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Economic growth and foreign direct investment in Balkans

Abstract. Foreign direct investment (FDI) has become a key source of economic growth for the Balkan countries, offering vital funding for development initiatives. Therefore, the purpose of this study was to examine the dynamics of FDI in Serbia, North Macedonia and Montenegro from 2000 to 2023. An econometric model was used to conduct the research, namely, the relationship between FDI and economic growth in the region was analysed. A multiple regression model was developed that includes gross domestic product growth as the dependent variable. It was established that significant fluctuations in the rates of economic growth are characteristic of all three countries during this period. Serbia has shown particular resilience, with positive growth rates prevailing in most years. Key sectors attracting FDI were also identified, including services, manufacturing, automotive, IT, agriculture, energy and tourism. The obtained results emphasised the importance of reforms aimed at business development, infrastructure development and regional integration, especially with the EU, as critical factors in attracting FDI. In addition, diversification of FDI sources was emphasised with increased investments from China, Turkey and the United Arab Emirates, which complement traditional investors from the EU. More than 60% of foreign investment in Serbia has been found to be concentrated in the services sector, while North Macedonia has successfully attracted investment in high value-added industries such as information technology and engineering. These findings are consistent with established economic theories about the impact of FDI on growth, while providing specific insights into the Balkan context. It found that a 1% increase in FDI was associated with a 0.3-0.5% increase in gross domestic product in the Balkan countries studied. The obtained results can become the basis for future political decisions and investment strategies in the region

Keywords: investment sectors; regional integration; investment incentives; infrastructure development; energy projects

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INTRODUCTION

In the conditions of a changing global economic environment, the study of the relationship between foreign direct investment (FDI) and economic growth in the Balkans has become particularly relevant. The Balkan region, historically characterised by political instability and economic challenges, has undergone significant transformations aimed at integration into the European and world economy. After the 2000s, the countries of the Balkans began to implement large-scale economic reforms aimed at creating a favourable investment climate and stimulating economic growth. Before the global financial crisis of 2008, the region demonstrated impressive rates of economic development. However, the crisis revealed the structural weaknesses of the economies of the Balkan countries, emphasising the need for further reforms and diversification of sources of economic growth.

The issue of sectoral distribution of FDI and its impact on various sectors of the economy of the Balkan countries remains insufficiently studied. M. Radulović & M. Kostić (2024) focused on the paradox of the relatively low level of FDI in the region, despite significant efforts to improve the investment climate. Their research highlighted the need for a deeper analysis of the factors influencing investment decisions in the context of the Balkan economies. F. Chen & G. Jiang (2023) examined the impact of institutional quality on FDI inflows, highlighting the critical importance of the rule of law and anti-corruption in attracting foreign investment. Their findings emphasise the need for further improvement of the institutional environment in the Balkan countries as a key factor in stimulating FDI. G. Lubeniqi (2023) considered the role of European integration in stimulating economic development and attracting investments to the region. This study indicated the positive impact of the prospect of EU membership on the investment attractiveness of the Balkan countries, but also emphasises the need for further structural reforms to maximise this effect. Special attention was paid to the impact of global economic crises on FDI dynamics in the region. A. Maksić *et al*. (2023) analysed in detail the consequences of the 2008 financial crisis for the economies of the Balkans, identifying significant structural problems that became evident during the crisis. This study emphasised the need to study the resilience of the Balkan economies to external shocks and the role of FDI in ensuring economic stability.

L. Benfratello *et al*. (2023) indicated an uneven distribution of investments between sectors, which may have long-term consequences for the economic development of the region. However, detailed analysis of this aspect in the context of current economic trends remains limited, creating an important research gap. A. Steinbach (2024) emphasised the importance of regional cooperation for increasing the investment attractiveness of the Balkans. However, the specific mechanisms and results of such cooperation, especially in the context of attracting FDI and stimulating economic growth, remain insufficiently researched. This opens up a promising direction, especially given the growing trend toward regional integration in the global economy. D. Derado & D. Horvatin (2023) investigated the impact of FDI on the productivity of local firms in Central and Eastern European countries, including some Balkan states. This study found the positive effects of technological and knowledge spillovers from foreign investors to local firms, but also highlighted the importance of the absorptive capacity of local economies to maximise these benefits. This raises the question of the readiness of the Balkan economies to effectively use the potential of FDI for technological development and increasing competitiveness.

During the literature analysis, several key areas of research in the field of FDI and economic growth in the Balkans were identified. Taking into account the identified gaps in existing research and modern economic challenges, the purpose of the article was to carry out a comprehensive analysis of the relationship between direct foreign investment and economic growth in the countries of the Balkan region in modern conditions. The study was aimed at identifying key factors influencing the effectiveness of FDI in stimulating economic development, and developing recommendations for optimising investment policy in the region.

LITERATURE REVIEW

In the modern economic literature, the study of the relationship between FDI and economic growth in the Balkans attracts considerable attention of scholars. This region, with its unique history and economic challenges, is of particular interest for studying the impact of FDI on the development of transition economies. A. Lazaj (2023) has made a significant contribution to the study of FDI in developing countries, particularly in the Western Balkans. This work focuses on the role of institutions, characteristics of host countries, and market entry strategies to attract FDI. E. Istrefi & J. Imeraj (2022) emphasised the importance of the institutional environment for the effectiveness of FDI, which is particularly relevant for the Balkan countries with their complex history of transformations. E. Zaimaj (2023) specialises in the study of FDI flows in the Western Balkans region. This work analysed the causes and consequences of FDI, as well as the challenges and potential for investment in the region. M. Hasani & B. Hasani (2023) found that the quality of institutions and macroeconomic stability are key factors influencing the attractiveness of Balkan countries for foreign investors.

Research by S. Mucha & B. Fetai (2023) covers a wide range of issues related to FDI in the Western Balkans, including an analysis of FDI patterns, their impact on economic development and their role in the transition of countries in the region to a market economy. A.M. Fazaalloh (2024) emphasised the importance of the sectoral structure of FDI for long-term economic growth. B. Mustafa & S. Abdullahu (2024) focus on the relationship between FDI and economic growth, the role of FDI in job creation and its impact on productivity. Researchers have focused on the relationship between FDI and economic growth, the role of FDI in job creation, and its impact on productivity. A study by A. Toska & B. Fetai (2023) demonstrates the positive impact of FDI on economic growth in the Balkan countries, but also points to the need for complementary policies to maximise this effect.

A. Hajdini *et al*. (2023) conducted an analysis of factors influencing FDI in the Western Balkans, focusing on market size, labour costs and institutional quality. Their research found that institutional quality is a particularly

important factor in attracting FDI to the region. S. Klaiqi *et al*. (2023) investigated the relationship between FDI and economic growth in the Western Balkans, analysing the impact of FDI on regional gross domestic product (GDP), employment and productivity. Their findings confirm the positive impact of FDI on economic growth, but also indicate the heterogeneity of this impact in different sectors of the economy. L. Hoxhaj & D. Qehaja (2024) conducted a comprehensive study of the determinants of FDI in the Western Balkans, finding that despite the improvement in the investment climate, the level of FDI in the region remains lower than expected. A study by V. Disha & B. Fetai (2024) emphasised the need for further institutional reforms to increase the attractiveness of the region for foreign investors. A. Branković & S. Sarajčić (2024) focused on the influence of the quality of institutions on the inflow of FDI in the Balkan countries. Their study found a strong correlation between indicators of the rule of law, control of corruption, and the amount of FDI flowing into the region.

S. Kurtović *et al*. (2023) investigated the impact of FDI on the productivity of local firms in Central and Eastern European countries, including the Balkan states. They found positive effects of technology spillovers from foreign investors, but also emphasised the importance of absorptive capacity of local economies. Y. Wu *et al*. (2023) analysed the impact of FDI on environmental efficiency in the countries of the region. Their research revealed a complex relationship between FDI and environmental performance, emphasising the need to develop policies to attract "green" investment. S. Berisha & X. Sopi (2023) studied the impact of European integration on FDI flows to the Balkan countries. It was found that the prospect of membership in the EU significantly increases the attractiveness of the countries of the region for foreign investors. V. Bucevska & A. Naumoski (2023) conducted an analysis of the impact of FDI on economic growth in Serbia, revealing a positive but heterogeneous impact of different types of FDI on the country's economic development.

I. Nikolić & M. Maksimović (2024) analysed the impact of FDI on the labour market in the Balkan countries, focusing on job creation and skills transfer. S. Zeković & A. Perić (2024) investigated geographical patterns of FDI distribution in the Balkans, revealing significant regional disparities in investment attraction. M. Cingolani (2023) conducted an analysis of the sectoral distribution of FDI in the Balkan countries, revealing the growing role of investments in the service sector and high-tech industries. These studies form a comprehensive picture of the impact of FDI on the economic growth of the Balkan countries, highlighting both the positive effects and the challenges associated with the attraction and effective use of foreign investments in the region. They also highlight the need for further research to understand the long-term effects of FDI and develop effective policies to maximise its positive impact on the economic development of the Balkans.

MATERIALS AND METHODS

The study covered the period from 2000 to 2023, focusing on three Balkan countries: Serbia, Montenegro and North Macedonia. An econometric model was developed and applied to analyse the relationship between FDI and economic growth. The basis for developing the model was the gravity model of J.A. Frankel (1997), which was modified to include dynamic aspects of FDI flows. The model specification took into account key economic indicators and factors affecting FDI and economic growth. The econometric model had the following form:

$$ln(FDIflowij) = \propto_0 + \propto_1 ln(Y) + \propto_2 ln(Y_{jt}) + \propto_3 ln(Di) + u, \quad (1)$$

where *i*, *j*, *t* – respectively: host economy, home economy and year *t*; *FDIflow* – FDI inflow into host economy coming from home economy in year *t*; *Yi*(*j*)*t* – GDP of host economy – home economy, in year *t*; *Dij* – distance between economic centers of host and home economies (constant for EU Member States during 1990-2009). The inclusion of random error *εijt* made it possible to take into account in the study the impact on GDP of all factors, except for capital, human capital and direct foreign investment, which ensured a more adequate reflection of reality in the model. The log-log model was used to estimate the elasticity coefficients. However, during its use, two key problems were discovered. First, variables with zero values could not be directly transformed into logarithms, which limited the applicability of the model. Second, the use of the least squares method to estimate the log-log equation led to significant biases in the results. To solve these problems, it was decided to replace the zero values with the value $1, which allowed to avoid zero values in the collected data and to apply a logarithmic transformation.

For the analysis of panel data, the method of fixed effects was applied, which made it possible to take into account the individual characteristics of countries that do not change over time. This helped the study control for unobserved country-specific factors that might have influenced the relationship between FDI and economic growth. To solve potential endogeneity problems, the method of instrumental variables was applied. As tools, the lag values of independent variables were used, which made it possible to obtain more reliable estimates of the coefficients of the model. Data for the study were collected from reliable international sources, including the databases of the World Bank ("Middle-income trap"..., 2024) and Eurostat (2024). The use of these sources ensured the reliability and comparability of data between countries and years. To visualise the results, graphs and charts were created illustrating the dynamics of FDI and economic growth in the studied countries during the analysed period. The applied methodology made it possible to carry out a comprehensive analysis of the relationship between FDI and economic growth in the Balkan countries, taking into account the specifics of the region and modern econometric approaches.

RESULTS

FDI has played an important role on the economic growth of Serbia, The Serbian government's efforts to draw FDI and the results obtained in this area have made the topic of FDI an almost constant topic in Serbian politics and the media. Authors can better grasp the relationship between FDIs and GDP growth with the aid of numerical statistics. Serbia experienced fluctuating economic growth rates between 2000 and 2023. The country witnessed periods of substantial expansion, with annual growth rates exceeding

6% in several years. However, economic contractions occurred in 2006, 2009, 2012, 2014, and 2020. Overall, Serbia's economy demonstrated resilience, with positive growth rates prevailing in most years (Fig. 1).

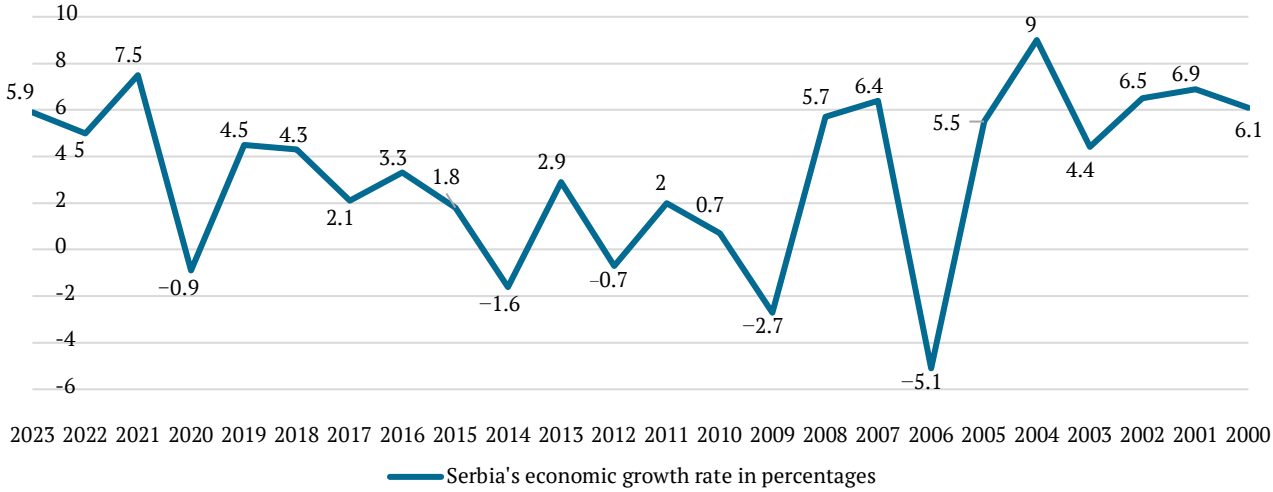

Figure 1. GDP growth of Serbia
Source: compiled by the authors based on "Middle-income trap" hinders progress in 108 developing countries (2024), Eurostat (2024)

Investment in Serbia's real economy, which creates goods and services, is essential to the country's economy since growth in these areas might help the nation's consistently negative trade balances. A recurrent issue with investment policy is revealed by the sectoral organisation of investment in the Serbian economy. The sector of services, where it is most concentrated, receives more than 60% of all foreign investment. In order to encourage economic growth and development, Serbia has been attempting to entice FDI. The Serbian government has carried out a number of measures in recent years to enhance the business environment and increase the country's appeal to foreign investors. Manufacturing, automotive, IT and software development, agriculture, energy, and real estate are a few important industries that have drawn FDI to Serbia. The nation's strategic position, affordable labour prices, and skilled labour force have all helped to make it appealing to foreign investors. Serbia has also ratified a large number of free trade agreements and bilateral investment treaties, giving investors preferential terms and access to several markets. Authors can identify a few key FDI trends in Serbia: In addition to various investments in the automobile industry (Fiat, wiring, tires), Chinese businesses have made three major investments (in mining and metallurgy), as well as Arab investments in agricultural (Fabregue, 2023; Lazaj & Duci, 2024).

Recently, Turkish businesses have made investments in Serbia's once-prolific textile and footwear industry. Major investments were made by the United Arab Emirates in P&O Port and Air Serbia. The Novi Sad port came under the administration of Dubai from the United Arab Emirates. On the production side, Siemens took over Milanovi Engineering from Kragujevac. Iemens has constructed a new facility for the manufacture of aluminium passenger coach bodies and will soon begin manufacturing trams. While most FDI manufacturing is geared toward export, some of it is for the home market. Serbia has made infrastructure investments in transportation, electricity, and telecommunications. These developments are intended to improve connectivity, logistics, and the general business environment in order to attract FDI. Serbia has negotiated and completed a number of free trade agreements, giving it access to a huge market and favourable trading terms. These agreements, which include those with the EU and the Central European Free Trading Agreement countries, help to attract foreign businesses looking to leverage Serbia as a regional trading hub. Serbia's relative regional stability has been a beneficial element in attracting FDI. The country's geopolitical location at the crossroads of Europe adds to its attractiveness as a regional investment destination.

FDI has played an important role on economic growth of North Macedonia. Here are some key points regarding FDI in North Macedonia. Sectors: FDI in North Macedonia has been attracted to various sectors, including manufacturing, services, energy, automotive, information technology, and textiles. The country has sought to diversify its economy and attract investments in high-value-added industries. Countries of origin: FDI in North Macedonia comes from a range of countries. Historically, investments from EU member states, such as Germany, the Netherlands, Austria, and Italy, have been prominent. Additionally, investments from non-EU countries, including Turkey, the United States, Switzerland, and China, have increased in recent years. Economic reforms: North Macedonia has implemented economic reforms to enhance the investment climate. These reforms include improvements in the legal and regulatory framework, simplification of administrative procedures, and strengthening of investor protection. The government has also worked to combat corruption and improve governance which are crucial factors in attracting FDI. Investment incentives: Special economic zones have been established to provide additional incentives and attract investments in specific regions.

Skilled workforce: North Macedonia benefits from a relatively well-educated and skilled workforce, particularly in the fields of information technology, engineering, and languages. The availability of a skilled labour force is an attractive factor for foreign investors seeking to establish operations or outsource services. Regional integration: N. Macedonia's integration with regional and international organisations, such as the EU, has facilitated foreign investment. Access to regional markets, trade agreements, and harmonised business standards are advantages that can attract investors (Sokil *et al.*, 2020). Infrastructure development: North Macedonia has invested in infrastructure projects, including transportation, energy, and telecommunications. These developments enhance connectivity, reduce logistics costs, and provide a supportive environment for businesses. General trends and elements that were significant at the time include the following. Pro-business reforms: to enhance the economic climate and draw FDI, North Macedonia has implemented a number of measures. Manufacturing and export-oriented industries: in the past, North Macedonia has drawn FDIs in manufacturing goods, mainly textiles, electronics, and food processing. Renewable energy and infrastructure: North Macedonia has prioritised investments in renewable energy initiatives including wind farms and solar parks. North Macedonia's economic performance between 2000 and 2023 was characterised by fluctuations. The country experienced periods of growth interspersed with contractions. While there were years of robust expansion, with growth rates exceeding 5%, the economy also faced challenges, including negative growth rates in specific years. Overall, North Macedonia's economic trajectory exhibited a varied pattern during this period (Fig. 2).

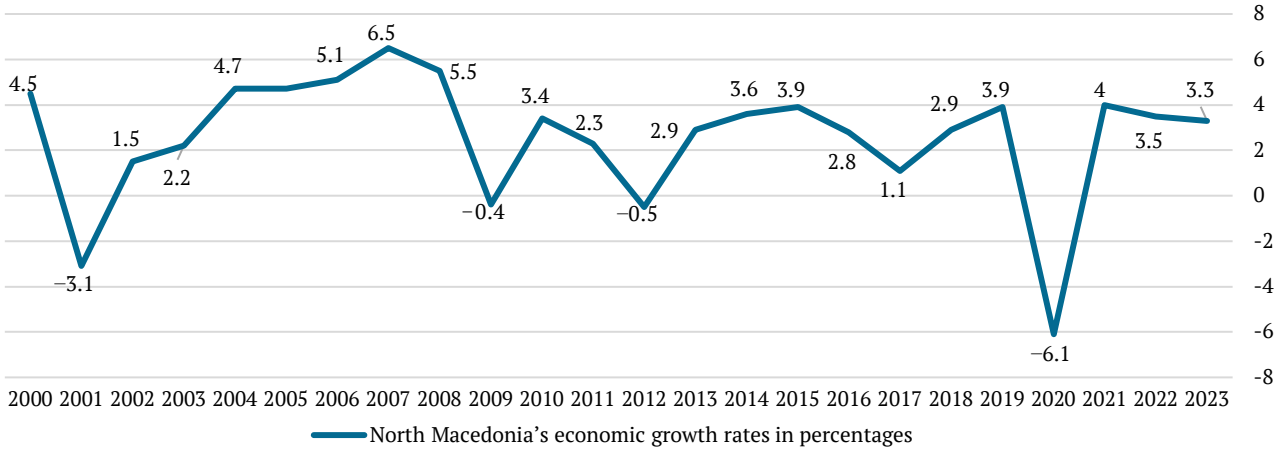

Figure 2. GDP growth of North Macedonia
Source: compiled by the authors based on "Middle-income trap" hinders progress in 108 developing countries (2024), Eurostat (2024)

Montenegro's economy has grown favourably. Its economy had been growing steadily before the COVID-19 epidemic, with an average yearly growth rate of roughly 3-4%. To entice investment and advance economic development, Montenegro has implemented market-oriented reforms and privatisation initiatives. These initiatives seek to boost competitiveness, enhance the business climate, and expedite administrative processes. Montenegro has made investments in the growth of its infrastructure, particularly in the areas of transportation and electricity. The economic growth of Montenegro has been significantly influenced by FDI. FDI inflows have mostly come from nations like Russia, Serbia, and EU member states. High unemployment rates, an aging population, corruption, and the need for more reforms in the economic environment are just a few of the difficulties Montenegro is facing. The emphasis on green initiatives and sustainable development in Montenegro is rising. The country has implemented reforms and initiatives to attract foreign investors and create a favourable investment climate. Here are some key points regarding FDI in the government of Montenegro offers investment incentives for foreign investors: the incentives may include subsidies, grants, and streamlined administrative procedures and tax breaks, special economic zones and free trade zones have been established to provide additional incentives and foster investment in specific regions.

FDI in Montenegro has been attracted to various sectors, including tourism, energy, real estate, manufacturing, services, and infrastructure development. The tourism sector has been a significant recipient of foreign investment, driven by Montenegro's natural beauty and coastal attractions. The EU accession process has encouraged reforms, provided access to EU funding and support, and natural resources and energy: Montenegro has potential natural resources, including minerals, water resources, and renewable energy sources. FDI has been attracted to energy projects, including hydropower, wind farms, and solar energy installations. Political stability and business environment: Montenegro has maintained political stability, which is an attractive factor for these investors. The Montenegro's government has made efforts enhance the legal, regulatory framework, and combat corruption. Montenegro's economy exhibited significant growth fluctuations between 2000 and 2023. The country experienced periods of rapid expansion, with annual growth rates surpassing 5% in several years. However, economic performance was uneven, marked by periods of slower growth and even contraction. Overall, Montenegro's economic

trajectory during this period was characterised by volatility (Fig. 3). Montenegro has begun the privatisation of its state-owned businesses, providing opportunities for foreign investors to invest in a range of industries, infrastructure, energy tourism etc. FDIs have been drawn in large amounts to the Montenegrin tourist industry, with funds going toward the development of hotels, resorts, and other tourism-related infrastructure (Trusova *et al.*, 2020). FDIs have been utilised to build hydroelectric facilities, solar parks, and wind farms. Montenegro developed special economic zones to draw FDI and foster economic development in particular areas.

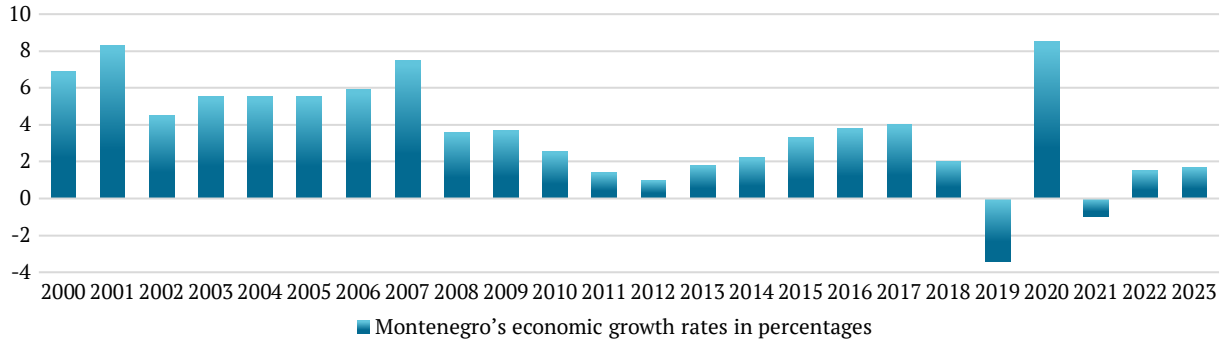

Figure 3. FDI in Montenegro
Source: compiled by the authors based on "Middle-income trap" hinders progress in 108 developing countries (2024), Eurostat (2024)

As a result of the research, a significant role of FDI in the economic development of Serbia, North Macedonia and Montenegro during 2000-2023 was revealed. All three countries were characterised by similar trends, in particular, periods of significant economic growth alternated with periods of slowdown and even recession, which indicates the vulnerability of the region's economies to external factors. Despite this, a high level of economic sustainability was found in the studied region. Serbia should be especially noted, where positive growth rates prevailed for most of the years. Reforms aimed at improving the business climate, infrastructure development and regional integration, especially with the EU, were key factors in attracting FDI for all three countries. The sectors that attracted the most FDI included services, manufacturing, energy and tourism, although the proportions varied between countries. It is important to note the diversification of FDI sources, with a noticeable increase in investments not only from the EU, but also from China, Turkey and the Persian Gulf countries. In general, the obtained results emphasise the critical importance of FDI for economic growth in the region and the need for further reforms to support stable investment inflows.

DISCUSSION

The results of the study demonstrate a complex and dynamic picture of the relationship between economic growth and FDI in the countries of the Balkan region, in particular in Serbia, North Macedonia and Montenegro. The obtained results are important for understanding the economic development of the region and developing potential strategies for further growth. In particular, during the analysis of the economic development of Serbia in the period from 2000 to 2023, an uneven growth dynamic alternating with periods of prosperity and decline was revealed. These results correlate with the conclusions of A. Pavlović *et al*. (2022) and B. Rexha *et al*. (2024), who also noted instability and structural imbalances in the Serbian economy after 2000. Despite such fluctuations, the conducted research confirms the general stability of the Serbian economy, since the vast majority of years were characterised by positive growth rates.

As a result of the discovery of a high concentration of FDI in the service sector of Serbia (over 60%), a challenge was formed regarding the long-term sustainability of the country's economic development. This approach is consistent with the conclusions of B. Marković *et al*. (2024), who noted the predominance of FDI in the service sector in most Balkan countries. However, contrary to these findings, this study found increasing diversification of FDI in Serbia, especially in the manufacturing, automotive and IT sectors. This shift suggests the potential for a more balanced distribution of investment, which could contribute to the country's long-term economic growth (Sejdiu *et al.*, 2024). Serbia's attractiveness for FDI is due to its good geographical location and active political measures to improve the business climate (Trusova *et al.*, 2022). These factors confirm the conclusions of studies, in particular I. Domazet *et al*. (2023), which emphasised the importance of institutional reforms and geographic location for attracting investment in the region. In addition, this study found that free trade agreements and bilateral investment treaties play a significant role in attracting foreign capital, which also correlates with the findings of I. Domazet *et al*. on the importance of international agreements for direct investment flows.

As for North Macedonia, it should be noted that a similar pattern of fluctuations in economic growth between 2000 and 2023 was established in the course of this study. S.I. Jelisavac Trošić & M.K. Arnaudov (2024) found limited diversification of FDI in the country. At the same time, this study emphasised the possible transition of this country to a more diverse economic structure, in the context of diversification of FDI sectors. North Macedonia's efforts to improve the business climate and fight corruption are consistent with the findings of F. Taskovski (2023), who emphasised the importance of institutional reforms to attract

FDI in the region. In the course of this study, the growing importance of regional integration, especially with the EU, as a factor of attracting FDI was also revealed, which also corresponds to the position of F. Taskovski (2023) about the positive impact of European integration on FDI flows in the Balkan countries.

In the case of Montenegro, significant fluctuations in economic growth were found between 2000 and 2023, with periods of rapid growth and deceleration. This volatility is consistent with the findings of S. Shahini & S. Kazazi (2023). The researchers noted the vulnerability of the Montenegrin economy to external factors. However, this study also highlighted the gradual improvement in the country's economic environment, particularly through efforts to attract FDI and develop key sectors. Special attention was paid to the concentration of FDI in the tourism sector of Montenegro, which accordingly reflects the country's natural advantages. At the same time, it raises questions about economic diversification, which is consistent with the conclusions of S. Shahini & S. Kazazi (2023), who emphasised the importance of tourism for the economy of Montenegro. Common between the studies is the expression of risks, which consist in excessive dependence of the country's economy on one sector. A growing interest in energy and infrastructure investments, which can contribute to more balanced economic development, has also been identified. Montenegro's efforts to privatise state-owned enterprises and create special economic zones in tourist regions correspond to the general trends in Montenegro identified by M. Benner (2020). This position correlates with the results of this study, as it highlights the potential of these initiatives to attract additional FDI and stimulate economic growth in this country.

Based on the above, it is possible to single out several key trends that exist in scientific doctrine and are consistent with the results of this study. First of all, the economic volatility of all three countries should be noted, as they show significant fluctuations in economic growth, which emphasises the need for strategies to increase economic stability. This position can be traced in all the scientific works analysed above and corresponds to the conclusions reached in this study. The importance of institutional reforms, the implementation of which is a necessary step for improving the business environment and fighting corruption in the context of attracting FDI, should be emphasised separately (Ketners, 2024). Also, all researchers describe the specifics of sectoral diversification, while there are differences between the countries under consideration. The general trend indicates a gradual diversification of FDI by sector. As for regional integration, the conclusions of this study fully coincide with the positions put forward in scientific doctrine. In particular, all three countries benefit from regional integration, especially with the EU, as a factor in attracting FDI. Infrastructure investment also plays a fundamental role in attracting FDI and stimulating economic growth among the countries studied. In conclusion, it can be noted that the results of this study and the analysed conclusions of other scholars provide an important contribution to the understanding of the dynamics of economic growth and FDI in the Balkan region, as they highlight both the achievements and challenges faced by these countries in their pursuit of sustainable economic development.

CONCLUSIONS

FDI in Balkans has been demonstrated in studies to produce beneficial spillover effects such as technology transfer, knowledge diffusion, job creation, and increased productivity. The Balkan countries have demonstrated investment potential, owing to their strategic position, natural resources, and comparatively low labour costs. FDI has been primarily concentrated in sectors such as telecommunications, tourism, banking and finance, manufacturing, energy projects, including hydropower and oil exploration, mining, construction, renewable energy projects, services, automotive, information technology, textiles, real estate, infrastructure development and agriculture have attracted significant foreign investment.

Changes in the distance between countries may have a big impact on FDI inflow, according to the analysis. A higher distance, results in a smaller FDI inflow. The reason is that investing in a foreign country that is geographically distant can be more costly, increase the perceived risks associated with FDI. A larger population can stimulate FDI by providing a broader consumer base, enabling economies of scale, and offering a larger labour pool. Additionally, it can serve as a gateway to regional markets. Higher real interest rates can attract foreign investment by offering higher returns. However, investors may also demand higher returns to compensate for increased capital costs, potentially influencing currency exchange rates. This can ultimately impact investor confidence and FDI flows. GDP has a positive impact on FDI because of market access and expansion, resource availability, cost efficiency and competitiveness, technological advantages and innovation, access to talent and expertise etc.

This state of affairs is caused by a number of factors, including: the size and potential of the market, competitive advantages, the level of technological development, the efficiency of supply chains and the development of infrastructure. The region governments have made efforts to improve the business environment and attract FDI. however, still need to be more. Reforms have been implemented to streamline administrative procedures, enhance legal and regulatory frameworks, and address issues related to corruption and bureaucracy. In the following scientific studies, it is advisable to consider the impact of macroeconomic indicators (inflation, budget deficit, exchange rate) on the attractiveness of the Balkan countries for investors.

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CONFLICT OF INTEREST

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Економічне зростання та прямі іноземні інвестиції на Балканах

Анотація. Прямі іноземні інвестиції (ПІІ) стали ключовим джерелом економічного зростання для балканських країн, пропонуючи життєво важливе фінансування для ініціатив розвитку. Відповідно метою цього дослідження було проаналізувати динаміку ПІІ в Сербії, Північній Македонії та Чорногорії з 2000 по 2023 рік. Для проведення дослідження було використано економетричну модель, а саме проаналізовано зв'язок між ПІІ та економічним зростанням у регіоні. Розроблено модель множинної регресії, яка включає зростання валового внутрішнього продукту як залежну змінну. Встановлено, що для всіх трьох країн характерні значні коливання темпів економічного зростання в зазначений період. Особливу стійкість продемонструвала Сербія, де в більшості років переважали позитивні темпи зростання. Також були визначені ключові сектори, що приваблюють ПІІ, зокрема це сфера послуг, обробна промисловість, автомобілебудування, інформаційні технології, сільське господарство, енергетика та туризм. Отримані результати підкреслили важливість реформ, спрямованих на розвиток бізнесу, розбудову інфраструктури та регіональну інтеграцію, особливо з ЄС, як критично важливих факторів залучення ПІІ. Крім того, було підкреслено диверсифікацію джерел ПІІ зі збільшенням інвестицій із Китаю, Туреччини та Об'єднаних Арабських Еміратів, які доповнюють традиційних інвесторів з ЄС. Понад 60 % іноземних інвестицій у Сербії зосереджено у секторі послуг, тоді як Північна Македонія успішно залучає інвестиції в галузі з високою доданою вартістю, такі як інформаційні технології та машинобудування. Ці висновки узгоджуються з усталеними економічними теоріями про вплив ПІІ на економічне зростання, водночас надаючи специфічне розуміння балканського контексту. Дослідження показало, що збільшення ПІІ на 1 % асоціюється зі зростанням валового внутрішнього продукту на 0,3-0,5 % у досліджуваних балканських країнах. Отримані результати можуть стати основою для майбутніх політичних рішень та інвестиційних стратегій в регіоні

Ключові слова: інвестиційні сектори; регіональна інтеграція; інвестиційні стимули; розвиток інфраструктури; енергетичні проекти

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Artificial intelligence for marketing product strategy in the online education market

Abstract. The online education market has experienced tremendous growth, creating a competitive landscape where effective marketing solutions are crucial for success. Artificial intelligence (AI) has emerged as a powerful tool, offering innovative ways to enhance product marketing strategy. The purpose of the article was to highlight the integration of artificial intelligence into marketing product strategies in the online education market and to evaluate the chances of success for launching a new training course implemented through AI algorithms. A systematic review of advanced technologies and products in the AI market was carried out, along with a comparative analysis based on data from

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various authors and reports from organisations, considering the aspects of interpreting qualitative and quantitative market characteristics. Leaders in the global and Ukrainian online education market were analysed, and research was conducted on the marketing product strategy measures of successful players, indicating qualitative and quantitative data using SimilarWeb and Semrush online services. These results allowed for an analysis of the connection between the identified market segments and influencing factors to make practical recommendations for improving elements of marketing based on the identified issues of products and the online education market. To demonstrate the relevance and effectiveness of the proposals, an approach was applied to test if a product with enhanced AI marketing would fit into the market using the example of the Projector Institute company. The assessment obtained from the calculations showed that AI can strengthen the marketing of online education products, as they will fully meet the interests of interested economic counterparts. The results of the study could be used by marketing, AI experts, product experts, business owners in marketing, etc. to enhance marketing solutions

Keywords: e-learning market; digital technologies; product development; AI-driven marketing; AI-based courses

INTRODUCTION

Over 2022-2023, the development of artificial intelligence (AI) technologies has reached a new level: scientists have started talking about the possibility of a complete revolution in the general perception of the modern world if this breakthrough is implemented in an increasing number of developments. AI is penetrating deeper and deeper into various areas of life, including marketing, and its main advantages are speed, the ability to analyse databases in seconds, and to perform almost any manual and repetitive work, which allows optimising work that would take a human much longer but not necessarily better. There are wide-spread concerns about AI, from the ethics of its use to the potential dangers of these technologies, which can manifest themselves in minor errors and inaccuracies, as well as in more threatening failures, monitoring, falsification, etc. These concerns are also evident in marketing, as the lack of legal regulation of the sector, even at the international level, is already causing conflicts. With this in mind, it is important to understand how AI will strengthen the marketing product strategy of the online education market in such a way that it works efficiently, correctly, and enhances products rather than making them generalised and non-unique for the consumer. The potential of AI in the area is almost endless: it allows personalising communication with customers, forming detailed proposals based on preliminary analysis, and generating accurate text elements, both for advertising messages and for assortment items and their descriptions.

