also due to Russian war in Ukraine. In Slovakia, agricultural insurance market is significantly less developed than in the Czechia or Austria. This is reflected in insufficient supply of insurance products and high insurance premiums. Therefore, state aid is used to support insurance rate of farmers for risks related to crop and animal production by compensating a share of insurance premium paid (up to 50%). The insurance premium compensation supports growing number of farmers. In 2020, 821 farmers received support, in 2021 920 farmers, and in 2022 1 039 farmers.

Green diesel compensation: Animal and special plant production (fruits and vegetables) have social, environmental, and economic benefits. On the other hand, in Slovakia they are less profitable than growing cereals or technical crops. Therefore, breeders and growers of fruits and vegetables are compensated in the form of relief on environmental taxes. Each farmer receives compensation determined as a standard (in liters) multiplied by the number of animals/hectares and the mineral oil tax rate for diesel. In 2020, 2 225 farms received support, in 2021 2 498 farmers and 2 697 farmers in 2022.

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State aid in form of Insurance premium compensation and Green diesel is distributed unequal to farmers. As shown by Lorenz curve (Figure 1), Insurance premium is distributed more equal than Green diesel compensations.

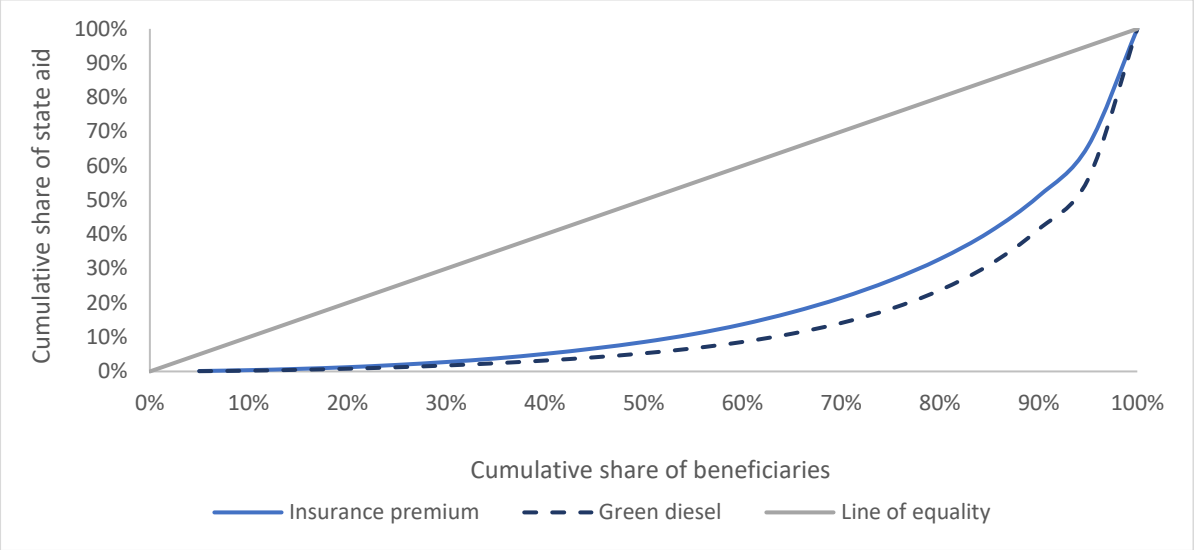

Figure 1: Lorenz curve of state aid distribution: Insurance premium and Green diesel in 2022
Source: APA, open data, own processing

Inequality of distribution is recorded in the table below (Table 6). 50% of all beneficiaries receive only 8.59% of the total state aid in case of Insurance premium compensation and only 5.29% of the total state aid in case of Green diesel. Higher inequality of Green diesel compensation is also confirmed by Gini coefficient. Gini coefficient of Insurance premium compensation is 0.64 and Gini coefficient of Green diesel compensation is 0.72.
10% of beneficiaries (104 farmers) with highest Insurance premium compensations receive 34.29% of the total support volume (2.74 mil. EUR out of total 8 mil. EUR). Highest compensation per farm was 307,6 thousand EUR in 2022.
10% of beneficiaries (207 farms) with highest Green diesel compensations receive 44% of the total support volume (14.1 mil. EUR out of total 32.03 mil. EUR). Highest compensation per farm was 1.15 mil. EUR in 2022.

Table 6: Distribution of state aid to beneficiaries in 2022: Insurance premium and Green diesel

Cumulative share of beneficiaries (%)	Cumulative share of Insurance premium support (%)	Cumulative share of Green diesel support (%)
0%	0,00%	0%
5%	0,12%	0,07%
10%	0,37%	0,23%
15%	0,74%	0,47%
20%	1,23%	0,79%
25%	1,91%	1,21%
30%	2,75%	1,74%
35%	3,79%	2,39%
40%	5,12%	3,18%
45%	6,72%	4,12%
50%	8,59%	5,29%
55%	10,88%	6,74%
60%	13,75%	8,61%
65%	17,26%	11,00%
70%	21,46%	14,13%
75%	26,58%	18,23%
80%	32,81%	23,71%
85%	40,69%	31,08%

90%	51,15%	41,46%
95%	65,71%	56,00%
100%	100,00%	100,00%
Gini coefficient	**0,64**	**0,72**

Source: APA, open data, own processing

4. Conclusion

Agriculture and farmers in EU are supported by public money and policies. EU Common agricultural policy is in terms of volume of financial support the most important policy supporting farmers in Slovakia. State aid is a complementary instrument.

Volume of state aid to farmers is increasing in Slovakia. Over the period 2018 to 2022 the volume reached 192.92 mil. EUR and this amount was paid to farmers in Slovakia using 12 schemes. Most of the financial support was paid through the scheme i) Green diesel compensation, ii) Drought compensation, iii) Insurance premium compensation and iv) Support for non-productive functions of forest. Number of beneficiaries is also increasing. While in 2018 only 192 beneficiaries were supported, in 2022 the number of beneficiaries increased to 4211.

The state aid is supporting mainly large farms in Slovakia. 92% of the total state aid was received by beneficiaries – legal persons. Only 8% of the financial support was paid to small farmers – natural persons. The state aid is unequally distributed. We analyzed 2 state aid schemes: i) Insurance premium compensations and ii) Green diesel compensations using Lorenz curve and Gini coefficient. Both do show high level of inequality. 50% of all beneficiaries within each scheme receive only 8.59% of the total state aid in case of Insurance premium compensation and only 5.29% of the total state aid in case of Green diesel. 10% of beneficiaries (104 farmers) with highest Insurance premium compensations receive 34.29% of the total support volume (2.74 mil. EUR out of total 8 mil. EUR). 10% of beneficiaries (207 farms) with highest Green diesel compensation receive 44% of the total support volume (14.1 mil. EUR out of total 32.03 mil. EUR).

Based on results of state aid concentration and inequality we recommend setting limits on volume of state aid per beneficiary. Similar instruments are also recommended within EU CAP and were introduced in Slovakia in form of capping Basic Income Support for Sustainability intervention.

Our analysis has several limitations. First, we will extend the observed period once data are publicly available, and we will also apply methodology (Lorenz curve and Gini coefficient) in individual years for all 12 state aid schemes. Second, we will evaluate the effect of state aid on profitability of farms and overcompensation by merging the data on state aid with financial statements of farms.

Acknowledgements:

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Driving Toward Sustainability: Understanding Consumer Attitudes and Preferences in the Electromobility Era

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Abstract

Paper's objective(s) and research background

Electric cars continue to actively enter our daily life, and become an independent, autonomously developing direction. In recent years, the importance of moving from a linear economy to a circular economy in every area and sector of the economy has been discussed more than ever before. This includes discussions on a net zero energy system as the basis for a fully decarbonised electricity sector. The increase in demand for electricity and the push for net zero emissions are leading to focus on the use of electric vehicles to meet the EU's sustainability targets. The article aims to find out the attitude of consumers towards electro mobility and their preferences and segment them.

Data/Methods

The main aim is to create homogeneous clusters of consumers preferences based on the obtained data from the questionnaire with the sample of 305 consumers. After calculation Cronbach's alpha and performing Shapiro-Wilk test of normality, segmenting big datasets was made using k-means clustering, followed by an Agglomerative Hierarchical Clustering (AHC) using the XLSTAT software.

Results/Conclusions/Value added

A gradual shift of the main interest from automakers to electric vehicles is seen, while simultaneously there are other questions connected to electric vehicles which need to be addressed and analysed as consumer preferences. The results showed that some consumers have insufficient information about electric cars. The constant debate on the subject has also influenced public opinion. Segmentation of consumers was done and clusters of consumer's preferences were described according their gender, age, status, education and field of work and other factors of preferences asked in the questionnaire. This can suit as a guide on the three groups of consumers on what information should be provided to them and discussed more, so consumers could be more and more confident to choose electro mobility.

Key words

Electric vehicles, consumer behaviour, cluster analysis, segmentation, preferences, k-means

JEL Classification

O30, O33, Q55, R40

1. Introduction

Growing environmental concerns and technological breakthroughs have sparked a dramatic paradigm change in the automotive industry toward sustainable transportation solutions in recent years. The Changes of climate effect significantly electric sector, electricity demand, supply, as well as infrastructure (Jaglom, 2014). The aim of the Paris Agreement from 2015 to keep global warming to no more than 1.5°C requires greenhouse gas emissions to reach net zero by 2050 (Bataille et al., 2018). As the result of global warming, the annual cost of

production of electricity will increase by 14% by 2050 (Gerlak, et al. 2018). Helmers and Marx (2012) state that electric vehicles have been identified as being a key technology in reducing future emissions and energy consumption in the mobility sector. Electric vehicles (EVs) are experiencing a rise in popularity over the past few years as the technology has matured and costs have declined, and support for clean transportation has promoted awareness, increased charging opportunities, and facilitated EV adoption (Muratori, 2021). However, as noted by Samarakoon et al. (2024), since electric vehicles are new to the market and their current market share is tiny, people must grasp a lot of information, including how beneficial it is for the environment and how, over time, it saves petrol money since current costs are soaring. Implementing electric vehicles faces challenges such as high upfront costs, limited driving range, charging infrastructure inadequacy, and public perception, despite that overcoming these challenges can accelerate the transition to a sustainable transportation system and mitigate climate change impacts (Alanazi, 2023).

In order to effectively navigate the shift towards a more sustainable transportation landscape, stakeholders such as politicians, industry participants, and researchers must have a thorough understanding of consumer attitudes and preferences in this era. Examining consumer perceptions of EVs provides information about the underlying causes, obstacles, and drivers affecting their uptake, which helps shape policies supporting environmentally friendly transportation. Studies in this area cover a wide range of topics, from the advantages that electric vehicles (EVs) have for the environment to the socioeconomic variables that affect customer decisions. To understand the intricacies of consumer behavior, researchers examine the interactions between legislative interventions, market dynamics, technology innovation, and personal preferences. According to Toolib, S. N., et al (2023), four factors were identified as important factors contributing towards EV adoption which are: (1) environmental concerns, (2) government policy, (3) government incentives, and (4) charging infrastructures. AS Soltani-Sobh et al., (2017) states in their research, electricity price affects electric vehicle adoption rate the most. Moreover, the time trend model analysis found that the electric vehicle adoption has been increasing over time, which is consistent with theories about diffusion of new technology. Sierzchula et al. (2014) results suggest that charging infrastructure was most strongly related to electric vehicle adoption. However, descriptive analysis suggests that neither financial incentives nor charging infrastructure ensure high electric vehicle adoption rates. High environmental concern individuals are more likely to purchase eco-friendly goods and take part in environmental conservation initiatives (Greaves et al., 2013). With the improvement of living conditions, people expect higher environmental quality and will pay more attention to environmental related topics. Therefore, government and relevant institutes can provide various channels for people to recognize environmental issues widely and thoroughly (Wu, J. et al, 2019). A key focus is the role of financial and soft incentives to encourage EV adoption as Broadbent, G. et al, (2018) states. Their analysis reveals that not all incentives are equally effective; an adequate recharger network appears to be a common concerning factor for EV adoption due to customer anxiety and vehicle limitations. Best practice strategies that could foster a faster transition to EV adoption include appropriate legislation, installation and maintenance of an adequate public recharger network, government procurement programs, and investment in information programs to accelerate the transition towards fossil free driving. However, the current policies in the EU are not making use of the full environmental potential of EVs and therefore regulatory gaps have been identified, moreover it was shown that existing policies do not differentiate sufficiently between different EVs (Peiseler and Serrenho, 2022).

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2. Data and Methods

The objective of the paper is to divide the sample of 305 Slovakian consumers into homogeneous clusters and further categorize them using the information gathered from the questionnaire collected online. The sample was chosen according to the gender as a balanced selection of 152 males and 153 females. Except gender, other five other primary sorting criteria were included in the questionnaire: status, field of work, age, region and monthly income. The rest were questions about the preferences, knowledge and attitudes toward electro mobility. The computation of Cronbach's alpha and the Shapiro-Wilk test of normality (Shapiro and Wilk, 1972) were performed, where non-normal data distribution was verified. XL-STAT software was used to perform next tests as Agglomerative Hierarchical Clustering (AHC) with the k-means clustering for segmenting large dataset and later interpreted.

3. Results and Discussion

Electric vehicles (EVs) play a pivotal role in driving towards sustainability. In Slovakia, the share of ECVs was 3.7 percent of all new registrations in 2022. The average annual net income for 2021 was €10,985 (The Slovak Spectator, 2023). By 2028, the unit sales of Electric Vehicles market in Slovakia are expected to reach 6.28k vehicles. The volume weighted average price of Electric Vehicles market in Slovakia is projected to be €50.3k in 2024. Slovakia's electric vehicle market is rapidly growing, fuelled by the country's strong automotive manufacturing industry (Statista, 2024). The study of Axsen et al. (2015), segmented respondents using two approaches that proved to be complementary. Preference-based segments, were potential EV buyers were split into a “EV-enthusiast” segment (8% of sample) with extremely high valuation of EVs and a broader “EV-oriented” segment (25%) that expressed moderately positive valuation of EVs. Second approach constructed lifestyle-based segments using cluster analysis on a subset of potential early EV buyers (33% of the total sample). Overall preferences were fairly similar across the clusters, though apparent motivations varied substantially by cluster as indicated by their differing engagement in lifestyles and environmental concern.

From the analysis of the obtained data, Cronbach's Alpha result of 0.776 showed that the model in use has a high degree of reliability and is appropriate for additional statistical analysis. The Shapiro-Wilk test revealed p values of less than 0.0001, indicating that the data do not fit into a normal distribution. The k-means followed by the AHC analysis resulted in computing segmentation 3 clusters of consumers, with visible distances between them (Figure 1).
Cluster one a three differs the most, because of longest distance between. Cluster one consist from 187 consumers out of which the gender is distributed in similar amount as well as in cluster two, but with the overall number of consumers of 58. Almost the same number of consumers is part of cluster three (61), but with more female consumers. All the clusters have highest number of consumers in the status as student followed by employed consumers. The first cluster differs with a high number of self employed consumers compared to other two clusters, and more than half is a working cluster. With a difference of almost 4 percentage points from the other clusters, cluster 3 has the greatest percentage for status of unemployed consumers. The status is connected as well with the age where the distribution among clusters are similar with the highest of 21- 30 - more than 50% of consumers from all 3 clusters, followed by 31-40 age.
Many EV owners are people with high incomes living in large households in or around cities, and thus similar to other multicar owners. They value the economy of electric motoring, the environmental benefits, and that EVs meet their transport needs as Figenbaum, E., (2014) discovered. Most of the consumers with the highest income were part of first cluster.

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Compared to other clusters, Cluster 1 exhibits significantly greater percentages of consumers from regions of Nitra, Banska Bystrica and Zilina. The percentages within clusters in Cluster two are comparatively balanced across various locations. When compared to other clusters, it stands out thanks to higher percentages for regions of Trnava, Trenčin and Košice.

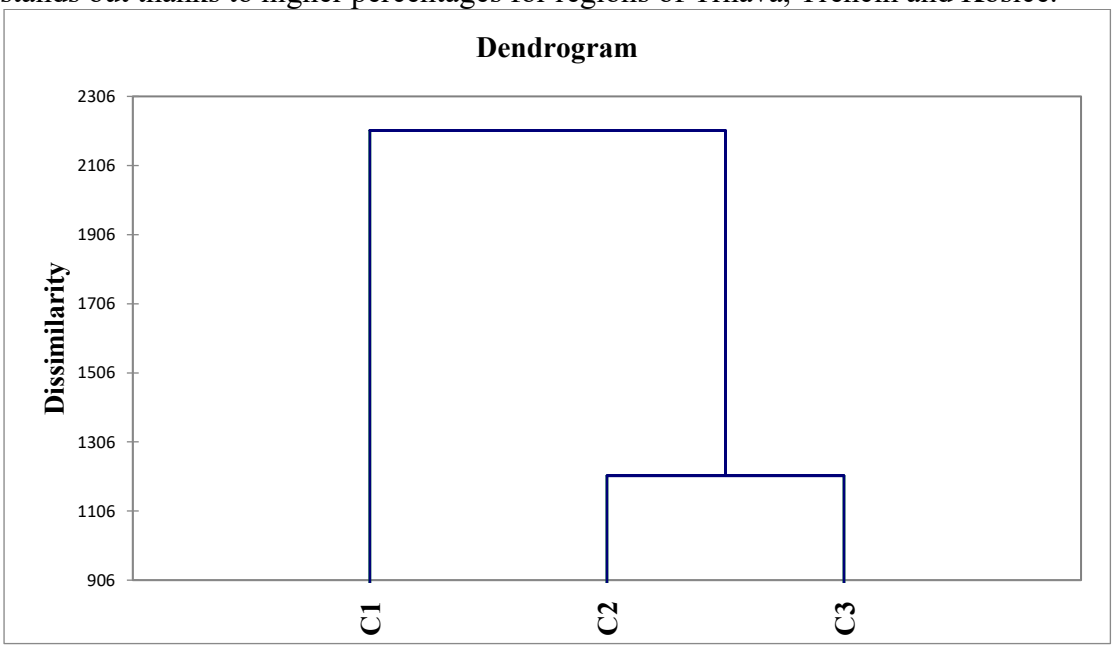

Figure 1: Dendogram of dissimilarities between clusters
Source: author's processing

The average position of data points within each cluster is represented by the cluster centroids in Agglomerative Hierarchical Clustering (AHC) analysis. In the process of hierarchical clustering, the centroid of a cluster is changed to reflect the new average position of the component data points after each phase of merging. The cluster's representative point is this centroid.

For following three questions to begin with the range of answers was: 0 yes and 1 for no:

Have you ever come across the term Electro mobility?

Do you think that electro mobility is our future?

Have you ever used an electric bicycle (e-bike)?

All the clusters had similar responses with close to 0, which means that they answered in positive manner on all of them.

Table 1. Class centroids factors 1-11

Class/factors	1	2	3	4	5	6	7	8	9	10	11
1	0.796	0.586	1.296	1.247	0.855	0.538	0.634	0.790	0.522	0.511	0.452
2	2.845	1.086	1.379	1.517	1.069	2.362	2.414	2.672	1.724	2.966	2.966
3	1.836	1.508	2.115	2.000	1.721	1.377	1.262	1.295	0.902	0.705	0.803

Source: author's processing

With the given range of responses (sure yes 0, rather yes 1, I don't know 2, rather not 3, certainly not 4) we can conclude that (table 1):

Interest in Owning an Electric Car

(1. Question: Would you ever like to own an electric car?):

Cluster 1: A significant predisposition towards wanting to acquire an electric automobile is indicated by the centroid score of 0.796.

Cluster 2: A higher inclination to dislike owning an electric vehicle is indicated by the centroid value of 2.845.
Cluster 3: A modest predisposition towards wanting to acquire an electric car is indicated by the centroid score of 1.836.
One of the most important features of an electric car is the range and power of movement (acceleration, speed, incline, loading and flexibility), charging time and the high price of batteries in most existing electric cars (Molavi, A., & Taghipour, M. 2023).

Need for Infrastructure for Electric Charging

(2. Question: Do you think it is necessary to have an electric station at home, or is it enough to charge in shopping centres, gas stations?):

Cluster 1: The centroid value of 0.586 suggests a preference for having an electric station at home than charging only in locations like shopping centres and gas stations.
Cluster 2: The centroid value of 1.086 indicates some uncertainty or ambivalence regarding the need for electric charging at home.
Cluster 3: The centroid value of 1.508 also suggests even higher uncertainty, leaning slightly towards the preference for not having charger at home.

Knowledge and Awareness (questions 3-5):
Do you know how far a fully charged electric car can travel?
Do you know the difference between the consumption of an electric car and a (diesel, gasoline) car
Do you know where electric cars are sold?
Cluster 1: In general, the centroid values are lower (They are more inclined towards "rather yes" responses) for questions pertaining the knowledge of electric cars, such as where they are sold.
Cluster 2: The little higher centroid values suggest that respondents in this cluster may be more questioning electric vehicles but still rather know about EV.
Cluster 3: No degree of knowledge and awareness is suggested by values (1.721-2.115) that are comparable to those of Class 2.
Buhmann, K. M., & Criado, J. R. (2023) also states that better infrastructure and information availability help to promote EVs.

Attitudes towards Electro mobility (question 6-9):
Would you buy an electric car to drive mainly around town?
Would you rather have a specialized electric car store in one place?
Do you consider an electric car a luxury form of vehicle?
If your employer provided you with the use of an e-bike for free, would you use this opportunity to ride to work?
Cluster 1: The centroid values of this cluster for these aspects indicate the strongest inclination towards these questions (0.522-0.790)
Cluster 2: The centroid values for these aspects indicate a reluctance or refusal towards adopting electromobility, while the values result from 1.724- 2.672 I don't know to rather not.
Cluster 3: This cluster showed moderate inclination towards adopting electro mobility from the values in table 1.

Environmental Factors to be considered (question 10-11):
Do you think that the predominance of electric cars over cars (diesel, gasoline, gas) would change the environment for the better?
Do you think that electromobility is the right investment for a greener future?

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Cluster 1: The centroid values are comparatively low “sure yes” for questions about environmental concerns. This suggests a stronger belief in the environmental advantages of electric vehicles.
Cluster 2: The centroid values are high (around 3), suggesting a greater tendency to respond "rather not" when asked about the advantages of electro mobility for the environment.
Cluster 3: Values are higher compared to Cluster 2 but still suggest a positive attitude towards the environmental benefits of electro mobility with rather yes responses.

Table 2. Class centroids of chosen factors

Class/ factor	Reason for buying EV	Advantage of EV	Dis-advantage of EV	Difference between EV and a regular car? (green license plate)	Motiva-tion to buy EV	Seen electric bicycle? What would you compare it to?	Which type of car would you choose in case of the same price
1	1.102	2.280	1.532	0.898	1.769	0.704	3.161
2	4.259	4.828	1.759	0.517	2.897	0.776	2.224
3	2.131	2.590	2.082	1.492	2.426	0.852	4.443

Source: author’s processing

The perceived usefulness, perceived ease of use, relative advantage, attitude and interest to buy were the factors investigated to know the interest and willingness of customers to buy the electric cars. (Prabaharan, M., & Selvalakshmi, M.,2020).
We can characterize clusters in more depth according to examined factors from the table 2.