The report by W. Holmes *et al*. (2022) critically examines the role of AI in education from the perspective of human rights, democracy, and the rule of law. It highlights the dual nature of AI, which offers both significant opportunities and challenges. The report emphasises the importance of empowering educators and learners without overempowering AI tools. It calls for a balanced approach to AI adoption in education, especially in the online education market, advocating for both AI literacy and a nuanced understanding of AI's impact on privacy, agency, and human dignity. The article by D.R.G. Cardosa & G.G. Brustenga (2023) highlights six key trends in generative AI for education, emphasising opportunities and risks. These trends include the use of multilingual videos with avatars to enhance accessibility and personalisation, AI tools supporting teaching staff in course design, and innovations in EdTech start-ups leveraging AI APIs. Additionally, AI's role in arts education, adaptive learning experiences customised for students, and simplified content creation are discussed. The study underscores the need for responsible AI integration in education.

A.K. Pradeep *et al*. (2018) explore how AI is revolutionising marketing and product development. They discuss AI's capabilities in predicting trends, enhancing customer connections, and boosting sales. They provide insights into various AI applications, such as data analysis, customer segmentation, dynamic pricing, and creative storytelling. The study serves as a non-technical guide for enhancing products with AI, emphasising practical tools and strategies for leveraging AI to drive innovation and efficiency in marketing efforts. Also, the studies by M. Jabeen (2022) and R. Naeem *et al*. (2024) examine the utilisation of AI in product marketing. The studies provide a conceptual analysis of the past, present, and future of marketing through the lens of AI and the role of AI in product-service innovation. The article by A.L. Priyanka *et al*. (2023) delves into the concept of AI in marketing, examining its role in contemporary marketing, its advantages and challenges, best practices for implementation, and ethical considerations. The objective of the study by Y. Masnita *et al*. (2024) is to explore the overall utilisation of AI in marketing by practitioners, as the existing literature frequently concentrates on specific goals such as branding, innovation, and analysing competitors' weaknesses. A. Haleem *et al*. (2022) investigate the specific applications of AI across various marketing segments and their transformative impacts on marketing sectors. It identifies and critically analyses the essential applications of AI in the field of marketing.

AI and its elements are an organic part of the innovations that have been taking place in marketing since its inception. Potential examples could be recognised in digitalisation, the increase in communication channels, and the emergence of new techniques, which will possibly lead to the next stage of total automation, accessibility, the emergence of tools and practices, and, of course, a fundamental renewal of the products and services that are offered on the market. However, questions regarding the systematisation of information contribute towards providing insights that may assist in the strategic planning of the marketing executive in the sector of online education while leveraging AI for a competitive advantage. Understanding if such products would be successful in the online education market is a way of proving said hypothesis true. Thus, the aim of the article was to explore the integration of AI into marketing

strategies for the products in the online education market and to assess the prospects for the successful launch of a new course, marketing frameworks of which were developed using AI algorithms.

MATERIALS AND METHODS

The research used the method of comparative analysis in a set way of defining features of markets of AI and online education. The chosen methodology of comparative analysis that was used in the given research implied diverse data collection and synthesis from scientific publications, besides credible reports of organisations. As such, there is an extensive search for scholarly databases and publishers to capture relevant studies and reports that may enlighten market dynamics and AI innovations in online education. The selection of these sources was guided by their recency, relevance to research questions, and the scientific rigour of the methodologies used. The systematic analysis approach provided a strong framework to interpret complex data through the market in a complex way. The results extracted the findings from predefined classifications based on the data collection matrix. The classification criteria consisted of market growth, technological advancement, user demographic pattern, and educational outcomes. This categorisation structured the overview of the findings but in a different way, and emphasised areas of consensus and disparity in the literature. Analytical matrices have been developed so that they can be juxtaposed with the identified features and implications for a greater appreciation of the subtleties of the market landscapes.

The analysis of the product array of products within the e-learning market adopted the use of longitudinal and content analysis. Methodological approach that consists of data collection and scrutiny about the various educational products in a systematic way, resulting in the extraction of general patterns and principles informing the market behaviour and trends of product development. The first step in this direction was comprehensive data collection, wherein information about the various products in online education was collected from all available sources: academic literature, market reports, industry whitepapers, and user reviews. Each of them was analysed, and every factor of the particular set of criteria was taken into account to know how criteria were satisfied, for instance, user engagement metrics, technological innovation, content quality, or market reception. Methodologies applied in identifying the relevant market segments and the AI technologies that might be integrated into marketing strategies were expert and abstract-logical methods. These kinds of methods use systematic abstract reasoning with the help of expert analysis that dissects the understanding of complex structures of markets and ability potentials from different AI applications.

The study focused on the assessment with a detailed approach for launching a new product into the market with a special reference to the improved marketing frameworks through the use of AI in an effort to enhance chances for success. It is a systematic approach to reviewing both internal and external scenarios that may affect the product's marketplace performance. The approach for assessing the chances of success in launching a new product involved the following steps. Outlining the interested market stakeholders (economic counterparts of the company). The analysis conducted showed that the interests of such market stakeholders should be considered: the commodity producer (companies), consumers, employers, the Ministry of Education and Science of Ukraine, and the military sector. Determining the level of interest of the company, as well as its economic counterparts, in the new product. The list of characteristics for assessment has been determined by an expert method with a generalised approach. All characteristics are estimated by an assessment for all market stakeholders.

The survey was conducted in February 2024 online through the Google Forms platform in compliance with the American Sociological Association's code of ethics (1997). Each question offered the respondent four options: disagree, rather disagree than agree, rather agree than disagree, and agree. The following scale is used when evaluating these responses accordingly: 1 point – the low level of the characteristics' compliance of product to the requirements of market participant; 2 points – the level of the characteristics' compliance of product to the requirements of market participant is below the average; 3 points – the level of the characteristics' compliance of product to the requirements of market participant is above the average; 4 points – the high level of the characteristics' compliance of product to the requirements of market participant.

According to the study by M. Basha (2023), a list of questions was made that was addressed universally to each stakeholder: the educational IT course, enhanced with AI-driven marketing strategies, is expected to generate significant interest among the stakeholder; the AI-enhanced marketing approach will effectively communicate the unique value proposition of the educational IT course to potential students; the marketing strategies employed for this course are likely to increase its visibility and attractiveness in the educational market; the course content and marketing messages align well with the needs and expectations of the target audience; the AI-enhanced marketing will likely lead to a higher enrolment rate for the educational IT course; the course's marketing strategy effectively highlights its compliance with national and international educational standards; the marketing campaign for the course will successfully engage key stakeholders and encourage their endorsement; the AI-enhanced marketing efforts will significantly enhance the course's brand perception among potential students and employers; the course's marketing strategy is expected to effectively address and highlight the skill gaps it aims to fill; the overall marketing plan for the educational IT course is likely to position it as a leading option in the educational market. Through expert survey, key evaluation characteristics were identified, and then the weights of these characteristics were determined. The weighted characteristics were estimated based on studies by B. Hrabovetskyi (2010) and O. Bilovodska *et al*. (2019) using following equations:

$$W_i = \frac{\sum_{j=1}^{m} w_{ij}}{\sum_{i=1}^{n}\left(\sum_{j=1}^{m} w_{ij}\right)}; \quad (1)$$

$$W_{ij} = \frac{c_{ij}}{\sum_{i=1}^{n} c_{ij}}, \quad (2)$$

where W_i represents the total weight assigned by experts to indicator i; m is the number of experts; n is the number of indicators; W_{ij} denotes the rank given by expert j for

indicator i; C_{ij} signifies the relative weight estimation (in points) set by expert j for indicator i. Statistical tools were utilised to assess the consistency of expert opinions (Yashkina, 2013). The obtained results were used to construct tables for assessment. This approach could comprise market acceptance, competitive response, and operational abilities. Integral calculating for the assessment of new product compliance with the interests for each market stakeholders using equation:

$$O = \sum_{i=1}^{n} P_i \times W_i, \quad (3)$$

where P_i is the point of the characteristic i; W_i is the weight of the characteristic i.

RESULTS

The AI market is complex and divergent, which is visible in the research conducted by the leading data analytical organisations (Precedence Research, Grand View Research, McKinsey & Company, Forrester Research, etc.). The online education market keeps on growing with strong players on the market, which is the reason new innovative products appear more often. Such changes lead to an extended use of AI in marketing online education products. AI has become a transformative force across various industries, and its impact on the online education market is particularly noteworthy. The online education sector has witnessed exponential growth, leading to increased competition and the need for innovative marketing strategies. AI offers a plethora of opportunities to enhance marketing product policies in the online education market. It is not easy to estimate the AI market, as the data from officially conducted reports by organisations and commercial institutions often differ. The difference in data happens since the concept of AI in the reports differs, as well as the difference in the concept of what to include in the AI market itself. The dynamics also show a market decline in 2022 as a result of Russia's full-scale invasion of Ukraine. If the study was conducted in 2022 or at the beginning of it, this moment would not have been noticed. A comparative analysis of the description of the AI market was conducted (Table 1).

Table 1. Comparative analysis of the AI market (based on various sources)

Parameter	Precedence Research data for 2022	Grand View Research data for 2023	Statista data for 2023
Market estimate, billion $	454.12	196.63	241.8
Compound annual growth rate (CAGR), %	12	37.3	17
Largest share of revenue, sector	BFSI	BFSI	BFSI
Largest geographical market, region	North America	Asia	North America
Estimate of largest geographical market, million $	167.3	62.9	84.7

Note: BFSI – banking, finance services, insurance

Source: created by the authors based on Artificial intelligence (AI) market size, share, and trends (2023), Artificial intelligence market size & trends (2024), Artificial intelligence – worldwide (2024)

AI in marketing works on the principle of three "D", according to J. Sterne (2017). Detect: AI has the ability to identify the most predictable elements or attributes in a huge amount of diverse data, highlighting the key characteristics to focus on while ignoring the rest. Deliberate: AI is able to derive rules from data, evaluate the most influential attributes against each other, and use this information to answer queries or make suggestions. AI can also reason about the importance of each attribute and ultimately draw conclusions. Develop: AI can evolve and become more sophisticated with each iteration. It can change its view of the environment and how it evaluates that environment by incorporating new information or the results of experiments. Its algorithms are capable of self-programming. When it comes to marketing combined with AI, automation is the first thing that comes to mind. Most working models fall under the category of mathematical algorithms that can be "sewn" into a set of rules that a robotic system will execute while learning from each experience of repeating these algorithms, analysing errors and possible areas for improvement, and implementing changes in subsequent iterations. This approach may seem too general, but the advantage of AI is the ability to implement such processes at the level of personalised marketing, looking for the best solution and forming an offer not for the target audience or even for its segments, but for each consumer individually. AI can be used at every stage and in every component of marketing, and in the modern world, it serves, among other things, as an element of attracting attention if it is part of or accompanies the sale of a particular product. A comparative characterisation of the global and Ukrainian online education markets is systematised and proposed (Table 2; Fig. 1).

Table 2. Comparative analysis of the global and Ukrainian online education markets

Parameter	World	Ukraine
Market volume of online education, billion $	3.993	0.15
CAGR, %	14	26
Projected market volume of online education for 2032, billion $	10.00	~ 0.5
Revenue of online education market, million $ including:	156	3.4
▪ distance higher education	100	0.3
▪ online learning platforms	50.5	2.5

Table 2. Continued

Parameter	World	Ukraine
▪ professional certification courses	5.5	0.408
Number of users of platforms for online learning as of 2023, million	73.3	1.3
Projected number of users of platforms for online learning as of 2028, million	1,000	–
Market penetration rate of online learning platforms as of 2023, %	9	3
Key players in the market (including holdings), Figure 1	LinkedIn, Udemy, Coursera, Blackboard Inc., Aptara Inc., Cisco Systems, Centerpoint Systems Inc	Coersera, Prometheus, Laba Group, Projector Institute, EdEra, GoIT, Lingva.Skills
Factors contributing to market growth	Internet penetration and mobile learning in hard-to-reach world regions; the rise in demand for continuous learning (life-long learning) and professional development in various sectors including the corporate sector and healthcare; innovations in educational technologies including learning management systems (LMS) and cloud solutions	Internet penetration and mobile learning in remote regions of the country; the war and occupation factor – lack of access to traditional forms of education; the opening of new businesses in the field of online education in Ukraine, digitalisation of education (as a government initiative)
Market issues	Lack of peer-to-peer interaction in the online environment affecting the learning process and student engagement; slow internet connection and poor network infrastructure in some regions limit the effectiveness and accessibility of online education, especially in rural and underdeveloped areas; digital divide; concerns about the quality and effectiveness of online learning, especially for subjects that require practical or real-world experience that is hard to replicate in a virtual environment; ensuring academic integrity and preventing fraud	
Market trends	Integration of AI and machine learning; gamification, interactive content, virtual reality, and augmented reality applications; development of B2B alliances between online education providers and businesses; increasing digitalisation of education and growing demand for digital devices; government initiatives towards digitalisation of education; growing recognition of online certificates and degrees as legitimate qualifications	Microlearning – shortening and intensification of content (simplification of learning); gamification, interactive content; automation and engagement of neural networks; increasing digitalisation of education and growing demand for digital devices; government initiatives towards digitalisation of education; the popularity of this learning format in the IT sector
Market demand characteristics	Steadily growing, noticeable increase during the COVID-19 pandemic in 2020	Unstable demand: rapid growth during the COVID-19 pandemic in 2020 and at the beginning of Russia's full-scale invasion in 2022; demand drop during blackouts at the end of 2022 and beginning of 2023

Source: created by the authors based on Online education market in Ukraine – analytical overview (2020), Global online education market – industry dynamics, market size, and opportunity forecast to 2031 (2022), Online education market (2023), Revolutionary growth projected for online education market expanding to USD 475 billion by 2030 with a striking CAGR of 9.1% unveiled in technology industry report by facts and factors (2023), P. Wadhwani (2023), O. Kovtun (2023), O. Melnichuk (2023), Online education – worldwide (2024)

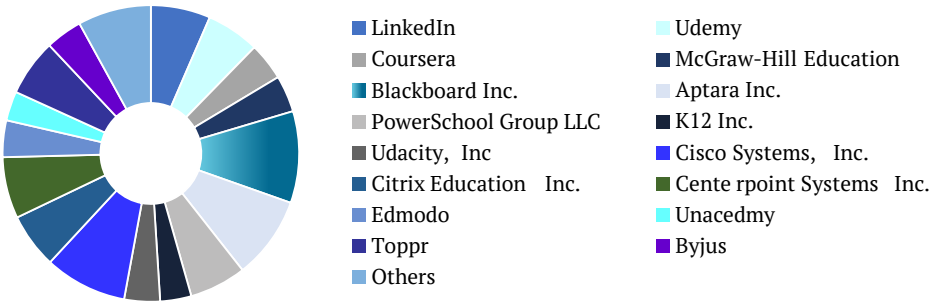

Figure 1. Online education market share of key players, 2022

Source: created by the authors based on Online education market (2023)

Based on a study of the online education market leaders and an analysis of their platforms, the five most significant products of the online education market were identified. Coursera offers a variety of courses, diplomas, professional certificates, and tutorials in a wide range of disciplines, partnering with more than 275 world-class institutions and 2,300 companies (We envision a world..., n.d.). This extensive network allows Coursera to serve a diverse learning audience of more than 113 million learners worldwide. The platform's business model has evolved over the years, initially generating revenue from the sale of certified products and later expanded to include various paid course options. In terms of financial performance, Coursera's revenue grew substantially from $184 million in 2019 to $294 million in 2020, largely as a result of the COVID-19 pandemic. However, the company operated at a loss, and its net loss in 2020 was only USD 66 million, mainly due to increased marketing and advertising costs.

Udemy, founded in 2010, is an online learning platform that offers a wide range of courses in various subjects (Udemy report..., 2023). It is known for its affordability, and frequent sales and discounts make courses available to a wide audience. Prices for Udemy courses typically range from $14 to $200, although various bonuses are often applied, which is why the course will rarely be sold at the original price (Bento, 2022). In terms of their business model, Udemy has a unique approach in the market. They have found that lower rates attract more students who stay engaged and loyal to the platform. The platform's success is evident in its ability to continuously attract new users and launch new courses. As a result, 10 million new students have registered on Udemy in a 12-month period, and more than 134 million courses have been made available.

Skillshare, founded in 2010 by M. Karnjanaprakorn and M. Ohn, is a well-known online learning platform that primarily focuses on creative industries (Cooke, 2024). It has gained considerable popularity, attracting more than 600,000 learners from around the world. Skillshare offers an extensive library of over 34,000 courses covering a wide range of subjects such as animation, illustration, music, photography, and more. The platform operates on a subscription model, with a monthly plan costing about $29 and an annual plan costing about $99 (equivalent to about $8.25 per month). Pluralsight (n.d.), founded in 2004, is an online education platform specialising in technology and creative skills. It stands out for its focus on the IT field, offering more than 7,000 courses in a wide range of technical disciplines such as Python, C#, Java, JavaScript, web development, mobile development, IT networking, internet security, and database administration, among others. Pluralsight offers different tariff plans. For individual users, there is a standard option costing about $9.50 per month with a limited library, as well as a premium option costing about $119.00 per year that provides access to the entire library of courses, including coding projects and certification exam preparation. For group subscriptions, Pluralsight offers customised plans with pricing that depends on team size and features required.

Preply is an online platform that connects learners with private tutors for one-on-one lessons, including language learning (Patiño, 2024). It offers a variety of learning methods, such as the direct method, total physical response, and engage-study-activate, providing a flexible and practical approach to language learning. Preply's key features include personalised real-time learning, direct contact with native speakers for immersive learning, and a flexible learning structure with no annual subscription requirement. The platform also offers a free blog and Q&A community for additional learning support. Lessons typically last 50 minutes, and the platform offers a variety of languages, with prices starting at around $15 per hour. Using SimilarWeb (n.d.) and Semrush (n.d.) online services, it was identified that Udemy occupied more than 50% of the market share relative to other competitors, Coursera had another 32%, and the other platforms had less than 10% each (Fig. 2). Geographically, the main countries of origin of platform users were India, USA, Brazil, Turkey, and the UK; due to the lack of access to these platforms, there were no users from China, which on many platforms in other markets could account for up to 50% of total traffic (Fig. 3).

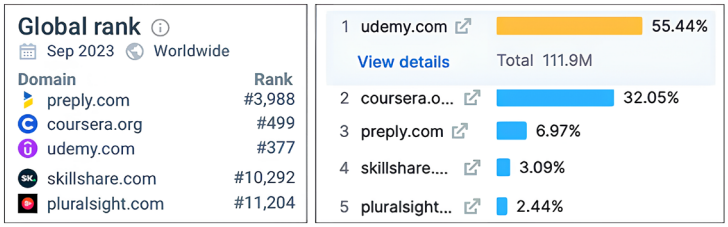

Figure 2. The positions of competitors in the market of web products for online learning and the market share distribution of companies
Source: created by the authors based on SimilarWeb (n.d.), Semrush (n.d.)

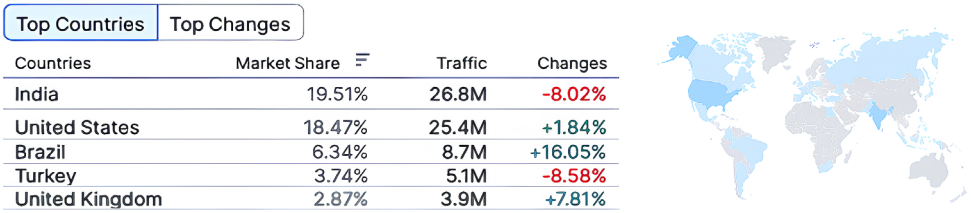

Figure 3. Geographical distribution of users of selected companies in the market of web products for online learning
Source: created by the authors based on Semrush (n.d.)

Based on SimilarWeb online service, a market growth matrix was built. As a result, in the first quarter of the matrix, Udemy and Preply were in the category of "market leaders" (the latter lags behind in terms of traffic but is a leader in its specialisation in remote language learning through tutoring). In the second quarter, Pluralsight was among the "transformers" since it became the first learning platform for IT professionals. The third quarter, "niche players", was occupied by Coursera, which, having created a unique niche, has remained the only company in it due to a stable level of trust and a unique number of high-profile contracts with the world's leading universities and companies. Skillshare, a "long-time player" that, despite few changes, remains unchanged by competitors in its area of focus, is in the fourth quarter. As for the amount of traffic, the ranking is similar to the market shares held by competitors. The largest number of users visit the Udemy platform, with more than 100 million accounts per month. The marketing channels for attracting users are homogeneous: paid acquisition (mainly through Google advertising), organic promotion (search engine optimisation, app store optimisation, web page optimisation), social media, email newsletters, and referral programmes. Direct links stand out in the engagement section, as most regular users save links to the course, website page, or material they need and open them directly, creating a disproportionate number of engagements through this channel that must be considered when analysing.

The approach to assessment of launching a new product into the market was applied with a special reference to the improved marketing frameworks through the use of AI as an effort to enhance its chances for success. An online learning company in Ukraine was chosen to conduct the study: Projector Institute. The type of product for which the chances of being accepted by the market were assessed: a new training course implemented by integrating AI algorithms into the strategies of marketing, which are AI target audience segmentation, AI offer and product customisation for each user, AI pricing adjustments depending on the user fit, and targeted advertising with AI enhanced media and text. To make the study objective, the characteristics of existing courses offered by Projector Institute and its competitors ITHillel and Beetroot Academy were analysed. The results are presented in Table 3.

Table 3. Characteristics of online learning marketing courses

Product	Price UAH/ course	Duration (months)	Number of teachers	Number of covered topics	Presence and checking of homework	Presence of a certificate upon completion
Internet marketing course, Projector Institute	27,000.00 UAH	3	2	40	Yes	Yes
Digital marketing course, Beetroot Academy	21,000.00 UAH	4	1	43	Yes	Yes
Online marketing course, ITHillel	13,100.00 UAH	4	1	38	No	Yes
Weighted characteristics of indicators	0.2	0.25	0.1	0.1	0.2	0.15

Source: created by the authors based on Online education market in Ukraine – analytical overview (2020)

The analysis shows that the company's top priorities are the interests of the following market stakeholders – the company's economic counterparties: consumers, employers (who hire course graduates), the Ministry of Education and Science of Ukraine, and the military sector. To determine the degree of interest of the commodity producer in the new product, it is necessary to assess the relevance of the new product to the interests of the commodity producer. The results are presented in Table 4. The assessment was influenced, among other things, by the fact that, if introduced, such a product would be unique in the market and could potentially increase the platform's profits. Enhanced marketing frameworks elevate a company's market positioning by showcasing innovation and adaptability. AI-driven marketing strategies leverage data analytics to create targeted, impactful campaigns. According to a report by McKinsey & Company, companies utilising AI in marketing see a 20-30% increase in marketing ROI (Deveau *et al.*, 2023). By adopting advanced marketing techniques, the company positions itself as a forward-thinking leader in education technology, attracting interest from potential partners and investors who value innovation.

Table 4. Assessment of compliance of a new product with the interests of the commodity producer

Product characteristic (weight)	Fully corresponds (4 points)	Sufficiently corresponds (3 points)	Partially corresponds (2 points)	Practically does not correspond (1 point)	Does not correspond at all (0 point)
Profitability (0.5)	+				
Expansion of product range (0.1)		+			
Automation (0.3)	+				
Increase in the number of consumers (0.1)	+				

Source: created by the authors

To determine the degree of consumer interest in the new product, whether the product meets the interests of consumers was assessed. The results are presented in Table 5. In this case, the personalisation of the experience played a significant role, distinguishing the potential product from competitors. Enhanced marketing frameworks enable a high degree of personalisation, ensuring that promotional content is tailored to the specific interests and needs of potential students. AI-driven marketing tools analyse vast amounts of data to understand consumer behaviour and preferences. According to a study by Q. Abbas (2024), personalised marketing messages can increase engagement rates by up to 20% compared to generic promotions. For students, this means receiving information that directly resonates with their career aspirations and learning preferences. Personalised marketing not only captures their attention but also helps them make informed decisions about their education, increasing the likelihood of enrolment in courses that are a perfect fit for their goals. Consumers also benefit from the transparency and detailed information provided through enhanced marketing frameworks, which aid in the decision-making process. AI-enhanced marketing frameworks can present detailed, customised content, such as course outlines, success stories, and potential career paths, through interactive platforms. Research by Y.E. Hofmann & M. Strobel (2020) indicates that comprehensive and transparent information significantly influences students' educational choices.

Table 5. Assessment of the compliance of a new product with the interests of consumers

Product characteristic (weight)	Fully corresponds (4 points)	Sufficiently corresponds (3 points)	Partially corresponds (2 points)	Practically does not correspond (1 point)	Does not correspond at all (0 point)
Price (0.3)		+			
Quality of the product (0.3)	+				
Personalisation of approach (0.2)	+				
Guarantee of result (0.2)			+		

Source: created by the authors

To determine the degree of interest of employers in new products, the relevance of the product to the interests of employers was assessed. The results are presented in Table 6. An individualised approach to training will mean more qualified personnel. AI-driven marketing frameworks improve the visibility and attractiveness of educational courses, aiding employers in acquiring top talent. Employers benefit from a wider and more engaged talent pool. By promoting educational courses that are visible and appealing to potential employees, companies can attract individuals with the latest skills and knowledge, thus enhancing their workforce quality. Enhanced marketing frameworks ensure that educational courses align closely with industry needs, producing graduates with relevant skills. A study by the World Economic Forum (2020) indicates that AI-driven market analysis helps tailor educational content to current job market demands. This ensures that the courses produce graduates with skills that are directly applicable to employer needs.

Table 6. Assessment of compliance of a new product with the interests of employers

Product characteristic (weight)	Fully corresponds (4 points)	Sufficiently corresponds (3 points)	Partially corresponds (2 points)	Practically does not correspond (1 point)	Does not correspond at all (0 point)
Availability of new trained personnel (0.5)	+				
Quality of training (0.5)	+				

Source: created by the authors

To determine the degree of interest of the Ministry of Education and Science of Ukraine in new products, the relevance of the new product to the interests of the ministry was assessed. The results are presented in Table 7. In the case of cooperation with non-profit initiatives, which the company regularly does, this is a chance for the ministry to get a high-quality way to ensure the inclusiveness of professional educational platforms, increase employment and the standard of education as such. Digital marketing strategies, supported by AI, optimise the distribution of promotional materials across various platforms, making educational opportunities more visible and accessible. Research by Y.E. Hofmann & M. Strobel (2020) shows that countries that integrate advanced technologies in education are better positioned to compete globally. AI-enhanced marketing not only promotes courses domestically but also internationally, attracting foreign students and collaborations.

Table 7. Assessment of the new product's compliance with the interests of the Ministry of Education and Science of Ukraine

Product characteristic (weight)	Fully corresponds (4 points)	Sufficiently corresponds (3 points)	Partially corresponds (2 points)	Practically does not correspond (1 point)	Does not correspond at all (0 point)
Creation of new educational opportunities (0.4)	+				

Table 7. Continued

Product characteristic (weight)	Fully corresponds (4 points)	Sufficiently corresponds (3 points)	Partially corresponds (2 points)	Practically does not correspond (1 point)	Does not correspond at all (0 point)
Increasing the employment level of the population (0.4)	+				
Inclusiveness (0.2)	+				

Source: created by the authors

To determine the degree of interest of the military sector in new products, the relevance of the new product to the interests of the military sector was assessed. The results are presented in Table 8. The military sector, with which the platform has also repeatedly cooperated, can benefit from innovative training technologies, which will positively affect the quality of education in the military. AI-enhanced marketing frameworks improve the visibility and attractiveness of educational courses, aiding military recruitment efforts. Enhanced marketing frameworks ensure that the military reaches a broader and more targeted audience. This can lead to an increase in the number of recruits with the necessary technical skills and interests aligned with the military's evolving needs.

Table 8. Assessing the relevance of a new product to the interests of the military sector

Product characteristic (weight)	Fully corresponds (4 points)	Sufficiently corresponds (3 points)	Partially corresponds (2 points)	Practically does not correspond (1 point)	Does not correspond at all (0 point)
Support of military infrastructure (0.5)			+		
Military education	+				

Source: created by the authors

The weight of economic counterparties is as follows: producer – 0.3; consumers – 0.3; employers – 0.2; MES of Ukraine – 0.1; military sector – 0.1. The calculations of the assessment of the new product's relevance to the interests of each market subject are as follows.

Commodity producer:

$$O1 = 0.5 \times 4 + 0.1 \times 3 + 0.3 \times 4 + 0.1 \times 4 = 3.9.$$

Consumers:

$$O2 = 0.3 \times 3 + 0.3 \times 4 + 0.2 \times 4 + 0.2 \times 2 = 3.3.$$

Employers:

$$O3 = 0.5 \times 4 + 0.5 \times 4 = 4.$$

Ministry of Education and Science of Ukraine:

$$O4 = 0.4 \times 4 + 0.4 \times 4 + 0.2 \times 4 = 4.$$

Military sector:

$$O5 = 0.5 \times 2 + 0.5 \times 4 = 3.$$

The calculation of the integral assessment of the new product's compliance with the interests of all the market subjects under consideration:

$$I = 0.3 \times 3.9 + 0.3 \times 3.3 + 0.2 \times \times 4 + 0.1 \times 4 + 0.1 \times 3 = 3.66.$$

Using the Table 9 for assessing the chances of a new product's market success, conclusions about the potential success of a new product on the market from the integrated assessment was drawn.

Table 9. Assessing the chances of a new product for market success

Evaluation	Correspondence to market stakeholders' interests	Level of expected total expenses	Level of expected total revenues	Solution
$3.0 < I \leq 4$	Complete	Low	High	All chances for success
$2.5 \leq I \leq 3.0$	Sufficiently complete	Moderate	Moderate	There are chances for success, but more scrutinised analysis is needed
$2.0 \leq I \leq 2.5$	Partial	High	Low	Chances for success are problematic. Perform detailed analysis

Source: created by the authors

$I = 3.66$, which means that the introduction of a new product (AI-assisted exchange rate) to the market is fully in the interests of economic counterparties. The total costs of the enterprise will potentially not be too high, as the company already has experience in assortment expansion, and the direction of writing AI algorithms is already being worked on the main learning platform (LMS and content management system). To minimise the risks, it is recommended to launch AI elements gradually in the A/B test format. The marketing product strategy in the online education market is complex; measures to improve it should be taken with attention and understanding of the sensitivity of this market, as well as responsibility to consumers. An important aspect of the online education market is product management. The Ukrainian market is rich in offers of various topics, but their structure on individual platforms is often not adapted to the needs of the user. Properly organised product nomenclature provides a logical user flow for

the consumer, which creates a learning need and increases the likelihood of purchase.

An example of a successful product nomenclature is offered; this is the method used by Coursera: offering the most popular courses first, the platform recommends similar courses with a lower rating based on the AI principle, thus balancing demand. Many AI technologies use the concept of design thinking to optimise the visual experience of products. Maximising the integration of consumer-generated content into the tools already available on a website would make more people spend longer on the site and increase the likelihood of a purchase. AI in this area can help to build the right "hooks" that would hold the user's attention and build interest in the product; this applies to internal content, platform menus, descriptions of learning elements, etc. As for the reputation that is formed through hidden marketing influences, a good solution would be to work with the internal marketing of the product and create a unique user experience for the consumer. AI can design and implement a personalised onboarding funnel for almost any product, as well as provide round-the-clock feedback on possible questions. Customisation of the educational programme at the registration stage is essentially the creation of an individual product offer, the value of which is almost priceless for the consumer, and for the AI algorithm, just a set of built-in rules.

DISCUSSION

The integration of AI into marketing strategies within the online education market has shown significant promise, as evidenced by the results of this study. The findings indicate that AI enhances marketing efforts by offering personalised and optimised solutions, improving targeting and engagement with diverse customer segments. These conclusions align with various recent studies, which further substantiate the transformative potential of AI in education and marketing. AI's ability to adapt and innovate further substantiates its growing influence in reshaping how content is marketed and consumed online. The global AI market analysis by Grand View Research projects substantial growth driven by continuous R&D and increasing adoption across industries (Artificial intelligence market…, 2024). This growth is mirrored in the findings of the current study, which indicate that the online education market is poised for significant expansion due to the integration of AI technologies. The report highlights the importance of AI in driving efficiency and scalability, which supports the authors' conclusion that AI can enhance marketing strategies by making them more efficient and targeted. The report covers various aspects, including solutions (hardware, software, services), technologies (deep learning, machine learning, NLP), functions, and end-uses. The report highlights the significant market size growth driven by continuous R&D by tech giants, increasing adoption across industries, and advancements in AI technologies like deep learning and NLP. It also discusses regional trends, key players, and the impact of regulatory scrutiny on the AI market. The report by P. Wadhwani (2023) from Global Market Insights Inc. analyses the e-learning market, projecting its growth from 2023 to 2032. It covers technologies such as online e-learning, LMS, mobile e-learning, and virtual classrooms, and segments by provider (service, content) and application (corporate, academic, government). The report highlights the market's significant growth driven by increasing internet penetration, corporate training demands, and advancements in e-learning technologies. Key regions include Asia Pacific, North America, and Europe.

K. Sudhir & O. Toubia (2023) provide a comprehensive overview of AI in marketing, focusing on its ability to analyse large datasets, predict trends, and optimise customer interactions. Their findings resonate with conducted research, which demonstrates that AI can enhance marketing effectiveness in the online education sector by leveraging data-driven insights to improve targeting and engagement. The studies by A. Murgai (2018), N. Thilagavathy & P. Kumar (2021) and A. Mani (2024) investigate the roles and factors that influence the interaction between marketing and AI, the evolving responsibilities of marketers in the digital age, and the impact of AI on the marketing process. These researchers examine the potential sectors within digital marketing where AI has established its presence. They focus on the comprehensive overview of the transition of marketing to the digital sphere, the role of AI in this transformation, and the dynamic and emerging relationship between digital marketing and AI. These studies confirm the authors' conclusions about how AI-driven tools can streamline communication channels, and predict market trends effectively.

A comparative analysis with the work of D. Raiko *et al*. (2023) on the motivation systems for marketing employees highlights the importance of AI in enhancing marketing effectiveness. Their study demonstrates that AI tools can significantly improve employee performance and customer engagement, which aligns with current study findings that AI-driven marketing strategies can lead to better targeting and higher engagement rates. The study by P. Wadhwani (2023) on the e-learning market emphasises the significant growth driven by technological advancements and increasing internet penetration. This growth trajectory supports the authors' findings, which indicate that the integration of AI in marketing strategies is essential for capturing and retaining a diverse learner base in a rapidly expanding market. The research by S. Mahendra (2024) on the Turing test and AI's capabilities further substantiates the potential of AI in creating intelligent marketing solutions. The study's emphasis on AI's ability to understand and respond to human behaviour supports the conclusion that AI can provide personalised marketing experiences that resonate with individual learners.

The future of learning: Generative AI's role in education in 2024 (n.d.) also discusses the future of AI in education, emphasising the importance of generative AI in creating dynamic and interactive learning environments. This perspective aligns with the authors' findings, which highlight AI's role in developing innovative marketing strategies that cater to the evolving needs of online learners. Additionally, the report by Statista on the global AI market highlights the significant investments being made in AI technologies across various sectors (Artificial intelligence – worldwide, 2024). This aligns with authors' the findings that AI-driven marketing strategies are becoming increasingly important in the online education market, driven by continuous technological advancements

and growing market demand. The analysis by O. Melnichuk (2023) on EdTech trends in Ukraine provides insights into the regional specificities influencing the adoption of AI in education. Their findings underscore the importance of tailoring AI solutions to local contexts, which supports the conclusion that AI can drive growth and innovation in specific markets by addressing the unique needs and challenges of local learners.

The studies by B. Namatherdhala *et al*. (2022), M.R. Ahmed & B.E. Ahmed (2023), and R.G. Cooper (2024) explore the new product development process in a rapidly expanding industry, analyse firm and supplier engagement, and devise a strategic model incorporating firm-supplier dynamics, AI, growth, and business models to foster long-term product development strategies amidst advancements in AI capabilities and competitive pressures, thereby offering managerial insights for achieving competitive advantage in the marketplace. These researches uncover the involvement of AI and its various branches in the product management paradigm, including the roles and responsibilities of AI product managers, and outline the broad and impactful applications of AI in new product development, which adduce with the authors' findings that an important aspect of the Ukrainian online education market is product management and the launching of a new product into the market, with particular emphasis on the enhanced marketing frameworks achieved through the utilisation of AI, aiming to increase the likelihood of success.

In conclusion, the integration of AI into marketing strategies for the online education market offers substantial benefits, including enhanced personalisation, operational efficiency, and scalability. The findings of this study align with the broader literature, underscoring the transformative potential of AI while highlighting the need for ethical considerations and balanced adoption strategies. Future research should continue to explore the evolving role of AI in marketing, particularly in response to emerging trends and technological advancements. While this study provides a comprehensive overview of the integration of AI in marketing strategies within the online education market, further research is needed to explore the ethical implications of AI, including data privacy and algorithmic bias. Longitudinal studies assessing the long-term impact of AI-driven marketing on learner outcomes, cross-cultural comparisons of AI performance, and investigations into AI's role in content creation and economic impact are essential. Additionally, examining the balance between AI-driven personalisation and learner autonomy, the potential of AI-enhanced learning analytics, the integration of AI with other emerging technologies, and the role of policy and regulation in AI deployment will provide deeper insights. Research on user experience and acceptance of AI tools can also offer valuable perspectives for maximising the benefits of AI in marketing.

CONCLUSIONS

This article explored the integration of AI into marketing product strategies within the online education market, highlighting its significant potential for enhancing personalisation, optimising marketing efforts, and improving customer engagement. By analysing various aspects of AI applications in marketing, the research underscored how AI-driven tools can tailor content to individual learners, streamline communication channels, and predict market trends effectively. The findings are consistent with existing literature, which emphasises AI's transformative impact across different sectors, including education. The research demonstrated that AI can support the development of innovative educational products and improve the efficiency of marketing strategies. The study also highlighted the importance of AI in driving market growth, as evidenced by substantial investments and advancements in AI technologies.

A comparative analysis of global and regional AI market trends, such as market size, CAGR, generated revenue, etc., revealed that the online education market is poised for significant expansion, driven by technological advancements and increasing demand for flexible learning solutions. This aligns with the broader market projections indicating robust growth in AI applications. Overall, the article provides valuable insights into the potential of AI to revolutionise marketing strategies in the online education market, offering practical recommendations for leveraging AI to enhance product marketing and meet the evolving needs of learners and educators. The findings contribute to a deeper understanding of the opportunities and challenges associated with AI integration, paving the way for future research and innovation in this dynamic field. Furthermore, the article identified several areas for future research, including ethical considerations, long-term impact assessments, cross-cultural comparisons, and the integration of AI with other emerging technologies. These areas are crucial for ensuring the responsible and effective deployment of AI in education and marketing.

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CONFLICT OF INTEREST

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Штучний інтелект у маркетинговій продуктовій стратегії на ринку онлайн-освіти

Анотація. Ринок онлайн-освіти переживає стрімке зростання, що створює конкурентне середовище, де ефективні маркетингові рішення мають вирішальне значення для досягнення успіху. Штучний інтелект (ШІ) став потужним інструментом, який пропонує інноваційні методи покращення продуктових стратегій. Мета статті – висвітлити інтеграцію штучного інтелекту в маркетингові продуктові стратегії на ринку онлайн-освіти та оцінити шанси на успіх нового навчального курсу, реалізованого шляхом впровадження алгоритмів ШІ. Проведено системний огляд передових технологій і продуктів на ринку ШІ, а також порівняльний аналіз на основі даних різних авторів і звітів організацій з урахуванням аспектів інтерпретації якісних і кількісних характеристик ринку. Проаналізовано лідерів світового та українського ринку онлайн-освіти, а також проведено дослідження заходів маркетингової продуктової політики успішних гравців зі зазначенням якісних та кількісних даних за допомогою онлайн-сервісів SimilarWeb та Semrush. Результати дозволили проаналізувати зв'язок між виявленими сегментами ринку та факторами впливу, запропонувати практичні рекомендації щодо вдосконалення елементів маркетингу на основі виявлених проблем продуктів та ринку онлайн-освіти. Для демонстрації актуальності та ефективності пропозицій було застосовано підхід до перевірки того, чи зможе продукт із посиленим ШІ-маркетингом мати успіх на ринку на прикладі компанії Projector Institute. Отримана в результаті розрахунків оцінка показала, що ШІ може посилити маркетинг продуктів онлайн-освіти, оскільки вони будуть повністю відповідати інтересам зацікавлених економічних контрагентів. Результати дослідження можуть бути використані маркетологами, фахівцями з ШІ, експертами з продукту, власниками бізнесу у сфері маркетингу тощо для вдосконалення маркетингових рішень

Ключові слова: ринок е-навчання; цифрові технології; розробка продуктів; маркетинг на основі ШІ; курси на основі ШІ

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Digital transformation management in Georgian business: Growth strategies and competitive advantages

Abstract. Innovative development is one of the key factors in a company's competitiveness. Ensuring a higher level of development and utilisation of the latest company technology is important and therefore the search for new methods is relevant. The study aimed to describe the current trends in digital business transformation in Georgia. The study analysed many different types of statistics describing both the state of digitalisation and innovative technologies in the country and the current describing the state of entrepreneurship. Based on the analysis, the study concluded that the situation with digital transformation in Georgia is improving, which correlates with the direction of development of enterprises. In Georgia, the government actively supports digital transformation through various initiatives aimed at developing digital infrastructure and offering e-services. This is evident in the level of existing projects in this area

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and the pace of change in the development of enterprises in the field of digitalisation. However, it is found that while the number of research and development institutions in the nation is rising, the expenditures (adjusted for inflation) are falling. New fintech businesses are starting to appear, providing cutting-edge services for online financing. Due to a mix of public policies, private funding, and international collaboration, Georgia is becoming progressively more digital. Nevertheless, the country needs to accelerate the pace of development of this area in companies, which indicates the need for more active stimulation of this area by the state. The findings of this study can be used to formulate both the company's long-term development strategy and to create a state policy in this area

Keywords: entrepreneurship; innovative technologies; macroeconomics; market relations; finance

INTRODUCTION

Implementation of the latest technologies is one of the main methods to achieve a better market position among companies. The need for businesses to implement innovative technologies is driven by several factors that include increasing efficiency, improving competitiveness, customer satisfaction, and long-term sustainability. The latest technologies make it possible to automate certain processes, making them less labour-intensive and more efficient, but importantly, they also provide an opportunity to reduce the cost of production. In this regard, the development of innovative technologies by companies and their subsequent implementation is extremely important to improve the performance of such companies. The problem of the research is the need to analyse how digital transformation affects the development of Georgian businesses and their ability to form competitive advantages. The importance of this topic is justified by the fact that in the current global changes, companies that do not adapt to digital technologies may lose their competitiveness in the market. Despite the significant benefits that can be achieved through digital technologies, many Georgian businesses face challenges associated with their implementation, including high integration costs, lack of skilled labour, and resistance to change within companies. The study focuses specifically on the adoption of digital technologies in Georgia, particularly in the context of opportunities for shaping growth and management strategies.

The possibility of using clusters to increase innovativeness in the region was addressed by M. Chechelashvili *et al*. (2023). The study highlighted the importance of cluster mechanisms in promoting the socio-economic development of Georgian regions, emphasising innovative territorial development, and the need for support from the central and regional government in developing clusters that serve as centres of economic growth. Recommendations for the government were also formed, including in terms of financial support, tax incentives, and support for the development of business incubators in general. M. Chechelashvili *et al*. (2021) also investigated changes in modern management paradigms. Three management paradigms were identified: production, bureaucratic, legal, and service paradigms. The modern paradigm is the service paradigm, which is crucial for achieving leadership in the service sector and economic well-being: shifting business to its foundations is crucial for maximising managerial performance (Ihnatenko *et al*., 2023). E. Sepashvili (2020) assessed the possibilities of achieving national goals in the context of the competitiveness of the economy through its digital transformation. The scientist noted that information and communication technologies (ICTs) play a central role in this transformation. The success of countries in this direction depends on how effectively governments can coordinate businesses and individuals to navigate digital technologies. Thus, policymakers should collaborate with stakeholders – businesses, academics, and individuals – to develop policies that support infrastructure development and adapt the environment to maximise the benefits of ICTs. National governments need to improve infrastructure for digital economic growth (Abdullayev *et al*., 2024).

N. Sachaleli (2021) described the role of digital technologies in tourism development in general and during COVID-19 using Georgia as an example. The scholar noted that the digital system offers significant advantages, including access to a large market, uniqueness, minimal investment requirements for partners, and a clear match between supply and demand. In such an environment, both producers and consumers benefit significantly more from the production and consumption of products. T. Bitchikashvili *et al*. (2023) addressed how the latest technologies can be utilised in business, improving the efficiency of its functioning. M. Vanishvili (2022) focused more on what opportunities exist to provide funding for innovative technologies in Georgia. The peculiarities of the digital business environment in the country were considered by T. Makasarashvili *et al*. (2023). Researchers studied how the use of online services in Georgia is developing. They were able to conclude that there is a steady trend of growth in the use of this kind of technology in the country, especially for the population between 18 and 35 years of age, which indicates the gradual digitalisation of business. T. Zhghenti & G. Gedenidze (2022) concluded that business models of the sharing economy are gaining popularity in Georgia. This is caused among other things by rapid digitalisation. Researchers have shown that in modern conditions, the extent to which a business can fulfil its specific needs is beginning to play a special role. Thus, despite the current research on the development of innovation and the introduction of digital technologies in Georgia, it is still necessary to study the current state of implementation of digital technologies. The study aimed to assess what are the trends of digital transformation in business in Georgia. The objectives of the study were to assess the level of digital transformation in Georgia, compare it with the level of business development in the country, and thus analyse the impact of digital technologies on businesses.

MATERIALS AND METHODS

Information from several main statistical sources was used to analyse the selected indicators. The main source was the

National Statistics Office of Georgia (Business statistics, n.d.; Science, n.d.). This source provided an opportunity to analyse the bulk of statistical data generated at the state level, allowing accurate and reliable information necessary to analyse the economic, social, demographic, and environmental situation in Georgia. Information from individual publications of this office was also used, which provided some more detailed information on how the digital economy is developing in Georgia (Non-survey based measurement..., 2023). Another source of statistical data was Statista, which is one of the global leading statistical information providers specialising in providing data on a variety of areas, including digital transformation (Digital & connectivity indicators..., n.d.). The study assessed a variety of data in the context of digitalisation development in Georgia. In particular, information on the number of researchers by level of education (doctors, masters, bachelor and short-cycle higher education), by age, by field of research (natural sciences, engineering and technology, medical and sanitary sciences, agricultural and veterinary sciences, social sciences, humanities), by "status" (researcher, technician or support staff of another kind), the number of institutions that engage in research and development (R&D) and the amount of money that has been spent to develop research in this area (adjusted for inflation) was analysed.

Furthermore, an assessment of metrics that characterise the development of infrastructure in the field of digital transformation was included. These indicators included the number of secure internet services, average internet speed, exports of ICT services, equipment costs, and the use of bank accounts and debit cards. Such indicators characterise a country's readiness and ability to integrate and use digital technologies in everyday life and business, which can be used to conclude in this area. In addition, data were assessed in the context of the development of digital technologies in entrepreneurship, but there were few such metrics in the public domain: share of enterprises with access to the Internet, share of enterprises with sales on the Internet, share of enterprises with sales on the Internet on several services at once. Nevertheless, data on the development of digitalisation in Georgia is quite limited, both in terms of the period for which data is available (most of the data is available only from 2019 to 2022, and the longest period is between 2016 and 2023, which is not enough to conduct a sufficiently detailed statistical analysis) and in terms of the indicators that are available. This, in turn, limits the possibility of conducting a more detailed and long-term statistical analysis, which should be accounted for results interpretation.

RESULTS

Digital transformation is the process of integrating digital technologies into all aspects of an organisation's operations, leading to fundamental changes in the way the organisation operates and delivers value to its customers. This process affects not only technology, but also business models, processes, culture, and the experience of employees and customers (Vaska *et al.*, 2021; Kraus *et al.*, 2022). One of its most important aspects is the use of cloud computing, artificial intelligence, the Internet of Things, big data, and other innovative technologies to optimise and automate business processes. It also involves the revision of existing business models, and the creation of new ones based on digital technologies (Van Veldhoven & Vanthienen, 2021; Kraus *et al.*, 2021). This may include a shift from selling physical goods to providing digital services or subscriptions. This is also the case in the context of automating existing business processes to increase efficiency, reduce costs, and improve the quality of products or services. It is necessary to create more personalised and convenient customer interactions using data and analytics, to create a new corporate culture that supports innovation, and to use data more effectively to make informed decisions and create new business opportunities. Digital transformation plays a key role in business transformation, affecting various aspects of its operation and providing competitive advantages (Ciarli *et al.*, 2021; Owoseni *et al.*, 2021). Some of the main roles of digital transformation in business as already mentioned, aim to increase the efficiency of processes (their automation), improve customer interaction, implement new business models, strengthen competitiveness, improve corporate culture and structure, and reduce security risks.

The development of business digitalisation in Georgia is currently characterised by several key aspects that contribute to a more competitive and sustainable economy. The Georgian government is actively promoting digitalisation through various programs and initiatives. The focus is on the development of digital infrastructure and the introduction of e-services. For example, the project "My.Gov.Ge" provides a wide range of government services in electronic form, facilitating the interaction of citizens and businesses with government agencies. An example of this is the official state portal of Georgia, which provides citizens, residents, and businesses with online access to various state services. This portal is designed to facilitate interaction between citizens and government agencies, offering a convenient and fast way to receive services without having to visit physical offices. Many electronic government services are available on it, including document retrieval, vehicle registration, tax filing, payment of fines, and business registration: the portal is integrated with various government agencies, allowing users to receive services from different sources through a single platform. Key benefits of using the platform include time savings, 24/7 availability of services, and transparency of processes, which allows users to track the stages of processing their requests.

One of the priorities is to improve the telecommunications infrastructure. The country is actively deploying a network of fibre-optic lines providing high-speed (5G) Internet access. At the same time, the country is preparing for the introduction of fifth-generation networks, which will be a significant step forward in the development of telecommunications. This creates the basis for the further development of digital services and technologies. E-commerce in Georgia is showing significant growth, with more and more companies starting to offer their goods and services via online platforms, driven by the growing internet penetration and the increasing number of mobile device users. Support from the government and the private sector to improve digital infrastructure, as well as programs to encourage small and medium-sized enterprises to enter the online market, play an important role (Sokil *et al.*, 2020). Payment systems are also actively developing, making online shopping convenient and secure.

Technology parks and start-up development centres are actively developing in Tbilisi and other major cities. They provide young entrepreneurs with access to resources, advice, and investment. Examples of such initiatives include the Tbilisi Technology Park and the Centre for Innovation and Technology of Georgia. This park provides startups and information technology (IT) companies with access to modern office space and laboratories, as well as educational and consulting services. The Technology Park regularly organises events aimed at developing entrepreneurial skills. This contributes to the formation of a community of technology entrepreneurs ready to work on the creation of products and services with high added value. In addition to Tbilisi, technology parks are being actively developed in other major cities of Georgia, such as Kutaisi and Batumi. Startup support centres are also being established in these regions to attract young entrepreneurs and specialists from different fields of technology. These technology parks serve as platforms for interaction between businesses, academic institutions, and government agencies, which helps to create new jobs and attract investment to the regions. Education in IT and digital technologies are also prioritised. Universities and specialised training centres are introducing programs aimed at training specialists in programming, cybersecurity, data analysis, and other key areas. This helps create a base for the skilled labour force needed to develop the digital economy.

With increasing digitalisation, there is a growing focus on cybersecurity. Georgia is implementing standards and best practices in data protection and information security. Specialised units and response centres are being established to respond to problems that arise in the context of personal data protection. Georgia is actively cooperating with international organisations and investors to attract financial and technical resources. This includes projects supported by the World Bank, the European Bank for Reconstruction and Development, and other institutions. Financial technologies are becoming an important part of business digitalisation. New fintech companies are emerging in the country, offering innovative solutions in mobile payments, online lending, and financial management. The digitalisation of business in Georgia continues apace, thanks to a combination of government initiatives, private investment, and international cooperation. This contributes to a more innovative and sustainable economic environment, ready for the challenges of the modern world. Data that characterise the current state of digital transformation in the country is noteworthy. Hence, information describing the state of science development in the country is shown in Tables 1-3.

Table 1. Number of researchers by degree, 2019-2022

Year	2019	2020	2021	2022
Total	10,191	11,859	12,030	12,991
Doctoral degree (ISCED 8)	7,277	7,992	8,393	8,909
Master's degree (ISCED 7)	2,726	3,599	3,324	3,719
Bachelor's degree (ISCED 6)	188	266	310	359
Short-cycle higher education (ISCED 5/4)	–	2	3	4

Note: ISCED – international standard classification of education
Source: compiled by the authors based on Science (n.d.)

Table 2. Number of researchers by age, 2019-2022

Year	2019	2020	2021	2022
Total	10,191	11,859	12,030	12,991
< 25	111	170	1,012	1,066
25-34	1,197	1,530	1,704	1,841
35-44	1,907	2,172	1,967	2,202
45-54	2,102	2,475	2,309	2,555
55-64	2,045	2,439	2,419	2,592
65+	2,829	3,073	2,619	2,735

Source: compiled by the authors based on Science (n.d.)

Table 3. Number of people in R&D by area, 2019-2022

Year	2019	2020	2021	2022
Total	10,191	11,859	12,030	12,991
Natural sciences	2,398	2,277	2,294	2,587
Engineering and technology	1,781	2,107	2,136	2,199
Medical and health sciences	1,369	1,887	1,880	1,898
Agricultural and veterinary sciences	442	474	420	472
Social sciences	2,324	2,769	3,065	3,167
Humanities and the arts	1,789	2,308	2,234	2,668
Not identified	88	37	1	0

Source: compiled by the authors based on Science (n.d.)

Notably, all metrics are gradually increasing, which indicates the development of science in Georgia, which has a positive impact on the development of digital technologies. Other data is shown in Tables 4-5.

Table 4. Number of researchers in R&D by status, 2019-2022

Year	2019	2020	2021	2022
Total	13,732	14,589	14,040	15,099
Researchers	10,191	11,859	12,030	12,991
Technicians and equivalent personnel	1,790	1,380	1,162	1,168
Other support staff	1,742	1,322	848	922
Not specified	9	28	0	18

Source: compiled by the authors based on Science (n.d.)

Table 5. Number of R&D institutions and expenditures (with and without inflation), 2019-2022

Year	2019	2020	2021	2022
Institutions	48	58	59	63
Total R&D expenditure, GEL	140.2	139.9	151.1	171
Total R&D expenditure adjusted for inflation, GEL	140.2	132.98	131.1	132.6

Source: compiled by the authors based on Science (n.d.)

As can be seen from Table 4, the number of researchers in the field is gradually increasing in general, which is a positive indicator. At the same time, the number of technicians and other support staff is declining, indicating that the growth of researchers is primarily driven by sciences that do not require direct experimentation. Table 5 also shows that although the number of institutions in the country engaged in R&D is increasing, the cost of R&D (adjusted for inflation) is decreasing. Since the downward trend has been visible since 2020, this can be attributed to the onset of the COVID-19 crisis; it also indicates the need to allocate more funds to this type of research to at least be able to cover the depreciation of the national currency. The indicators that characterise the development of digital infrastructure in the country are shown in Table 6.

Table 6. Data describing the development of digital infrastructure, 2019-2028

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Secure Internet servers, thousands	10.3	13	13	14.5	16.2	17.8	19.5	21.1	22.7	24.2
Average broadband connection speed, thousands kbps	8	13.8	14.2	15.6	19	20.3	21.5	22.6	23.6	24.5
Exports of ICT services per capita, USD	30.1	30.3	57.5	160	151	180	219	266	320	381
ICT equipment – consumer spending, USD million	148	173	218	240	293	318	348	377	408	439
Utilisation of bank accounts, %	58.2	60.9	63.4	65.9	68.3	70.6	72.8	74.8	76.8	78.7
Use of debit cards, %	41.1	41.7	42.3	42.1	42.9	43.7	44.6	45.5	46.3	47.2

Note: data from 2024 projected based on forecasts from Statista and National Statistics Office of Georgia
Source: compiled by the authors based on Digital & connectivity indicators – Georgia (n.d.), Non-survey based measurement of e-commerce and the digital economy (2023)

As can be seen from Table 6, most of the indicators that characterise the development of digital infrastructure in Georgia have been increasing over the selected period. Moreover, such growth is expected to continue in the future (at least until 2028). Data characterising the development of digitalisation in business are shown in Table 7.

Table 7. Data characterising the development of digital technologies in business, 2016-2023

Year	2016	2017	2018	2019	2020	2021	2022	2023
Share of enterprises with access to the Internet	97.5	98.4	98.5	93	94	95	84.2	84.4
Share of enterprises selling goods or services via the Internet, %	–	–	–	–	3	2.7	2.9	–
For e-commerce websites or applications used by multiple businesses to trade goods or services (e.g. Booking, eBay, Amazon, etc.)	–	–	–	–	1.1	1.9	1.9	–

Source: compiled by the authors based on Digital & connectivity indicators – Georgia (n.d.), Non-survey based measurement of e-commerce and the digital economy (2023)

As can be seen from Table 7, the number of enterprises with access to the Internet in Georgia is gradually decreasing. This is primarily because small and medium-sized enterprises in this sector do not have access to such technologies, while the share of medium and large enterprises has only increased. This indicates that the country has certain problems in providing new small businesses with access to the Internet, which is quite unusual for modern companies. To determine the overall situation in the context of entrepreneurship development in the country, it is also worthwhile to evaluate some data describing its formation and development in the country. This is shown in Tables 8-9.

Table 8. Key data characterising business development, 2017-2022

Year	2017	2018	2019	2020	2021	2022
Turnover, billion GEL	71.7	86.6	109	114.3	150.4	181.8
Value of manufactured products, billion GEL	38.2	41.6	47.5	46.2	57.6	71.8
Value added, billion GEL	19	20.9	24.2	24	29.8	36.2
Intermediate consumption, billion GEL	34.9	33.8	36.8	44.7	46.8	35.6
Fixed assets, GEL billion	34.9	33.8	36.8	38.7	44.7	46.8
Number of employees, thousand people	708.2	734.2	756.9	703.9	744.3	779.4
Average monthly salary of employees, GEL	1,019.7	1,101.3	1,161.7	1,222.9	1,347.6	1,605.9

Source: compiled by the authors based on Business statistics (n.d.)

Table 9. Key data characterising business development (inflation-adjusted), 2017-2022

Year	2017	2018	2019	2020	2021	2022
Turnover, billion GEL	71.7	84.4	101.3	101	121.3	131
Value of manufactured products, billion GEL	38.2	40.5	44.1	40.8	46.4	51.7
Value added, billion GEL	19	20.4	22.5	21.2	24	26.1
Intermediate consumption, billion GEL	34.9	32.9	34.2	39.5	37.7	25.7
Fixed assets, GEL billion	34.9	32.9	34.2	34.2	36	33.7
Number of employees, thousand people	708.2	734.2	756.9	703.9	744.3	779.4
Average monthly salary of employees, GEL	1,019.7	1,073.2	1,079.7	1,080.4	1,086.6	1,157.1

Source: compiled by the authors based on Business statistics (n.d.)

As can be seen from Tables 8 and 9, the country is experiencing business development, as evidenced by the growth of most of the indicators that characterise it, including inflation-adjusted ones. This is a positive indicator, and it also correlates with most of the data describing the country's digital transformation. Nevertheless, it is difficult to state how strong the correlation between different indicators is, as this requires more data to build a longer time series. It is therefore necessary to conduct a similar study in the future.

DISCUSSION

A recent study showed that digital transformation has a positive impact on business development. A study of the impact of international markets and new digital technologies on business innovation in emerging markets was conducted by L. Dana *et al*. (2022). The researchers noted that digital technologies have a significant impact on business innovation by reorganising economic activities, reducing costs, increasing trust, and transforming business processes. It was also concluded that early internationalisation, driven by market conditions and strategic entry decisions, had a positive impact on business innovation. Companies using new digital technologies are more successful in innovation, as noted by O. Tsapova *et al*. (2024). The results highlight the need to improve interaction with international markets and adopt new digital technologies to achieve business innovation in emerging markets, thereby contributing to business sustainability and survival. Recommendations were also made to review and adapt operational processes to consider the impact of digital technologies and international markets, to use new digital technologies and focus on international markets to drive innovation, and to identify the entrepreneurial skills of employees to drive innovation. The conclusions drawn by these scholars are the same as those formed in the current study in the context of the impact of digital transformation on business development.

The study concluded that digital transformation does have a positive impact on business development. However, not all statistical indicators confirmed this relationship. Disclosure of the impact of digital technology adoption on firms' innovation activities was also addressed by A. Usai *et al*. (2021). They noted that previous studies often assume a direct positive effect of digital technologies on innovation but do not distinguish between different types of digital technologies and their actual effects, but they obtained different findings. Researchers showed that digital technologies have a limited impact on innovation performance compared to R&D activities. While digital technologies can increase efficiency, they often standardise knowledge, which can undermine creativity and reduce competitive advantage (Bochko *et al*., 2024). The study thus challenges the notion that digital technologies are key drivers of innovation. It emphasises the need to focus on innovation for significant improvements in innovation and suggests that digital technologies should be seen as complementary rather than primary drivers of innovation. The results highlight the need for a more nuanced understanding of how digital technologies and R&D interact to influence innovation development. Thus, the findings from both the current study and these papers are similar. The work points out the role of digital transformation both to improve the

efficiency of the functioning of enterprises and to achieve better success in the direction of developing their innovative development capabilities. Thus, the findings of the study above, although different from those of the current study on transformation in Georgian business, have a basis for being true. Further research in this area should be conducted in the future to conclude the extent to which innovative technologies are drivers of innovation.

The possibilities of using digital technologies in the current conditions in Georgia were partially described in the current study. In particular, the study demonstrated how this kind of technology is currently used in enterprises in the country. Digital technologies and firm performance were addressed by E. Martínez-Caro *et al*. (2020). The scholars wrote about how digital technologies are modifying modern business. In the conclusions, the scholar writes that the digitisation of business stimulates the activities of enterprises, but its full potential is only realised if there is a supportive digital culture. The study highlights the important role of organisational culture in achieving successful digital transformation. The scholar highlights the importance of developing a digital culture to overcome the challenges and maximise the benefits of digital transformation. As part of their study, M. Yang *et al*. (2021) evaluated the adoption of digital technologies in supply chains. The scholars reasoned on the increasing influence and importance of digital technologies, identified the main drivers in the direction, and developed a model for digital technology adoption. However, scholars have noted that despite the benefits, digital technology adoption may fail due to the gap between the adoption strategy and its subsequent implementation. The use of digital technologies by small and medium-sized enterprises was examined in a study by T. Papadopoulos *et al*. (2020). The scientist stated that crises (in the framework of the work, the evaluation was carried out on the example of COVID-19), create problems in supply chains and for the functioning of the business in general, which can be solved with the help of digital technologies. Business risk management has a particularly important role to play, as noted by I.V. Pashaeva *et al*. (2020). Thus, the study emphasises the need for small and medium-sized enterprises to adopt a sociotechnical approach to digital transformation implementation strategies. In other words, both papers conclude that although there is a trend in Georgia to reduce internet usage among small and medium-sized enterprises, these problems need to be addressed to significantly improve the quality of their work.

Although not emphasised in the current study, the use of digital technologies is highly relevant for achieving sustainable development goals. Digital technologies catalysing business model innovation for the circular economy were addressed by V. Ranta *et al*. (2021). The study analysed how digital technologies improve value creation in the circular economy in different industries. Researchers concluded that digital technologies optimise internal processes such as inventory management and material handling. Digital sustainable entrepreneurship in the context of business model perspectives on the adoption of digital technologies to create social and environmental value was addressed by P. Gregori & P. Holzmann (2020). The scholars concluded that digital practices support the integration of environmental, social, and commercial logic, but also introduce tensions. They stated that digital technologies can increase convenience, and efficiency and reduce the cost of sustainable products and services, leading to more balanced value propositions for customers; digital technologies facilitate community engagement, co-creation, and greater stakeholder integration; and platform approaches help manage diverse stakeholder relationships and create dynamic, open business models. The researchers also concluded that digital applications help to scale socio-environmental and financial value, although there may be conflicts with environmental and social goals. Digital technologies also create awareness and educational value beyond direct sales, influencing a wider audience and supporting socio-environmental impact. Despite all the benefits that digital technologies bring, scholars stated that it is quite difficult to apply and implement them effectively, especially in the context of raising additional money and managing the formation of these processes. Thus, the use of these technologies in enterprises is important not only to achieve results in the direct functioning of enterprises in the market but also to improve the quality of life of the local population and reduce the burden on the external environment.

CONCLUSIONS

Thus, digital transformation in Georgia is developing rapidly, becoming a key factor in shaping the country's economic landscape and societal progress. The integration of digital technologies in various sectors has led to significant improvements in efficiency, customer engagement, and innovation of business models. This process is characterised by the widespread adoption of cloud computing, artificial intelligence, the Internet of Things, and big data, which together increase the automation of business processes and facilitate the creation of new digital services. The government of Georgia played a crucial role in facilitating this transformation through strategic initiatives aimed at improving digital infrastructure, promoting e-services, and supporting the digitalisation of small and medium-sized enterprises. Telecommunications infrastructure in Georgia has advanced significantly with the expansion of fibre-optic networks and the upcoming introduction of 5G technology, laying a solid foundation for the further development of digital services.

The growth of e-commerce in Georgia, driven by increasing internet penetration and the use of mobile devices, is further evidence of national digital progress; government and private sector initiatives have played an important role in promoting online business. In addition, the establishment of technology parks and startup incubators in Tbilisi and other major cities has created a favourable environment for innovation and entrepreneurship, as has education in innovative technologies, the increasing role of cybersecurity, and international cooperation. The statistical data characterising the development of digital technologies in the country were examined, and their dynamics are positive, and on par with the pace of business development. Nevertheless, there is currently insufficient statistical data to make a thorough assessment. For future research, it is necessary to assess the possibility of introducing and developing innovative technologies by Georgian enterprises to achieve better results in the process of

their activities and better results in the context of international competition. Moreover, it is worth repeating the assessment of the relationship between digital transformation and the level of business development in the country in the future, when the amount of available data will be large.

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CONFLICT OF INTEREST

None.

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Управління цифровою трансформацією в грузинському бізнесі: стратегії зростання та конкурентні переваги

Анотація. Інноваційний розвиток є одним із ключових факторів конкурентоспроможності компанії. Забезпечення більш високого рівня розвитку та використання новітніх технологій компанії є важливим, а тому пошук нових методів є актуальним. Метою дослідження було описати сучасні тенденції цифрової трансформації бізнесу в Грузії. У дослідженні було проаналізовано багато різних типів статистичних даних, що описують як стан цифровізації та інноваційних технологій в країні, так і поточні дані, що описують стан підприємництва. На основі проведеного аналізу зроблено висновок, що ситуація із цифровою трансформацією в Грузії покращується, що корелює з напрямком розвитку підприємств. У Грузії уряд активно підтримує цифрову трансформацію через різні ініціативи, спрямовані на розвиток цифрової інфраструктури та надання електронних послуг. Це видно з рівня існуючих проєктів та темпів змін у розвитку підприємств у сфері цифровізації. Однак виявлено, що тоді як кількість науково-дослідних установ у країні зростає, витрати на них (з урахуванням інфляції) зменшуються. З'являються нові фінтех-бізнеси, які надають передові послуги з онлайн-фінансування. Завдяки поєднанню державної політики, приватного фінансування та міжнародної співпраці Грузія стає дедалі діджиталізованішою. Тим не менш, країна потребує прискорення темпів розвитку цього напряму в компаніях, що свідчить про необхідність більш активного стимулювання цього напряму з боку держави. Результати цього дослідження можуть бути використані як для формування довгострокової стратегії розвитку компанії, так і для створення державної політики в цій сфері

Ключові слова: підприємництво; інноваційні технології; макроекономіка; ринкові відносини; фінанси

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Analysis of tools for evaluating the effectiveness of the personnel adaptation system in the context of the social entrepreneurship

Abstract. In the context of war and economic instability, social enterprises in Ukraine face numerous challenges, including limited resources and the need for a special approach in the human resources area. These factors make an effective system of employee adaptation crucial for ensuring the stability and sustainable growth of such enterprises. The article aimed to study and analyse the main tools and approaches for assessing the effectiveness of the staff adaptation system in the context of social enterprises. To achieve this goal, the methods of analysis, synthesis and content analysis were used to systematise existing scientific data. The study found that well-organised staff adaptation system helps to reduce staff turnover, increase productivity and engage employees in the social mission of the enterprise. The analysis of scientific works has identified the key factors of successful personnel adaptation under martial law, as well as the main

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challenges and risks faced by newcomers. The essence of assessing the effectiveness of the adaptation system is revealed, the priority criteria and tools for its evaluation, their advantages and risks are identified. The need for regular assessment of the socio-psychological climate and the level of professional training was justified. The most priority criteria and tools for assessing the effectiveness of the staff adaptation system are highlighted. The objective and subjective results of the assessment are considered, on the basis of which recommendations to improve the adaptation processes in enterprises are developed. The practical value of the study lies in the development of specific recommendations for assessing and optimising adaptation processes in social enterprises, ensuring their stability and success even in conditions of war and limited resources; the results of the study can be used in business opera-tions, particularly in social enterprises of various ownership forms, to improve the efficiency of decisions in the human resources area

Keywords: onboarding; rating; sole proprietor; labour productivity; key performance indicators; tool kit; public organisations

INTRODUCTION

Entrepreneurship is a key driver of economic development, creating jobs, fostering innovation, and increasing overall prosperity. It reduces unemployment and stimulates economic activity by launching new businesses. Entrepreneurs seek novel solutions to problems and meet consumer needs, leading to innovative products and services that enhance productivity, efficiency, and competitiveness. New businesses also stimulate market competition, compelling existing companies to improve efficiency, lower prices, and enhance service. Successful entrepreneurs attract both domestic and international investment, supporting economic growth through venture capital, private investments, and government grants. By investing in local communities, entrepreneurs develop infrastructure, education, and social programmes, improving the quality of life and contributing to economic growth. For example, V. Terziev *et al*. (2020) highlighted a trend across various European countries, including Greece, Bulgaria, Ireland, Italy, Malta, and Estonia, where organisations that combine entrepreneurial spirit with social goals are emerging. This trend is driven by increased and diversified needs due to changing behaviour patterns, lifestyles, and transformations in social security systems. The concept of social entrepreneurship is particularly relevant for supporting and revitalising Ukraine's economy amid wartime challenges. Social enterprises play a role in social stabilisation by integrating veterans, internally displaced persons, and other war-affected groups, and addressing issues such as unemployment and social inequality.

A number of scholars study various aspects of the social entrepreneurship concept. The article by O. Yurchenko & O. Svyryda (2022) examined the essence and main criteria of social entrepreneurship, its development in European countries, assessment of the impact on the competitiveness and efficiency of the European economy, as well as the emergence and formation of this concept in Ukraine. N. Pylypenko & O. Karpets (2021) discussed the essence and features of social entrepreneurship, its role in solving socio-economic problems of society, as well as the differences between traditional and social entrepreneurship. N. Pylypenko & O. Karpets (2021) argued that understanding the essence of social entrepreneurship can lead to the introduction of new, more effective tools for solving socio-economic problems, and identify factors that contribute to the success of social entrepreneurial projects. O. Zhurakhivska (2024) explored the potential of social business to transform Ukraine after the war. She emphasises that the social economy is more sustainable and efficient than some other traditional economic sectors, as it creates a foundation for supporting employment of vulnerable groups and promotes economic growth. Therefore, social entrepreneurship has a great potential to stimulate Ukraine's recovery.

Social entrepreneurship carries dual risks: social and economic. These enterprises allocate part of their profits to social projects, which may be non-profit or loss-making. For success, social enterprises need a higher level of professionalism in managing both business and social aspects, particularly during economic crises and wartime. One of the key aspects that will help social enterprises to remain effective and able to help society in solving important social problems is to increase the efficiency of staff adaptation, which optimises resource use, reduces turnover, and fosters strong, mission-focused teams. According to the Human Capital Institute, around 60% of companies limit employee onboarding to brief introductions, which triples the risk of resignation during the probationary period (Why new employees quit, 2019). Effective onboarding, which integrates new hires quickly, enhances staff stability, reduces turnover, and improves the company's human resources (HR) rating. Achieving high-quality onboarding requires defining goals, methods, and tools for assessing effectiveness, and constantly monitoring and improving the system. Despite numerous studies on the concept of social entrepreneurship in general and on the adaptation of commercial enterprises' staff in particular, the specifics of employee adaptation in social enterprises still remain underexplored. Effective adaptation can significantly enhance productivity and stability in resource-limited enterprises with specific social missions. Therefore, this study aimed to analyse and assess the main tools and approaches for evaluating staff adaptation systems in social enterprises, identify unique aspects of adaptation, and develop recommendations to improve these processes.