Eco-conscious Enthusiasts: Consumers in this cluster see the reason for buying an electric car in charging them as an expense in the accountancy. They think that the biggest advantage of an electric car is an ecological aspect and biggest disadvantage is the charging and degrading of a battery. Most of them didn’t come across green licence plate and state support in the form of a subsidy or monthly vehicle testing would motivate them to buy EV. They would you compare electric bicycle to riding a motorcycle and they would choose CNG engine (compressed natural gas engine) in case of the same price of any vehicles.

Skeptical Consumers: Consumers in this cluster don’t know the reason for buying an electric car. They see the main benefits in their easiness of use and disadvantage in the degrading of a battery. About half seen the green license plates and half not. Scrapping fee for an old car would be a motivation to buy EV. When same prices of various vehicles, they would prefer LPG and they also compare electronic bicycle to riding a motorcycle.

Moderate Adopters: This group of consumers see the benefits of purchasing an electric vehicle in the low noise which they also chose as the biggest advantage. They view battery degradation as a drawback. Most can’t see the difference between an EV and a regular car and an incentive to purchase an EV would be monthly vehicle test. They would choose EV when the prices of other cars were the same, and they also liken riding an electronic bicycle to riding a motorcycle.

4. Conclusion

This study aims to explore the nuances of consumer attitudes and preferences in the electro mobility age in this environment. In order to clarify the specifics of consumer behaviour in the

context of sustainable mobility, this research focuses on ideas from academic literature, empirical research, and industry reports.

We segmented the consumers to three distinct clusters using cluster analysis according to the selected factors. First and the most different cluster from others were Eco-conscious Enthusiasts, which can be characterized with strong inclination towards adopting electro mobility for environmental reasons, preference for having an electric station at home, moderate knowledge and awareness about electric cars and would be motivated by state support and incentives to buy EVs, but still would choose CNG before EV. Sceptical Consumers are reluctant towards adopting electro mobility. They are uncertain about the benefits of owning electric car, view battery degradation as a drawback and prefer LPG when prices of vehicles would be the same. Moderate Adopters incline towards adopting electro mobility, see benefits in the low noise of electric vehicles, view battery degradation as a drawback and as the only one cluster would choose EV when prices of other cars are the same. Overall, Cluster 1 is distinguished by its strong tendency to embrace electro mobility and conviction in its environmental advantages, whereas Cluster 2 demonstrates doubt and ambiguity, and Cluster 3 is indicative of a more moderate position with optimistic views regarding environmental factors.

This study intends to educate policymakers, industry stakeholders, and researchers on practical ways in which different consumers could be encouraged to choose electro mobility and cultivate a more sustainable future by clarifying these dynamics. Muratori, M., et al. (2021) detailed review also paints a positive picture for the future of EVs for on-road transportation, and the authors remain hopeful that remaining technology, regulatory, societal, behavioural, and business-model barriers can be addressed over time to support a transition toward cleaner, more efficient, and affordable transportation solutions for all.

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Food Security in Eastern and Central Europe During the COVID-19 Pandemic: A Case Study of Slovakia

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Abstract

Paper's objective and research background

This study examines the dynamics of food security in Slovakia, with a broader focus on Eastern and Central Europe, particularly considering recent global crises such as the COVID-19 pandemic and the conflict in Ukraine. The research investigates how these crises influenced household expenditure structures, with an emphasis on food expenses, within the period from 2019 to 2021. Given the significant economic disruptions caused by these events, the study aims to assess the extent of changes in household consumption patterns and their implications for food security.

Data and Methods

The analysis is based on data from the Household Budget Survey (HBS) conducted by the Statistical Office of the Slovak Republic, complemented by comparable data from Eurostat. The study employs descriptive statistical methods to examine shifts in expenditure allocations, particularly focusing on the share of household income spent on food and other essential goods. Additionally, comparative analysis is used to contextualize the findings within the broader European framework, distinguishing trends in Eastern and Central European countries from those observed in the EU-27.

Conclusions

The findings reveal a notable shift in consumer behavior regarding expenditure allocations in Slovakia. Households increasingly prioritized essential goods such as housing and food while reducing spending on discretionary categories like restaurants, hotels, culture, and recreation. In 2021, Slovak households allocated 26.4% of their income to housing, reflecting an increase of 4.3 percentage points compared to previous years, while food expenditures rose to 30.7%. This trend suggests growing financial pressure on households and a potential risk of deteriorating food security. Similar patterns were observed across Eastern and Central Europe.

Key words

Food security, Covid-19, HBS, COICOP, Household expenditures

JEL Classification

D12, Q18, O13, P46

1. Introduction

Food security is a key concept in public health and social stability (FAO, 2023; Jonas et al., 2013; García-Díez et al., 2021). The concept of food security was formulated and adopted in the Declaration on World Food Security in 1996 (FAO, 1996). Food security of a country is defined by various indicators such as the country's food self-sufficiency, the quality of products on the market, food supply chains, and the price of the foods themselves. These factors influence the extent of household income allocation to food and non-alcoholic beverages. The proportion of household expenditure on food is one of the indicators of a country's food security. Economically, it is observed that poorer and more vulnerable households spend a

larger proportion of their income on food. As income increases, there is an increase in expenditure on food and an even higher increase in expenditure on other products, resulting in a decrease in the proportion of total income spent on food (Nsabimana et al., 2020; Bidisha et al., 2021; Maimekova & Amico, 2021; Gill & Nagle, 2022; French et al., 2019).

In the regions of Eastern and Central Europe, food security has had varied developments. For most countries in the region, economic liberalization caused dramatic changes in the food demand system as well as overall agricultural productivity (Swinnen & Herck, 2012). During the 1990s, a period of transition, food security worsened and poverty increased in the countries of Eastern and Central Europe. However, since 2000, these regions have experienced significant growth and increasing incomes, which reduced poverty and improved food security (Burkitbayeva et al., 2021). A positive trend was also recorded in Slovakia. In a case study on food demand, researchers noted a decrease in the ratio of household food expenditures between 2004 and 2010 throughout the entire period studied (Cupak & Pokrivcak, 2015). However, there was a reversal in this trend after the 2010s. According to Eurostat results for the period from 2009 to 2019, the share of food expenditure increased the most among Slovak and Czech households (among European Union countries). In the Czech Republic, there was an increase of 1.3% (to 15.2%), and in Slovakia, an increase of 1.1% (to 17.3%) was recorded. In most European Union countries, household food expenditures remained stable (Eurostat, 2020).

The state of food security, whether globally or in the countries of Eastern and Central Europe, has been negatively affected by the Covid-19 pandemic and the ongoing war in Ukraine. The Food and Agriculture Organization (FAO) stated in its global assessment report that in 2022 the world was still recovering from the Covid-19 pandemic and had to face a new adverse situation, the war in Ukraine (FAO, 2023). The Covid-19 pandemic and the conflict in Ukraine caused problems in Europe such as supply chain disruptions, food insecurity, rising food prices (food inflation), increases in agricultural inputs and energy costs, and a reduction in the purchasing power of the population. These issues have a direct negative impact on global food security (Behnassi & Haiba, 2022; Molteni, 2023; Caprile & Pichon, 2022; Faqin et al., 2023). A statement from the United Nations mentioned that the combination of the Covid-19 pandemic and the conflict in Ukraine has led to the biggest food crisis since World War II (United Nations, 2022).

2. Data and Methods

In this study, we use data from the Household Budget Survey (HBS) collected by the Statistical Office of the Slovak Republic. Additionally, we use HBS data from Eurostat for European countries (Eurostat, 2024). Both data sets capture the allocation of household income according to the "Classification of Individual Consumption by Purpose" (COICOP). COICOP consists of twelve categories: Food and non-alcoholic beverages; Alcoholic beverages, tobacco and narcotics; Clothing and footwear; Housing, water, electricity, gas and other fuels; Furniture, household equipment and general home maintenance; Health; Transportation; Recreation and culture; Education; Restaurants and hotels, and Various goods and services. HBS data are commonly used to analyze social policies, quality of life, to define the weights of the consumer price index, and to estimate household consumption in national accounts. Our database from the Statistical Office of the Slovak Republic consists of three annual rounds from 2019 to 2021. The data from the Slovak Household Budget Survey (HBS) make up a database of 4633 households, each assigned a weight based on the representativeness of the sample. Information on household expenditures is collected over a one-month interval by the Statistical Office of the Slovak Republic. The data used from Eurostat represent the final table with average household expenditures by purpose for each country in Europe. Due to differences in data collection methodologies between domestic HBS and Eurostat HBS, there are slight discrepancies between the data. Although both HBS sources and Eurostat use COICOP for

categorizing data, the data collection methods, time frames, sample sizes, and sample weights differ between the two sources. These differences can lead to variations in the percentage share of expenditures on COICOP categories between HBS data collected by the Statistical Office of the Slovak Republic and data from Eurostat (Eurostat, 2024). Therefore, we do not compare data from different sources directly but conduct separate analyses in the datasets. All data from the HBS database are recalculated to household size. In this work, we do not use the number of persons as household size, as consumption patterns for children or larger adult families change non-linearly. Therefore, we use the equivalent household size according to the OECD scale[3]. The aim of our work is to evaluate the impact of Covid-19 on the food security of Slovak households based on these HBS data from the Statistical Office of the Slovak Republic and from Eurostat.

Before using descriptive statistics, it was necessary to prepare the data, to check whether there are zero or non-numeric values in some essential expenses (such as housing and food expenses), plus we aggregated some variables such as Food and non-alcoholic beverages (CP01) and Catering services (CP111) and we created a new variable "total expenditure on catering". We implemented these modifications using the Pandas library and NumPy in Python. We then used descriptive statistics such as weighted mean, median using the Statsmodels library in python. We implemented data visualization using Matplotlib and Seaborn library in Python.

3. Results and Discussion

In our research, we primarily focus on the area of household expenditures, although it should be noted that when analyzing a country's food security, several aspects of the country need to be considered. We will analyze the food security of Slovakia by using the allocation of Slovak household expenditures according to the COICOP classification. The COICOP classification divides household expenditures by purpose into 12 categories. The structure of Slovak household expenditures according to the COICOP classification in 2021 and the difference in expenditure allocations of Slovak households between 2019 and 2021 can be seen in Figure 1. The dark blue values in Figure 1, labeled "SVH HE 2021," capture the allocation of household expenditures in Slovakia in 2021. The pale blue color represents the percentage change in expenditure allocation between 2019 and 2021. There was an increase in expenditures primarily in basic goods and services, such as housing and food and non-alcoholic beverages. In 2021, households in Slovakia had on average 4.3% higher housing expenditures compared to 2019, which can be considered a negative phenomenon. A similarly negative trend was observed in expenditures related to food, where Slovak households in 2021 spent 2.2% more on food and non-alcoholic beverages than in 2019.

[3] First adult in the household = 1.0; each additional adult (aged 14 and older) = 0.5; each child (under 14 years of age) = 0.3; Calculation rule: HB062 = 1 + (0.5*(A-1)) + (0.3*B); A = Total number of household members where MB03 >= 14; B = Total number of household members where MB03 < 14.