MATERIALS AND METHODS

The theoretical and methodological basis of this study is the work of scholars on the organisation of the adaptation process at an enterprise and evaluation of its effectiveness. In the process of writing the paper, a system of general scientific and special methods was used. Generalisation – to generalise the theoretical and methodological principles of personnel adaptation in general and to evaluate the effectiveness of the adaptation system, in particular; to form a

general idea of impact of the staff adaptation on enterprises, the role of staff adaptation in Ukrainian enterprises for stabilising the economy, in particular during wartime. Analysis and synthesis, induction and deduction – to set the goal of the research; to review and systematise existing researches related to social enterprise; to identify the main challenges and risks that a newcomer may face in martial law; to highlight the most priority criteria and indicators for evaluating the effectiveness of the staff adaptation system, determining their advantages, possible risks and shortcomings, as well as expected objective and subjective results; to consider the process of adaptation as a holistic system consisting of several stages and including the interaction between employees, management and the external environment. Content analysis method – to analyse scientific publications and research on the topic of staff adaptation. Statistical method – to process quantitative data, including the number of registered individual entrepreneurs in Ukraine, the number of social enterprises in different European countries, and other indicators that characterise the activities of social enterprises. Comparative method – to compare the development of social entrepreneurship in Ukraine and other European countries; to identify common trends, as well as peculiarities of the development of social enterprises in wartime in Ukraine; to compare different systems of staff adaptation, including those used in normal conditions and those needed in times of war.

The following statistics and other materials were used in the research: data on the number of social enterprises in Europe; the number of people employed in social enterprises in the EU and the approximate value of this indicator in Ukraine according to existing studies; data on the involvement of vulnerable groups of the population by social enterprises; data on the organisational forms of social enterprises in Ukraine and the share of each; data on the number of registered individual entrepreneurs in 2021-2023 and start of 2024 in Ukraine; identification of the most popular types of activities among new individual entrepreneurs in 2023 (Social entrepreneurship in Ukraine..., 2020; Terziev *et al*., 2020; Novyk, 2022). This data was used to confirm the importance of social enterprises in addressing economic, social and environmental challenges, as well as to analyse trends in social enterprise development in Ukraine and Europe.

RESULTS

Ukrainian society is going through a series of wartime challenges that have led to the development of crises in the social, economic, and political spheres. Under such conditions, the state demonstrates limited capabilities against an unlimited number of unresolved social problems. A low level of material security, mass unemployment, and a high proportion of vulnerable population groups – all these factors drive the search for alternative ways to solve social problems. One of the innovative tools for addressing these issues could be the activities of social enterprises. The main directions of this sector's activities are the social and economic integration of socially vulnerable groups into public life, the reduction of unemployment and poverty, and the implementation of social measures, among others. Social enterprises, which combine commercial activities with social goals, play a crucial role in supporting vulnerable population groups, creating jobs, and ensuring stability at the local level. Social entrepreneurship represents a concept that creates alternative business models which are market-oriented and at the same time benefit society. Such enterprises integrate all market participants: employees, employers, investors, consumers, and other stakeholders.

In European countries, there are more than 2,000,000 social enterprises providing jobs to nearly 11,000,000 workers. The highest number of social enterprises is found in the United Kingdom (around 70,000 units) (Social entrepreneurship in Ukraine..., 2020). The main types of social enterprises in this country are traditional cooperatives, social cooperatives, medical/social associations, volunteer organisations, and sheltered workshops for disabled individuals. Social enterprises in Poland, Italy, the Netherlands, Portugal, Hungary, Ireland, and Estonia also make significant contributions to the national economy. According to foreign researchers, social enterprises play an important role in enhancing the competitiveness and efficiency of the European economy in various ways: by increasing economic activity of unused labour resources; mobilising local resources; raising entrepreneurial culture; removing market rigidity; and promoting market flexibility (Terziev *et al*., 2020). Ukraine has numerous social enterprises that demonstrate it is possible to engage people in work who have found themselves in social isolation and turn their vulnerability into a driving force for business projects, as well as improve the existing market products or services. Social businesses that earn more also invest more in social change. This stimulates growth in public awareness, demand, trust, and profits, which are reinvested in changes, a factor that is especially relevant in the difficult conditions of war.

The activities of social enterprises are of great importance to society in addressing economic, environmental, and social problems. For example, in 2020, the leading indicator of the quality of social business activities – employment – showed that the approximate annual figures averaged 250 employed individuals per specialised social enterprise (Social entrepreneurship in Ukraine..., 2020). Hence, the approximate annual figures for all social enterprises amounted to 87,500 employed individuals. This constitutes 21% of all employed individuals in the country for the year. Social enterprises predominantly focus on employing individuals from socially vulnerable categories. Consequently, social enterprises approximately employ an average of 2% of such individuals (persons with disabilities, internally displaced persons, veterans) per year. The significant role of social enterprises in addressing economic and social issues is highlighted by data, according to which social enterprises provide social services to an average of 80 socially vulnerable individuals per month (Social entrepreneurship in Ukraine..., 2020). This means that, on average, around 960 individuals become clients of one social enterprise annually. Across the entire social business sector, the annual client base averages 960,000 individuals. This represents 16.5% of the recorded socially vulnerable categories (persons with disabilities, internally displaced persons, veterans, individuals in difficult life circumstances, homeless people).

The number of social enterprises in Ukraine has been steadily increasing. This growth is a response to the manifestations of the socio-economic crisis and the necessity to find alternative sources of funding and tools to address the social problems of the most vulnerable categories of citizens. As a result, like-minded individuals often come together around this activity, and financial capital is formed through the attraction of financial support from investors or by pooling the funds of like-minded founders. As of 2023-2024, there is no official statistical information on the number of social enterprises in Ukraine. With the start of hostilities in February 2022, the registers and the State Statistics Service of Ukraine do not have the right to publish such data. Since the first days of the full-scale invasion of Russian troops into Ukraine, both military and civilian citizens in various regions of the country have come under shelling and airstrikes. For many Ukrainians, the consequences of the loss of health from the actions of the Russian army are irreversible, they become disabled. It is these and other issues that are the driving forces behind the active development of social enterprises.

After the start of the full-scale invasion, Ukrainian society began to actively participate in the organisation of forms of social entrepreneurship (public organisations, charitable foundations, and volunteer organisations). Social enterprises as subjects of entrepreneurial activity can be represented by various forms of activity, namely: individual entrepreneurs – 26%, private enterprise – 16% and public organisation – 14%. It is also possible to register social enterprises in the following forms: limited liability company – 13%, agricultural cooperative – 10%. In June 2023, 31,477 individual entrepreneurs were registered – a record number over the past three years. On average, about 25,000 new cases are registered per month. As of the first quarter of 2024, more than 74,000 new individual entrepreneurs were registered in Ukraine (Fig. 1).

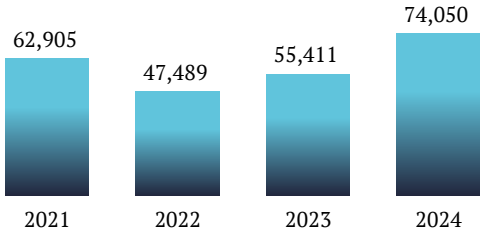

Figure 1. The number of registrations of new individual entrepreneurs in Ukraine
Source: created by the authors based on I. Novyk (2022)

This value is 33.6% more than last year. The majority of individual entrepreneurs are registered in Kyiv and Dnipropetrovsk regions. The most popular among new individual entrepreneurs in 2023 were the following areas: retail trade, information technologies (IT), provision of other individual services, wholesale trade, food and beverage services. Among new sole proprietors that provide individual services, hairdressers and beauty salons were the most used by type – 18,059 new businesses. The most popular areas for new companies were wholesale trade, activities of public organisations and provision of social assistance. In Ukraine, social entrepreneurship operates within small and medium-sized businesses and as a self-financing tool for public organisations seeking financial sustainability. So far, it cannot cover a large business in terms of the scope of its activities and capabilities. The main types of activities of social enterprises are given on the Figure 2.

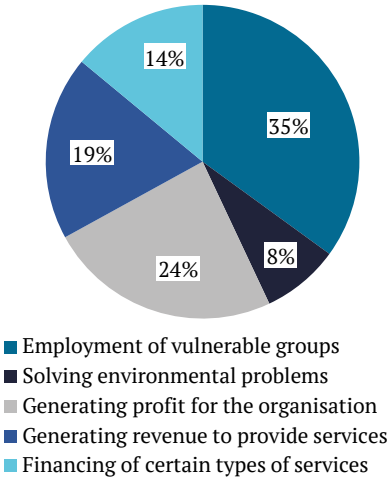

Figure 2. Main types of activities of social enterprises
Source: created by the authors based on I. Novyk (2022)

The conducted study confirmed the gradual increase in the number of social enterprises in Ukraine. The trend towards social business existed in Ukraine even before 2022. However, the full-scale war has highlighted that this form of entrepreneurship can effectively address the problems of those most in need of support. Many Ukrainian businesses have a social mission. At the same time, social entrepreneurship has not yet reached a sufficient level of development in the country. As noted by O. Yurchenko & O. Svyryda (2022), issues such as the lack of initial capital, insufficient public awareness about the essence and mechanism of this type of entrepreneurial activity, as well as the absence of a legislative framework regulating the functioning of social enterprises, contribute to this.

Social enterprises, unlike traditional commercial ones, have specific missions aimed at solving social problems, which requires a special approach to handling HR. Social enterprises often work with vulnerable groups of the population, which creates additional physical and psychological stress on employees (Mito *et al.*, 2024). Therefore, the effective adaptation of employees in social enterprises helps them integrate more quickly into the work team, which increases their productivity and job satisfaction. Reducing stress and increasing the comfort of new employees during the adaptation process is key to ensuring their long-term engagement and loyalty to the enterprise. Social enterprises have a unique mission and values that must be conveyed to new employees. An effective adaptation process helps to quickly integrate new employees into the corporate culture, encouraging their engagement in the enterprise's social mission. This, in turn, boosts employee motivation and their willingness to actively contribute to achieving the organisation's goals.

It should also be noted that social enterprises often have limited resources, so the effective adaptation of new employees is economically advantageous. Reducing training costs and shortening the time required to reach full

employee productivity allows the enterprise to optimise its operational expenses and allocate the saved resources to the implementation of social projects. This is especially important in times of economic instability, when every resource counts. Effective adaptation helps reduce employee turnover, which is an important factor for the stability and sustainable development of social enterprises. High turnover can lead to the loss of accumulated knowledge and experience, negatively impacting the overall efficiency of the organisation. Ensuring a proper adaptation process helps retain qualified employees, which is particularly critical for social enterprises that often rely on the specialised knowledge and skills of their staff. Developing and implementing an effective onboarding system is a logical extension of the hiring process. It is a kind of return on investment. The company has spent some money on the selection and recruitment of staff, and now, having found the best candidate, it must do everything to ensure that the newcomer stays with the company and returns the money spent in the form of successful implementation of their knowledge, skills and abilities.

The term "staff adaptation" or "onboarding" is defined as a system aimed at involving newly arrived employees in the performance of direct work duties in a new environment with soft and effective integration into established organisational groups (teams). According to W. Walker-Schmidt *et al*. (2022) and R. Gomes & D. Sousa (2023), an effective staff adaptation system addresses several crucial tasks (Adaptation of personnel, 2020). Firstly, it aims to minimise the costs associated with hiring and adapting new employees. When a newcomer quickly acclimatises and starts performing their job duties, the return on investment from a well-structured adaptation system helps the company achieve its strategic goals more rapidly. Secondly, it reduces the feeling of uncertainty. The human psyche is such that uncertainty and a sense of being "suspended" do not facilitate the performance of daily tasks, whether domestic or work-related. A well-designed adaptation system minimises these feelings, allowing new hires to take up their immediate duties more swiftly. Furthermore, an effective adaptation system lowers the risk of dismissal during the probationary period. When new hires are unsure of their abilities and do not understand their next steps, they are more likely to consider leaving the company. The system also enables better estimation of the newcomer's future time commitment. Facing new tasks for the first time often forces employees to seek help from more experienced colleagues, thereby distracting them from their duties. With a proper onboarding system, on-the-job training becomes an integral part of the process, minimising such disruptions. Additionally, it enhances the employee's sense of ownership of organisational processes and fosters the adoption of the organisational culture. Organisations that establish an emotional connection with their employees early in the process tend to have higher levels of overall engagement and retention. This emotional connection ultimately boosts productivity, as new employees are more likely to achieve productivity gains when they feel connected to the organisation.

A. Lobza *et al*. (2021) believe that a common element of the staff adaptation system in business is the development of an algorithm (toolkit) of measures, which is essentially a kind of memo for newcomers. There they can find answers to the most common questions that they may have in the course of work. This measure also has a strong psychological impact – the implementation and use of such plans makes the employee understand that the company has taken care of them, it is a manifestation of a kind of attention. As a variant of team building, branded products and wishes from colleagues can be added. When implementing the onboarding system, the company facilitates access to the necessary resources to help the newcomer get started as quickly and efficiently as possible. This can include training courses, numerous soft and hard skills development trainings, and access to educational courses. Support from the company's leadership and colleagues in training and staff development as part of the adaptation policy is an extremely important element of building staff loyalty. Interaction with more experienced colleagues and the adoption of their experience ultimately creates a sense of belonging and unity for the newcomer and the team (Gajda, 2019). In general, the employee onboarding system can be divided into four key stages (Fig. 3).

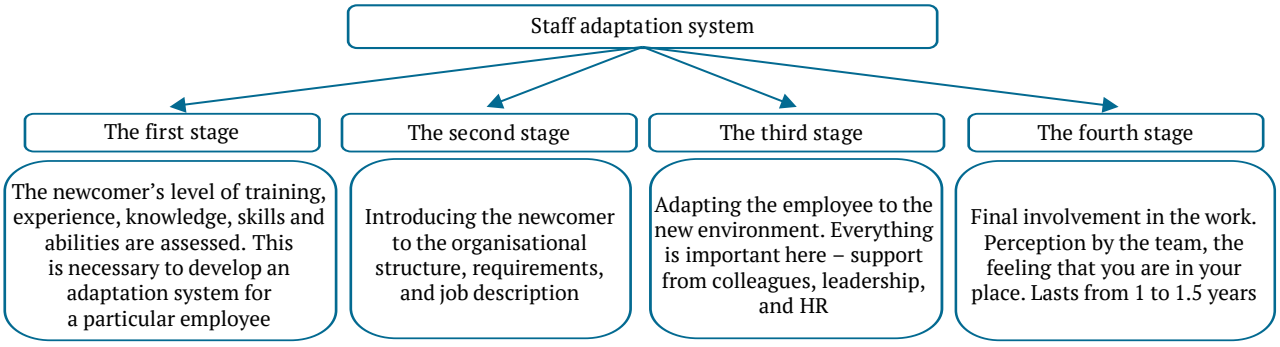

Figure 3. Staff adaptation system

Source: created by the authors based on Adaptation of personnel (2020), T.Yu. Fedorchuk & T.V. Mozharovska (2023)

Effective staff adaptation in Ukrainian enterprises during armed aggression plays a pivotal role in maintaining operational stability, supporting employee well-being, fostering resilience, and enabling strategic agility. By investing in comprehensive adaptation processes, enterprises can better navigate the complexities of the conflict,

protect their workforce, and sustain their business operations. Effective adaptation allows enterprises to swiftly realign their strategies and operations to adapt to the changing environment. It enables employees to acquire new skills and competencies needed to navigate the challenges posed by the conflict, such as remote work, digital communication, and agile decision-making. This flexibility and adaptability are key to maintaining competitiveness and ensuring long-term survival in a volatile context. The process of staff adaptation in the context of armed aggression can be a boost that will help employees get out of their perceived comfort zone, pay attention to their own development and training to meet the current needs of the labour market. But for this, they need support from colleagues and leadership, both psychological and organisational.

When implementing staff adaptation measures in the current conditions of a full-scale invasion, it is necessary to find answers to the following questions: does the system really help new employees to adapt to work under martial law; at what stages of adaptation do the greatest difficulties arise; how can the adaptation system be improved to meet the new conditions. The quality of staff adaptation during the wartime period is of particular importance, as it is important to take into account the emotional state of employees and their individual needs. I. Chornodid *et al*. (2022) believe that in this context, it is important to expand communication with employees in order to maintain their moral and psychological state, as well as to provide physical protection and psychological assistance. Such adaptive approaches aimed at caring for employees and their families are becoming key components of HR practices in wartime, which allows to preserve the potential of the staff and ensure productive work even in difficult circumstances.

Effective adaptation of an enterprise's staff can have a significant positive impact on the economy as a whole through several key mechanisms: increased labour productivity, reduced unemployment, improved quality of products and services, reduced staff turnover costs, investment attraction, improved social climate and increased innovation. Well-adapted employees reach a high level of productivity faster, which increases the overall productivity of the enterprise. This contributes to the growth of production of goods and services, which has a positive impact on the country's economic performance. When employees quickly and successfully adapt to new working conditions, they are less likely to leave. This helps to reduce unemployment, stabilise the labour market and improve the welfare of the population. Adapted employees have a better understanding of their responsibilities, quality standards and corporate culture, which contributes to the quality of products and services, increasing the company's competitiveness in both domestic and foreign markets.

Effective onboarding reduces the costs associated with recruiting, hiring and training new employees, allowing businesses to allocate the savings to other important areas such as innovation and development. Businesses with a high level of staff adaptation demonstrate stability and efficiency, which attracts investors. Domestic and foreign investments contribute to economic growth and the development of new projects. Effective adaptation creates a positive social climate at the enterprise, which promotes employee loyalty and reduces stress, improving the overall atmosphere in society and contributing to social stability. Employees who are well adapted are better engaged in the work process and tend to generate new ideas, stimulating the innovation activity of enterprises, which leads to technological development and increased competitiveness of the economy. Thus, effective staff adaptation helps to increase productivity, reduce costs, improve the quality of products and services, attract investment and stimulate innovation, which all have a positive impact on the country's economy.

Noting the significant contribution of scientists to the study of the essence and content of the process of staff adaptation, it should be noted that at present, modern research and publications do not identify a single tool for assessing the system of staff adaptation at enterprises. The tools for assessing its effectiveness are rarely considered separately, most often they are studied in conjunction with the organisation's personnel policy. It should also be noted that the scientific literature demonstrates a significant lack of qualitative research on the specifics of adaptation of social enterprise staff. Most of the available studies focus on the adaptation of employees in commercial structures, which does not take into account the specifics of social enterprises. Social enterprises have unique tasks and missions that combine economic and social goals, so staff adaptation in such conditions has its own peculiarities. The lack of in-depth research in this area limits the ability to develop effective adaptation strategies that take into account the specific challenges faced by social enterprises. It also makes it difficult to integrate new employees and reduces the efficiency of such enterprises. Filling this research gap is necessary to increase the level of understanding of adaptation processes in social enterprises and to develop methodologically sound recommendations for their successful integration into the socio-economic environment.

According to scientists A. Lobza *et al*. (2021), the success of the adaptation process depends on many factors. It is the provision of relevant and comprehensive information on such aspects as: informing newcomers about the company's mission, strategic goals and development vectors; core values of the company and the role of the employee in their direct formation; basic personnel and production processes in the company, their organisational structure and features of internal corporate communications; personnel policy of the company; organisational structure of the company, features of subordination, vertical and horizontal hierarchy; corporate culture, code and other informal. The more information employees receive, the more thorough it is, the sooner they will be able to become full members of the team and perform duties as efficiently as possible. The factors that contribute to the adaptation of a newly hired employee are also identified in the article by J. Gajda (2019). Adaptation should be an organised and controlled process. It should include the following mandatory elements: set deadlines (at least 2 months of adaptation); provision of information on the specifics of the company's activities, tasks in this position and other important aspects of functioning in the organisation; availability of an experienced mentor; a high-quality social environment where the roles of colleagues are clearly understood and there is space to build and maintain proper interpersonal relationships.

In social enterprises, staff onboarding has unique aspects due to the dual nature of their activities, combining economic and social goals. New employees need to

understand and accept these two areas, which requires specialised training and socialisation. It is important that new employees share the ethical and social values of the enterprise, integrating into cultural norms and practices that are geared towards achieving social goals. Social enterprises also often hire representatives of vulnerable groups, such as veterans or people with disabilities, which requires a special approach to adapt to their specific needs. Key factors for the successful integration of new employees are high-quality professional training and development, including orientation, training and mentoring. Psychological support, especially in times of high stress and crisis, is important to reduce stress and increase productivity. Effective communication and regular feedback help to solve problems and keep employees motivated, while inclusiveness ensures that all employees feel part of the team, taking into account different cultural and social backgrounds.

In addition to internal factors influencing the adaptation of personnel, the effectiveness of personnel adaptation is currently largely determined by the external conditions of operation of enterprises. Starting from February 2022, the issue of staff adaptation of Ukrainian enterprises in the context of armed aggression is relevant. The system of staff adaptation of modern Ukrainian enterprises during the war period faces many challenges and risks. The main ones are noted by M. Pyzhova & O. Pyzhov (2023). Economic instability leads to job losses and increased competition in the labour market. In times of economic crisis, businesses are often forced to cut costs, including reducing the number of employees. This increases the number of unemployed people actively looking for new job opportunities. As the number of candidates for a limited number of vacancies grows, competition for jobs increases significantly. This, in turn, may lead to lower requirements for salaries and working conditions, as employers are able to choose from a larger number of applicants willing to work on less favourable terms. This puts additional psychological pressure on job seekers who feel uncertain about their ability to find a job that meets their needs and qualifications. In the early stages of employment, new employees often face additional challenges related to the need to quickly adapt to new working conditions, learn new responsibilities and fit in with the team. In times of economic uncertainty, these challenges can be even more pronounced, as employees feel additional pressure to lose their jobs if they do not perform well or do not meet the employer's requirements. This can lead to increased stress levels, decreased motivation and a general deterioration in the psychological state of employees, which in turn negatively affects their productivity and performance (Pyzhova & Pyzhov, 2023).

The need to adapt to new political, social and economic conditions has become a challenge for many people who have been forced to change their place of residence and, consequently, their jobs due to the military aggression. The massive displacement of the population caused significant changes in the labour market as people sought employment in new cities and regions. This often required them to adapt not only to new living conditions, but also to new professional responsibilities, work environments and corporate cultures. Many employees in new locations faced the need to retrain or learn new skills, as their previous experience and knowledge may have been irrelevant or unnecessary in the new environment. This created an additional burden on the education and training system, which had to respond quickly to new labour market demands. In addition, many people who had previously held full-time jobs were forced to switch to temporary or part-time employment, which affected their financial situation and income stability. This has also affected businesses, which have had to adapt their HR strategies to the new environment, including the introduction of more flexible working hours, the development of remote work and other measures to support their employees in the new environment. Social adaptation also became an important aspect, as employees had to integrate into new teams and establish relationships with new colleagues and leadership. This required a high level of communication skills and emotional stability. For employers, this meant the need to create a favourable working environment that would facilitate the quick and effective adaptation of new employees. The economic situation in the new regions could also be different from their previous place of residence, requiring employees to quickly understand the new economic realities and working conditions. This included differences in salary levels, cost of living, access to social services and other factors affecting the quality of life of employees and their families.

During martial law, business needs can change extremely quickly, requiring companies to be highly flexible and adaptable. This may apply to production processes, logistics, HR, finance and marketing strategies. In addition, changes in legislation and regulatory requirements that may be introduced during martial law also affect business operations. Companies should be prepared to respond quickly to new regulations, which may include export and import restrictions, quotas, changes in tax policy and other regulatory measures. This requires prompt analysis and changes to the company's internal processes and policies. So new employees face the challenge of acquiring new knowledge, skills, advanced training, retraining, education and development. With the need to significantly change their career path and life, many employees have been forced to retrain for professions that are radically different from their usual ones. In this case, the adaptation system should be particularly gentle and unhurried (Pyzhova & Pyzhov, 2023).

Changes in the business environment, including through innovation, often require employees to adapt to new technology platforms or organisational methods. For example, companies may integrate new software solutions to automate processes or use new tools to analyse data, which requires employees to acquire new skills and knowledge. This encourages employees to actively learn and upgrade their skills, which may include participating in training, refresher courses, or learning new technologies on their own. Attracting new employees who can quickly adapt to these changes is also an important aspect for companies. This reduces the time required to integrate new employees into the workflow, increases productivity, and reduces the risk of project delays. Quickly adapting new employees to new conditions and tasks helps companies stay competitive and maintain a high level of innovation even in difficult conditions.

The emotional and psychological aspects of adaptation are crucial in work environment, where stress, emotional burnout, and depressive disorders are increasingly

common among adults of working age. Addressing these issues should be a key component of any adaptation plan. By providing support to help employees manage and overcome such crises, companies can foster a high level of loyalty and commitment. An effective methodology for reintegrating employees into a stable routine not only promotes their well-being but also ensures that they remain productive and engaged, ultimately benefiting the company through enhanced performance and reduced turnover (Pyzhova & Pyzhov, 2023). In addition to addressing psychological challenges, helping newcomers develop essential skills such as creative thinking, critical thinking, and decision-making flexibility is vital. These competencies are crucial for navigating the rapidly changing and often disruptive conditions. Training and development programmes aimed at enhancing these skills enable employees to respond effectively to unexpected challenges and make informed decisions that support the company's operations. By investing in the development of these skills, organisations can ensure that their staff are not only capable of handling current demands but also adaptable and resilient in the face of future challenges.

To enhance the effectiveness of adaptation processes in social enterprises, it is important to integrate social and economic aspects into adaptation programmes, designing them with consideration for professional training and understanding of the social mission. Personalised adaptation programmes should address the individual needs of employees, particularly those from vulnerable groups, by providing additional support and guidance. Implementing a mentoring system, continuous monitoring of the adaptation process, and using digital technologies to manage this process will help to more effectively collect, analyse, and utilise information to optimise adaptation. There is an opinion that staff adaptation as a social process at an enterprise is difficult to formalise and measure. Since the success of staff adaptation is determined mainly by whether it was possible to form new stereotypes of labour behaviour among employees, to support positive motivation and to maintain the desire to achieve sustainable results in work. Therefore, in order to form a system of criteria and indicators of the effectiveness of staff adaptation, it is advisable to approach the evaluation process as organisational function. Evaluation is considered to be the systematic determination of the operations or results of a programme or policy against a set of explicit and implicit standards with the aim of improving the programme or policy. It is divided into process evaluation and outcome evaluation. Process evaluation is the study of what happens within a programme during its implementation (effectiveness evaluation) and is used at an early stage to improve the programme. Outcome evaluation focuses on the final results of the programme and their significance, the achievement of the goal (effectiveness evaluation). Process evaluation focuses on the involvement of participants, activities, events, staff practices, and client actions, while outcome evaluation focuses on what happened to clients (participants) after the programme was implemented.

Evaluation of the effectiveness of the personnel adaptation system in the crisis conditions is a well-organised and purposeful process of determining the level of compliance of the employee's basic professional qualities with the key requirements of the organisation (in particular, job requirements). The toolkit for evaluating the effectiveness of the employee adaptation system is a set of actions and procedures that allow assessing the newcomers' ability to work, their performance, work intensity, and the effort they make to adapt more quickly. And the more professional this toolkit is, the better the results of its implementation will be. It is advisable to distinguish the following groups of approaches that help a manager to evaluate a new employee: assessment through satisfaction, evaluation through the development of own key performance indicators (KPIs), and integrated assessment of the entire set of adaptation measures in the organisation. The assessment through satisfaction approach focuses on how satisfied the new employee is with various aspects of the job, including work (interest, challenge, responsibility, meeting expectations), workplace (working conditions, equipment, comfort), colleagues (relationships, support, communication), leadership (management style, accessibility, feedback), and salary (meeting expectations, fairness). The evaluation through the development of own KPIs approach focuses on the specific results expected of a new employee, including indicators that characterise the degree of task completion, deadlines, quality of work, number of errors, and so on. The integrated assessment of the entire set of adaptation measures approach provides an overall picture of the effectiveness of adaptation, taking into account the level of satisfaction, KPI achievement, feedback from the manager and colleagues, and integration into teamwork.

To evaluate an employee based on the results of the adaptation period at work (Chornodid *et al.*, 2022), the following toolkit is proposed: a plan-evaluation of entry into the position (a table showing all employee adaptation procedures, the time and results of their implementation); evaluation of a new employee by a mentor (level of professional competence, relationships with work colleagues); assessment by a new employee of the mentor's work and the internal climate in the unit; a report on the execution of control tasks; assessment of work performance, knowledge and skills from the job profile; assessment of the degree of adaptability of the employee, focused on the results of professional adaptation. In order to determine the effectiveness of the adaptation system, it is also necessary to assess the social and psychological climate in the team and the level of professional training of staff from time to time. This assessment should be based on the following criteria: level of professional training; assessment of personal qualities, knowledge, skills and professional abilities; social and psychological climate, degree of informal communication and relationships in the team. After the development and implementation of a set of necessary adaptation measures, the criteria for assessing the performance of staff and the effectiveness of all stages of adaptation should be determined. The main criteria include mastering (improving) the basic knowledge, skills, and abilities required to work in a particular position; prompt completion of tasks in accordance with the adaptation plan and participation in achieving the organisation's strategic goals; social and psychological climate in the team; awareness of the company's key regulatory documents, codes of conduct, rules of business and customer relations; quality of interaction

with leadership and colleagues; job satisfaction and feeling of being part of a team.

An important factor that determines the positive (successful) adaptation of employees and the effectiveness of the personnel adaptation system as a whole is the state of the socio-psychological climate at the enterprise. This factor is especially important in the context of martial law. A harmonious and supportive team fosters favourable conditions for adaptation, relieving stress and promoting confidence through effective leadership and open communication. Psychological support also mitigates stress and aids emotional health. In social enterprises, the socio-psychological climate is even more vital due to the additional emotional demands of supporting vulnerable populations. A positive climate helps manage stress and reinforces commitment to social goals. Effective leadership and a supportive environment are essential for maintaining morale and facilitating adaptation. Moreover, new employees must align with the enterprise's ethical and social values for successful adaptation. This alignment aids integration, strengthens commitment to the mission, and enhances productivity. When new hires share the enterprise's values, they contribute more effectively to its social objectives, boosting the organisation's impact and success.

Employees who find it difficult to work within the team may experience decreased job satisfaction, higher stress levels, and lower productivity. These issues can result in higher absenteeism, increased turnover, and reduced overall performance. The negative impact on productivity and increased costs associated with high turnover can affect the organisation's financial health and competitive position. In the broader economic context, organisations with a positive socio-psychological climate contribute to economic stability by maintaining a more effective and engaged workforce. They are better positioned to meet market demands, innovate, and achieve their strategic goals. On the other hand, organisations struggling with a negative socio-psychological climate may face challenges that hinder their economic performance and long-term sustainability. Thus, fostering a supportive work environment not only benefits individual organisations but also contributes positively to the broader economy by promoting a more resilient and productive workforce.

The analysis of the social and psychological climate allows to determine its general state and to divide team members into those whose work takes place in comfortable moral and psychological conditions and those who find it difficult to be in a work team, which can directly affect the results of work. The analysis uses a list of specific criteria, for example: satisfaction; productivity; warmth; friendliness, etc. This list can be standard or be formed depending on the needs of the organisation. Ya.V. Amurova & M.A. Momot (2023) identified signs of a comfortable social and psychological climate of a group (team). Subjective signs: trust and mutuality between team members; friendly attitude and constructive claims; freedom to express opinions and ideas on team activities; lack of pressure from leadership and recognition of the right to make decisions; awareness of team members about the goals and state of affairs in the group; high level of emotional connection and mutual assistance; taking responsibility for the state of affairs in the group by each of its members. Objective signs: high performance indicators; low staff turnover; high level of labour discipline; absence of tension and conflicts in the team, etc. These and other indicators can be used as the basis for the tools for assessing the system of adaptation of the personnel of a social enterprise. It is recommended to use a combination of quantitative and qualitative indicators to obtain the most objective assessment. To improve the quality of assessing the effectiveness of staff adaptation at social enterprises, it is advisable to systematise the criteria for assessing the effectiveness of the staff adaptation system at a social enterprise and the relevant assessment tools that are of practical value in the activities of social enterprises, in particular in the conditions of martial law. The most priority criteria and indicators for evaluating the effectiveness of the personnel adaptation system have been allocated (Table 1).

Table 1. Criteria and tools for assessing the effectiveness of the personnel adaptation system at the social enterprise

Criteria	Sphere of influence	Assessment tools
Career development	Prospective internal relocation (both vertical and horizontal)	Calculation of staff performance, KPIs
Organisational culture	Staff loyalty	Calculation of staff turnover rates, staff stability rate, labour force stability index
Objectives of the organisation	Identification of the employees with the organisation, integration of their personal goals with the strategic goal of the organisation	Building a strategic map of goal alignment, using the specific, measurable, achievable, relevant, and time-bound goals (SMART) methodology
Relations with the team	Friendly communication, no social and psychological tension, no conflicts	Employee survey results, monitoring of the social and psychological climate
Relations with leadership	Loyalty to leadership, work motivation	Number of proposals to improve a particular work aspect, involvement in decision-making
Norms and rules in the organisation	Clear organisational hierarchy, no violations of personal boundaries, clear understanding of key rules and regulations	Personnel efficiency, minimisation of downtime, labour productivity
Job description	Correlation of the employee's direct functions and duties performed with the prescribed standards	Determination of time absorbers, calculation of time standards (downtime, training, preparatory and final periods, etc.)
Openness towards leadership and colleagues	Loyalty to the team, leadership, self-identification of the newcomer as a full member of the team	Performance, achievement of own KPIs

Table 1. Continued

Criteria	Sphere of influence	Assessment tools
Training and development	Readiness to learn, speed of mastering new knowledge necessary for the effective performance of direct job duties	Comparison of the company's performance indicators before and after the training of a new employee. Calculation of staff qualification coefficients, educational level
Workplace	Employee satisfaction with their workplace	Ergonomics, downtime, preparatory and final time. These indicators characterise how comfortable and equipped an employee's workplace is
Conflicts	Absence of conflict situations, absence of tension in the team	The level of stress resistance in the team, strategies of behaviour in conflict situations, psychological analysis of the personality
Work in progress	Level of interest in work, tasks, level of competence	KPI achievement, performance, motivation by work and results
Transparency	Understanding of one's own mistakes and a desire to correct them. Adequate attitude of the leadership to the imperfect work of the newcomers at the initial stages of their cooperation with the organisation	Calculation of time savings, materials used, financial costs, labour productivity
Work and qualifications	The ratio of these two indicators makes it possible to assess the effectiveness of the personnel selection procedure and, accordingly, further adaptation measures	Reduction of time costs, financial costs, calculation of the effect of staff training and development, productivity and efficiency
Collaboration with colleagues	Coordinate your efforts with other team members to achieve the strategic goal of the company	Effect of teamwork, productivity of one employee and the team as a whole, team KPI
Motivation and incentives	Satisfaction with the reward system and personal motivation to complete tasks	Calculation of payroll, bonuses, surcharges and their impact on the result
Psychological state	Stable psychological state of the employee, ability to adapt to changes, willingness to work in complex and dynamic conditions	Level of emotional intelligence, level of stress resistance, communication skills

Source: created by the authors based on I. Chornodid *et al*. (2022), I. Shapka & N. Yashkina (2023), Ya.V. Amurova & M.A. Momot (2023)

The results of the assessment of adaptation measures can be briefly described as follows: the employee meets the needs and requirements of the company; the employee meets the chosen position; the employee does not meet the requirements of the company; the employee does not meet the chosen position. Adaptation measures can be considered successful if employees have a clear understanding of their goals and coordination with the company's strategic goal; perform tasks promptly and efficiently and meet deadlines; are not afraid to ask questions, want to learn something new and do not feel ashamed of it; the newcomers are able to find a common language with their colleagues, do not provoke conflict situations, do not stay away from corporate events, and feel like a full-fledged part of the team; the results of their work are approved by the leadership and the employees themselves. Moreover, their performance is not measured in terms of individual performance of job duties, but rather in terms of teamwork and the interconnectedness of the tasks performed.

The criteria and tools for evaluating the effectiveness of the system of staff adaptation at an enterprise, allocated in the article, have a number of advantages. They provide a high degree of objectivity, as most evaluation tools are based on specific metrics and indicators, allowing for the acquisition of objective data on the effectiveness of the adaptation process. They also enable the monitoring of results, facilitating the tracking of staff adaptation outcomes at different stages, which allows for the timely identification of problems and the implementation of corrective measures. Additionally, these tools support decision-making, enabling to make informed decisions regarding the further development of the adaptation system and the improvement of staff integration strategies. The comparability of these tools allows for the evaluation of adaptation effectiveness across different departments or among various groups of employees, helping to identify the most effective approaches and methods. Finally, their versatility ensures that most tools can be utilised to assess various aspects of adaptation. However, it should be noted that there are possible risks and disadvantages of using this toolkit for assessing the effectiveness of the personnel adaptation system at the enterprise. It should be borne in mind that some aspects of adaptation (e.g., psychological state) are difficult to quantify, and therefore their assessment may require significant time, special knowledge to conduct and interpret the results.

Evaluation of the effectiveness of the personnel adaptation system is informative for the top leadership of an enterprise and can produce objective and subjective results. The objective results of the assessment of the effectiveness of the adaptation system include the reduction of recruitment costs, the minimisation of staff turnover, particularly among those on probation, the reduced waiting time for results from the work of a newcomer, which shortens the onboarding period and increases employee loyalty to the organisation, and the reduction of the time

needed for the adaptation of new employees, allowing staff to spend more time on their direct duties. Subjective results include an improved social and psychological climate in the team and the level of satisfaction of the newcomer with their new job and the employing company in general. According to the results of the assessment of the staff adaptation system at the enterprise, several measures can be taken. The HR department should prepare work instructions, providing an algorithm of actions for a newcomer in a new workplace. The practice of mentoring, supervision, or coaching should be introduced in accordance with the needs of the position and the company's strategy. A toolkit of actions for newcomers should be developed and implemented, and an onboarding plan should be drawn up and communicated. Timely feedback should be provided, and step-by-step monitoring of the adaptation process should be conducted. Depending on the company's needs, a standard of adaptation measures can be developed, offering methodological recommendations for conducting adaptation at the enterprise for different categories of employees (Lobza *et al*., 2021).

The effectiveness of the personnel adaptation system allows a top manager to quickly integrate an employee into their duties, understand and accept the new organisational and corporate culture, and avoid the stressful aspect of transition to a new job (or first employment). The introduction of modern tools for evaluating the effectiveness of the adaptation system in the business environment should be carried out through the phased implementation of the company's adaptation policy, each stage of which should contain a certain set of tools and techniques by which the manager can assess the correctness of his actions and monitor the process of adaptation of the new employee into the company's life. The key signs of the effectiveness of the adaptation system are the proper performance of duties by new employees and the presence of responsibility for solving tasks, the level of their compliance with behavioural norms and the degree of contact with other employees, as well as the facts of their membership in informal groups, etc. Properly selected tools for assessing quantitative and qualitative indicators of the effectiveness of the adaptation system have a positive impact on the newcomer, involving the study of both the subjective characteristics of the employee and the factors of the production environment, the nature of their impact on the indicators and results of adaptation. Improving the efficiency of staff adaptation under martial law is an important investment in the company's future. It gives the company the opportunity to increase labour productivity, reduce downtime and staff turnover, retain talented personnel and increase competitiveness, and, consequently, increase profits as the main goal of the company's functioning in the market.

DISCUSSION

Thus, the study highlights the critical role of staff adaptation in ensuring the effective operation of social enterprises, especially in conditions of limited resources and wartime. For effective staff adaptation, the subjective and objective factors, possible risks and threats should be taken into account. This will create opportunities for stabilisation and sustainable development of the social enterprise in the context of increased instability of the external environment due to martial law. The study confirmed the importance of staff adaptation as a key factor for the effective functioning of social enterprises in conditions of limited resources, especially during the war. An effective adaptation system helps to reduce staff turnover, increase productivity and sustainability of enterprises that address social problems. This is especially important for businesses that employ vulnerable groups such as veterans, internally displaced persons and people with disabilities. Staff adaptation is multifaceted and includes psychological support, integration into the team, and professional development. This allows not only to engage new employees in productive activities more quickly, but also to increase their motivation and involvement in the company's social mission. As a result, it contributes to long-term staff retention and optimisation of training and adaptation costs, which is critical in an environment of economic instability.

Effective adaptation is vital for business success, promoting staff stability, increasing productivity, and reducing costs, which is particularly important for social enterprises with limited resources. M. Pyzhova & O. Pyzhov (2023) prove the importance of employee adaptation in modern business conditions, focusing on the key components of the adaptation process, taking into account the challenges that arise in martial law, with recommendations for optimising this process. A. Vasylyk & K. Murza (2020) review modern approaches to staff adaptation and organisational socialisation, highlighting the need for a comprehensive process integrated into professional selection and talent development. They stress the importance of process automation and addressing company-specific needs, and identify common mistakes that negatively affect employee attitudes and company reputation. Other authors also consider the problems of social enterprise development. For example, J. Lortie *et al*. (2021) highlight how macroeconomic factors such as public policy and market dynamics affect social entrepreneurship. This broad perspective provides a valuable context for understanding how social enterprises operate in their environments. In contrast, S.C. Talukder & Z. Lakner (2023) focus on the role of crowdfunding as an important financial mechanism for social enterprises, emphasising the external sources of funding that support these enterprises. Both perspectives contribute to a comprehensive view of social entrepreneurship, although they address different aspects of the field. However, these articles do not directly address the challenges of military conflict or limited resources. In contrast, current study focuses on social enterprises in Ukraine that are facing the challenges of military aggression and economic instability. It specifically examines tools and approaches for assessing staff adaptation in the context of conflict and limited resources.

Methodological approaches and conceptual frameworks play a crucial role in understanding and evaluating social entrepreneurship. A. Klarin & Y. Suseno (2023) provide an in-depth analysis of the concept and components of social entrepreneurship that helps to outline the role of employee adjustment in this context. In addition, J.M. Diaz-Sarachaga & A. Ariza-Montes (2022) present a methodology for aligning social entrepreneurship with the Sustainable Development Goals, emphasising the integration of worker development and labour relations into a broader decent work agenda. This article is interesting

for the current research because the development of personnel and the harmonisation of labour relations, as a constituent element of the concept of Decent Work, is an extremely important aspect of the Sustainable Development Goals. These studies bring methodological rigour and conceptual clarity to the discourse on social entrepreneurship and employee adjustment. While J.M. Diaz-Sarachaga & A. Ariza-Montes (2022) offer a framework related to sustainable development, they do not focus on the immediate needs of workforce adaptation in the context of a specific crisis.

M.L. Benjumea Arias & D. Arango-Botero (2019) discuss the significance of the human factor in social entrepreneurship, affirming the view that personnel are a critical element in the effective development of social initiatives. This perspective is further supported by J. Ramya *et al*. (2024), who emphasise the importance of a human-centred approach in social entrepreneurship, advocating for the alignment of employee adaptation systems with the broader human-centric goals of the enterprise. However, their focus is broader and not specifically linked to the pressures of military conflict or economic instability. In contrast, the current study highlights the importance of a human-centred approach under significant external pressures. It directly connects the effectiveness of adaptation systems with the stability and productivity of social enterprises in crisis conditions. An important topic for research is the adaptation of employees in response to changing working conditions. For example, O. Pinco *et al*. (2024) examine how remote work, a trend accelerated by the COVID-19 pandemic, has transformed employee adjustment processes. This research is particularly relevant in light of the current global situation, when many businesses, including those affected by conflict, are shifting to remote working models. Similarly, R. Britto *et al*. (2020) investigate employee adaptation in the IT sector, which is particularly prevalent in social enterprise. The focus is on how these organisations manage workforce and operational change, reflecting the unique challenges and needs of the sector. It is worth noting that these studies do not take into account the impact of military conflict or limited resources on the business in general and the effectiveness of the staff adaptation system in particular.

Thus, as can be seen, there is much common ground in scholars' views on social entrepreneurship and its approach to working with personnel. However, this study on personnel adaptation systems in Ukrainian social enterprises provides a targeted analysis relevant to the specific conditions of a crisis, whereas the reviewed articles offer a broader range of perspectives on social entrepreneurship and adaptation. The primary distinguishing feature of this research lies in its specific focus on challenges arising from crisis conditions and the tailored recommendations for improving personnel adaptation processes in the context of military conflict and limited resources (both human and material, including unstable funding, issues with power supply, communication interruptions, internet connectivity, etc.). This makes the current study both relevant and deserving of the attention of the academic community.

CONCLUSIONS

The paper identifies the key factors that influence the effectiveness of adaptation, as well as the main challenges and risks that newcomers may face in martial law. It is important to note that the stressful situation in the country is a significant destabilising factor in itself, and in combination with a change of job, profession or place of residence, it can cause depressive disorders and emotional stress among employees. In view of this, the leadership of enterprises should pay maximum attention to the development of an effective system of staff adaptation and its adequate assessment. The toolkit for assessing the effectiveness of the adaptation system should include a set of actions and procedures that allow assessing the newcomer's performance, productivity, work intensity, and the efforts. Based on the analysis of scientific studies, the article summarised the priority criteria and tools for assessing the effectiveness of the employee adaptation system. The article identified the advantages, disadvantages and possible risks of using these tools at enterprises, as well as the objective and subjective results that leadership of enterprise can obtain in the process of such an assessment. As a result, a set of measures adapted to the needs of the enterprise based on the assessment of the staff adaptation system was proposed.

It was also found that social enterprises in Ukraine face a number of challenges, including a limited resource base and the need for a special approach to HR. However, an efficiently organised adaptation system can compensate for these shortcomings, ensuring the stability and sustainable development of the enterprise. Thus, the development and implementation of a system of staff adaptation is a prerequisite for the success of social enterprises in Ukraine, especially in times of war, when it is important to make the most efficient use of available resources and ensure social stability. Further research should focus on a deeper analysis of the impact of different models of staff adaptation on the performance of social enterprises. Another important area for further research is the economic and mathematical modelling of the impact of external factors, such as the political and economic situation, on the process of staff adaptation in social enterprises. This will help to understand how different adaptation strategies can be adapted to changing conditions, especially in the context of crisis situations such as war.

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CONFLICT OF INTEREST

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Аналіз інструментів оцінювання ефективності системи адаптації персоналу в контексті соціального підприємництва

Анотація. В умовах війни та економічної нестабільності соціальні підприємства України стикаються із численними викликами, зокрема з обмеженням ресурсів та необхідністю особливого підходу в кадровій сфері. Ці фактори роблять ефективну систему адаптації працівників необхідною для забезпечення стабільності та стійкого розвитку таких підприємств. Метою статті було дослідити та проаналізувати основні інструменти й підходи щодо оцінки ефективності системи адаптації персоналу в контексті соціальних підприємств. Для досягнення цієї мети використано методи аналізу та синтезу, а також контент-аналіз для систематизації існуючих наукових даних. У ході дослідження встановлено, що добре якісно організована система адаптації персоналу сприяє зниженню плинності кадрів, підвищенню продуктивності та залученню працівників до соціальної місії підприємства. У результаті аналізу наукових праць визначено ключові фактори успіху адаптації персоналу в умовах воєнного стану, а також основні виклики та ризики, з якими стикаються нові працівники. Розкрито сутність оцінки ефективності системи адаптації, визначено пріоритетні критерії та інструменти для її оцінювання, їх переваги та ризики. Обґрунтовано необхідність регулярної оцінки соціально-психологічного клімату та рівня професійної підготовки. Виокремлено найбільш пріоритетні критерії та інструменти оцінювання ефективності системи адаптації персоналу. Розглянуто результати оцінки, на основі якої розроблено рекомендації для покращення адаптаційних процесів у підприємствах. Практична цінність дослідження полягає у розробці конкретних рекомендацій щодо оцінки та оптимізації адаптаційних процесів на соціальних підприємствах, що може забезпечити їхню стабільність і успішне функціонування навіть в умовах війни та обмежених ресурсів; результати дослідження можуть використовуватися у діяльності бізнесу, зокрема соціальних підприємств різних форм власності, для підвищення ефективності рішень у кадровій сфері

Ключові слова: онбординг; оцінка; фізична особа-підприємець; результативність праці; ключові показники ефективності; інструментарій; громадські організації

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The influence of psychological factors on investment decision-making: Psychological features of economic relations formation

Abstract. The article aimed to analyse the influence of psychological factors on the investment decision-making process, which shapes the economic behaviour of investors in Ukraine. The research involved surveys and experimental tasks conducted among investors, with the data analysed using statistical methods to identify the impact of psychological factors on investment decisions. Fear and greed have been found to be most significant emotions affecting investment decisions, whereas fear leads to excessive caution and risk avoidance. In contrast, greed drives investors to take on excessive risks. Overconfidence in one's knowledge and skills results in an overestimation of opportunities and an increased risk of losses, while confirmation bias leads investors to seek information that supports their previous decisions, ignoring conflicting data. Expert opinions and group behaviour significantly influence investment decisions, particularly under conditions of uncertainty, often resulting in herd behaviour and the formation of economic bubbles. The experimental tasks demonstrated that investors frequently make irrational decisions under the influence of emotions and cognitive biases, even when they can access complete information about risks and opportunities. The survey results also indicated that investors with higher levels of financial literacy are less susceptible to the influence of emotions and cognitive biases, highlighting the importance of financial education in improving the quality of investment decisions. These findings illustrate how psychological factors can distort the investment decision-making process and underscore the necessity of considering these factors when developing investment strategies

Keywords: fear; greed; excessive risks; losses; cognitive biases

INTRODUCTION

Investment decision-making is a complex and multifaceted process influenced not only by economic indicators but also by subjective psychological factors. Understanding how emotions, cognitive biases, and social influences shape investment behaviour is crucial for enhancing the effectiveness of investment strategies and avoiding financial losses. Given the increasing uncertainty in financial markets, research into the psychological aspects of investment decision-making is becoming increasingly significant. The research problem lies in the fact that investors often make irrational decisions under the influence of various factors, such as greed, overconfidence, disregard for risks, and expert opinion. These factors can distort the assessment of risks and opportunities, leading to financial losses and ineffective asset management. As traditional economic models often fail to account for these psychological aspects, there is a need for a comprehensive understanding of their impact to improve the quality of investment decisions and develop more effective risk management strategies.

An incomplete understanding of how various psychological mechanisms influence investment decision-making can lead to flawed investment strategies and reduced

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market efficiency. Researches by H.V. Voznyak & L.Ya. Benovska (2021) and O. Shubalyi & P. Kosinskyi (2024) have demonstrated that cognitive biases, such as overconfidence and confirmation bias, coupled with emotional responses and social influences, can significantly impact decision-making and market fluctuations. However, a gap in this research is the insufficient exploration of the integration of these psychological mechanisms in real-world market conditions, a limited number of studies considering diverse cultural contexts, and a lack of practical recommendations for improving investment strategies based on psychological data. Media and information flows significantly influence investment decisions and market trends. Researches by V. Sinkovska (2022) and N. Pysarenko *et al*. (2023) has shown that social media can amplify investors' cognitive biases and create a herd effect, which impacts market trends and can lead to financial anomalies. Their research found that social media intensifies cognitive biases, while information flows can trigger market anomalies through social influence. However, there are gaps in the research, such as an insufficient exploration of the specific mechanisms by which social media influences investment decisions in various types of markets and economic conditions, as well as a lack of detailed studies considering diverse cultural contexts.

The insufficient exploration of the influence of social status and material well-being on investment decisions is a pertinent topic in the field of financial psychology. M. Hanlon *et al*. (2021) and D. Kolinchuk (2023) have found that social status and wealth influence investment decisions. Their research has primarily focused on general motivational aspects, such as social comparisons and consumption preferences. They have shown that investors may be inclined to make riskier decisions to maintain their social status or achieve a certain level of material success. However, there has been a lack of detailed research into how specific social status and material well-being influence decision-making in different economic contexts. Groupthink and social pressure have a significant influence on investment decision-making. The findings of P.H. Huang (2020) and A. Tarasenko (2024) indicate that groupthink can lead to conformity and decreased critical thinking in decision-making, while social pressure can compel investors to follow the group's opinion, even when it contradicts their own beliefs. However, these studies have not thoroughly examined how different forms of social pressure and groupthink interact with specific types of investments, nor under which conditions their impact is most pronounced.

The issue of the insufficient understanding of the impact of cultural differences on investment decisions is a relevant topic in the field of international economic relations. H. Hussain *et al*. (2023) have found that cultural differences can significantly influence investment decisions due to varying communication styles, risk tolerances, and social influences. Cultural contexts shape perceptions of risk and reward, which in turn impact investment strategies and investor behaviour. Some cultures may be more risk-tolerant, while others exhibit more conservative investment strategies, as noted by D. Campbell *et al*. (2024). However, these studies do not delve into how specific cultural aspects shape the formation of long-term investment strategies in a global context. This article focused on investigating the role of human psychology in investment management and its impact on the formation and maintenance of stable economic relationships. The research aimed to analyse the influence of psychological factors such as fear, greed, and overconfidence on investment decision-making; to examine cognitive biases and their impact on economic behaviour; to study social factors and their influence on the formation of investment strategies; to assess the role of emotional factors in the decision-making process; and to determine the impact of financial literacy on mitigating the negative effects of psychological factors.

MATERIALS AND METHODS

The survey was conducted from 1 February to 30 April 2024. Data was collected online using email, social media, professional platforms (such as LinkedIn), and investment and finance-related online groups and forums. A total of 800 respondents participated in the survey, of which 450 (56.25%) were male and 350 (43.75%) were female. The age distribution of respondents was as follows: 120 individuals (15%) were in the 18-24 age group, 250 individuals (31.25%) were aged 25-34, 220 individuals (27.5%) were in the 35-44 age group, 150 individuals (18.75%) were aged 45-54, and 60 individuals (7.5%) were over 55 years old. The survey covered various regions of Ukraine, including Kyiv, Lviv, Kharkiv, Dnipropetrovsk, Odesa, and Poltava regions. All participants had a basic understanding of investing and were either active or potential investors. Participation in the study was voluntary, and all respondents gave their consent for their answers to be used for research purposes. The survey aimed to collect quantitative data reflecting the influence of these factors on investment decision-making. The questionnaires included questions designed to identify psychological factors such as fear, greed, overconfidence, cognitive biases, and social influences (Table 1).

Table 1. Identifying the impact of various factors on investment decision-making

No.	Question	Answer
1	Sex	Male
		Female
2	Age	18-24 years
		25-34 years
		35-44 years
		45-54 years
		Over 55 years
3	Field of activity	Finance and investment
		Business and entrepreneurship
		Education and science
		Public sector
		Other (please specify)

Table 1. Continued

No.	Question	Answer
4	Your income	Up to 10,000 UAH per month
		10,001-20,000 UAH per month
		20,001-30,000 UAH per month
		Over 30,000 UAH per month
5	Your investment experience	Less than 1 year
		1-3 years
		3-5 years
		More than 5 years
6	What types of investments do you use? (multiple options are available)	Shares
		Bonds
		Real estate
		Funds
		Cryptocurrencies
		Other (please specify)
7	Do you use the services of financial advisors?	Yes
		No
8	What level of risk are you willing to accept when investing?	Low (the investor chooses instruments with the least likelihood of capital loss, such as government bonds or bank deposits, ensuring stable income with minimal fluctuations)
		Medium (the investor is willing to accept moderate risk to achieve higher returns by investing in the stocks of large companies or diversified funds that combine capital growth with a certain level of security)
		High (the investor accepts a high level of risk to achieve very high returns, choosing instruments with high volatility, such as cryptocurrencies or shares of small companies, with a readiness for significant losses)
9	Your place of residence (specify the region)	_____
10	What are the main sources of information you use to make investment decisions? (multiple options are possible)	Financial news
		Advice from family and friends
		Consultations with financial experts
		Social networks and online forums
		Own market analysis
11	How do you respond to investment advice from friends and family? (assess the impact of social pressure)	I feel strong pressure and often follow their advice
		I listen to their advice but make my own decisions
		I consider their advice less important and follow my own strategy
		I ignore social influences and stick to my own experience and knowledge
12	How would you rate your level of financial literacy?	Low (you have limited knowledge of financial instruments and rarely engage in financial planning or investing)
		Average (you possess basic knowledge of financial products and occasionally manage personal finances, such as budgeting or saving money)
		High (you have a good understanding of various financial instruments, regularly engage in financial planning and investing, and have the ability to make informed financial decisions independently)
		Very high (you possess deep knowledge and experience in finance, continuously monitor financial markets, complex investment instruments, and utilise sophisticated strategies to optimise your financial outcomes)
13	How often does fear influence your investment decisions?	I regularly experience fear of risky investments and often avoid them because of this fear
		Fear sometimes influences my decisions, but does not always dictate my actions
		Fear has little effect on my decisions, I usually ignore it
14	How do you typically react to an opportunity to make a quick return on investment?	I invest money quickly, even if it involves high risk, to avoid missing out on the chance for substantial returns
		I cautiously analyse the opportunity and only then make a decision, even if it means passing up some opportunities
		I do not pay much attention to the possibility of quick profits and always adhere to my investment strategy
15	What will influence your decision to invest in a new project with high-profit potential?	The promise of significant returns is the primary factor that encourages me to invest, even if the risks are high
		I consider both potential profits and risks, making decisions based on a balanced approach
		I focus on stable and proven investments and rarely consider projects with high-profit potential but also high risks

Table 1. Continued

No.	Question	Answer
16	How do you respond to the lack of specific data on an investment opportunity that promises high returns?	I am willing to invest without detailed analysis, hoping for the promised benefit
		I attempt to gather as much information as possible and do not proceed with an investment without adequate confirmation
		I refrain from investing if there is insufficient data to assess the risks
17	Have there been cases when you sold assets out of panic or bought out of a strong desire not to miss an opportunity?	I often sell assets under the influence of panic due to sharp fluctuations
		I frequently purchase assets out of a strong desire to seize an opportunity, disregarding all risks
		I strive to remain calm and objectively analyse the situation, avoiding panic or excessive enthusiasm
18	Do you experience feelings of regret after making investment decisions?	I often feel regret, which makes me more cautious in subsequent decisions
		Feelings of regret occur infrequently and have minimal impact on my future decisions
		I rarely feel regret, and it does not affect my subsequent decisions
19	Are you prone to overestimating your knowledge and skills in investing?	I often overestimate my knowledge, which has repeatedly led to erroneous decisions
		My confidence sometimes exceeds my actual skills, but this does not happen all the time
		I believe I accurately assess my knowledge and skills, with mistakes occurring rarely
20	How often do you seek information that confirms your previous investment decisions while ignoring contradictory data?	I tend to seek information that supports my decisions and ignore contradictory data
		Occasionally, I pay attention to evidence that confirms my decisions, but I also consider conflicting data
		I strive to take all data into account, rather than focusing solely on confirmation of my decisions
21	Have there been instances when you followed the decisions of the majority of investors (herd effect), even if you personally had doubts?	I often follow the majority, even if I have personal doubts
		Sometimes, I am influenced by the majority, but I usually take my own opinions into account
		I try not to succumb to the herd effect and make decisions based on my own analysis

Source: created by the author

The experiment was conducted from 1 May to 30 June 2024. A total of 200 participants were involved in the study, of which 110 were male (55%) and 90 were female (45%). The age distribution of respondents was as follows: 18 to 25 years – 40 individuals (20%), 26 to 35 years – 60 individuals (30%), 36 to 43 years – 50 individuals (25%), 44 to 53 years – 30 individuals (15%), and 54 years and older – 20 individuals (10%). The experiment covered major regional centres of Ukraine, including Zhytomyr, Kyiv, Vinnytsia, Kharkiv, Ternopil, Chernihiv, and Cherkasy. All participants had experience in investing and provided voluntary consent to participate in the study. The conducted experiment contributed to a deeper understanding of the influence of emotional and cognitive factors on investment decisions, allowing for the identification of specific reactions and biases that shape the economic behaviour of investors. Before the commencement of the experiment, participants were asked to complete a brief questionnaire to ascertain general information (Table 2).

All study participants were fully informed about the purpose and methods of the research and provided written consent to participate, with full confidentiality of the respondents' personal data being ensured. The online tasks, which were presented through a specially designed platform, included various scenarios for investment decisions and emotional stimuli (Table 3).

Table 2. General information about the participants of the experiment

No.	Question	Answer
1	Sex	Male
		Female
2	Age	18-25 years
		26-35 years
		36-43 years
		44-53 years
		54 years and older
3	Your place of residence (specify the city)	_____
4	Your investment experience	Less than 1 year
		1-3 years
		4-7 years
		More than 7 years
5	What is your level of experience in investing?	Beginner (you are just starting to familiarise yourself with the basics of investing and have limited experience in this field)
		Intermediate (you already have some experience in investing and are familiar with the basic strategies and instruments)

Table 2. Continued

No.	Question	Answer
5	What is your level of experience in investing?	Advanced (you actively invest and apply various strategies, understanding complex financial instruments)
		Expert (you have extensive experience in investing, regularly analyse the market, and utilise professional strategies and tools)

Source: created by the author

Table 3. Investment decision scenarios

No.	Description of the online task
1	**Market fluctuation scenario.** Respondents participate in a virtual financial market simulation where they are tasked with making investment decisions under conditions of sudden and significant price fluctuations. They begin with a specific sum of virtual money and have the opportunity to invest in various assets, receiving information on current prices and forecasts. Throughout the simulation, sudden price changes occur, mimicking real-world market conditions. Participants must make buy or sell decisions under conditions of uncertainty. Emotional stimuli include fear of loss when asset values drop sharply and the temptation of profit during price increases, which can encourage risky strategies. The experiment aims to identify the impact of these emotions on respondents' decisiveness and the changes in their investment strategies in response to stressful situations and the desire to maximise profits.
2	**Financial crisis scenario.** In this task, respondents encounter a simulated economic crisis that impacts all financial assets within a virtual market. Throughout the simulation, they are provided with information about sharp declines in market prices, mimicking real-world economic crises. Respondents must adapt their investment strategies by making decisions about buying or selling assets under conditions of significant devaluation. Emotional stimuli include anxiety caused by market uncertainty and instability, as well as panic that may arise from rapid price declines. The goal of this task is to investigate how crisis situations affect respondents' decisiveness, their investment decisions, and the manifestation of fear and anxiety when making decisions under economic downturn conditions.
3	**High-returns scenario.** Participants are presented with a scenario in which they are invited to invest in projects promising high potential returns but also accompanied by high risks. A virtual environment is simulated where participants have the opportunity to choose from several investment options, each with a different level of risk and potential return. According to this scenario, participants must decide which high-return projects they are willing to support, despite the significant level of risk. Emotional stimuli in this task include greed, which can arise from the prospect of significant financial gains, as well as emotional excitement from the possibility of making a large profit. The goal of this scenario is to assess how the possibility of significant returns influences participants' investment decisions and whether it leads to excessive risk-taking. The experiment aims to uncover the extent to which the potential for high income can affect investors' willingness to take risks and whether this promotes irrational decision-making.
4	**Confirmation bias scenario.** Participants receive initial information about investments that confirms their pre-existing beliefs and strategies. Initially, they are provided with information that reinforces their prior opinions about the effectiveness of certain investments, creating a positive confirmation bias context. Subsequently, participants receive contradictory data or news that directly contrasts with the initial information. Respondents are tasked with evaluating this new conflicting information and deciding whether to change their investment strategy in line with the new data or continue to adhere to their previous decision. Emotional stimuli in this scenario include confirmation of personal beliefs, which arises from the initial positive data, as well as the tendency to ignore contradictory data, which may be a result of confirmation bias. The goal of this task is to investigate how confirmation bias affects respondents' willingness to change their investment decisions, despite the presence of new contradictory information. The experiment seeks to ascertain the extent to which strong confirmation bias can hinder the adaptation of strategies and the making of more informed decisions.
5	**Group influence scenario.** In this experiment, respondents first make investment decisions based on personal analysis. They are then provided with the results of a vote or recommendations from an imaginary group of investors, which may either confirm or contradict their decisions. Respondents are tasked with deciding whether to change their decisions based on the group's recommendations or to stick with their initial choices. Emotional stimuli include social pressure and groupthink, which can influence their willingness to follow group advice. The goal of this task is to investigate how social pressure and group influence change respondents' investment decisions and whether they are inclined to change their decisions based on group recommendations.
6	**Information overload scenario.** Respondents are presented with a vast amount of information about various investment opportunities, provided in the form of detailed descriptions, statistical data, and forecasts. After reviewing all materials, they must select the best investment option for further investment. The task involves deciding between numerous options and attempting to organise and analyse information that may be excessively large. Emotional stimuli include information overload and stress due to the need to make a quick decision under conditions of a large amount of data. The aim is to assess how excessive information influences the decision-making process and to determine whether it causes errors or biases in the choice of investment opportunities.

Source: created by the author

To process and analyse the data obtained from the respondents in detail, Statistical Package for the Social Sciences (SPSS) Statistics Version 28.0 was used. This allowed for a comprehensive analysis of the impact of psychological factors on investment decisions, revealing statistically significant patterns and obtaining well-founded conclusions, which significantly increased the scientific accuracy and reliability of the research results. Regression and correlation analyses identified key factors and relationships between them that influence investment decision-making.

RESULTS

Psychological factors play a pivotal role in investment decision-making, influencing risk and reward perception, emotional responses to market fluctuations, and overall investor confidence. In the context of investing, they encompass aspects such as emotional reactions (fear, greed), cognitive biases (confirmation bias, overconfidence), and social influences (groupthink, social pressure). These factors can distort objective analysis of risks and opportunities, leading to erratic or irrational market decisions (Duxbury *et al.*, 2020). Investing is the commitment of financial resources to various assets or projects to generate a profit or achieve another economic benefit in the future. This may involve purchasing shares, bonds, real estate, or investing in businesses or start-ups. Investing typically involves assessing risks and potential returns, as well as strategic planning to achieve financial goals (Yang & Wang, 2023). Economic relationships represent the interactions between investors, companies, markets, and government bodies, determining the processes of capital allocation, investment decision-making, and asset management. This encompasses relationships arising from the investment of money in financial instruments, enterprises, or projects, and also influences investment returns, risks, and economic efficiency (Van Dijk & De Dreu, 2021). Financial markets are platforms or systems where the buying and selling of financial instruments, such as stocks, bonds, currency pairs, and other securities, takes place. They provide a mechanism for valuing assets, managing risks, and allocating capital, allowing investors to effectively manage their investments and achieve their financial goals (Aman *et al.*, 2022; Ruda & Kraus, 2024). Economic bubbles are situations where the prices of financial assets significantly exceed their true or justified value due to speculative demand and excessive expectations. This can lead to an artificial increase in asset prices, which may ultimately end in a sharp price decline when the market realises its true value (Ngoc & Tien, 2021). These concepts are important in the context of this research, as psychological factors influence investment decisions, shaping economic relationships and behaviour in financial markets, which can lead to market bubbles and other asset price anomalies.

According to the analysis of survey results, the largest proportion of respondents work in the finance and investment sector, accounting for 30% of the total sample. Business and entrepreneurship representatives follow, making up 23.75%. Education and science represent 16.25%, and the public sector accounts for 13.75%. Other sectors of activity made up 16.25%. Regarding income, the largest group of respondents earn up to 10,000 UAH per month (35%), while 31.25% have an income in the range of 10,001-20,000 UAH. 21.25% of respondents earn from 20,001 to 30,000 UAH, and 12.5% have an income of over 30,000 UAH per month. Survey results indicate that, among the 800 respondents, 27% (216 individuals) have less than a year of investment experience, 34% (272 individuals) have between 1 and 3 years, 23% (184 individuals) have between 3 and 5 years, and 16% (128 individuals) have over 5 years. Regarding investment types, 68% of respondents (544 individuals) invest in shares, 49% (392 individuals) in bonds, 43% (344 individuals) in real estate, 38% (304 individuals) in funds, 29% (232 individuals) in cryptocurrencies, and 13% (104 individuals) use other investment instruments. 57% of respondents (456 individuals) use the services of financial advisors, while 43% (344 individuals) do not. The distribution of respondents by the level of risk they are willing to take when investing is expressed by the data indicating the number of responses from participants (Fig. 1).

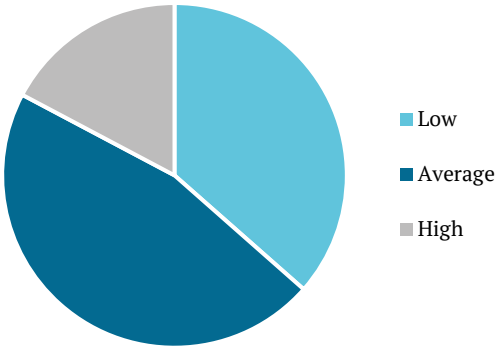

Figure 1. The level of risk
Source: created by the author

The low-risk cluster includes respondents who focus on minimising risk and opt for conservative investment instruments. This group comprises 36.5% of respondents who prioritise stability and reliability in their investments, choosing government bonds, bank deposits, and other less risky instruments. The medium-risk cluster includes 46.25% of respondents who are willing to take on moderate risk for higher returns. These investors prefer shares of large companies, diversified funds, and other investment instruments that provide a balance between risk and return. The high-risk cluster includes 17.25% of respondents who are inclined towards high risks for potentially large profits. These investors choose highly volatile instruments, such as cryptocurrencies and shares of small companies, and are prepared for significant financial losses in case of failure. The majority of respondents prefer a medium level of risk, which may indicate a desire for a balanced approach to investing. A significant proportion of respondents are willing to accept low risks, while a smaller group opts for high risk for the possibility of significant returns.

Survey results indicated that the largest representation was from the Kyiv Region, accounting for 27.625%, followed by the Kharkiv Region at 18.625%, the Lviv Region at 17.875%, the Odesa Region at 16.375%, the Poltava Region at 11.375%, and Dnipropetrovsk Region at 8.125%. Regarding sources of information for making investment decisions, the largest proportion of respondents (68.875%) indicated financial news as their primary source. A personal analysis of the market is used by 60.125% of respondents, making it the second most important source. Advice from family and friends is used by 42.625%, consultations with financial experts by 37.375%, and social media and online forums by 35.125%. Out of 800 respondents, 285 (35.6%) experience significant pressure from friends and family regarding investments and often follow their advice, while 340 (42.5%) listen to these suggestions but make decisions independently. 135 respondents (16.9%) consider this advice less important and follow their own strategy, and 40 individuals (5%) ignore social influences and rely on their

own experience. Regarding financial literacy levels, 104 respondents (13%) rated their knowledge as low, 236 (29.5%) as average, 320 (40%) as high, and 140 individuals (17.5%) as very high, indicating a predominance of high levels of financial literacy among survey participants.

The results revealed the following trends in the influence of fear on investment decisions: 27.3% of participants regularly experience fear of risky investments and often avoid them. The majority, specifically 45.8%, indicated that fear sometimes influences their decisions but does not always dictate their actions. Meanwhile, 26.9% of respondents believe that fear has a minimal impact on their decisions and they usually ignore it. Reactions to the possibility of quick profits show that 23.1% of respondents quickly invest money, even if it is accompanied by high risk, in order not to miss out on a chance for a large profit. At the same time, 52.4% of respondents carefully analyse the opportunity before making a decision, even if it means missing out on some opportunities. 24.5% of respondents do not pay much attention to the possibility of quick profits and always follow their investment strategy.

Trends in attitudes towards investing in new projects with high profit potential indicate that: 32.8% of respondents believe that the promise of a large profit is the main factor that motivates them to invest, even if the risks are high. 46.4% of respondents approach investments with a more balanced strategy, considering both potential profit and risks. Another 20.8% of respondents focus on stable and proven investments, rarely considering high-risk projects. When it comes to the absence of specific data on the possibility of investments with promised high returns, 28.6% of respondents are willing to invest without detailed analysis, hoping for the promised benefit. At the same time, 47.3% of respondents try to gather as much information as possible and do not make an investment without sufficient confirmation. Another 24.1% of respondents refuse to invest if there is not enough data to assess the risks.

About selling assets in a panic or purchasing through a strong desire to seize an opportunity, 29.2% of respondents often sell assets under the influence of panic due to sharp fluctuations. 27.8% of respondents often buy assets due to a strong desire to take advantage of an opportunity, without considering all the risks. However, 43% of respondents try to remain calm and objectively analyse the situation, avoiding panic or excessive enthusiasm. Regarding feelings of regret after making investment decisions, 34.4% of respondents often feel regret and this makes them more cautious in future decisions. 48.9% feel regret infrequently, and it has a minor impact on their subsequent decisions. The remaining 16.7% of respondents rarely feel regret, and it does not affect their subsequent decisions. When assessing the tendency to overestimate their knowledge and skills in investing, 27.3% of respondents often overestimate their knowledge, which repeatedly leads to wrong decisions. 45.1% admit that their confidence sometimes exceeds their actual skills, but this does not always happen. 27.6% of respondents believe that they adequately assess their knowledge and skills, and mistakes rarely occur.