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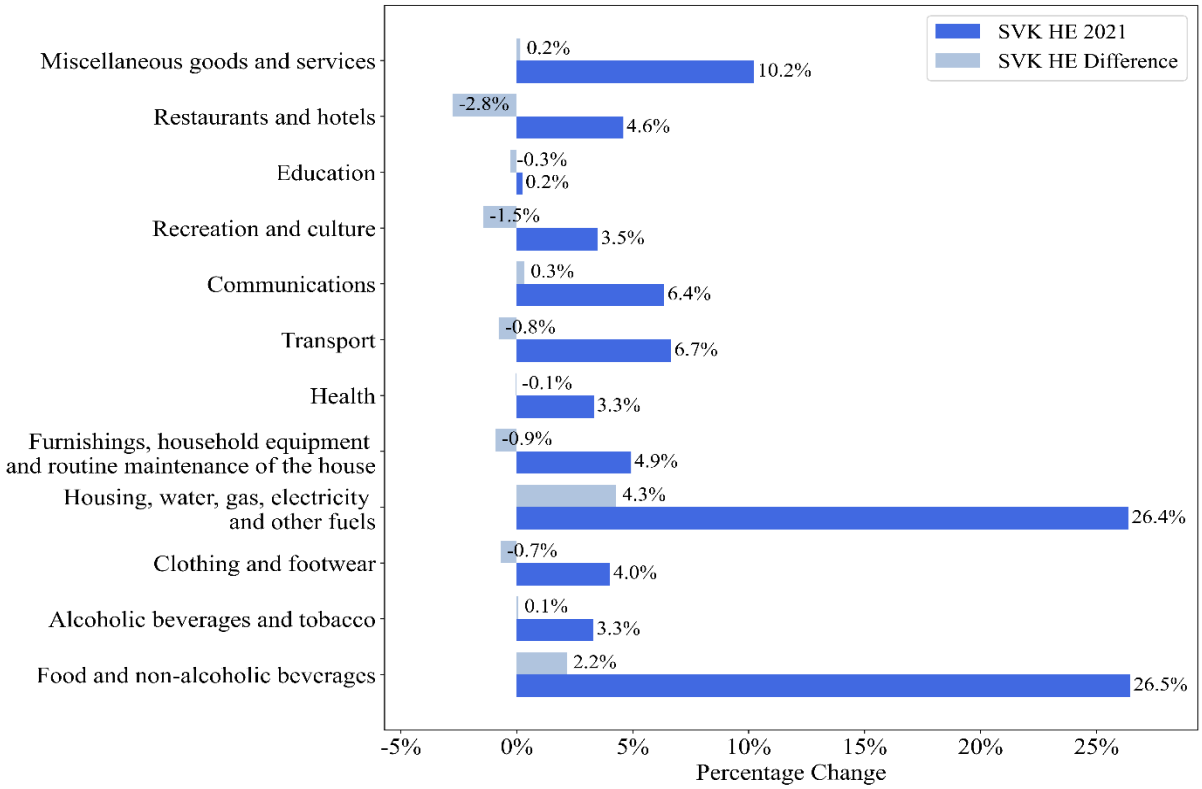

Figure 1: Comparison of Household Expenditures by COICOP Category
Source: Statistical Office of the Slovak Republic, own processing in Python
Note: SVK HE 2021: Weighted household expenses in 2021.
SVK HE Difference: Difference between weighted household expenses in 2019 and 2021

The dark blue values in Figure 1, labeled "SVH HE 2021," capture the allocation of household expenditures in Slovakia in 2021. The pale blue color represents the percentage change in expenditure allocation between 2019 and 2021. There was an increase in expenditures primarily in basic goods and services, such as housing and food and non-alcoholic beverages. In 2021, households in Slovakia had on average 4.3% higher housing expenditures compared to 2019, which can be considered a negative phenomenon. A similarly negative trend was observed in expenditures related to food, where Slovak households in 2021 spent 2.2% more on food and non-alcoholic beverages than in 2019. Conversely, the largest decrease in expenditures occurred in goods and services that have a more luxurious character in terms of price elasticity. These were goods and services from the "Restaurants and Hotels" category, which saw a decrease of 2.8%, and from the "Recreation and Culture" category, where there was a decrease of 1.5% in total household expenditures. It should be noted that during the Covid-19 pandemic, this consumer behavior was consistent with larger global trends (GLOBSEC, 2022).

If we look at the separate monthly expenditures of Slovak households on food and non-alcoholic beverages, and at expenditures on catering services recalculated per household size shown in Figure 2, we can see that there were changes in consumer behavior between 2019 and 2021.

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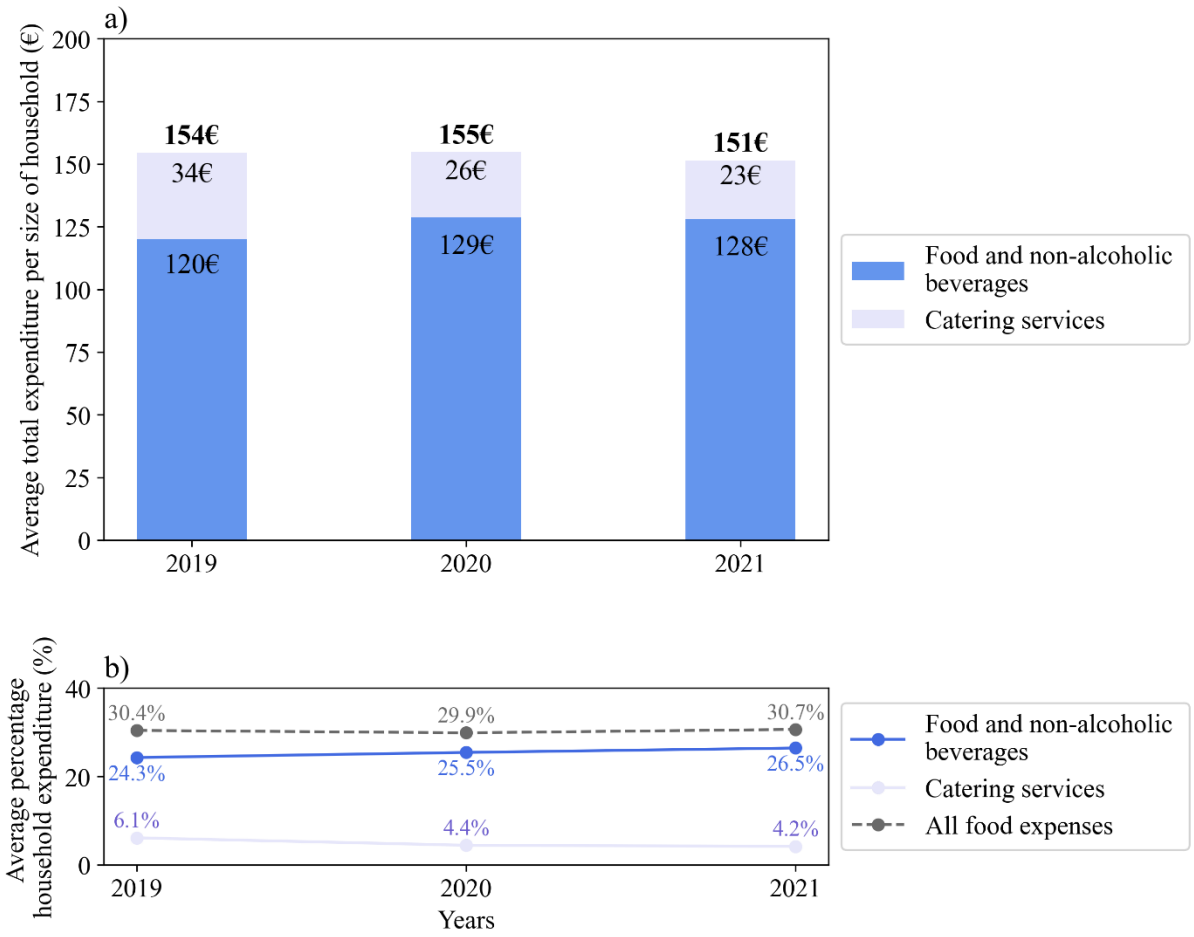

Figure 2: Household Food Expenditures; a) per person; b) distribution of household expenditures on food

Source: Statistical Office of the Slovak Republic, own processing in Python

Note: Food and non-alcoholic beverages CP01, Catering services CP111

Expenditures allocated in 2019 for catering services partially transformed in 2021 into expenditures on food and non-alcoholic beverages. In 2019, the average monthly expenditures per household size were €120 (24.3%) on food and non-alcoholic beverages and €34 (6.1%) on catering services. Together, the average expenditures on food recalculated for the size of a Slovak household were €154. The average Slovak household allocated 30.4% of its income to food in 2019. In 2021, the structure of expenditures spent on food changed. Households allocated more of their income to food and non-alcoholic beverages and less to catering services. These changes in consumer behavior can be attributed to the Covid-19 pandemic, which has forced households to eat more at home. In 2021, the average monthly expenditures per household size were €128 (26.5%) on food and non-alcoholic beverages and €23 (4.2%) on catering services. Together, the average expenditures on food recalculated for the size of a household were €151. Although households allocated a higher percentage of their income to food, their overall budget remained essentially the same. Such a situation may indicate reduced purchasing power of households. However, to confirm these conclusions, further studies of household consumer behavior would be necessary.

Analyzing the effects of Covid-19 is essential within a geopolitical context, as it affected households in every country around the world. According to COICOP data from Eurostat, an increase in the share of household expenditures on food and non-alcoholic beverages was observed in nearly every country in the European Union between 2019 and 2021. The increase

in expenditures on food and non-alcoholic beverages among Slovak households between 2019 and 2021 was 1.8%, according to Eurostat data. This increase was larger than the EU average and the highest among the V4 countries (Eurostat, 2023). It should be noted that during the Covid-19 pandemic, this consumer behavior was consistent with broader global trends, but the rate of increase in expenditures on basic goods and services was higher in Eastern and Central European countries, which have a higher proportion of low-income households.

On the other hand, all household expenditures on food (expenditures on food and non-alcoholic beverages and expenditures on catering services) [4], there was a decrease in the allocation of income to food in most European countries between 2019 and 2021. On average, EU-27 households experienced a decrease of 0.5% in expenditures on dining. Conversely, households from countries such as Albania, Montenegro, Turkey, Cyprus, Bosnia and Herzegovina, Switzerland, Poland, Latvia, Slovakia, Portugal, and Bulgaria saw an increase in dining expenditures between 2019 and 2021. According to a research report by GLOBSEC, households in Eastern and Central Europe redirected most of their expenditures to basic goods and services between 2019 and 2021. The report also states that the Central and Eastern European region is more vulnerable to the negative impacts of price shocks in food than the EU average (GLOBSEC, 2022). These findings indicate that, although Covid-19 has impacted all European countries, Slovakia is among those countries, whose food security situation has deteriorated the most from an economic perspective.

4. Conclusion

In terms of household income allocations according to HBS economic data and Eurostat data, we have confirmed a deterioration in food security in Slovakia. The increased spending on food and non-alcoholic beverages from 2019 to 2021 was largely offset by a decrease in expenditures on catering services. According to HBS data, Slovak households in 2021 spent 30.7% of their income on food. Such a high percentage of food expenses can be an indication of financial strain and potential risk of food insecurity. Significant deterioration was observed in the housing sector, where expenditures related to housing increased by 4.3% (to 26.4%) between 2019 and 2021. The increasing share of expenditures on basic goods and services such as housing and food may limit the ability to cover other important expenses, such as healthcare, education, and savings. The worsening food security in Slovakia is also confirmed by the low presence of Slovak products in stores or the deteriorating balance of foreign trade with agricultural and food products, as well as high food inflation after 2021. Despite these findings, we recommend conducting more comprehensive analyses of food security based on newer data and expanding to include additional factors, such as food availability, food quality, and the sustainability of food systems on their own. Solutions for food security require a multidimensional approach. Such an approach should include not only macroeconomic policies aimed at stabilizing prices but also measures to support local food production and distribution

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Biodiversity of Crop Structure in Kuyavia-Pomerania Voivodeship: Spatial Contexts

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Objective(s) and research background
The preservation of biodiversity is one of the most important challenges facing humanity in the 21st century. In agriculture, one determinant of level of biodiversity is the crop structure of farms in an area. A diverse, even crop structure (i.e., many different crops each covering a similarly sized area) positively affects the diversity and abundance of fauna and flora species in an area. By contrast, a simplified crop structure involves an area being sown with only a few species (often for several years) or, in extreme cases, only one crop (i.e., a monoculture).
The main aim of the study is to assess the biodiversity of crop structure in Kuyavia-Pomerania Voivodeship using the crop register of the Agency for Restructuring and Modernisation of Agriculture. The studied voivodeship is a region of importance to the country in terms of food security. Its farms are characterised by a high level of commercial production and productivity.
Data/Methods
The basic source of information was the crop register provided by the Agency for Restructuring and Modernisation of Agriculture, whic is the main disburser of Common Agricultural Policy funds in Poland. The register contains information on areas covered by 324 plant species cultivated by agricultural producers benefiting from a Single Area Payment. Data for 2023 were used. The spatial scope of the study is Kuyavia-Pomerania Voivodeship divided into 144 communes (of which, 88 rural communes, 39 urban–rural communes, 17 urban communes). The study used index methods and the Shannon–Wiener index (H'). The results were presented using cartographic methods (simple cartogram).
Results/Conclusions/Value added
The study showed strong spatial variability in the level of crop diversity in the region. The structural diversity is due to such factors as: natural predisposition for agricultural production (primarily, soil quality), distance from major cities (market) and organisational characteristics of the farms themselves (of which, primarily, the spatial distribution of farms of various sizes, which in Poland results from historical political divisions). The findings should be taken into account in shaping territorially targeted support under CAP programmes and activities aimed at protecting biodiversity. The ARMA data on the area devoted to individual crops were shown to be of great utility.

Key words – cropping structure; agriculture; biodiversity; Kuyavia-Pomerania Voivodeship; Poland; socioeconomic geography; Shannon–Wiener index

JEL classification – R14, Q15, Q57

1. Introduction

Biodiversity, understood as the diversity of ecosystems and species on Earth or in a specific area, provides functions that maintain the functioning of the economy and society. Protecting biodiversity is therefore justified not only for moral or environmental reasons, but above all for

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economic reasons. It is estimated that more than half of global GDP depends on nature, and in some economic sectors (e.g. agriculture) it is a key element (EC, 2020).

Agricultural landscapes worldwide are increasingly dominated by intensively managed monocultures (Meyer et al., 2019). Intensive crop production has negative impacts on farmland biodiversity due to reduced crop varieties and intensive soil cultivation (Clermont-Dauphin et al., 2014; Yang et al., 2022). Major challenges to intensive agricultural production include overall biodiversity decline, poor soil structure and health, nutrient and soil particle runoff, and high greenhouse gas emissions (Brooker et al., 2021).

The particulars of agriculture and its reliance on natural processes make it an important part of the process of protecting biodiversity and slowing unfavourable phenomena. This relates to various practices, from selecting appropriate protection measures or dates for agrotechnical treatments to crop diversification and appropriate crop rotation. Pro-environmental activities are an increasingly important part of the European Union's Common Agricultural Policy.

The aim of the study was to assess the biodiversity of crop structure in Kuyavia-Pomerania Voivodeship. In this case, crop biodiversity is examined using the number of crop species and the proportional differences between crops in a given spatial unit. This made it possible to designate areas where farmers have a diversified crop structure (i.e., they grow many plant species covering similar-sized areas) and areas where the crop structure is dominated by a few main species. The study did not take into account the individual value of individual crops from the point of view of intra-species richness, assuming equal weight for all varieties of crops.

The work consists of four chapters. The first introduces the subject matter and formulates the aim of the study. The second chapter discusses the data and methods used and presents and briefly characterizes the research area (Kuyavian-Pomeranian Voivodeship). The third chapter describes the results and relates them to previous findings from the literature. The fourth chapter presents the most important findings.

2. Data and methods

2.1. Data and scope of the study

The basic source of information used in the study was the crop register created and updated annually by the Agency for Restructuring and Modernisation of Agriculture (ARMA), whic is the main disburser of Common Agricultural Policy funds in Poland. The register contains information on areas covered by 324 plant species cultivated by agricultural producers receiving a Single Area Payment. The data are aggregated into administrative units (voivodeships, districts, communes).

Data for 2023 were used. The spatial scope of the study is Kuyavia-Pomerania Voivodeship divided into 144 communes (of which, 88 rural communes, 39 urban–rural communes, 17 urban communes).

2.2. Methods

The study used index methods and the Shannon–Wiener index (H'). The sizes of areas devoted to individual crops in communes were analysed, paying particular attention to the number of crops and the distribution of the most important species. Diversity of crop composition was assessed using one of the most popular biodiversity indicators (Neogi & Bidyut, 2022; Njeru et al., 2022) – the Shannon–Wiener index (H') (Shannon & Wiener, 1949), as determined by the formula:

$$H' = -\sum_{i=1}^{S}(p_i)(lnp_i), \quad (1)$$

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where H' – Shannon–Wiener index;
p_i – area per crop, ha;
ln – natural logarithm

Calculated in this way, the highest index values indicate an even share of species (i.e., the species have the same p_i factor as each other). Assuming communes with identical numbers of crops, the biodiversity index will be higher in the communes with the more even distribution of crops.

Moreover, in order to examine spatial dependencies between communes in terms of biodiversity of crop structure, spatial autocorrelation methods were used. In this study, use was made of the Moran's *I* autocorrelation coefficient (Moran, 1950), which is expressed by the following formula:

$$I = \frac{n}{s_0} \cdot \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}(x_i-\overline{x})(x_j-\overline{x})}{\sum_{i=1}^{n}(x_i-\overline{x})^2} \quad (2)$$

where: n – number of spatial units, c_{ij} – elements of the neighbourhood matrix C, c_{ij} – sum of matrix C elements, S_0 – feature value for the *i-th* and *j-th* unit, $x_i x_j$ – mean of all values of the feature of the area examined.

The key element is the construction of the neighbourhood matrix C. In this study, spatial relationships are defined by the inverse distance method, in which the closest neighbours of the target object will have a significant impact on the intensity of the phenomenon investigated. The strength of interaction of the units adjacent to the neighbours of a given unit is lower.

The coefficient value obtained is interpreted as follows:

$I >$ -1/(n-1) – there is a positive spatial autocorrelation (neighbouring units show similarity),
$I <$ -1/(n-1) – negative spatial autocorrelation (neighbouring units do not show similarity),
$I \approx$ -1/(n-1) – random distribution of the value of the variable.

The coefficient presented above is an overall measure and therefore Local Indicators of Spatial Association (LISA) were used to detect deviations from the overall pattern. The group of these indicators, which were defined by Anselin (1995), include the local Moran's *I*, which is expressed by the following formula:

$$I = z_i \sum_{j=1}^{n} w_{ij} z_j \quad (3)$$

where: z_i – deviations from the mean value of the feature z_j – row-standardised elements of neighbourhood matrix C.

Local coefficients make it possible to detect what is referred to as "agglomeration effects", i.e. clusters with low and high (statistically significant) values of the feature under investigation. Designed in this way, the analysis allows the following two main types of clusters to be distinguished: High-High (HH) – in which units with a high value of the feature investigated are surrounded by units with equally high values, and Low-Low (LL) consisting of units with low values surrounded by similar units. In addition, outliers can be identified, where units with high values are adjacent to units with low values (High-Low – HL) and vice versa (Low-High – LH).

The results were presented using cartographic methods (i.e., simple cartograms). The intervals in choropleth maps were determined based on the Jenks method of natural breaks (Jenks, 1967). The four largest cities in the region are marked and labelled on the maps (i.e., Bydgoszcz, Toruń, Włocławek and Grudziądz).

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2.3. Agriculture in Kuyavia-Pomerania Voivodeship

Kuyavia-Pomerania Voivodeship is located in the north-central part of Poland (see Fig. 1) and is one of the 16 voivodeships created under the administrative reform of January 1, 1999. It ranks 10th in terms of area (17,971K ha) and number of inhabitants (2 million; as of June 30, 2023). In terms of GDP *per capita (*approximately PLN 66,000) it ranks ninth (Statistics Poland, 2023). The region is primarily developed alongthe Vistula River, which flows through the four most important cities: Włocławek, Toruń, Bydgoszcz and Grudziądz.

The agricultural economy of Kuyavia-Pomerania Voivodeship is based on favourable natural conditions. Of particular importance is its significant share of arable land of high soil-quality classes. The above, combined with a high level of agricultural culture, makes it one of the most important food baskets of the country (Wiśniewski et al., 2020).

However, the region is highly internally diverse. Figure 1 shows the value of the agricultural production space quality index, which assesses the suitability of four basic elements of the natural environment, i.e. soil, relief, water conditions and climate. There are two compact areas with very favourable conditions – Kuyavia in the south and the Chełmno Lake District in the north. Large areas of central Kuyavia are covered with black earth – some of the most fertile soils in Poland.

The agricultural weaknesses include, primarily, insufficient water resources for agriculture, high prices for agricultural land (one of the highest in the country) (ARMA, 2024), limited possibilities of expanding farms and an insufficient integration of farmers into producer groups (K- PAAC, 2019).

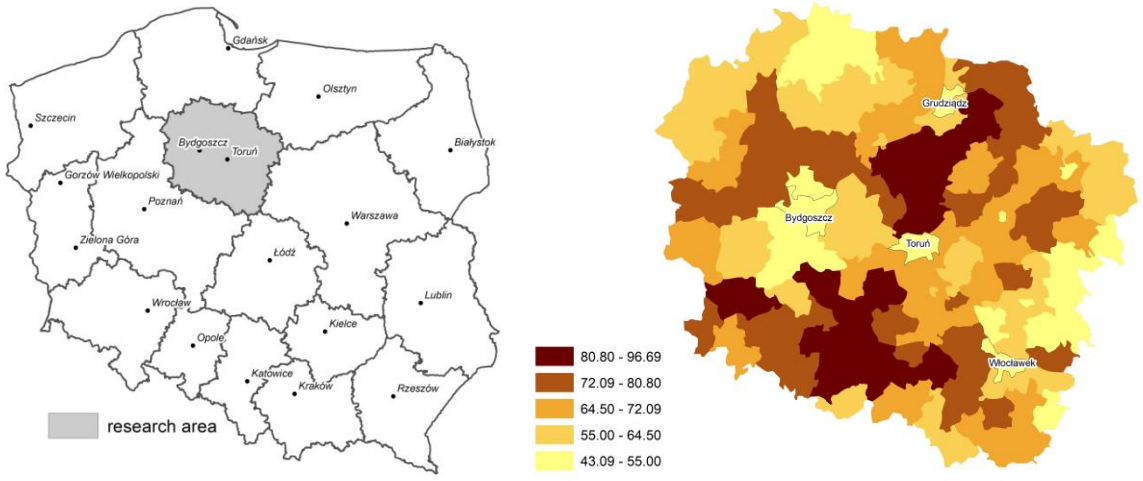

Figure 1: (A) Location of study area and (B) indicator of agricultural production space quality in the communes of the study region

Source: own study based on Witek and Górski (1977)

3. Results and discussion

3.1. Crop structure

In Kuyavia-Pomerania Voivodeship in 2023, on an area of 1,003K ha of agricultural land, 208 plant species were cultivated (64% of the total number of crops in the register). Two species dominated in the crop structure – winter wheat and maize (sown areas of 217.4K and 205.2K ha, respectively). In total, they constituted over 42% of the total agricultural area, and there are

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communes in which the above-mentioned species constitute almost two thirds of the area. Large areas were also devoted to winter rapeseed (99K ha), permanent grassland (73.3K ha) and winter triticale (69.5K ha) (see Fig. 2). The spatial distribution of the most important crops is shown in Figure 3.