Among respondents, 31.4% tend to seek information that confirms their previous investment decisions and ignore contradictory data. 45.9% sometimes look for confirmation of their decisions but also consider contradictory data, while 22.7% try to consider all data, not relying solely on confirmation of their decisions. Regarding following the decisions of the majority of investors (herd effect), 28.6% of respondents often follow the crowd, even if they have personal doubts. 46.3% are sometimes influenced by the majority but usually consider their own opinions. 25.1% try not to succumb to herd effect and make decisions based on their own analysis. The survey helped to reveal that respondents' investment decisions are often influenced by psychological factors such as fear, the desire for quick profits, and social pressure. The vast majority of participants tend to seek confirmation of their decisions and conform to the opinion of the majority, which underscores the need for a conscious approach to investing.

A survey of 200 respondents revealed the following geographical distribution: Kyiv had the highest representation with 37%, followed by Kharkiv (23%) and Vinnytsia (17%). Respondents from Chernihiv (11%), Zhytomyr (9%), Cherkasy (5%), and Ternopil (3%) were less numerous. Regarding the duration of investment, the majority of respondents have been investing for 1 to 3 years (37%), while 27% have experience from 4 to 7 years. However, 19% of respondents have been investing for less than 1 year, and 17% for more than 7 years. According to their level of investment experience, 41% of respondents have an intermediate level of experience, 27% are advanced, 23% are beginners, and 9% are experts in this field.

In a virtual experiment simulating market fluctuations, involving 200 respondents, several key trends in investor behaviour during stressful situations were recorded. 47% of respondents made decisions to buy assets during market rallies, tempted by the possibility of quick profits. At the same time, 33% of respondents more frequently sold assets during market downturns, primarily due to fear of losses. Another 20% of respondents exercised caution, trying to avoid significant changes in their investments even in volatile conditions. Notably, 54% of respondents, faced with a sharp decline in prices, tried to minimise losses, indicating a high level of fear of potential financial losses. However, 46% of respondents continued to actively seek out profitable opportunities during market rallies, demonstrating a significant temptation for quick gains. The analysis by sex revealed that males were more likely to take risks and purchase assets during periods of price increases (51% compared to 43% among females). Females tended to be more cautious during asset price declines (37% compared to 29% among males). Age also influenced investment strategies: younger respondents (18-25 years) were more inclined to follow market trends and take greater risks (62%), whereas older respondents (54 years and older) were more cautious and reduced activity during periods of uncertainty (38%). These results illustrate how different emotional and age-related factors affect respondents' investment decisions during a simulated financial market with unpredictable fluctuations.

In a simulated economic crisis where 200 respondents had to adapt their investment strategies in the face of a sharp decline in asset prices, several key behavioural patterns emerged. A total of 97 participants (48%) decided to sell some or all of their assets due to fear and anxiety triggered by the crisis conditions. Meanwhile, 65 respondents (32%) adapted their investment strategies, seeking to

capitalise on opportunities to purchase assets at reduced prices, while 38 individuals (20%) chose to hold onto their assets, hoping for a market recovery. Among males, 55 individuals (50%) actively sold assets due to panic, 38 males (35%) adapted their strategies, and 17 (15%) chose to hold onto their assets. Among females, 42 respondents (47%) sold assets under the influence of anxiety, 27 (30%) changed their strategies in the face of the crisis, and 21 (23%) opted for a holding strategy. The age distribution showed that among younger respondents (18-25 years), 48% engaged in panic selling of assets, 57% of those aged 26-35 adapted their strategies, and 48% of those aged 36-43 chose to retain their assets. In the 43-53 age group, 50% of respondents sold assets out of fear of the crisis, while 45% of those aged 54 and older held onto their assets, hoping for recovery. These results demonstrate the diverse strategies and behavioural responses of respondents to a financial crisis, highlighting both fear and opportunities for adaptation to market fluctuations.

In an online task focused on high returns, the results indicated that 54.5% of males and 50% of females choose high-risk investments, highlighting the influence of potentially high profits on their decisions. An analysis of age categories revealed that respondents aged 26-35 years, comprising 17.5% of the total sample, and those aged 36-43 years (14% of the total) exhibited the greatest interest in risky investments. Regarding emotional influence, greed was the most significant factor affecting decision-making, with its effect observed in 35% of respondents. Another 27.5% of respondents noted the temptation of large profits, 25% displayed increased risk-taking, and 12.5% maintained a neutral approach. These results suggest that the possibility of significant returns significantly influences respondents' willingness to take risks, emphasising the role of emotions in shaping investment strategies.

In the "Confirmation bias scenario" experiment, some interesting data was obtained. Among males, 71% (78 individuals) continued to adhere to their initial investment strategies, despite contradictory information. Among females, this figure was 59% (53 individuals). Age distribution showed that the highest confirmation bias was exhibited by respondents aged 26-35 years, where 39% (23 individuals) maintained their strategies without changing them, even in the presence of new data. 25% (10 individuals) of respondents aged 18-25 years and 20% (6 individuals) aged 43-53 years also ignored contradictory information. Only 31% (62 individuals) of respondents were willing to adapt their strategies according to new data, demonstrating a readiness for change. These results confirm a significant influence of confirmation bias on investment decision-making, hindering the adaptation of strategies even in the face of new contradictory information. In the "Group influence scenario" experiment, the results demonstrated how respondents' opinions shifted under the influence of the crowd (Fig. 2). The data reflects the number of individuals who made decisions.

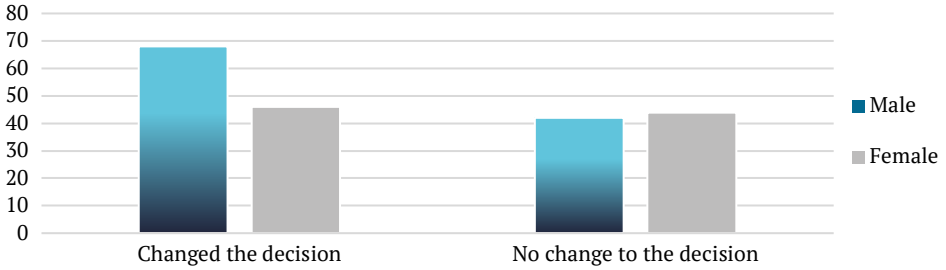

Figure 2. Susceptibility to social pressure

Source: created by the author

An analysis of age categories revealed that respondents aged 26-35 years were most susceptible to group influence, with 58% (35 individuals) altering their decisions based on group recommendations. Meanwhile, 20% (8 individuals) aged 18-25 years and 15% (3 individuals) aged 54 and over were also inclined to follow group recommendations. These results indicate a significant impact of social pressure and groupthink on investment decision-making, with a majority of respondents tending to change their initial decisions based on group recommendations. The "Information overload scenario" revealed that 65 out of 110 males (59%) experienced significant information overload and made errors in data analysis, while 45 males (41%) successfully coped with the information load. Among females, 35 out of 90 respondents (39%) made errors due to information overload, whereas 55 females (61%) did not. Age distribution of respondents showed that among those aged 18-25, 20 out of 40 participants (50%) felt overwhelmed, while 20 (50%) completed the task without errors. In the 26-35 age group, 30 out of 60 respondents (50%) made mistakes, while 30 (50%) successfully coped. Among respondents aged 36-43, 15 out of 50 (30%) felt overwhelmed, and 35 (70%) made no errors. In the 43-53 age category, 10 out of 30 individuals (33%) made mistakes, while 20 (67%) were successful. Among respondents aged 54 and over, 5 out of 20 (25%) experienced information overload, and 15 (75%) coped without errors.

The experiment results suggest that information overload has a greater impact on males and younger age groups, while females and older respondents cope better with large amounts of data. Experiments have shown that respondents with different levels of experience and age groups have varying degrees of influence from emotional and social factors on their investment decisions: younger people and males are more susceptible to risky situations and social pressure, while older individuals and females tend to adopt a more cautious approach, being less susceptible to information overload. Based on the results of the surveys and experiments, key factors influencing investment decisions were identified (Table 4).

Table 4. Influencing factors

High impact	Moderate impact	Low impact
Panic and fear of loss	Herd effect	Sex
Greed	Overestimation of your knowledge and skills	
Confirmation bias	Age	
Information overload		

Source: created by the author

Panic and fear of loss can lead to impulsive and irrational decisions due to intense emotions of fear. Respondents experiencing panic are prone to quickly exiting investments, even if this may harm their long-term portfolio (Bayar *et al.*, 2020). Greed drives investors to seek maximum profit, which can lead to excessive risk-taking. This can influence decisions to invest in projects with high potential returns but also high risk (Alkaraan *et al.*, 2023). Confirmation bias compels investors to seek information that confirms their prior beliefs and ignore contradictory data. This can delay or complicate adaptation to new market conditions (Alkhawaja & Albaity, 2020). A large amount of information can be difficult to process, leading to difficulties in decision-making. This can lead to errors in evaluating investment opportunities due to an excessive amount of data (Yee *et al.*, 2021). The influence of social pressure and general trends can compel investors to follow the crowd, even if it contradicts their own analyses. This can lead to fluctuations in decisions. Investors who overestimate their abilities may make riskier decisions due to overconfidence. This can affect the accuracy of their investment strategies (Bordalo *et al.*, 2022). Although sex may influence investment decisions, this influence is smaller compared to other factors. Differences in investment decisions between males and females are not significant (Khanchel *et al.*, 2024). Age also has a smaller impact on investment decision-making, although it may influence investment strategies and risk profiles. Older investors may have a different approach to investing compared to younger ones (Fatma *et al.*, 2021).

Factor analysis revealed three primary categories influencing investment decision-making. Psychological factors exerted the highest influence: panic and fear of loss (0.78), greed (0.74), confirmation bias (0.71), and overestimation of one's knowledge and skills (0.68). Information pressure, encompassing information overload (0.82) and herd effect (0.77) impacted decision-making through disorientation and social influence. Demographic characteristics had a smaller impact: age (0.69) and sex (0.62). This confirms that psychological and informational factors are the primary determinants of investment decisions, while demographic characteristics play a less significant role. Correlation analysis helped to identify important relationships between the factors influencing investment decisions (Table 5).

Emotional reactions and cognitive biases have the most significant impact on investors' behaviour, while social influences and age-related factors play a lesser role. Regression analysis helped identify key factors determining the choice of investment strategies (Table 6).

Table 5. Interrelation of factors

Pair of factors	Correlation, *r*
Panic and fear of loss – Greed	0.68
Confirmation bias – Information overload	0.57
Herd effect – Greed	0.46
Overestimation of knowledge and skills – Confirmation bias	0.52
Information overload – Confirmation bias	0.34
Age – Overestimation of knowledge	0.29

Source: created by the author

Table 6. Influence of various factors

Factor	Type of influence	Beta coefficient	Level of significance
Panic and fear of loss	Positive	0.45	$p < 0.01$
Greed	Positive	0.38	$p < 0.01$
Confirmation bias	Positive	0.32	$p < 0.05$
Information overload	Positive	–0.29	$p < 0.05$
Herd effect	Positive	0.27	$p < 0.05$
Overestimation of your knowledge and skills	Positive	0.22	$p < 0.1$
Age	Neutral	0.15	$p > 0.1$
Sex	Neutral	0.10	$p > 0.1$

Source: created by the author

Panic and fear of loss, as well as greed, stimulate a willingness to take investment risks. Confirmation bias inclines individuals to stick to their initial beliefs, regardless of new data. In contrast, excessive information complicates decision-making, reducing investment readiness. Herd effect increases the tendency to follow group recommendations, and overestimating one's own knowledge has a moderately positive effect. Age and sex do not have a significant impact on investment readiness.

DISCUSSION

The research findings confirm the significance of psychological factors in the investment decision-making process. Data analysis reveals that fear of loss, greed, confirmation bias, and social pressure can significantly alter investment strategies, reducing their effectiveness and increasing risks. These results underscore the need to consider psychological aspects when developing investment strategies and educating investors to enhance their resilience to the influence of emotions and biases. Many investors regularly experience a fear of risky investments and often avoid them. This finding aligns with the research of V. Baid & V. Jayaraman (2022), which also revealed that fear of potential losses significantly influences investors' decisions to avoid risky ventures. Both studies demonstrate that fear substantially hinders the willingness to take investment risks, confirming that this psychological factor is a powerful barrier. This underscores that regular fear can be a significant aspect in shaping investment decisions.

Overestimating one's knowledge and skills in investing often leads to erroneous decisions (Herus, 2024). This result aligns with the research of A. Hu & S. Ma (2021), found that investors who overestimate their knowledge and skills are prone to making poor investment decisions. Both studies underscore that overconfidence often does not correspond to investors' actual abilities, leading to an increased number of mistakes. This study also shows that a significant portion of respondents acknowledge their tendency to overestimate their knowledge, but this does not always occur, whereas the study by A. Hu & S. Ma (2021) focuses on the general trend of overconfidence. This reflects a difference in approaches to measuring overconfidence and its impact on decision-making. Most respondents approach investments with a balanced strategy, considering both potential returns and risks. This finding differs from the research of K. Sood *et al*. (2023), which revealed that a majority of investors tend to make decisions driven by promises of high returns, often underestimating the associated risks. In this study, 46.4% of respondents demonstrate a balanced approach, while K. Sood *et al*. (2023) suggest that only around 30% of investors consider risks as carefully as potential gains. The difference may be attributed to this study's inclusion of a more knowledgeable sample of respondents who have experience in investing and access to relevant resources for making informed decisions.

During economic crises, most investors chose to sell some or all of their assets due to fear and anxiety caused by the crisis conditions (Dunayev *et al*., 2024). This finding does not align with the research of N.M. Zayed *et al*. (2022), whose results indicate that most investors typically hold onto their assets during crises, hoping for market recovery. They found that only a minority of investors sell assets out of fear, while the majority attempt to adapt their strategies or take advantage of opportunities for long-term investments. The results of this study suggest that fear and anxiety have a significant impact on decision-making, leading to panic selling of assets. This could be attributed to a lack of preparation and the inability to conduct in-depth analysis under crisis stress, which differs from the long-term adaptation strategies described in the study by the researchers. A significant proportion of respondents, both male and female, tend to opt for high-risk investments if they are associated with potentially substantial returns. This is especially true for young and middle-aged individuals who exhibit a heightened interest in such risky investments. The data aligns with the research of C. Slimani & M. Alaoui (2022), which identified a similar trend where investors, influenced by the prospect of high returns, frequently choose risky assets. As in this study, the researchers note that younger and middle-aged investors are particularly sensitive to promises of significant financial gain, and this influences their investment decisions. This is consistent with the theory of economic bubbles, where high return expectations can lead to excessive risk-taking (Saifnazarov, 2024). Therefore, the results of this study corroborate the observations of C. Slimani & M. Alaoui (2022), demonstrating that the possibility of large returns has a strong influence on risk-taking propensity across different age groups.

Investors aged 26-35 are most susceptible to social pressure and groupthink. They are more likely to change their decisions based on group recommendations than other age groups. This finding aligns with the research of R. Rosdiana (2020), which demonstrated that younger age groups are more prone to social influence compared to older ones. R. Rosdiana (2020) suggests that younger individuals are often in a stage of actively forming social connections, making them more sensitive to collective opinion. This study corroborates these results, emphasising that younger respondents are indeed more influenced by social pressure, which may be attributed to their social environment and the search for validation of their decisions through group consensus. Information overload has a greater impact on males and younger age groups, while females and older respondents cope better with large amounts of data. The results align with the research of J. Humphrey *et al*. (2021), which found that males and younger individuals more frequently experience difficulties under conditions of information overload, leading to errors in data analysis. They note that younger individuals may have less experience in managing information and are more prone to stress when processing large amounts of data. This is also supported by observations that males often exhibit a greater emotional reaction to information overload. This study confirms these findings, showing that males and younger respondents more often encounter information overload and make more mistakes in such conditions. This can be explained by a lack of sufficient experience in managing large amounts of data and the stress that accompanies information overload.

Psychological and informational factors have a primary influence on investment decision-making, while demographic characteristics have a lesser impact. This finding contradicts the research of L. Dang & J. Zhao (2020), which identified a greater influence of demographic characteristics, such as age and sex, on investment decision-making. Researchers emphasise that demographic variables significantly influence investment strategies, indicating the importance of age and sex differences in shaping investment preferences. However, this study has shown that psychological stimuli, such as fear, greed, information pressure, and herd effect, have a significant impact on decision-making. This may be due to the fact that modern investment conditions are rapidly changing, and psychological and informational factors are gaining more weight in determining investment strategies than traditional demographic

variables (Kalna-Dubinyuk *et al*., 2023). Panic and fear of loss have a strong positive correlation with greed (Nuzhna *et al*., 2023). Similar results were obtained in the research of R. Jain *et al*. (2022), where it was found that emotional states, particularly fear and greed, are closely linked and can influence investment decisions. Both studies suggest that past investment losses can stimulate the adoption of riskier strategies in an attempt to recoup losses or achieve greater gains. Discussions confirmed that the factors influencing investment decision-making are complex and multifaceted, varying depending on individual and social circumstances. Various studies have shown that the impact of emotional states, social pressure, and information overload on investment decisions can vary significantly. Emotional reactions, such as panic and fear of loss, as well as social pressure, can have a substantial impact on the choice of investment strategies.

CONCLUSIONS

A comprehensive analysis was conducted to understand the impact of psychological factors on the formation of economic relations. This involved examining the role of emotional states, cognitive biases, social factors, and financial literacy in shaping economic relationships and investment decision-making. The study found that panic and fear of loss have a significant positive correlation with greed ($r = 0.68$), confirming their influence on investment decisions. It was confirmed that overconfidence, manifested in overestimating one's own knowledge and abilities, correlates with confirmation bias ($r = 0.52$). This suggests that individuals who overestimate their skills are more likely to trust their beliefs, which can influence the decision-making process. The study found that confirmation bias correlates with information overload ($r = 0.34$), meaning that ignoring contradictory information often accompanies information overload. This highlights the importance of being aware of cognitive biases in the investment decision-making process. The results of the analysis of social factors confirm that the herd effect has a moderate correlation with greed ($r = 0.46$), indicating a strengthening of the desire for high returns under the influence of social pressure. This information indicates a significant influence of social pressure and groupthink.

The evaluation of emotional factors revealed that psychological stimuli such as panic and fear of loss (0.78), greed (0.74), and confirmation bias (0.71) have the most significant impact on decision-making. This confirms the importance of considering these emotional factors when developing strategies to maintain stable economic relations. Demographic factors, such as age (0.69) and gender (0.62), were found to be less significant compared to psychological and informational factors. It was also established that increasing financial literacy can reduce the negative impact of psychological factors on investment decision-making, as educated investors have a better understanding of risks and opportunities, helping them make more informed decisions. The results of the study confirm that psychological and informational factors are the primary determinants of investment decisions, while demographic characteristics have a less significant influence. Discussion confirmed that emotional factors, particularly fear and greed, have a significant impact on investment decisions, and cognitive biases and social influences shape asset management strategies, highlighting the need to consider psychological aspects in developing investment strategies and making decisions to ensure the stability and efficiency of investment processes. Limitations of the study include unpredictable economic and political events, which can affect market conditions and investor behaviour, as well as limitations in access to complete information about market trends and individual investment strategies, which may impact the accuracy and completeness of the results obtained. Further research in this area could focus on exploring the impact of new psychological factors and changes in the socio-economic environment on investment decision-making, and on developing new methods to minimise their negative effects.

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CONFLICT OF INTEREST

None.

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Вплив психологічних чинників на прийняття інвестиційних рішень: психологічні особливості формування економічних відносин

Анотація. Метою статті було проаналізувати вплив психологічних факторів на процес прийняття інвестиційних рішень, що визначають економічну поведінку інвесторів в Україні. Під час дослідження було проведено анкетування та експериментальні завдання серед інвесторів, а отримані дані були проаналізовані за допомогою статистичних методів для виявлення впливу психологічних чинників на інвестиційні рішення. Виявлено, що страх та жадібність є найбільш вагомими емоціями, які суттєво впливають на прийняття інвестиційних рішень, де страх призводить до надмірної обережності та уникання ризику, а жадібність навпаки стимулює інвесторів до прийняття надмірних ризиків. Надмірна впевненість у власних знаннях і навичках призводить до переоцінки можливостей та підвищення ризику втрат, тоді як підтверджувальне упередження змушує інвесторів шукати інформацію, яка підтверджує їхні попередні рішення, ігноруючи суперечливі дані. Думка експертів та поведінка групи значно впливають на інвестиційні рішення, особливо в умовах невизначеності, що часто призводить до ефекту натовпу та формування ринкових бульбашок. Експериментальні завдання показали, що інвестори часто приймають ірраціональні рішення під впливом емоцій та когнітивних упереджень, навіть якщо вони мають доступ до повної інформації про ризики та можливості. Результати анкетування також показали, що інвестори з більш високим рівнем фінансової грамотності менш схильні до впливу емоцій та когнітивних упереджень, що підкреслює важливість освіти в галузі фінансів для покращення якості інвестиційних рішень. Ці результати демонструють, як психологічні чинники можуть викривляти процес прийняття інвестиційних рішень та підкреслюють необхідність врахування цих чинників під час розробки інвестиційних стратегій

Ключові слова: страх; жадібність; надмірні ризики; втрати; когнітивні упередження

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Analysis of the impact of the volumes of state commissioning on the economy's availability of specialists in certain professions

Abstract. In Ukraine, there are imbalances between the specialities of graduates of higher education institutions and the needs of the market, so the issue of studying the possibilities of state influence on increasing the popularity of strategically necessary professions for the development of the country through the state-commissioned education is relevant. The purpose of the study was to determine how changes in the volume of state orders affect the choice of professions and competitive scores, and to develop recommendations for optimising the national policy in the field of financing specialities important for the country's economic development. Clustering of specialities by the number of applicants enrolled for training was carried out, trends in changes in clusters in dynamics for 2018-2023 were considered, forecast models for changes in the number of applicants for each of the clusters were constructed, and correlation dependencies were determined on the impact of changes in the volume of state orders on attracting capable applicants to the speciality. The results of clustering, the visualisation of which is carried out using graphical methods, to a certain extent determine the popularity of the relevant professions and specialisations among applicants, including the level of sensitivity of the choice of applicants to the influence of external factors. It was determined that fluctuations in the number of applicants in small specialities occur within 1% despite significant changes in the share of state-funded places financed by budgetary funds, but in the cluster of specialities with a large number of applicants, such fluctuations are within 10%. The practical significance of the study lies in the possibility of using the constructed models for each speciality to determine their sensitivity to the impact of changes in the amount of funding for state-commissioned education, which would optimise the distribution of financial resources for training specialists for sectors of the economy

Keywords: budget financing; training of specialists; clustering of specialities; imbalances; attractiveness; financial support

INTRODUCTION

The quality of specialist training and higher education has a significant impact on the quality of the country's human capital. In the context of the post-war recovery of the country's economy, human capital will be of paramount importance for the pace of recovery and development of the country's economy. In conditions of limited funding,

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inefficient use of available financial resources from various sources for training specialists with higher education is unacceptable. The issue of the effectiveness of using funds in the current system of financing the training of specialists with higher education in Ukraine remains open. Improvement of the solution requires a number of issues, including the system of financing higher education institutions (HEIs) and training of specialists with higher education, which are necessary for the restoration and development of the country's economy; the system of developing a state order for training specialists of relevant profession from the moment of determining the need for specialists of certain specialities to ensure their quality training; the development and implementation of a system of motivations for attracting more capable education applicants, and then work in areas that are most important for the restoration of Ukraine; the discrepancy between the structure of specialists and the existing and promising strategic needs of the market in Ukraine.

The place of human capital cannot be underestimated, and O. Kuzmin *et al*. (2020) examined its role in the development of the country's economy. Hostilities in Ukraine have a negative impact on all components of socio-economic life, including the development of human capital. The quality of human capital is determined by several components. G. Nazarova & V. Rudenko (2022) identified three main components: "demographic component", "development of the education system", and "development of the healthcare system". With the outbreak of hostilities, more than 6 million people left the territory of Ukraine, more than 60% of them have higher education (Survey: Attitudes of Ukrainian refugees, 2023). More than two years later, 2.4 million people remain outside the country. According to experts' forecast estimates, most of them do not plan to return back to Ukraine. Such a part of the working-age population and their children become irretrievable losses for the country's human capital both at the current time and in the future. Teenagers who have incurred the cost of forming the basic foundations of the "education" and "health" components by the state, and who enter the labour market after a certain time, will be involved in creating the national income of another country, and not Ukraine.

T. Vasyltsiv *et al*. (2022) focused on the impact of migration processes, internal movement of citizens, businesses, as a result of active military operations on the territory of Ukraine, on the aggravation of imbalances and imbalances in the labour market on the example of the western region of Ukraine. They considered the issues of business relocation and the problem of equivalent mixing of employees. Special emphasis is placed on imbalances in the context of industries and areas of state policy to level significant gaps. The researchers also propose ways to stabilise the labour market in the post-war period. The study by A. Vorontsova *et al*. (2021) stressed the importance of an integrated approach to the study and resolution of labour market imbalances, including the interaction between market mechanisms and government regulation, and the adaptation of educational processes to market needs. The researchers focused on identifying the causes that lead to these imbalances, in particular in certain professional groups and sectors of the economy. They investigated how the uneven development of different sectors of the economy creates imbalances in the labour market and focused on the need for more active government intervention through educational programmes, employment policies, and other mechanisms.

V. Chekina & O. Vorhach (2020) conducted an empirical analysis of the relationship between education costs and labour market indicators. They considered generalised indicators of the labour market and unemployment without identifying problems in individual specialities. The effectiveness of the use of educational resources and their impact on the country's development potential was investigated by H. Liao *et al*. (2024). The researchers considered more than 30 European countries. They noted the close link between the country's productivity and the quality of education, focusing on the importance of providing high-quality higher education. They also investigated problems that lead to gaps in education. V. Usyk (2019) stressed that in the structure of Ukraine's gross domestic product, the share of spending on education corresponds to the average level of European countries. The scientist emphasised that the main problem lies precisely in the distribution of these funds, both between the levels of educational institutions and between institutions of the same level, suggesting improvements in the financing mechanism through the establishment of certain financial rules.

The researchers of the current study hypothesised that only the use of state order volumes as a tool for influencing the choice of the applicant's future profession does not ensure the development of the necessary structure for the Ukrainian economy of training specialists in various professions. In contrast to the statement of the leadership of the Ministry of Education and Science of Ukraine, and the position of the Cabinet of Ministers of Ukraine, about providing the country's economy with the necessary professions precisely through the financing of training in such specialities (The principle..., 2024). The purpose of the study was to comprehensively analyse the relationship between changes in the amount of state funding for training specialists in certain professions and their impact on the attractiveness of such specialities for applicants, and to determine the effectiveness of such influence for popularising specialities that are strategically important for the post-war reconstruction of Ukraine and its development.

MATERIALS AND METHODS

The study was based on information on the recruitment of higher education applicants for the bachelor's degree (USEDE, n.d.), based on complete general secondary education in the period 2018-2023, and identified factors that affect the number of applicants enrolled in a particular speciality and specialisation. During the study period, there was a fluctuation in the total number of positions, namely, specialities and specialisations for which recruitment for training was carried out in the range of 191-216 positions, which were further considered in the study. Further, clustering was carried out to identify five clusters of specialities and specialisations, depending on the number of applicants who chose the appropriate profession, and who are enrolled in each speciality at the bachelor's educational level based on full general secondary education. This distribution acts as a certain indicator of the popularity of the speciality among applicants. The study covered specialities

and applicants for education who study at HEIs, which are subordinate to one administrator of budget funds, namely the Ministry of Education and Science of Ukraine.

Using the capabilities of the built-in functions and add-ons of the Microsoft Excel software suite, forecast models were built to determine the forecast number of applicants in the specialities of each of the clusters to determine the dynamics of changes in the average number of applicants in the forecasting speciality, carried out through the function of linear and nonlinear dependencies. The use of the Python software product, statsmodels application, helped to construct a pair linear regression equation for each speciality, which describes the dependence of two variables, namely, changes in the volume of the state order for training applicants for education in a particular speciality, which determines the change in state support for financing the training of relevant specialists, and changes in the competitive entrance score for enrolment in such a speciality. The level of the competitive entrance score characterises the attractiveness of the chosen profession for the most capable applicants. Correlation and determination coefficients were also determined for each model. The results were summarised using the built-in functions of the Microsoft Excel toolkit. The use of the built-in average value function (AVGVAL) (_) for the data array of the Microsoft Excel software determined the average value of a series of data, namely, the number of enrolled applicants per speciality, for each of the periods.

$$Xavg = \frac{\sum_{i=1}^{n} xi}{n}, \quad (1)$$

where *Xavg* – mathematical average of a number of values of enrolled applicants for a particular speciality; X_i – current value of the value and data series, $i \in [1; n]$; n – number of members of the group (number of majors and specialisations for which applicants were recruited through a broad competition). Amplitude of fluctuations in the weight fraction of incoming users:

$$\Delta W_i = W_i max - W_i min, \quad (2)$$

where W – fluctuations in the share of applicants. The method of graphical visualisation was used to analyse the structure and dynamics of popularity of specialities through the analysis of quantitative characteristics of clusters of specialities for which the recruitment of educational applicants for each cluster was carried out. This helped to identify high risks of forming incomplete groups. The paper used tools for economic and mathematical forecasting. To construct predictive models for the absolute number and relative share of applicants for each of the clusters, indicating the type of trend line function calculated by the mathematical equation. A more detailed analysis of the structure of each cluster, trends, and factors that affect them was carried out using the index method. The use of relative indicators was one of the tools for identifying trends in economic phenomena and processes. The index method tools were used, on the one hand, to measure a phenomenon in a time section, and on the other, to compare elements that describe the same phenomenon, but have different meters. A comparative analysis of the results of the admission campaign, identification of factors of influence, and trends was carried out by converting data series, such as the volume of state orders placed through a broad competition, the minimum competitive score, and the total number of enrolled applicants, through indices to values without units of measurement, which allowed them to be included in a single system.

RESULTS

Training of specialists with higher education is carried out by HEIs of various forms of ownership, namely state, municipal, and private. HEIs in Ukraine have different departmental subordination. As of November 1, 2023, 195 state-owned HEIs were subordinated to 14 different ministries and agencies (USEDE, n.d.). Municipal HEIs are subordinate to the regional level, namely regional, city, or district. The number of government departments subordinated to 39 municipal HEIs at the regional level is much higher and amounts to 21 structures. More than 75% of all applicants for non-military specialities receive education at all levels of training in the system of the Ministry of Education and Science of Ukraine. In accordance with the current regulatory framework in Ukraine, higher education in specialities is provided at the expense of budgetary funds and at the expense of individuals and legal entities (Law of Ukraine No. 1556-VII, 2014; Resolution of the Cabinet of Ministers of Ukraine No. 708, 2023; Procedure for Admission to Higher Education in 2023, 2023). In Ukraine, to a certain extent, a system of joint financing of the process of training specialists with higher education is being implemented. These issues are discussed in detail in the paper by V. Ponomarenko (2021).

The number of places for which training is financed from budget funds is defined as the volume of state orders for a speciality. Applicants with the highest rating (passing, competitive) score are enrolled in budget places. The applicant's competitive score determines the possibility of entering a university in the chosen speciality and the possible form of financing. The result of the entrance campaign is determined by the number of applicants enrolled in the relevant specialities and specialisations for which competitive proposals were developed. The level of competitive passing score in a particular speciality can be considered as an indicator of its popularity among applicants, and as evidence that this particular speciality attracts the most capable applicants. If applicants with high scores are enrolled in field training under a state order, this indicates that the state invests in the education of the most capable students, thereby contributing to the training of highly qualified and competitive specialists in this speciality for the future labour market.

It should be noted that there is a significant differentiation in the number of enrolled applicants in various specialities. This is determined by the needs of the market and the state through quantitative indicators of targeted placement of state orders, and the preferences of applicants and their parents, their personal ideas about the possibilities of their own implementation in a particular profession, etc. As part of the study, five clusters of specialities were developed in terms of the number of enrolled applicants from the minimum to 100 people – this is the 1st cluster to a significant number – more than 2,000 people – the 5th cluster. The number of applicants enrolled in the educational level of bachelor based on full general secondary education for

each speciality and specialisation, except for the military, for budget funds and funds of individuals and legal entities, determine whether such a speciality belongs to the cluster. The dynamics of changes in the number of specialities in each of the clusters during 2018-2023 is shown in Figure 1. The so-called distribution by popularity of the speciality.

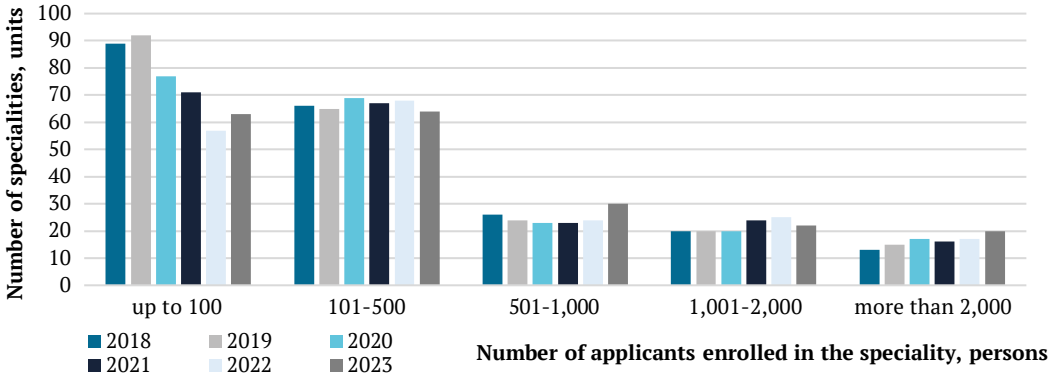

Figure 1. Results of clustering specialities by set of applicants
Source: compiled by the authors based on USEDE (n.d.)

The 1st cluster is a group of small specialities and specialisations, which have less than 100 people enrolled in all Ukrainian HEIs. Since 2019, the number of such specialities and specialisations is gradually decreasing and amounts to 57 positions in 2022 against 89 in 2018 and 92 in 2019, respectively, but in 2023 it was 63 positions. The 2nd cluster includes a list of specialities and specialisations, in which the total number of applicants enrolled in the budget and contract form of funding is from 101 to 500 people for each. The number of specialities that fall into the 2nd cluster remains almost unchanged, fluctuating in the range of 64-69 positions. The 3rd cluster includes specialities with 501 to 1,000 students, and their number is also quite stable, ranging from 23-26 positions from 2018 to 2022, and 30 in 2023. The 4th cluster includes specialities and specialisations with 1,001 to 2,000 students enrolled in each of them under contract and budgetary forms of funding. The number of such specialities is 20-25 positions. The most popular specialities among applicants for education, for which more than 2,000 people are enrolled at the expense of the budget and at the expense of individuals and legal entities, are assigned to the 5th cluster. The 5th cluster includes 13-20 positions of specialities and specialisations, which is 6-10% of the total number of specialities for which training is carried out.

The researchers state that training in small specialities and specialisations (the 1st and 2nd cluster), where the number of enrolled applicants for education is less than 500 people throughout Ukraine, accounts for 130-160 specialities, depending on the year, which is 65.0-72.7% of the total number of specialities and specialisations for which applicants for education are recruited. Table 1 shows examples of small numbers of specialities and specialisations that, based on the results of clustering, are assigned to the first cluster, with the number of bachelor's degree students up to 100, and a list of specialities that, based on the results of the 2023 enrolment, are assigned to the 5th cluster with the number of bachelor's degree students over 2,000.

Table 1. Examples of individual specialities and specialisations of the 1st and 5th clusters with the number of enrolled applicants on budget and contractual basis in 2023

Example of specialities and specialisations of the 1st cluster	Number of applicants	Specialities and specialisations of the 5th cluster	Number of applicants
015 "Professional Education" (015.34 "Mechanical Engineering")	84	081 "Law"	8,656
112 "Statistics"	77	073 "Management"	7,399
145 "Renewable Energy and Hydropower"	76	053 "Psychology"	7,058
015 "Professional Education" (015.35 "Mining, Processing and Transportation of Minerals")	70	122 "Computer Science"	6,707
035 "Philology" (035.060 "Eastern Languages and Literatures, first – Arabic")	66	121 "Software Engineering"	4,684
015 "Professional Education" (015.36 "Technology of Light Industry Products")	54	075 "Marketing"	4,443
035 "Philology" (035.052 "Romance Languages and Literatures")	48	192 "Construction and Civil Engineering"	4,309
014 "Secondary Education" (014.023 "French Language and Foreign Literature")	37	035 "Philology" (035.041 "German Languages and Literature, first – English")	4,171

Table 1. Continued

Example of specialities and specialisations of the 1st cluster	Number of applicants	Specialities and specialisations of the 5th cluster	Number of applicants
015 "Professional Education" (015.32 "Electronics, Metrology and Radio Communications")	30	017 "Physical Education and Sports"	4,126
224 "Technologies of Medical Diagnostics and Treatment"	26	201 "Agronomy"	3,579
015 "Professional Education" (015.31 "Construction and Welding")	25	141 "Electric Power Industry, Electrical Engineering and Electromechanics"	3,452
015 "Professional Education" (015.33 "Power Engineering, Electrical Engineering and Electromechanics")	23	051 "Economy"	3,239
226 "Pharmacy, Industrial Pharmacy"	22	125 "Cybersecurity and Information Protection"	2,870
015 "Professional Education" (015.15 "Occupational Health and Safety")	10	181 "Food Technologies"	2,705
011 "Educational and Pedagogical Sciences"	3	076 "Entrepreneurship and Trade"	2,378

Source: calculated by the authors based on USEDE (n.d.)

Clusters 1 and 2 mainly include speciality 035 "Philology" by language groups, and specialities 014 "Secondary Education", 015 "Professional Education". These are specialities and specialisations with extremely low popularity. Only the specialisation 035.041 "German Languages and Literature, first – English" of the speciality 035 "Philology" has a high attractiveness and is included in the 5th cluster. The average number of bachelor's degree applicants for the available competitive offers, i.e., for the specialities and specialisations for which the recruitment of applicants is carried out through a broad competition for the period under study, was calculated using Microsoft Excel. The calculations helped to determine the average number of applicants who were enrolled in specialities and specialisations for each of the periods.

$$Xavg_{2018} = 631;$$

$$Xavg_{2019} = 687;$$

$$Xavg_{2020} = 730;$$

$$Xavg_{2021} = 749;$$

$$Xavg_{2022} = 799;$$

$$Xavg_{2023} = 776.$$

There was a positive trend in the average number of applicants per speciality from 2018 to 2022, which was the result of a reduction in the number of small specialities and specialisations and their actual consolidation, but in 2023 the average number decreased. A predictive mathematical model of changes in the average number of applicants in the speciality is constructed in the form of a linear trend:

$$y = ax + b;$$

$$y = 30.857x + 620.67;$$

$$R^2 = 0.8827.$$

Coefficient of multiple determination (R^2) confirms a high level of reliability of the model. The forecast model indicates an upward trend in the average number of applicants enrolled in a particular speciality or specialisation. Two clusters consist of specialities in which the set of applicants is lower than the average in Ukraine, two more clusters consist of specialities in which the set of applicants is higher than the average in Ukraine, and one cluster, which includes specialities with the volume of enrolment of applicants that are close to the average level. The method of graphical visualisation revealed that significant quantitative changes in the list of positions of specialities and specialisations for which bachelor's degree applicants were recruited occurred in the 1st cluster of specialities with the lowest total number of enrolled applicants, up to 100 people per speciality in the country. The number of small specialities and specialisations from 2019 to 2022 decreased from 92 to 57, but in 2023 it was 63, and the number of positions for which enrolment was carried out for the same period as a whole decreased by 11.5%. This was a consequence of transformational processes among small specialities due to the addition of some specialities to others, the closure of recruitment, etc. An increase in the number of small specialities in 2023 indicates an increase in polarisation among the priorities of applicants and an increase in the number of low-demand specialities. In the total number of specialities and specialisations for which applicants for higher education are recruited, with the exception of military ones, the share of specialities with a small number of applicants up to 500 people (clusters 1 and 2) is about 70%. Almost 70% of specialities are not popular among applicants for education, that is, applicants and their parents do not see any prospects in the future. Along with this, there are specific specialities in which a limited number of applicants for education should be trained. A significant branching of small specialities carries high risks of forming small, incomplete groups, for the training of which a smaller amount of funds will actually be attracted from various sources of funding, namely from general and special funds (Ponomarenko, 2021).

Insufficient funding for the training of applicants for such groups leads to a combination of negative consequences. Reducing the possibility of ensuring the educational process at a high level, which meets modern advanced requirements, affects the quality of training of specialists who are trained both for budget funds and for the funds of individuals and legal entities. Deterioration of the quality of training of specialists negatively affects the development of human capital, both in the short and long term. It also causes image losses of the higher education system as a whole. Insufficient funding for the training of specialists, combined with its negative consequences, actually becomes an irrational use of both financial resources, budget funds, and funds of individuals and legal entities, and human resources.

The approach proposed by V. Ponomarenko (2022), to prevent the dispersion of budget funds through the introduction of regulatory mechanisms at the stage of formation of competitive proposals by HEIs, and limiting the possibility of enrolment in places at the expense of the state budget, in specialities and specialisations in which a certain HEI has formed incomplete small groups in recent years. The quantitative distribution of specialities by clusters differs significantly from the distribution of the total number of applicants enrolled in these specialities by certain clusters for budget funds and funds of individuals and legal entities. The total number of applicants for budget and contract forms of education who are enrolled in the specialities of the corresponding clusters is shown in dynamics in Figure 2.

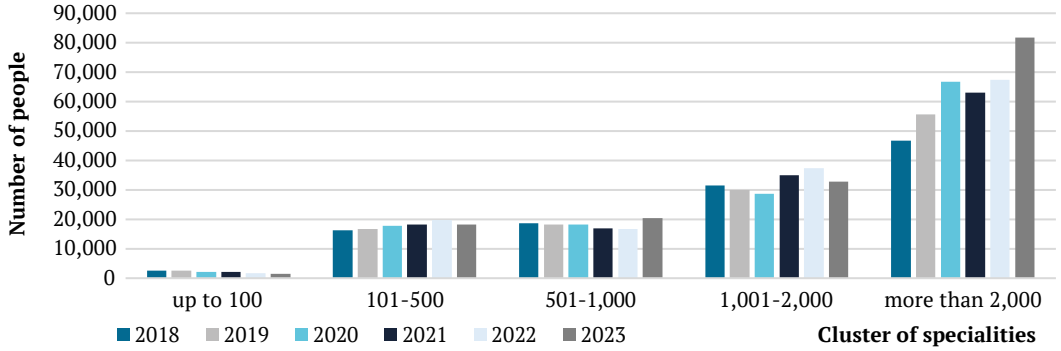

Figure 2. Dynamics of the total number of applicants enrolled in the specialities of each of the clusters
Source: compiled by the authors based on USEDE (n.d.)

13-20 specialities and specialisations of the 5th cluster with the largest set during the study period account for from 40% to 50% of all applicants, excluding military specialities. This is a group of the most popular and popular specialities. In absolute terms, the total number of applicants in these specialities has increased. A wide range, within 10%, of fluctuations in the proportion of applicants in the total number of applicants who choose specialities of the 5th cluster indicates the presence of a set of factors that influence the applicant's decision about the future profession. However, more than 140 specialities and specialisations (65-73% of the total number), which enrol up to 500 people (clusters 1 and 2), account for less than 15% of all applicants for education. Fluctuations in the share of applicants for cluster 1 and cluster 2 in 2018-2023 occurred within 1.0% for each cluster. That is, the share of applicants who choose such small specialities and specialisations for higher education remains quite stable from year to year and almost does not change. This is directly conditioned by the specific features of the specialities and specialisations that are included in these clusters. This confirms the hypothesis that there is a limited list of specialities with a low level of sensitivity to the influence of external factors regarding their attractiveness. Changes in existing external factors have almost no effect on changing the attractiveness of such specialities.

The amplitude of fluctuations in the weight share of applicants enrolled in specialities of clusters 3 and 4 is in the range of 4.5-6.0%. Thus, the share of incoming specialities of the 3rd cluster with the number of 501-1,000 people varies from $W_3 min = 11.76\%$, up to $W_3 max = 16.19\%$. Share of applicants for specialities of the 4th cluster with the number of 1,001-2,000 people from $W_4 min = 21.42\%$, up to $W_4 max = 27.26\%$. According to the specialities of these clusters, there are additional factors that influence the choice of the applicant regarding the future line of training, which caused fluctuations in the share of applicants in different periods compared to the factors of choosing specialities of clusters 1 and 2. The largest amplitude of fluctuations between the minimum and maximum share of applicants was found in the specialities of the 5th cluster, which is 9.65%. The amplitude of fluctuations in the proportion of applicants who choose one or another speciality depends on a combination of factors. The almost stable share of applicants who chose small specialities of clusters 1 and 2, with a fluctuation of 1%, indicates a low level of sensitivity to factors that affect the choice of applicants. A well-established part of society prefers training in certain specialities and specialisations. And neither socio-economic, nor political factors, nor other factors have a significant impact on their choice. The amplitude of fluctuations in clusters of specialities and specialisations with a set of more than 500 people ranges from 5% to 10%, which indicates an increased level of sensitivity of such specialities. That is, the decision to choose a speciality is influenced by a combination of additional factors.

Figure 2 indicates different dynamics of changes in the indicators of each cluster, both in the direction of growth or decline, and in the nature of changes linear or nonlinear. The tendency of a series to change in the time dimension

is a trend (Gupta *et al.*, 2024) and can be described using a mathematical equation. Table 2 shows the results of constructing forecast models for the absolute number and relative share of applicants for each of the clusters, indicating the type of trend line function, the calculated mathematical equation, and the coefficient of determination R^2, which characterises the degree of reliability of the constructed forecasting model.

Table 2. Forecast models of the number and share of applicants enrolled in specialities in the context of each cluster

Cluster	Type of functional dependency	Mathematical equation	R^2
Total number of applicants			
1	Linear	$y = -195.9x + 2{,}808.1$	0.9129
2	Linear	$y = 837.6x + 15{,}220$	0.9584
3	Polynomial	$y = -51.071x^2 - 213.07x + 19{,}006$	0.988
4	Polynomial	$y = 1{,}109.4x^2 - 4{,}991x + 35{,}228$	0.8663
5	Polynomial	$y = -1{,}748.9x^2 + 15{,}377x + 33{,}002$	0.9149
Relative share of applicants			
1	Linear	$y = -0.2408x + 2.4544$	0.956
2	Polynomial	$y = 0.1397x^2 - 0.9046x + 14.815$	0.9906
3	Linear	$y = -1.1208x + 17.162$	0.9913
4	Polynomial	$y = 0.9842x^2 - 5.978x + 32.089$	0.6672
5	Polynomial	$y = -1.2079x^2 + 8.7483x + 32.891$	0.8567

Source: calculated by the authors

The high level of reliability of models that are built is indicated by high values R^2, which is close to 1. The exception was the forecast model of changes in the relative share of applicants in cluster 4, according to which $R^2 = 0.6672$, which indicates an acceptable level of reliability of the model. The heterogeneous dynamics of enrolment volumes in specialities of different clusters makes it necessary to conduct a further detailed analysis of the factors of influence for each cluster separately. The provision of state-ordered places indirectly acts as an indicator of the level of state support for a particular speciality. The state, through the relevant managers of budget funds, carries out orders for the training of specialists at each of the levels, in the amounts that it determines as necessary, through the volumes of the state order that are formed for each speciality and specialisation. Within each cluster, the average percentage of applicants who are enrolled in places funded from budget funds is determined as the average value for each speciality of the cluster.

The results obtained indicate that the financing of training of specialists in the specialities included in the 1st, 2nd, and 3rd clusters, that is, with the number of up to 1,000 people, on average by 50% or more is carried out at the expense of budget funds, except for 2022 and 2023. The amount of funding for specialities assigned to the 4th cluster, with a number of 1,001 to 2,000 people, at the expense of budget funds on average for the group ranges from 40% to 50%, except in 2023. The lowest share of budget funding on average is provided for the training of applicants for higher education in the specialities of the 5th cluster, which are most popular among applicants. The average percentage of budget funding ranges from 23.5% in 2020 to 30% in 2022.

An economic analysis of the results of the impact of changes in state support for specialities, through the volume of investment in the training of specialists under the state order in certain specialities, revealed the following. In the specialities of the 5th cluster that are most popular among applicants, with a total number of enrolled applicants of more than 2,000 people, the following trends are obtained. From 2018 to 2020, the share of places for which applicants were enrolled at the expense of the state budget decreased from 28.5% to 23.5%, while the total number of applicants who chose the specialities of this cluster increased, both from 2018 to 2020, and in subsequent periods. Despite the obvious trends in reducing state support through funding for the training of specialists, this did not affect their popularity among applicants. This indicates that the decline in state support was not a decisive factor in changing the popularity of these specialities, moreover, the influence of this factor was offset by others. The number of applicants has increased, which may be due to other factors, such as the demand for specialists in these areas in the labour market or the prestige of these specialities in society.

Analysis of fluctuations in the share of places funded by the state budget in the specialities of the 1st, 2nd, and 3rd clusters (with the number of enrolled applicants up to 1,000 people) revealed that changes in the range from 43% to 56% almost did not affect the total number of enrolled applicants. This shows that, despite variations in the share of state funding and investment in training in certain specialities, and a large share of places for training for budget funds, this does not increase the popularity of specialities in these clusters. This result may indicate that for specialities with fewer applicants (few popular specialities), the key factors of choice are other circumstances, and not just the volume of the state order.

Correlation of the results of the analysis of the dynamics of the share of places funded by budget funds by clusters of specialities with fluctuations in the dynamics of the share of applicants who choose specialities in these clusters gives grounds to draw the following conclusions. Fluctuations in the share of places with budget funding in the range of 43-56% in the specialities of clusters 1 and 2 did not affect the choice of applicants. Fluctuations in the total share of persons enrolled in specialities and specialisations of the 1st and 2nd clusters during 2018-2023 are observed in the range of only 1%. This indicates that to increase the attractiveness of certain specialities that are strategically necessary for the development of the country, the use of only one lever of influence, namely, the number of places

of state order for education, is insufficient. The thesis is actively put forward that one of the main tools for influencing the choice of an incoming future profession is the allocation of budget places (Zub & Zhezhnych, 2022) for training in the relevant speciality. Providing the country's economy with specialists that are strategically important for its recovery can be achieved by changing the structure of investment in training specialists, namely by increasing the volume of state orders for training specialists.

The authors of this study suggest that the unambiguity of the above hypothesis is debatable and not reasoned. An increase in the volume of state orders for training specialists in a particular speciality does not mean an unconditional increase in the total number of applicants for such a speciality and its popularisation. The presented results of the analysis of the dynamics of the share of budget places and the share of enrolled applicants for specialities of the 1st and 2nd clusters confirm the absence of such growth. The volume of state orders and changes in the structure of budget allocation between specialities can be only one of the levers of influence on the "attractiveness" of a particular speciality, but not always an effective tool. To test or refute the above hypothesis, paired linear regression equations were constructed for each speciality and specialisation for which recruitment was carried out during 2018-2023, which determine the presence of a relationship between indicators. The relationship between the financing of training of applicants for a certain speciality through the indicator of changes in the volume of state orders for training specialists, and changes in the popularity of the speciality, one of the evaluation characteristics of which is a change in the competitive passing score. The equation of paired linear regression, for example, for the speciality 193 "Geodesy and Land Management" has the form:

$$Y_{193} = 1.06412 \times X_{193} + 279.773.$$

The equation describes the relationship between the number of applicants enrolled in state-commissioned training (variable X_{193} and the value of the passing (competitive) score (Y_{193}) for the specified speciality during 2018-2023. The equation shows that as the volume of the state order increases (X_{193}) for each additional unit, the competition score (Y_{193}) increases by an average of 1.06412. Such a positive relationship between X and Y it indicates that with the increase in the number of places for study, which are financed from the state budget, the competitive scores of applicants also tend to increase. There is an assumption that this may indicate an increase in the interest of applicants with higher scores in admission due to an increase in the number of places allocated by the state for this speciality. More places available for public funding attract more capable applicants with higher competitive scores.

Given the weak correlation ($r = 0.4$), and low coefficient of determination $R^2 = 15.94$, this growth is not a decisive factor. The level of the correlation coefficient indicates a weak positive relationship between the change in the volume of the state order and the competitive score, which indicates a moderate influence of these factors on each other. Coefficient of determination $R^2 = 15.94$ means that only about 15.94% of variations in the competition score can be explained by changes in state order volumes. This indicates a low explanatory power of the model, i.e., there is a combination of other factors that significantly affect competitive scores in this speciality. The statistical quality level of the model is assessed as low, which indicates that the regression model does not accurately predict changes in the competitive score based on changes in the state order. The model demonstrates how changes in the number of public places affect the average level of the competition score, which may indicate a change in the quality of applicants or political and economic priorities in the development of a state order. Similarly, the equation of paired linear regression is constructed and the coefficient is determined for each of the specialities and specialisations for which applicants to the bachelor's educational level were recruited in the period 2018-2023. The results obtained are systematised for each of the clusters and summarised in Table 3.

Table 3. Systematisation of clusters

Cluster	Correlation coefficient *r* (average by cluster)	Coefficient of determination R^2, % (cluster average)	% of specialities in the cluster for which the correlation coefficient is applied $r < 0$	% of models in the cluster by the level of statistical quality of the model	
				high	low
1	**2**	**3**	**4**	**5**	**6**
1	–0.267	39.75	66.67	18.52	81.48
2	0.085	40.24	40.38	23.08	73.08
3	–0.05	31.63	45.45	13.64	86.36
4	–0.26	37.72	60.87	21.74	73.91
5	–0.42	50.87	80.00	46.67	53.33
Total			53.96	23.02	74.82

Source: compiled by the authors

The summary table shows the average values of the corresponding indicators for each of the clusters. The results of the analysis show the heterogeneity of trends in each of the clusters. Cluster average value of the correlation coefficient *r* (column 2) reflects the average degree of linear relationship between changes in state order volumes and competitive scores within a group of specialities belonging to the same cluster. A positive value of the coefficient indicates a general trend towards a positive relationship, that is, with an increase in the number of places under the state order, competition points also increase. A negative value of the coefficient indicates a feedback loop. The modular value of the indicator describes the strength of the relationship between variables. The average *r* value

close to zero indicates a weak or no linear relationship between changes in the amount of state funding for training and competitive scores for cluster specialities.

In column 4 of Table 3, the proportion of cluster specialities for which a negative correlation between the indicators is observed. With an increase in the volume of enrolment of applicants at the expense of the state order, the possibilities of admission of less trained applicants are expanding, and as a result, competition points tend to decrease. The calculation of this indicator provides a quantitative assessment of negative trends in the cluster, where an increase in state order volumes does not contribute to increasing or maintaining high passing scores. This may indicate that an increase in the state order for certain specialities does not encourage attracting more capable or talented applicants with higher competitive scores. The indicator helps to better understand the general trends in the cluster and their possible implications for the quality of student admission.

It is indicative to calculate the proportion of cluster specialities for which the level of statistical quality of the model is defined as high (column 5) and, accordingly, low (column 6). The high quality of the model means that the regression equation explains the relationship between variables well, i.e., changes in the competitive score are well predicted based on state order volumes. This indicates the reliability and accuracy of the model in this cluster. The low level of statistical quality of the models means that the model is not reliable enough to accurately predict the competitive score based on changes in state order volumes. A high percentage of models with low statistical quality indicates the presence of other influential factors, in addition to the volume of the state order, affecting the level of the competition score, and therefore, the interest of the most capable applicants to choose such specialities.

The 1st cluster, which includes the least popular specialities (less than 100 applicants), shows a negative average correlation coefficient (−0.267) and an average coefficient of determination of 39.75%. These figures show that the number of applicants for these specialities tends to decrease, and models cannot explain changes in the data well enough. The quality of models in this cluster is one of the lowest: only 18.52% of models are of high quality, while 81.48% of models show poor quality. The 2nd cluster is characterised by a positive average value of the correlation coefficient ($r = 0.085$), which indicates a weak direct relationship between indicators, but the average coefficient of determination (40.24%) indicates a slightly higher explanatory power of models compared to other clusters. The statistical quality of the 2nd cluster models is low, as only 23.08% of the models are of high quality, while 73.08% have low quality. The 3rd cluster shows a further decrease in the average coefficient of determination to 31.63%, which indicates an even lower explanatory power of the models. The average correlation coefficient approaches zero (−0.05), which indicates that there is no clear trend in changing the number of applicants over time. At the same time, the quality level of models remains low: only 13.64% of models are of high quality, and 86.36% are of low quality. The 4th cluster (specialities with the number of applicants from 1,000 to 2,000) shows slightly different dynamics. The average coefficient of determination decreases to 37.72%, which indicates a decrease in the ability of models to explain changes in data. The negative average correlation coefficient (−0.26) also indicates an inverse relationship between the dependent variables. In this cluster, the percentage of specialities with a negative correlation is 60.87%. The quality level of models in this cluster is much lower: only 21.74% of models have a high level of quality, while 73.91% of models show a low level.

The 5th cluster, which includes the most popular specialities (with more than 2,000 applicants), is characterised by the highest average value of the coefficient of determination ($R^2 = 50.87\%$). This suggests that in this cluster, models can explain more than half of the differences in the data. There is also a negative average correlation coefficient ($r = -0.42$), which means that there is feedback between the indicators. Moreover, 80% of the cluster's specialities have a correlation coefficient of less than zero, which indicates a general trend towards an increase in the competitive passing score with a decrease in the amount of funding for places under the state order. The level of statistical quality of models in this cluster shows some inconsistency: only 46.67% of models are of high quality, while for 53.33% of models, the quality is low. This may indicate that there are objectively popular professions in the cluster, and specialities whose popularity is situational in nature and depends on the available priority opportunities, such as increasing places with budget funding.

The results obtained for different clusters indicate a significant variation in the relationship between the state order and the competition score, depending on the popularity of specialities. The results of the analysis of the summary data in the generalised table confirm the hypothesis that the dynamics of changes in the volume of state orders is not a determining factor in attracting more capable and talented applicants with high competitive scores to enrol in specialities that are not widely popular among applicants, but are strategically important for the development of the state. The constructed regression models show that even an increase in the number of public places in certain specialities does not guarantee the attraction of applicants with high academic achievements. This indicates that the popularity of the speciality among applicants largely depends on other factors, such as the prestige of the profession in the labour market, prospects for further employment, social significance, and general economic and social conditions. Even if the state increases funding for specialities of strategic importance, this does not necessarily contribute to attracting the best applicants with high entrance scores.

Summary data also show that specialities with low popularity among applicants tend to reduce competition scores, even in the face of a stable or increased state order. This confirms the conclusion that in order to attract more talented students to such specialities, it is necessary to apply other, additional incentive mechanisms that go beyond increasing state funding. The study of the impact of changes in the volume of state orders on the competitive scores of applicants, which reflects the attractiveness of specialities, is important in the context of research on the development of human capital. Changes in the volume of state orders can affect the qualitative composition of future specialists in a particular profession, because an increase in state funding due to an increase in the number of

places state-commissioned education does not always contribute to attracting talented applicants. This is important for the development of human capital, since the high level of knowledge and competencies of graduates determines the economic development of the country and its ability to innovate.

It is proved that the growth in the number of places where applicants are trained for budget funds, that is, the growth in the volume of state orders for training specialists in the specialty, is not an absolute factor in the growth of popularity, attractiveness of such specialties, the growth in the number of applicants enrolled in such specialties and does not correlate at all with the involvement of the most capable applicants for these specialties. Changes in the amount of state funding for the training of specialists have different effects on the attractiveness of specialities, but this factor is not the only one that determines. For some specialities, government support is a crucial factor, while for others it may not play a significant role. The popularity of a speciality depends on market conditions, employment prospects, the prestige of the profession and the level of awareness of applicants about future prospects, and the attitude of society towards representatives of the speciality. For strategically important specialities, it is necessary to implement comprehensive measures, including career guidance, an information campaign and material incentives, etc. Along with additional incentives in the learning process through budget support for educational applicants, it is important to introduce information campaigns to promote the speciality, create transparent and attractive career opportunities that increase the value of choosing certain specialities, and create conditions for high-quality training in specialised educational institutions. It is a set of measures that will provide the necessary number of qualified specialists for the development of key sectors of the economy.

DISCUSSION

The role of the state in the development of the structure of training of specialists that would meet the needs of the country in stimulating the training of specialists of one or another profile, the tools of state support for training in relevant specialities, the effectiveness of such mechanisms, the specifics of financing the higher education system and financing the training of specialists with higher education, all these issues are reflected in studies not only by Ukrainian scientists, but by researchers from all over the world. V. Cherneha (2023) analysed the dynamics of quantitative indicators of the higher education system of Ukraine, both indicators of the number of institutions and applicants for education, and the dynamics of state funding, considered the reasons for structural changes in educational institutions of different levels, among which the decline in the prestige of groups of professions was also determined.

S. Londar (2021) examined the specifics of financing different levels of education in Ukraine, namely, secondary, vocational, vocational pre-primary, higher education, including in terms of the ratio of budget expenditures between different levels of education, confirming that a significant share of education expenditures is directed to higher education in Ukraine. The question of the existing imbalances in the distribution of places financed by the state order, the presence of significant differences in the quality of training of specialists, a significant dispersion in the use of budget funds, the spread of a negative image regarding the quality of training in Ukraine due to the presence of facts of poor quality of training of applicants for education who studied at the expense of individuals and legal entities, all this remained out of the researcher's attention.

Exploring the structure of investments in physical and human capital, W. Paczos *et al*. (2023) insist on the expediency of changing approaches to the interpretation and classification of financial investments in education as an important component of human capital. The researchers examined the impact of reducing public spending on education and human capital in general on various countries of the European Union, and recommended the introduction of an investment approach to human capital financing. It should be noted that in the development of human capital, the professional structure of specialists and the compliance of training in specialities with the strategic needs of the country are of great importance. Therefore, the issue of using a wide range of tools in popularising priority specialities requires a thorough study.

Z. Liu *et al*. (2024) analysed investment in education in various provinces of China was carried out and the impact of state funding on the development of human capital and the features of further development of innovation processes and innovation potential in the provinces of China was determined. The researchers concluded about the insufficiency of increasing funding for education to ensure innovative development in the future. The researchers insist on the need to transform the model of development of the education system and create an innovative environment, and also prove the need to introduce a differentiated approach to the development strategies of different provinces, considering their specific features and the creation of their own development strategies, and not transfer the experience of other countries. Conclusions obtained by Z. Liu *et al*. (2024) correlate with the results of this study and confirm the conclusions made by the authors about the need for a systematic approach to the transformation of the system of state financing of higher education as a component of the development of high-quality human capital. The authors of the current study suggests that the use of only one lever is insufficient, namely, regulating the volume of state orders for training specialists to regulate quantitative and qualitative indicators of training specialists in a particular speciality.

The problem of the effectiveness of investing in higher education was considered by Y. Sun *et al*. (2023). The researchers analysed the existing imbalances that are inherent in the Chinese education system, despite the relatively significant amount of state funding for education. The researchers concluded that the effectiveness of higher education can be achieved with a comprehensive approach to solving such a problem and a comprehensive transformation of the system, considering regional, industry, and other factors. The conclusions relate to the results obtained in the above study, which indicate the need to apply an integrated approach in the process of developing high-quality human capital in conditions of limited funding and the introduction of a set of measures to improve the efficiency of using budget funds for training specialists.

The problems of the presence of imbalances in the financing of training applicants, and a discriminatory approach to various HEIs on the part of the state, are considered in the paper by V. Chentsov *et al*. (2019). The researchers emphasise the need to transform approaches to financing higher education, including through the prism of the effectiveness and efficiency of such investments, and propose the introduction of an integrated approach to the development of the higher education system in Ukraine. The study by L. Yurchyshena (2021) analysed the results of applying the formula distribution of budget funds among the HEIs of Ukraine in 2020 and 2021 based on the results of institutions' activities, with a study of the impact of individual components of the formula. The researchers agree with the conclusions about the negative aspects of applying the formula in the existing version of the regulatory framework, and also focuses on the presence of a significant impact of the number of applicants for education who study under a budget order on the amount of funding, which does not always characterise the results of the HEI's activities. V. Kolpin & M. Stater (2024) examined various government policies in the higher education system, highlights how imbalances in financial support from the state affect educational institutions, the market of educational services. They also analyse the impact of changes in financial support for students through various financial instruments on their motives for choosing a speciality and institution for future study. The impact of financial incentives and policies on the popularity of strategically important professions can be analysed by comparing them with international experience and various models of education management. I. Baker (2024) examined various models of higher education funding in the UK, Germany, and France, and how these models affect university outcomes and speciality development. This correlates with the problem of financing the training of specialists at the expense of public funds, since different approaches to the distribution of funds create conditions for attracting or alienating more capable applicants. Research based on institutional policy logic shows how different funding models affect higher education outcomes.

The study by S. Laderman *et al*. (2023) examined the sources of funding for higher education in the United States, the impact of public funding on higher education systems in the United States, in particular, how reduced public investment leads to changes in the distribution of resources between universities, how it affects the structure of educational institutions, their ability to maintain the quality of education and infrastructure. Attention was paid to assessing the impact of cuts in public investment, their impact on the availability of education, educational outcomes, and changes in funding policies. The researchers analysed how state support determines the opportunities for developing educational programmes and affects the competitiveness of specialities in the education market. This study correlates with the study of the impact of changes in the financing of training in a speciality on the change in the attractiveness of such specialities, since financial resources can determine the popularity and competitiveness of certain areas of study.

Losses in human capital are reflected in the loss of a certain share of the country's national income. The country's potential productivity is declining. The problem of imbalances in the labour market is becoming particularly acute. The problem of imbalances in the labour market of Ukraine is the gap between the demand for specialists in certain areas and the number of trained highly qualified personnel. One of the key prerequisites for the emergence of this phenomenon is the discrepancy between the educational policy and the needs of the labour market. The high demand for specialists in technical and engineering industries, which are necessary for the development of the country, is not met due to the low attractiveness of these specialities among applicants. The rapid development of certain sectors of the economy to which education does not have time to respond, labour migration and human losses as a result of military operations exacerbate this problem, which is fraught with a lack of qualified specialists in key sectors of the economy.

CONCLUSIONS

The results of clustering specialities by their level of popularity indicate the following. More than 70% of the total list, which is from 130 to 160 specialities and specialisations, depending on the year, are not very popular among applicants, since they are chosen by less than 500 people each throughout Ukraine. At the same time, 40-45% of specialities and specialisations are made up of small ones, with up to 100 people each. However, a cluster of the most popular specialities has been identified, which is 6-10% of the total number, for which from 2,000 to 7,000 applicants are enrolled. That is, 13-20 specialities of the 5th cluster receive from 40 to 50% of applicants, while 130-160 specialities of the 1st and 2nd clusters account for less than 15% of all applicants. It is revealed that the share of applicants whose training is carried out at the expense of funding for budget funds, and therefore supported by the state, is higher precisely for clusters of small specialities and amounts to more than 50%, while for a cluster of specialities with a high number of applicants, the share of state-commissioned places is on average 23.5%. Relatively large state support for small specialities did not significantly contribute to an increase in the number of applicants for these specialities. For six years, the fluctuation in the share of applicants for specialities of clusters 1 and 2 did not exceed 1%, subject to fluctuations in the share of applicants enrolled in training at the expense of the state budget in cluster specialities, from 43% to 56%.

The paper proves that the impact of changes in the volume of state orders on the attractiveness of certain specialities is heterogeneous and varies depending on the nature of the speciality and market conditions. For some areas, an increase in the state order contributes to an increase in competition points and popularity, while for other specialities, changes in funding do not significantly affect the attraction of more capable applicants. This confirms that the attractiveness of a speciality is formed under the influence of multiple factors, and not just funding. An increase or decrease in the volume of state orders for training specialists in certain specialities can only be one of the tools for influencing the development of the future structure of the labour market through the appropriate structure of training specialists. A comprehensive system of measures should be introduced to increase the

attractiveness, prospects from the standpoint of applicants and their parents, and specialities that are needed for economic recovery and development. Among the areas of prospects for further research, it is possible to determine the development of a system of measures to promote specialities that are most important for the recovery of the Ukrainian economy. It is also necessary to agree on effective mechanisms for determining the forecasted need for specialists and create a state order in accordance with real market demands to minimise funding losses.

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CONFLICT OF INTEREST

None.

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Аналіз впливу обсягів державного замовлення на забезпеченість економіки фахівцями певних спеціальностей

Анотація. В Україні наявні диспропорції між фахом випускників закладів вищої освіти та потребами ринку, тому питання дослідження можливостей державного впливу на підвищення популярності стратегічно необхідних для розвитку країни спеціальностей через фінансування підготовки фахівців за державним замовленням є актуальним. Дослідження мало на меті визначити, як зміна обсягів державного замовлення впливає на вибір спеціальностей, конкурсні бали, а також сформувати рекомендації щодо оптимізації державної політики у сфері фінансування спеціальностей, важливих для економічного розвитку країни. Здійснено кластеризацію спеціальностей за чисельністю вступників зарахованих на навчання, розглянуто тенденції зміни кластерів у динаміці за 2018-2023 роки, побудовано прогнозні моделі щодо зміни чисельності вступників для кожного з кластерів, а також визначено кореляційні залежності щодо впливу зміни обсягів державного замовлення на залучення здібних вступників на спеціальність. Результати кластеризації, візуалізація яких здійснена з використанням графічних методів, певною мірою визначають популярність відповідних спеціальностей та спеціалізацій серед здобувачів, а також рівень чутливості вибору вступників до впливу зовнішніх факторів. Визначено, що коливання кількості вступників, малочисельних спеціальностей відбувається у межах 1 % незважаючи на суттєві зміни частки місць із державним фінансуванням, які фінансуються за рахунок бюджетних коштів, проте в кластері спеціальностей із великою чисельністю таке коливання у межах 10 %. Практична цінність роботи полягає у можливості використання побудованих моделей для кожної спеціальності для визначення їх чутливості до впливу змін обсягів фінансування підготовки фахівців через державне замовлення, що дозволить оптимізувати розподіл фінансових ресурсів для підготовки фахівців для галузей економіки

Ключові слова: бюджетне фінансування; підготовка фахівців; кластеризація спеціальностей; диспропорції; привабливість; фінансова підтримка

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Mitigating economic losses and prospects for the development of the energy sector in the Republic of Kosovo

Abstract. The purpose of the study was to analyse the current economic problems in the energy sector of Kosovo and to develop effective strategies to overcome them, in particular ways to minimise losses and increase the stability of the energy system, as well as to study opportunities for ensuring the country's long-term development and energy security. The main focus was on the economic impact of implementing international energy standards, particularly European ones, within Kosovo's national policy and development strategy. The analysis emphasised the financial benefits and challenges associated with aligning the country's energy sector with EU directives, especially those related to renewable energy sources and energy efficiency. Key areas of the study included the economic potential of enhancing energy security, promoting renewable energy development, and reducing reliance on fossil fuels. Additionally, the study evaluated the economic implications of these reforms on Kosovo's energy market and overall economic growth trajectory. The study also included an economic analysis that assessed possible economic losses associated with the transition to renewable energy sources. Risks were considered, including job losses in traditional energy sectors such as coal and the significant financial costs required to upgrade infrastructure. However, the study found that the long-term benefits of a green energy transition, including increased energy security, reduced dependence on energy imports and improved environmental conditions, outweigh the short-term economic costs. The results showed that although the economic transition is accompanied by significant financial costs, the long-term

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benefits, such as increased energy security and reduced emissions, are substantial. The study highlights the importance of further reforms and investments to ensure the sustainable development of Kosovo's energy sector, as well as the country's integration into the European energy environment

Keywords: modernisation; sustainable development of the industry; impact of reforms; attraction of foreign capital; innovative technologies

INTRODUCTION

The energy development in Kosovo is characterised by a number of challenges related to limited internal energy resources, low efficiency of energy consumption and the need to adapt to the new conditions of the international energy market. The Republic of Kosovo, being a relatively young state, faces fundamental problems of economic development, which are closely related to energy independence and stability. Unresolved issues of energy security and dependence on energy imports create additional risks for the country's economic stability. Ageing infrastructure is one of the key challenges, leading to significant energy losses during its production and transportation, exacerbating economic difficulties as maintenance costs for such systems rise and overall efficiency remains low. A high level of electricity losses and insufficient capacity to meet domestic demand negatively affect the economic development of the country, restrain the development of industry and increase the burden on the state budget. A significant dependence on imported energy sources increases Kosovo's vulnerability to external shocks, such as fluctuations in global energy prices or political tensions.