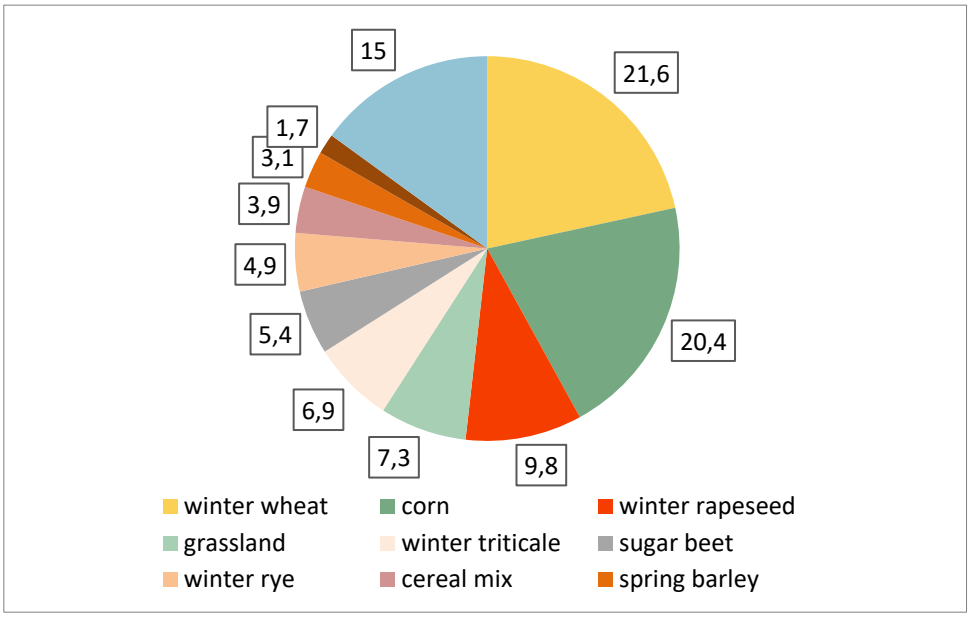

Figure 2: Crop structure in Kuyavia-Pomerania Voivodeship in 2023

Source: own study based on ARMA data

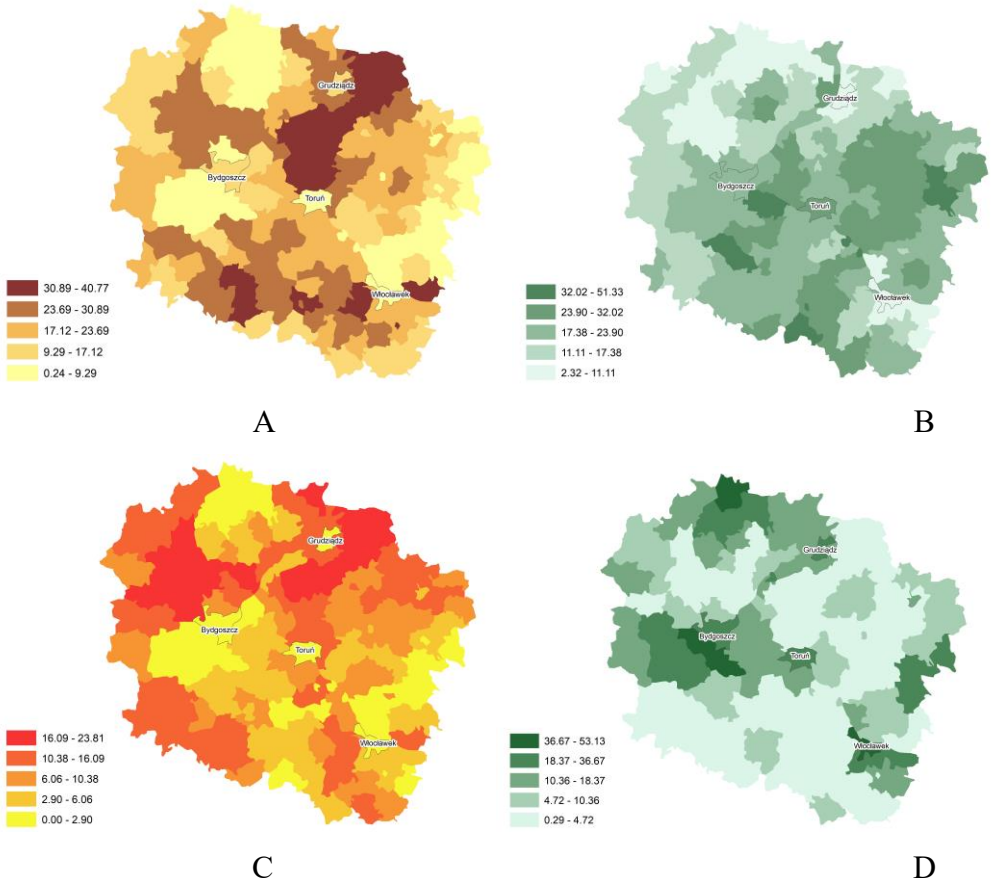

Figure 3: Share of selected species in total agricultural area

A – winter wheat, B – maize, C – winter rapeseed, D – permanent pasture

Source: own study based on ARMA data

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In addition to 116 species whose cultivation was not recorded, there were a number of species of marginal importance in terms of their rank in the region's crop structure. For example, 81 species of crops did not exceed 10 ha, while 31 species did not exceed 1 ha. The smallest crops in terms of area were mushrooms and melons (0.02 ha each).

The average number of crops per commune was 55 and ranged from fewer than 20 in small towns such as Aleksandrów Kujawski (with the fewest crops, at only 9), Chełmno, Lipno, Chełmża (whose population is less than 20,000 inhabitants) to over 90 crops in the communes of Koronowo, Inowrocław, Choceń, Włocławek and Brześć Kujawski (with the most crops, at 104) (see Fig. 4).

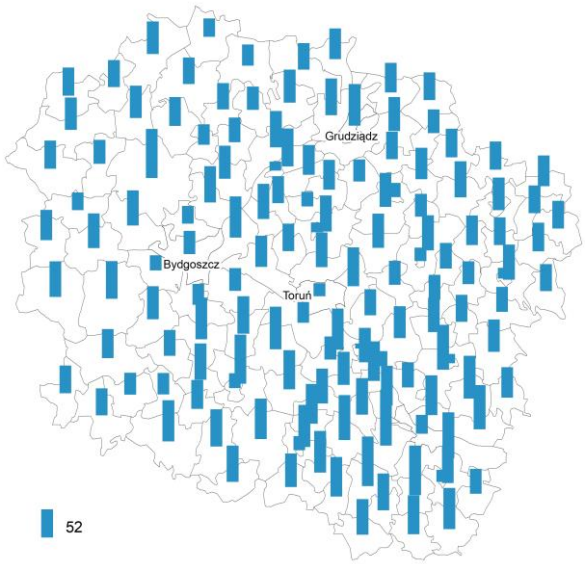

Figure 4: Number of crops in individual communes of Kuyavia-Pomerania Voivodeship in 2023

Source: own study based on ARMA data

3.2. Biodiversity of crop structure

The number of crops alone does not allow for a clearly assessment of the crop structure in a commune. There may be situations in which several species dominate the crop structure. Therefore, the mutual relations between individual species should also be assessed, and these are revealed using the H' index. The index value ranged from below 1.80 points in Aleksandrów Kujawski and the rural communes of Białe Błota and Nowa Wieś Wielka to over 2.80 points in Dąbrowa Biskupia and Fabianki communes (see Fig. 5A). The largest contiguous area of communes with low values is located in the north of the region and includes, among others, parts of the Chełmno Lake District, which are very well predisposed to agricultural production. A similar situation occurs in the Kuyavia part. Low crop biodiversity was also recorded in suburban communes of the region's largest city, Bydgoszcz. For example, in the Białe Błota commune, only 28 species were cultivated, and almost half of the agricultural land was permanent permanent pasture. Intensive suburbanisation processes and a gradual decline in the importance of agriculture are visible in the commune's economic structure. Conversely, the crop structure was most diverse in communes concentrated in the south-east of the region near Włocławek; these are areas with average predispositions towards agricultural development.

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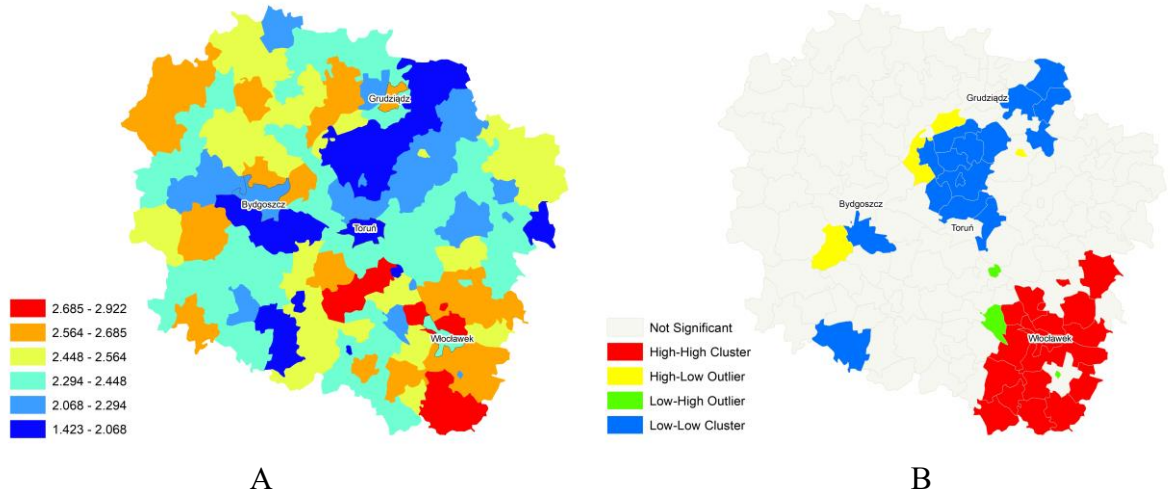

Figure 5: (A) Shannon–Wiener index (H') for individual communes of Kuyavia-Pomerania Voivodeship and (B) agglomeration effects determined on the basis of local Anselin autocorrelation coefficients

Source: own study based on ARMA data

The study confirmed the occurrence of a spatial autocorrelation, i.e. the intensity of a phenomenon in one spatial unit affecting the probability of its occurrence in neighbouring units. Spatial dependencies can be determined to exist by the relatively high, positive and statistically significant value of Moran's I coefficient of 0.23 (*z-score* parameter 3.24; *p-value* 0.001).

Then, based on the values of local coefficients in individual spatial units, clusters of communes with specific spatial dependencies were distinguished (see Fig. 5B). The largest number (17) of units located in the south-east of the studied region were classified as type HH. This type indicates that units with a high value of a characteristic are surrounded by units with equally high values of the same characteristic. The opposite situation, i.e. low-value spatial units being surrounded by similar units (LL), was found for 16 communes concentrated in the areas between Toruń and Grudziądz (i.e., Chełmno Lake District), but also occurred randomly in other locations. The remaining two types of clusters (HL and LH) were represented by a few communes that were usually adjacent to communes of types LL and HH.

3.3. Discussion

Biodiversity is considered an asset in adapting to current environmental changes (Vigouroux et al., 2011). A key consequence of agricultural intensification is the simplification of the landscape, including cropping patterns, which exacerbates biodiversity losses, which in turn leads to a reduction in the ecosystem services on which agriculture depends (Landis, 2017).

Nationwide research on the level of biodiversity of the crop structure conducted for districts (comprising several communes) based on the results of the last agricultural census (2020) indicates that Kuyavia-Pomerania compares favourably to Poland, which exhibitsa clear north–south divide(with some exceptions) (Wiśniewski, 2023a). Also, the internal assessment of the studied region's diversity is consistent with the obtained in this study results, despite the data source being different and the set of crops/species being much smaller. Studies on changes in biodiversity during membership in the European Union (Wiśniewski, 2023b) indicate a deterioration in biodiversity in most voivodeships. This is also true of Kuyavia-Pomerania, although the pace of this process is among the lowest nationally here.

It is worth noting that greater biodiversity occurs in areas with weaker environmental predispositions and a worse size structure of farms, which confirms the observations of Vigouroux et al. (2011) indicating that farmers still have a large impact on the diversity of

crops in agricultural systems based on small farms. The size of the cultivated fields itself also has an impact on biodiversity. The smaller it is, the greater the biodiversity of fauna and flora (Fahrig et al., 2015; Šálek et al., 2015). High heterogeneity is associated with better provision of resources throughout the year in dynamic landscapes (Estrada-Carmona et al., 2022).

4. Conclusion

A significant number of species grown on similar areas (the opposite of monocultures) is desirable from a biodiversity perspective. This is reflected, for example, in the CAP's bonuses for practices involving rotation, greening, etc. It is important to monitoring changes in biodiversity levels in order to assess the effectiveness of these policies. It is particularly important to take a spatial approach. The study aimed to assess the biodiversity of crops in Kuyawia-Pomerania – one of the agriculturally most important regions in Poland.

It has been shown that the level of biodiversity varies and this can only be explained using in-depth analyses that take into account a range of factors. However, it has been shown that communes well predisposed to agricultural production usually score low on biodiversity of crop structure. This indicates that economic profitability is the factor primary importance in shaping crop structure.

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The Basic Commodities Rise in Prices in Connection to Average Income

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Abstract
The article presents an overview of the rise in prices of selected consumer basket items in the Slovak republic over a 13-year period, correlating them with the average monthly nominal income. The analysis tracks income increases and links to the purchasing power of the population. The article compares the rate of growth and observes which items reacted unusually, despite expectations of a different trend. It is an overview article that illustrates changes over time, which affect us all, as basic commodities, such as food, cannot be excluded from our lives.

Paper's objective(s) and research background
The aim of the study is to gain an overview of the development of basic food items and goods tracked by the Statistical Office of the SR in its consumer basket between 2010 and 2022. The interest lies in determining the rate of growth and identifying those food items and goods that experienced the highest changes during the observed period in connection to average monthly income, as well as pinpointing those whose prices remained relatively stable throughout the period under review.

Data/Methods
Data: Datacube of the Statistical Office of the Slovak republic for the basic commodities defined in the consumer basket and average nominal monthly income between 2010 and 2022
Methods: Univariate (description statistics and correlation) and multivariate (fuzzy c-mean clustering) statistical methods

Conclusions
Statistical analyses conducted on the development of basic food items and goods revealed two distinctive trends. The first cluster predominantly comprises items whose consumption is unavoidable, encompassing Groceries, and partially Energy and Transport. These items face a notable surge in prices, aligning with the increase in average nominal monthly income. Conversely, the second cluster primarily includes categories such as Clothing and Footwear and Selected Household Items, characterized by less pronounced price increases compared to the first cluster. Certain items within this cluster have experienced price reductions compared to the base year. Items falling within the fuzzy exhibit a distinct trend differing from both the first and second clusters. This includes primarily Grocery items, such as granulated sugar. Not all items of the consumer basket positively correlated with average nominal monthly income.

Key words
consumer basket, average monthly income, price growth, purchasing power

JEL Classification
P46 Consumer Economics • Health • Education and Training • Welfare, Income, Wealth, and Poverty

1. Introduction

The aim of the study is to gain an overview of the development of basic food items and goods tracked by the Statistical Office of the Slovak Republic in its consumer basket between 2010

and 2022. This topic is discussed by many authors from various perspectives, and articles focus on numerous aspects that influence purchasing preferences. A diverse range of statistical methods is used in data processing. The purpose of this article is to gain an overview of the development of prices of basic goods and to compare them with the development of average nominal monthly income with intention to test the research question whether this development is adequate and not necessarily affects the purchasing power of the population. We assume that the development of prices of basic goods is in positive correlation with the development of average nominal monthly income without any apparent excesses.

Average nominal monthly income is undoubtedly the key variable that significantly influences the parity of the population's purchasing power. This was addressed by Stankovičová (2018) where income per capita was identified as an indicator highlighting disparities with consumer expenditures representing the highest share in Slovakia. This fact was as also noted by Williams et al. (2006), who investigated the correlation between household income and the ability to purchase adequate food meeting basic dietary requirements. Jayasankaraprasad (2014) examined the purchase of basic groceries, considering monthly household income and value for money. Exploratory factor analysis, zero-order correlation matrix, and multiple discriminant analysis were employed, with a primary focus on the increasing trend of cross-format shopping (consumers regularly shop at multiple types of grocery stores). Clerides, Courty and Ma (2023) also delved into the topic of cross-format shopping, exploring potential savings by leveraging price discrepancies in grocery stores. The authors found that savings were achievable due to varying prices across different stores, with consumers able to save more by shopping where their basket is cheaper rather than where prices are lower overall. Scholdra, Wichmann, Eisenbeiss, and Reinartz (2021) examined grocery shopping expenditures influenced by both micro and macro conditions, such as personal income and economic cycles, over an 8-year period tracking the shopping habits of 5000 households. Their study revealed correlations between household expenditures on groceries and personal income, highlighting the impact of both shocks and unforeseen circumstances on spending patterns. Moreover, this was noted also by Boyle et al. (2021), authors observed shifts in grocery shopper behaviour resulting from the COVID-19 pandemic, with consumers exhibiting a willingness to increase spending and purchase more items to fulfil their needs. Impact of economic cycles on consumer buying behaviour was examined also by Kučerová and Zeman (2012), particularly focusing on the influence of recession on declining food consumption and structural shifts in household spending patterns in the Czech Republic. Given the Czech consumers' strong emphasis on cost, there has been a notable rise in the preference for cheaper and lower quality products. Bronnenberg, Klein, and Xu (2023) investigated the impact of incremental time, proposing a theoretical model considering both money and time constraints when determining the composition and size of grocery shopping baskets. Their findings suggested that households tend to purchase a greater variety of products, increase shopping frequency, and gravitate towards more time-intensive options. Consequently, online food retailers have entered the market in response to these trends and the increase in e-commerce due to globalization, leading to a proliferation of product variety and influencing consumer spending habits was noted (Yeo, 2022). As consumers continue to respond positively to prices, Moodley, Chiclana, Caraffini and Carter (2019) proposed an algorithm aimed at enhancing the effectiveness of retailer promotions, utilizing fuzzy c-means clustering to identify optimal customer segments to target.

2. Data and Methods

The analysis incorporates data from the Statistical Office of the Slovak Republic for the basic commodities defined in the consumer basket and the average nominal monthly income between

2010 and 2022. The consumer basket consisted of 46 items, which were divided into 4 categories:

Grocery - Peeled rice, Semi-coarse wheat flour, Dark bread, Plain white roll, Egg noodles, Boneless beef, Boneless pork leg, Chicken, Sausages, Ham salami, Durable salami, Pasteurized semi-skimmed milk, Fruit yogurt, Sour milk, Eidam cheese brick, Smoked cheese, Cottage cheese, Fresh chicken eggs, Fresh butter, Edible oil, Apples, Potatoes, Granulated sugar, Milk chocolate, Universal laundry detergent (powder), Toilet soap

Clothing and Footwear - Children's short-sleeved shirt, Men's suit, Men's long-sleeved shirt, Women's long-sleeved sweater, Children's winter jacket, Men's leather walking shoes, Women's leather walking shoes, Children's walking shoes

Energy and Transportation - Electricity tariff DD1 - D1, Brown coal, Automobile gasoline 95 octane, Diesel, Bus: regular fare 91-100 km

Selected Household Items - Wardrobe with double doors, Combined refrigerator with freezer, Electric suitcase sewing machine, Steam iron, Children's bicycle, LCD television, Downhill skis (150-170 cm) with safety bindings

For the analysis, we utilized methods of univariate (descriptive statistics, correlation) and multivariate statistics (fuzzy c-means clustering). Described methods of analysing relationship between prices of the basic commodities and the average nominal monthly income were applied in studies by Jayasankaraprasad (2014), Scholdra, Wichmann, Eisenbeiss, and Reinartz (2021), and Moodley, Chiclana, Caraffini, and Carter (2019). The selected statistical methods were chosen to identify the development of trends of the basic commodities prices in relation to average nominal monthly income which are demonstrably distinct from each other, to highlight those commodities that price development align with the development of average nominal monthly income, and those that deviate from it in either positive or negative correlation. The aim is to identify those commodities that trend cannot be classified into any of the similar developmental groups of commodities, i.e., those that exhibit demonstrably different behaviour and we may call them as extremes.

3. Results and Discussion

The assumption is that the increase in prices of commodities within the consumer basket over the observed timeframe adequately corresponds to increase of the average nominal monthly income. Using correlation analysis, we identified those commodities that diverge from this pattern. Table 1 presents items in the consumer basket that are independent of, or negatively correlated with, the average nominal monthly income. We uncovered, that with exception of Granulated sugar, these commodities are categorized under Energy and Transportation, and Selected Household Items. The rest of the correlation analysis suggests that the commodities essential for daily consumption within the consumer basket significantly increase when the average nominal monthly income grow.

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Table 1: Correlation between commodities within the consumer basket and average nominal monthly income that diverged from the pattern of positive correlation

	r
Diesel	0.248
Automobile gasoline 95 octane	0.162
Bus: regular fare 91-100 km	0.058
Electricity tariff DD1 - D1	-0.304
Granulated sugar	-0.396
Electric suitcase sewing machine	-0.474
Steam iron	-0.492

Source: author's calculations

Subsequently, we were interested in direction in which the total consumer basket evolved in relation to the average nominal monthly income. We calculated the ratio to average nominal monthly income during a given time period, assuming that all items in the consumer basket would be hypothetically purchased in one month. Although the correlation coefficient is significant (r = 0.969), the ratio indicated that the average nominal monthly income increased faster than expenditures on the total consumer basket. For a better presentation, both average nominal monthly income and the total consumer basket were presented in logarithmic form, the ratio maintained unchanged (Figure 1). This implies that in 2010 we could afford the total consumer basket for 3.75 times of the average nominal monthly income, while in 2022 we would only require 2.95 times of the average nominal monthly income, thus, the purchasing power over the monitored period increased. Similarly reacted the Grocery category only. Whereas in 2010 we could purchase the Grocery consumer basket 12.67 times within the average nominal monthly income, by 2022 we could afford the same consumer basket 14.08 times.

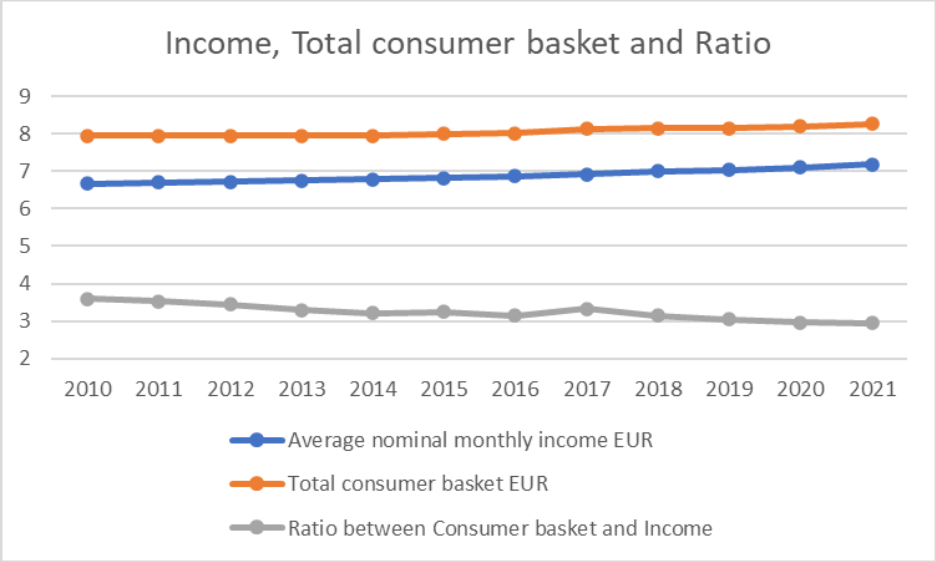

Figure 1: Consumer purchasing power indicating the purchasing power over the monitored period increased

Source: author's calculations

Categorization of the consumer basket into four distinct segments facilitated an analysis of evolving dynamics of individual categories within the consumer basket. These segments encompassed items essential for daily consumption, such as Grocery and partly Energy and

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Transportation, alongside those whose consumption frequency is non-daily or might be postponed (Clothing and Footwear, Selected Household Items). Data for each category underwent transformation, establishing the reference year of 2010 with a value of 100. As depicted on Figure 2, it becomes apparent that the categories of Grocery, and Energy and Transportation exhibit more pronounced and closely mirrored responses to fluctuations in the average nominal monthly income compared to the categories of Clothing and Footwear and Selected Household Items. Subsequent validation of this descriptive analysis was undertaken through the following statistical test.

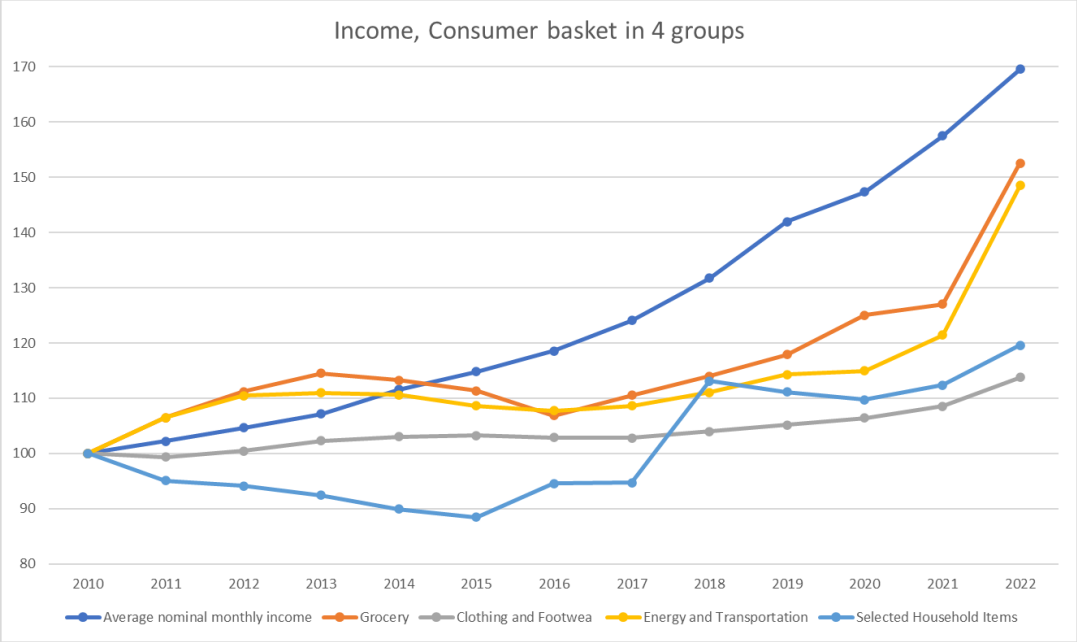

Figure 2: Development of prices in selected consumer basket segments compared to average nominal monthly income revealed various distinctive trends

Source: author's calculations

Using fuzzy c-means clustering analysis we aimed to identify those items in the consumer basket that behaved similarly over the monitored period. The analysis incorporated all items comprising the consumer basket refraining from categorization, and involved transformed data where the initial period, the year 2010, was defined with a referential value of 100. Two clusters were identified as the most suitable (coefficient of overall separation 36.83). Cluster 1 represents items whose prices initially rose faster than the average nominal monthly income until 2013, subsequently we even observed a decline in prices of items in the first cluster, which is not surprising given the deflationary trend from 2014 to 2016. However, from 2016 onward prices steadily increased, albeit at a slower pace than the growth of the average nominal monthly income. By 2022, we noted nearly the same price level as reached by the average nominal monthly income. Items classified into the first cluster are those whose prices escalated quickly in response to the growth of the average nominal monthly income. These items predominantly belong to the first and partly the third category of the consumer basket, namely Grocery, and partly Energy and Transportation, that are commodities essential for daily consumption. Items classified into the second cluster exhibit milder changes in price compared to those in the first cluster. We observed a decline in prices in this cluster since 2012 till 2016, followed by a steady increase in the price level of these items. The second cluster mainly comprises items from the second and the fourth category of the consumer basket, items that are not essential for daily consumption and whose purchase can be deferred (Figure 3). The

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following items appeared as fuzzy: Children's T-shirt with short sleeves, Diesel, Edible oil, Toilet soap, Granulated sugar and Plain white roll.

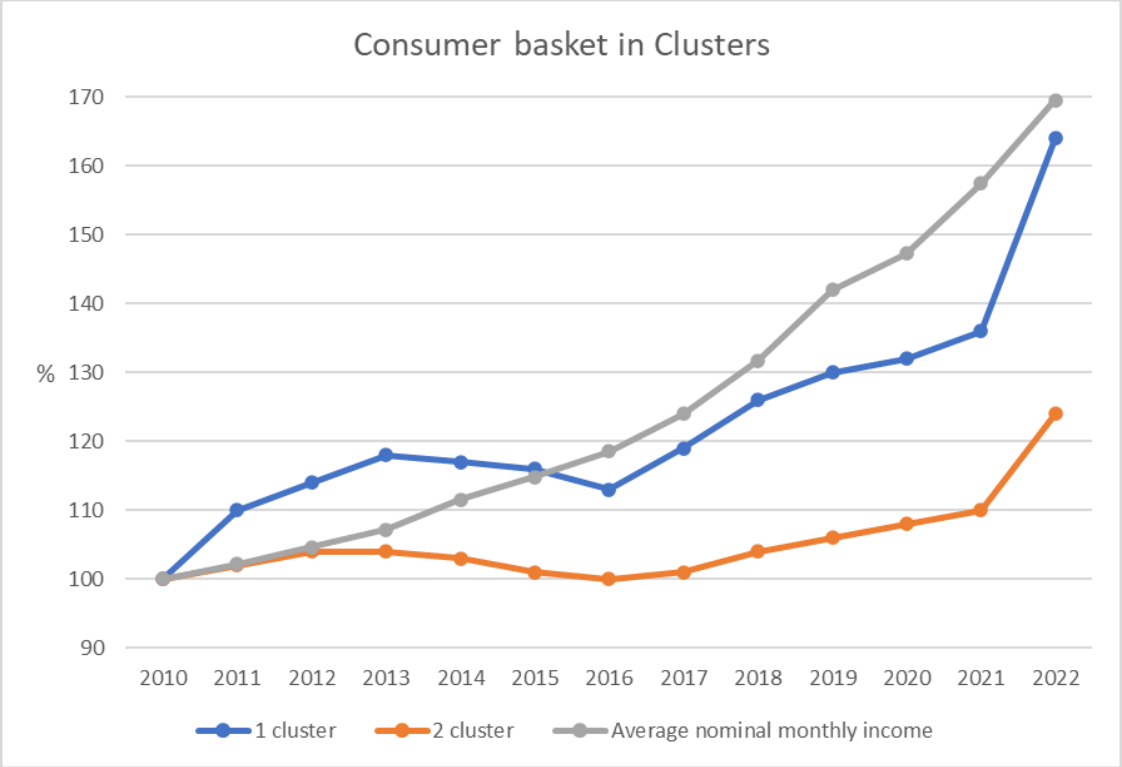

Figure 3: Fuzzy c-mean clustering confirmed 2 independent clusters (trends) of consumer basket commodities over the monitored period

Source: author's calculations

4. Conclusion

Statistical analyses have shown that development of basic food items and goods tracked by the Statistical Office of the SR in its consumer basket between 2010 and 2022 exhibit two trends.

The first cluster, or trend, primarily includes items whose consumption is inevitable (Grocery, and partially Energy and Transport). These items experience a sharp increase in prices and mirror the rise in average nominal monthly income, and since 2014 they have not exceeded the income growth. The steepest increase is observed in the last period due to an exceptionally high inflation rate compared to other years. The items included in the first cluster of the consumer basket are: Edam cheese brick, Sour milk, Children's bicycle, Pasteurized semi-skimmed milk, Men's long-sleeved shirt, Fresh butter, Milk chocolate, Egg noodles, Fresh chicken eggs, Brown coal, Apples, Boneless beef, Semi-coarse wheat flour, Sausages. This trend is evident in aggregated sums for Grocery, Energy and Transport, and Average nominal monthly income. The highest increases over the observed period are recorded for Semi-coarse wheat flour (136% increase compared to the reference year 2010), Sausages (132% increase), and Fresh butter (98% increase). However, this category also includes items whose consumption can be deferred or managed without, yet they still showed significant price hikes. These include Children's bicycle (74% increase) and Men's long-sleeved shirt (43% increase).

The second cluster primarily comprises groups of items categorized as Clothing and Footwear and Selected Household Items. The price increases are less pronounced compared to the first cluster, except for the last observed year, which correlates with a high inflation rate. Items

belonging to the second cluster of the consumer basket are: Universal laundry detergent (powder), Automobile gasoline 95 octane, Electric suitcase sewing machine, Durable salami, Steam iron, Electricity tariff DD1 - D1, Combined refrigerator with freezer, Boneless pork leg, Bus: regular fare 91-100 km, Wardrobe with double doors, Peeled rice, Women's long-sleeved sweater, Children's walking shoes, Women's leather walking shoes, Downhill skis (150-170 cm) with safety bindings, Men's leather walking shoes, Fruit yogurt, Children's winter jacket, and Men's suit. The second cluster also includes the aggregated items for Clothing and Footwear and Selected Household Items. The highest increases in the observed period are recorded for Durable salami (42% increase compared to the reference year 2010), Peeled rice (38% increase) and Automobile gasoline 95 octane (36% increase), indicating that these are items shifting the second cluster values upward. However, within this group, we also observe price reductions compared to the base year, such as Electric suitcase sewing machine (16% decrease), Steam iron (7% decrease), Women's long-sleeved sweater (3.6% increase) and Women's leather walking shoes (3.8% increase).

Items falling into the fuzzy category are exhibiting a specific trend, which is dissimilar to the trend in either the first or the second cluster. The following items appeared as fuzzy: Children's T-shirt with short sleeves, Diesel, Edible oil, Toilet soap, Granulated sugar or Plain white roll.

The conclusion of this analysis is that the prices of commodities that cannot be excluded from our daily lives, such as groceries, and partially commodities of energy and transport, were increasing faster during the observed period than the prices of commodities whose consumption might be excluded from our lives or postponed (such as clothing and footwear, and selected household items). The analysis showed that although the rate of growth of non-deferrable commodities was faster than that of deferrable ones, even the non-deferrable commodities did not exceed the rate of growth of the average nominal monthly income. This means that during the observed period the purchasing power parity of the population did not weaken, and our research hypothesis was confirmed, stating that the increase in prices of commodities within the consumer basket over the observed timeframe adequately corresponded to the increase in the average nominal monthly income.

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