The issue of reducing economic losses and prospects for the development of the energy sector has become the subject of numerous studies by various scientists who sought to find ways to stabilise the country's energy system and ensure its sustainable development. Among the scientists who focused their attention on this issue, there are specialists in the fields of energy, economics and international law. Their research covers both the purely technical aspects of energy infrastructure and the economic consequences of energy crises, as well as possible options for the modernisation of Kosovo's energy system. A. Gjukaj *et al*. (2024a; 2024b) paid special attention to the analysis of the historical background that led to the current state of the energy sector in Kosovo. The work considered the impact of political and economic transformations and their impact on the energy infrastructure. The research focused on examining the issues of Kosovo's energy dependence on electricity imports, as well as the need for investment in domestic energy resources such as coal and renewable energy sources. D. Almeida *et al*. (2023) analysed the potential of green energy development in Kosovo. The work was aimed at studying the possibilities of introducing the latest technologies in the fields of wind, solar and hydropower. They also explored the economic benefits of switching to renewable energy sources, stressing that this would not only allow the country to reduce economic losses but also achieve long-term energy independence and sustainability.

C. Iweh *et al*. (2021) and T. Nadeem *et al*. (2023) paid attention to the macroeconomic consequences of energy crises in Kosovo. The studies emphasised that the constant economic losses associated with interruptions in energy supply and inefficient use of energy resources hinder the development of industry and the attraction of foreign investment. Attention was focused on the need for deep reforms in the energy sector, aimed at increasing production efficiency and reducing losses during energy transportation. The research included a comparative analysis with situations in other post-conflict regions, which made it possible to outline Kosovo's prospects in the context of global trends. Other scholars in this direction are L. Feldhaus & C. Stiewe (2021), the experts on Kosovo's energy policy. The work focused on a detailed analysis of the country's domestic energy policy, including the influence of international organisations and donors on the energy sector. They argued that the successful transformation of Kosovo's energy system is possible only with active cooperation with international institutions such as the European Bank for Reconstruction and Development. The study has highlighted the importance of reforming state-owned energy companies, particularly in terms of improving governance and reducing corruption risks in this industry.

Scientific research on reducing economic losses and developing Kosovo's energy sector covers a wide range of aspects, from technical and infrastructural issues to economic and legal challenges. The importance of these studies lies not only in the analysis of the current situation, but also in the development of recommendations on effective strategies to achieve energy security and economic stability in the country. The purpose of the study was to analyse the current economic problems in the energy sector of Kosovo and to develop effective strategies to overcome them, in particular ways to minimise losses and increase the stability of the energy system, as well as to study opportunities for ensuring the country's long-term development and energy security.

MATERIALS AND METHODS

Conceptual approaches and theoretical foundations of the development of measures to reduce economic losses and ensure sustainability of energy security were studied. The main attention was paid to the study of modern trends in world energy policy and the impact of economic factors on the energy sector. Such international documents as Decision of the Ministerial Council of the Energy Community No. D/2012/04/MC-EnC (2012), which regulates the interaction of countries within the framework of the Energy Community, and the Declaration on Energy Security and Green Transition in the Western Balkans (2022). The main provisions of these documents were studied, including the definition of strategic directions of energy policy, which contribute to energy security and support the transition to "green" energy sources. Not only concepts, but also practical examples of the implementation of similar strategies are analysed to determine the extent to which these approaches can be adapted to the conditions of Kosovo.

Particular attention was paid to the aspects of diversification of energy sources, improvement of the efficiency of resource use, as well as reduction.

The main focus was on the economic impact of the implementation of international energy standards, particularly European ones, in the national policy and development strategy of Kosovo. The main goal was to determine the extent to which Kosovo's legislation in the field of energy meets European standards, as well as to assess the country's potential for integration into the European energy system (European Standardization..., 2011). Considerable attention was paid to the study of Law of the Republic of Kosovo No. 05/l-084 (2016) which establishes the legal basis for the functioning of the energy market in Kosovo and regulates the activities of public and private participants in this market. This study used a multi-step economic analysis to assess the impact of integrating international energy standards, particularly European ones, into Kosovo's national energy policy and development strategy. A data-driven analysis was conducted using national energy consumption statistics, financial reports and energy market trends. The focus was on assessing the economic benefits and costs associated with the alignment of Kosovo's energy sector with EU directives, particularly in the field of renewable energy and energy efficiency.

An important aspect of the study was the comparison of Law of the Republic of Kosovo No. 05/l-084 (2016) with relevant European regulations, in particular with the Directive of the European Parliament and of the Council No. 2018/2001 (2018). The directive is a key document within the framework of The European Green Deal (2020) and defines targets in the overall structure of energy consumption. A detailed analysis was carried out to understand how far Kosovo has progressed in the implementation of "green" technologies and whether the country's legislation provides adequate incentives for the development of renewable energy sources. The study was devoted to a comprehensive study of international and national energy initiatives, in particular, such as the Kosovo Energy Security of Supply (USAID, 2021) and Kosovo Energy Sustainability Activity (2022). It included an in-depth analysis of strategic documents that determine the direction of development of Kosovo's energy policy in accordance with European standards (European standardization..., 2011).

In the context of the Kosovo Energy Sustainability Activity (2022) initiative, its main goals were considered, such as improving energy efficiency. The measures implemented within the framework of this program, as well as their impact on the local energy market and the environment, were subject to analysis. It was studied which projects and investments were involved, as well as which results were achieved in the field of reducing emissions and improving energy infrastructure. Similarly, the Kosovo Energy Security of Supply was analysed in terms of its impact on the security of energy supply in Kosovo (USAID, 2021). As part of this analysis, the mechanisms ensuring the stability of energy supply, as well as actions aimed at adapting to climate change and improving the resilience of the energy system, were considered.

Attention was paid to strategic documents such as the European Union National energy and climate plans (2020) and the Sofia Declaration on the Green Agenda for the Western Balkans (2020). In addition to the already described stages of the research, an important aspect was the conduct of an economic analysis, which focused on the existing and potential economic losses of the country due to the transformation of the energy sector. This stage contributed to a deeper understanding of situation in Kosovo, as well as possible ways to reduce the negative consequences of the transition to sustainable energy sources. As part of this analysis, data on economic losses that may occur in the next few years due to the introduction of new technologies and the transition to renewable energy sources were considered. It turned out that the main risks are the reduction of jobs in traditional energy industries, in particular coal, as well as the need for investments in infrastructure modernisation, which may require significant financial costs. At the final stage of the research, the results of the analysis of regulatory legal acts and international documents were integrated, which made it possible to form a complete picture of the prospects for the development of the energy sector in Kosovo. Systematisation of data based on sources such as International Energy Agency's (IEA) World energy outlook 2023 (2023) and Energy Statistics Data Browser (2023). Energy Strategy of the Republic of Kosovo 2022-2031 (2022) outlines a comprehensive framework for the development and modernisation of the energy sector in Kosovo.

RESULTS

The energy sector in Kosovo has historically faced numerous obstacles, including a reliance on coal-based power generation, ageing infrastructure, and environmental concerns. To address these issues, the government and stakeholders must focus on diversifying energy sources, enhancing energy efficiency, and investing in renewable energy technologies. Additionally, modernising the existing energy infrastructure is essential to minimise transmission losses and improve overall system reliability. This includes upgrading the electricity grid and integrating smart technologies that enhance monitoring and control capabilities. Another key aspect is enhancing energy efficiency across various sectors, including residential, commercial, and industrial. Public awareness campaigns and educational programs can encourage energy-saving practices among consumers, while financial incentives can motivate businesses to adopt energy-efficient technologies. Regional cooperation is vital for Kosovo's energy future. Collaborating with neighbouring countries on energy projects, sharing resources, and participating in regional energy markets can enhance energy security and stabilise prices (Semenenko *et al.*, 2024). The path to mitigating economic losses and fostering development in Kosovo's energy sector involves a comprehensive approach that prioritises renewable energy adoption, infrastructure modernisation, energy efficiency improvements, and regional collaboration. By embracing these strategies, Kosovo can build a more resilient and sustainable energy future that supports economic growth and environmental sustainability.

In Kosovo's energy sector, electricity generation is predominantly based on lignite, a low-grade coal, with reserves exceeding 12.5 billion tonnes (The energy sector in Kosovo, 2020). Lignite-fired power plants, currently accounting for approximately 90% of Kosovo's electricity production, are not only dated but also highly inefficient

(The future…, 2024). This inefficiency manifests in significant operational losses, costing the economy millions of euros annually. For instance, in 2021, the inefficiency of lignite-based power plants, exacerbated by high maintenance costs and frequent outages, resulted in economic losses estimated at EUR 100 million (Energy Statistics Data Browser, 2023). Although lignite prices for domestic generation are as low as EUR 3 per tonne, allowing domestic coal-based electricity prices to remain significantly lower than those in the EU, these benefits are offset by other factors (Di Bella & Thaci, 2023).

Analysis of conceptual approaches and theoretical foundations underlying the development of measures to reduce economic losses and ensure sustainability of energy security in Kosovo is critical for the formation of effective strategies in the face of modern challenges. The main conceptual directions in this area are diversification of energy resources, introduction of renewable energy sources, improvement of energy efficiency and adaptation to global climate changes. Diversification of energy sources involves not only expanding the use of renewable sources, such as solar and wind energy, but also importing energy from different countries, which reduces dependence on one supplier and increases the stability of energy supplies (Qawaqzeh *et al*., 2020). The theoretical foundations of this concept emphasise the importance of reducing risks associated with fluctuations in energy prices and political instability in the region. Research in the field of energy efficiency indicates a significant potential for cost reduction through the optimisation of energy consumption in industry, the residential sector and utilities. The introduction of innovative technologies and energy efficiency standards can significantly reduce economic losses and improve the overall competitiveness of the country. The issue of adaptation to climate change is important, which requires the integration of environmental aspects into the strategy of energy development. The implementation of "green" technologies and the reduction of greenhouse gas emissions are necessary to ensure environmental sustainability and compliance with international standards.

The Decision of the Ministerial Council of the Energy Community No. D/2012/04/MC-EnC (2012) regulates the interaction of countries within the Energy Community and is a document that contributes to the integration of energy markets and ensuring stability in the region. This document creates a framework for cooperation between participating countries to develop joint energy projects, improve energy efficiency and ensure energy security. The Declaration on Energy Security and Green Transition in the Western Balkans (2022) forms the basis for the transition to sustainable energy systems in the region. For example, Albania is actively developing hydroelectric plants, which provide most of its energy needs, while North Macedonia is investing in solar and wind power, creating the conditions to reduce dependence on traditional fuel sources (Governments' support…, 2023). Montenegro, in turn, implements projects on energy efficiency in the residential sector, which reduces the energy costs of the population.

Analysis of the national legal framework of the Republic of Kosovo reveals the importance of compliance with international standards and requirements, especially in the context of the energy sector. Law of the Republic of Kosovo No. 05/l-084 (2016) is the main legal document that establishes the legal basis for the functioning of the energy market in Kosovo, regulating the activities of both public and private participants in this market. The key provisions of this law cover the regulation of tariffs, monitoring of the activities of energy companies, licensing of operators and protection of consumer rights. Kosovo Energy Sustainability Activity (2022) and Kosovo Energy Security of Supply (USAID, 2021) are important initiatives aimed at ensuring the sustainable development of the energy sector of the Republic of Kosovo. The analysis of these programs indicates their contribution to the formation of the national energy policy, which meets the modern challenges in the field of energy security and sustainable development.

The National energy and climate plans (2020) show that Kosovo defines specific indicators to achieve goals related to energy security and sustainable development. In particular, the country sets ambitious goals for increasing the share of renewable sources in the overall energy balance. As part of the National energy and climate plans (2020), Kosovo plans to achieve 30% renewable energy by 2030, which meets EU requirements. Kosovo is also focusing on reducing greenhouse gas emissions, pledging to reduce them by 40% compared to 1990 levels. These goals are consistent with the pan-European goal of achieving carbon neutrality by 2050. The Sofia Declaration on the Green Agenda for the Western Balkans (2020) also supports these goals, emphasising the importance of environmental sustainability and the integration of environmental standards into national policies. This includes the joint efforts of the countries of the region to improve air quality, reduce emissions and develop a green economy.

Kosovo's transmission and distribution networks also contribute to economic losses in the energy sector. Transmission losses are at an acceptable level of 1.26%, comparable to regional and European benchmarks, but technical losses in the distribution system remain high, reaching 12.21% in 2022 (Gjukaj *et al*., 2024a). The financial implications of these losses are significant. In 2020, these network losses resulted in approximately €68 million in lost revenue – funds that could have been reinvested in the energy sector or other critical areas of the economy (Energy Strategy…, 2022). Reducing these losses to a more acceptable level, such as 15%, could lead to annual savings of around €30 million. Additionally, unauthorised consumption, or commercial losses, account for 10.42%. In 2020, the Kosovo A and Kosovo B power plants, located approximately 9 and 14 kilometres from the city centre, exceeded national emission ceilings for sulphur dioxide (SO_2), nitrogen oxides (NO_x), and particulate matter (PM) (Comply or close…, 2021). SO_2 emissions in 2020 amounted to 19,987 tonnes, 1.8 times the national ceiling. NO_x emissions increased to 22,846 tonnes, nearly 3,700 tonnes more compared to 2018. PM emissions in 2020 were 4.25 times above the national ceiling, amounting to 5,867 tonnes, significantly exceeding 5,042 tonnes in 2018 (The health harm…, 2020). These figures underscore the severe environmental challenges facing the country. The World Health Organisation states that there is no safe level of air pollution, and the link between pollution and respiratory and cardiovascular diseases is well established (New WHO…, 2021).

The World Bank supports Kosovo through the KOMPAS project (KOMPAS..., 2024). The project, whose total budget is approximately USD 20.01 million, aims to improve the country's health care system and includes three main components. The first component, with a budget of USD 6.87 million, is aimed at strengthening the structural elements of the health care system, including improving health care preparedness and response, improving the quality of services provided, and providing technical assistance in strategic procurement (Labor management procedures..., 2024). The second component, valued at approximately USD 12.2 million, involves the development and implementation of an Integrated Health System that supports digital health services, improves health data management, and modernises health infrastructure. The third component, with a budget of about USD 0.94 million, provides project management, monitoring and evaluation, including funding for consulting services, procurement of office equipment and covering operational costs (Fig. 1).

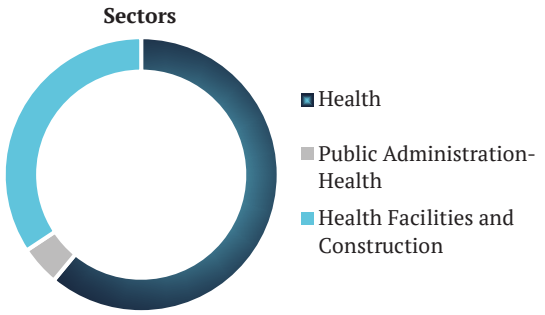

Figure 1. Component statistics "Sectors of KOMPAS project"

Source: created by the authors based on KOMPAS – Kosovo comprehensive approach to health system strengthening project (2024)

2022 saw a slowdown in overall economic growth, which was the result of several factors, among which losses in Kosovo's energy sector played a significant role. Economic growth slowed to 3.5% from 10.7% in 2021, mainly due to the negative impact of trade conditions and rising energy costs, which in turn weakened private demand (International Monetary Fund, 2023). In 2023, the country's trade deficit reached a record level of EUR 5.1 billion, a large part of which is due to rising costs of energy imports, which exceeded exports by EUR 5.9 billion (Bami, 2024). The main goal of the strategy is to increase the share of electricity produced from renewable sources from 6.3% at the beginning of implementation to 35% by 2031. To achieve this goal, the government plans to develop new power generation facilities with a total installed capacity of 1.6 GW. In particular, the strategy calls for the installation of wind and solar farms, each with a capacity of 600 MW, as well as 100 MW of rooftop solar photovoltaic panels for consumption (Nuttall, 2024).

The Energy Strategy of the Republic of Kosovo 2022-2031 (2022) was created in accordance with the National Development Strategy – 2030 (2022), which serves as the primary long-term strategic framework for achieving Kosovo's vision by outlining development priorities, objectives, and impact indicators. Within this framework, the National Development Strategy established goals that are specifically linked to the Energy Strategy. Rising per capita incomes also contribute to increased demand for electricity. According to the World Bank, Kosovo's per capita income last year was USD 11,839 (at purchasing power parity), well below neighbouring Albania (USD 14,495) and the EU average (USD 46,468) (KOMPAS..., 2024). According to the IEA, the share of electricity in total energy demand in the EU is expected to rise to 29% by 2040 from the current 21%, leading to a 10-20% increase in per capita electricity consumption (Table 1).

Table 1. Connection between the strategic objectives of the National Development Strategy and the Energy Strategy

Development Goals (National Development Strategy – 2030)	Strategic Objectives (National Development Strategy – 2030)	Strategic Objectives (Energy Strategy of the Republic of Kosovo 2022-2031)
High-quality, reliable, and integrated infrastructure	Improving energy supply security, sustainability and affordability	Enhancing system robustness
		Safeguarding and empowering consumers
	Integration into regional and pan-European energy markets	Strengthening regional cooperation and market functioning
Sustainable environment and improved utilisation of natural resources	Raising the proportion of renewable sources	Decarbonisation and the advancement of renewable energy
	Improving energy efficiency	Increasing energy efficiency

Source: created by the authors based on Energy Strategy of the Republic of Kosovo 2022-2031 (2022), National Development Strategy – 2030 (2022)

Over the past five years, the country's energy intensity has decreased by 10%, but in 2020 this indicator worsened again due to an economic downturn caused by a 4% reduction in gross domestic product. Over the past 10 years, energy intensity has decreased by almost 40%, which is one of the best results in the region. However, despite these achievements, Kosovo's energy intensity is still 25% higher than the Western Balkans average and three times higher than the EU average (Fig. 2). High energy intensity is one of the key issues in the field of energy efficiency in Kosovo. Currently, the Kosovo Energy Efficiency Fund focuses mainly on investments in public buildings, but further development requires a review of the legal and regulatory framework (Rizvanolli, 2019). Such changes could attract more private investors and promote the development of the Energy service companies (2024) market, which would be a significant step towards improving energy efficiency in the country. In its strategy of integration into regional and European energy markets, Kosovo attaches great importance to strengthening cooperation with Albania. Integration with the Albanian market is seen as an important priority and key goal (Kosovo* 2020 report, 2020).

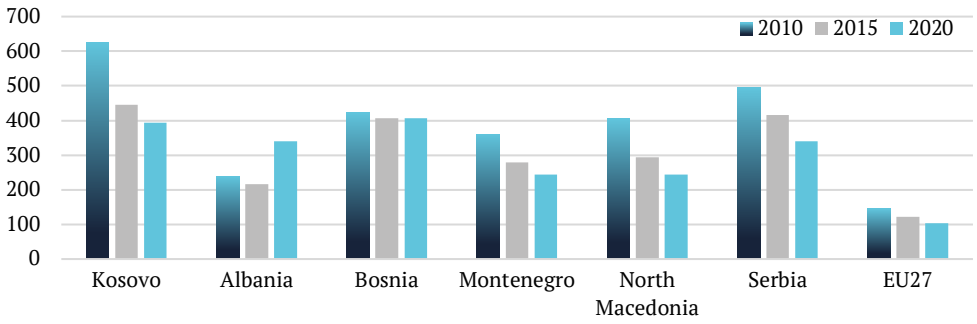

Figure 2. Energy intensity in the Kosovo, Western Balkans and in the EU
Source: compiled by the authors based on OECD (2021)

Despite the short-term economic costs associated with Kosovo's transition to an environmentally sustainable energy system, the long-term potential for development and growth is significant. The initial expenses involved in restructuring the energy sector – such as upgrading infrastructure, implementing new technologies, and adjusting regulatory frameworks – will be offset by various economic and social benefits that emerge over time. One of the key drivers of this transition will be investments in solar and wind energy. These investments will not only create direct employment opportunities during the construction, operation, and maintenance phases of renewable energy projects, but they will also stimulate job creation in related industries. For instance, the renewable energy supply chain – comprising manufacturing, transportation, and distribution of equipment – will see increased demand, which will further bolster employment. Beyond job creation, such investments will make an attractive destination for foreign capital. Foreign direct investment is likely to increase as international investors seek to capitalise on the growing demand for renewable energy in the region. Kosovo's move towards green energy will signal to the global market its commitment to sustainability, which can foster long-term economic partnerships and attract more diverse sources of capital (KSV/024: Energy transition…, 2023).

In addition to financial investments, the transition will drive innovation and technological advancements. As Kosovo develops its renewable energy sector, there will be a growing demand for new technologies, especially in energy storage, grid management, and energy efficiency solutions. The country will have the opportunity to become a hub for green energy innovation, where local and international companies collaborate to develop cutting-edge technologies tailored to the region's specific needs. Over time, these innovations can lead to greater cost reductions in energy production and consumption, making renewable energy more affordable and accessible (KSV/024: Energy transition…, 2023). A critical component of Kosovo's renewable energy policy is the introduction of an auction system for renewable energy projects. This system will ensure transparent and competitive bidding processes, attracting both domestic and international investors to participate in energy projects. The competitive nature of auctions can drive down the cost of renewable energy production by encouraging companies to innovate and offer lower bids, ensuring that Kosovo obtains at more affordable rates. Moreover, the auction system will promote efficiency by rewarding projects that can deliver energy at the lowest cost, thus optimising the use of available resources.

Reducing losses in energy transmission and distribution networks will help lower costs for consumers and ensure that more of the energy produced is effectively used. This increase in efficiency will make Kosovo's enterprises more competitive, both domestically and internationally, as lower energy costs translate into reduced operational expenses. Businesses that can operate more efficiently will be better positioned to expand, invest in innovation, and enter new markets (The European Green Deal, 2020). The transition to renewable energy will also have far-reaching environmental and social benefits. By reducing greenhouse gas emissions and air pollution, Kosovo will improve public health and contribute to global efforts to combat climate change. A cleaner environment will enhance the quality of life for its citizens and create new opportunities for the development of ecotourism. With its natural landscapes and rich cultural heritage, Kosovo can position itself as a destination for eco-conscious travellers, further diversifying its economy and generating additional income streams.

Energy Statistics Data Browser (2023) and World energy outlook 2023 (2023) will be important tools for Kosovo in mitigating economic losses and developing the energy sector. Energy Statistics Data Browser (2023) provides up-to-date data and analytics on global energy trends that will help Kosovo assess how other countries are reducing energy costs and improving energy efficiency. The data will become the basis for the development of a national strategy for energy development, which will allow optimising energy consumption and reducing dependence on the import of energy resources. In addition to policy development, these tools will support Kosovo's efforts to attract international investment in its energy sector. Investors typically seek markets where there is a clear, data-driven strategy for growth and risk mitigation. By using the IEA's data and aligning its strategy with European trends, Kosovo can demonstrate that it is a forward-thinking, reliable partner for international energy investments. This will be crucial for securing the funding necessary to expand its renewable energy capacity, modernise its grid infrastructure, and invest in innovative technologies that will further drive down costs and emissions.

The Energy Strategy of the Republic of Kosovo 2022-2031 (2022) contains specific strategies and measures aimed at the transition to renewable energy sources, which is relevant for Kosovo. Studying the experience of the EU

in this direction will allow Kosovo not only to integrate renewable energy sources into its energy system but also to attract investments for infrastructure development. In particular, it will contribute to the creation of new jobs in the field of green energy, stimulation of innovation and technological development, which will also positively affect the economic growth of the country. In addition, the European Green Deal provides financial support for countries making the energy transition (Medvedieva *et al.*, 2024). For Kosovo, this opens up the possibility of attracting additional resources for the implementation of projects, which will help not only to reduce dependence on fossil fuels but also to reduce economic losses from fluctuations in energy markets. Implementation of the principles of the European Green Deal will increase the country's energy security and contribute to stable economic development. Therefore, despite the initial costs, the transition to sustainable energy will provide Kosovo with significant long-term benefits. It will contribute not only to the renewal of the economy but also to the creation of new industries that will have a positive impact on the employment of the population, as new jobs will be opened, innovative technologies and ecological construction. The transition to clean energy will also stimulate the development of ecotourism, contribute to the growth of the green economy and increase the country's international competitiveness.

DISCUSSION

The results of the study highlight the importance of a strategic approach to reforming the energy industry in the face of modern challenges. Kosovo faces serious economic losses due to its dependence on fossil fuels, especially in light of rising global energy prices and the need to modernise its energy infrastructure. The development of renewable energy sources, such as solar and wind power, opens up prospects not only for reducing energy imports, but also for creating new jobs and attracting investment. The introduction of mechanisms to support innovations and the development of market relations in the field of energy, such as auctions for the implementation of projects from renewable sources, will be an important stage on the way to energy independence (Shahini *et al.*, 2024). Future opportunities for the development of Kosovo's energy sector include the intensification of cooperation with international partners, especially with neighbouring countries and the EU. In particular, integration into European energy markets will allow Kosovo to participate in regional development processes and strengthen its own energy security. Active use of international financial instruments and attraction of investments can significantly accelerate the transition to clean energy sources, which will contribute to the improvement of economic indicators (Shyle *et al.*, 2021).

The study shows some parallels with the results obtained in the work of S. Patnaik *et al.* (2022). Research highlights the importance of integrating renewable energy sources to improve the efficiency of energy systems. The research focuses on the fact that the modernisation of energy infrastructure in Kosovo is critical for reducing dependence on energy imports. At the same time, the works of scientists confirm that the introduction of modern technologies, in particular energy storage systems, can significantly increase the efficiency of distribution systems. A common aspect of the research is the need for innovation to improve energy stability. The results indicate the importance of attracting international investment for the development of the energy sector, which is consistent with the conclusions of S. Patnaik *et al.* (2022). They noted that integration into European energy markets opens up new opportunities for countries, in particular for Kosovo, in attracting financial resources and creating new jobs.

M. Abid *et al.* (2023) scholars who studied the concept of economic losses and prospects for the development of the power sector. The research carried out by scientists showed that it has a lot in common with the conclusions presented in the work, which showed the importance of the introduction of renewable energy sources to reduce economic losses and improve the environmental situation. The conducted research emphasised that the use of solar and other renewable energies can significantly reduce Kosovo's dependence on energy imports, as well as reduce the costs of energy resources. In this context, the works of M. Abid *et al.* (2023) emphasised the environmental benefits of solar photovoltaic systems, which confirms the need for a transition to sustainable development in the energy sector. It is important to note that the introduction of new technologies requires not only financial investments but also support from the state to create favourable conditions for the development of the relevant infrastructure (Trusova *et al.*, 2022). Both studies indicate that without political will and strategic planning, it is difficult to achieve significant results in this area.

The study on mitigation of economic losses and prospects for development is consistent with the findings presented in M. Banja *et al.* (2020). The study highlights the critical importance of the transition to renewable energy sources for the reduction of pollution and economic losses arising from the use of traditional energy sources. In particular, the study notes that the active implementation of renewable energy sources in Kosovo can significantly improve the environmental situation, which is also confirmed by the conclusions of M. Banja *et al.* (2020). However, if the research of scientists focuses on environmental aspects, the conducted research also points to the importance of social involvement of the community in the process of reforms. Scientists point to risks associated with insufficient communication and public involvement, which can lead to resistance to change. The conducted research emphasises that without a proper information campaign and active involvement of the population, energy reforms can be perceived as imposed, which increases the likelihood of social instability.

The study, which analyses the mitigation of economic losses and the prospects for the development of the energy sector, supports the key ideas presented in the work of A. Gjukaj *et al.* (2024b). In the study, the authors emphasise the need for a strategic approach to the transition to sustainable energy, emphasising the importance of integrating renewable energy sources to ensure economic stability. The results of the conducted research show that the direct implementation of investments in renewable energy sources will not only help to reduce dependence on imported energy carriers but will also create new jobs, which will positively affect the local economy. Studies highlight that a lack of proper communication between the government and the public can lead to a negative perception of reforms,

which in turn increases the risks of social instability. It is important not only to ensure technical changes but also to develop effective information campaigns to raise public awareness of the benefits of sustainable energy solutions.

The research conducted was based not only on the legal aspects but also on the wider economic consequences of the implementation of this environmental policy in Kosovo. While H. Rastegar *et al*. (2024) were quick to argue the importance of legislative alignment with the EU to drive innovation, authors explore how these legal reforms translate into economic opportunities and challenges. Compared to the findings presented in H. Rastegar *et al*. (2024) study on the impact of environmental policy on renewable energy innovation, this study offers a more economically oriented perspective on Kosovo's energy transition. M. Vyas *et al*. (2022) focused on increasing energy production in urban environments through innovations such as solar photovoltaic trees that maximise electricity production while minimising land use. The study emphasised the importance of optimising the ratio of land to electricity in densely populated areas, a concept that aligns with global trends for sustainable development and reducing the carbon footprint. The study did not delve into specific technological innovations, such as photovoltaic trees, but emphasised the broader economic opportunities offered by the integration of renewable energy sources, such as solar and wind, into Kosovo's national energy mix. Therefore, the results of the study are consistent with the ideas of scientists, emphasising that a strategic approach to the integration of sustainable technologies in the energy sector is critically important for reducing economic losses and ensuring sustainable development. It allows not only to reduce emissions but also to strengthen the country's economy, creating new jobs and improving the quality of life of the population.

CONCLUSIONS

The study reveals in detail the challenges faced by the country in the process of transition to sustainable energy development, as well as the prospects that open up to the energy sector in the context of integration into the European energy system. Special attention was paid to the issues of energy security, diversification of energy sources and introduction of "green" technologies. The study highlighted the importance of improving the efficiency of energy use and reducing greenhouse gas emissions to achieve sustainable development goals. Key laws were reviewed, such as Law No. 05/l-084 on the energy regulator, which regulates the operation of the country's energy market. It is important that the country implement more effective incentives for the development of renewable energy sources and ensure market stability through transparent regulatory mechanisms. A review of Kosovo's legal framework for compliance with European standards has shown progress in reforming the energy sector, but significant gaps remain, particularly in tariff regulation, licensing and market transparency. Analysis of national initiatives, such as the Kosovo Energy Sustainability Activity and Kosovo Energy Security of Supply programs, indicated successes in increasing energy efficiency and the development of renewable sources but also revealed the need for infrastructure modernisation. Economic analysis has shown the potential losses associated with the energy transition, including the risks of job losses in traditional industries such as the coal industry and the significant investment required to modernise the energy system. Despite these challenges, the long-term benefits, including increased energy security and environmental sustainability, far outweigh the short-term economic costs.

In general, the study emphasises the need for further reforms in the legislative framework, ensuring market transparency and attracting investments in energy infrastructure. Only through an integrated approach will Kosovo be able to ensure the sustainable development of the energy sector, compliance with European standards and the achievement of energy security. The main challenges are dependence on coal, an imperfect legal framework and insufficient investment in infrastructure. However, prospects include energy efficiency initiatives, the development of renewable energy sources and integration into European energy programs. Despite the need for significant investment, the transition to "green" energy promises economic and environmental benefits for the country. In the future, it is advisable to investigate several key areas related to the mitigation of economic losses and prospects for the development of the energy sector in the Republic of Kosovo. It is important to analyse the socio-economic factors influencing the implementation of renewable energy sources in order to identify barriers and opportunities for investment. Researching the effectiveness of policies supporting the development of renewable energy will allow improving approaches to attracting financing.

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None.

CONFLICT OF INTEREST

None.

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Пом'якшення економічних втрат та перспективи розвитку енергетичного сектору в Республіці Косово

Анотація. Метою дослідження було провести аналіз поточних економічних проблем в енергетичному секторі Косова та розробка ефективних стратегій їх подолання, зокрема шляхів мінімізації втрат і підвищення стабільності енергетичної системи, а також вивчення можливостей забезпечення довгострокового розвитку та енергетичної безпеки країни. Основна увага була зосереджена на економічному впливі впровадження міжнародних енергетичних стандартів, зокрема європейських, у національну політику та стратегію розвитку Косова. Аналіз підкреслив фінансові вигоди та виклики, пов'язані з приведенням енергетичного сектору країни у відповідність до директив ЄС, зокрема тих, що стосуються відновлюваних джерел енергії та енергоефективності. Ключові сфери дослідження включали економічний потенціал посилення енергетичної безпеки, сприяння розвитку відновлюваної енергетики та зменшення залежності від викопних видів палива. Проведено оцінку економічних наслідків реформ для енергетичного ринку Косова й загальної траєкторії економічного зростання. Дослідження також включало економічний аналіз, яким оцінено можливі економічні втрати, пов'язані з переходом на відновлювані джерела енергії. Розглянуто такі ризики, як втрата робочих місць у традиційних енергетичних секторах, таких як вугільна промисловість, і значні фінансові витрати, необхідні для модернізації інфраструктури. Однак дослідження показало, що довгострокові переваги переходу до «зеленої» енергетики, включаючи підвищення енергетичної безпеки, зменшення залежності від імпорту енергоресурсів і поліпшення стану навколишнього середовища, переважають короткострокові економічні витрати. Результати показали, що хоча економічний перехід супроводжується значними фінансовими витратами, довгострокові вигоди, такі як підвищення енергетичної безпеки та скорочення викидів, є суттєвими. Дослідження підкреслює важливість подальших реформ та інвестицій для забезпечення сталого розвитку енергетичного сектору Косова, а також інтеграції країни в європейське енергетичне середовище

Ключові слова: модернізація; сталий розвиток галузі; вплив реформ; залучення іноземного капіталу; інноваційні технології

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Optimization of direct supply chains in the restaurant industry: Addressing key challenges through technological innovation

Abstract. This study aimed to explore the potential of different supply channels in the restaurant industry, with a focus on optimizing direct supply using advanced technologies. By applying economic and statistical methods, the research analyses the role of large distributors and wholesalers in the United States food supply chain. While these supply chain participants support restaurant and manufacturer operations, they can also increase costs, reduce marketing and logistics control, and hinder the development of customer relationships. Direct supply presents significant advantages, such as improved brand loyalty, higher profit retention, and access to high-quality products. However, its growth is constrained by challenges like high marketing expenses and the implementation of same-day delivery. These costs include investments in advertising, technology platforms, CRM systems, and staff remuneration. Key obstacles to same-day delivery include staff shortages (especially drivers), high delivery costs, and inefficient logistics. The study suggests that technological solutions, including the development of direct access networks, automated promotional tools, and logistics infrastructure, can help mitigate these challenges. The Sample Box Marathon and Rgand Prime Fulfilment platforms are analysed as practical solutions that reduce costs and improve profitability. The findings of this research can provide valuable insights for producers and restaurants looking to optimize their supply chain operation

Keywords: distributors; wholesalers; same-day delivery; technology; customer loyalty; brand development

INTRODUCTION

The issue of choosing the most profitable and efficient supply channels, particularly in the restaurant industry, is a topic of active discussion among marketers and academics. For restaurants, choosing the right supply channel means being able to get a wide range of products of the right quality in the right time frame. For producers, the choice of distribution channel should be such that it takes into account both the needs of the consumer and their own, maximizing profits and minimizing costs. In the United States (US), wholesalers and distributors play an important role in the food industry, generating a significant share of the government's revenue. Most of their customers are independent restaurants, which are an integral part of the economic, social and cultural life. During the spread of the COVID-19 epidemic, many suppliers were threatened with bankruptcy, and this was a time when restaurants realized the importance of working directly with producers, as noted by E. Amel *et al.* (2020). US legislation is aimed at supporting the development of small farms that supply products to restaurants and beyond (O'Hara *et al.*, 2021). At the same time, such development is still hampered by a number of problems, such as high initial costs, as well as a lack of knowledge, human capital, etc. Therefore, optimizing direct supply in the restaurant industry is a crucial task both at the state level and at the level of individual business entities, and is a topical issue for discussion among scientists.

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Z.T. Plakias *et al*. (2020) noted the growing popularity of short supply chains among farmers in the United States. At the same time, the study highlights certain barriers to the development of this area related to the specifics of the industry. In particular, farmers are more likely to sell their products directly than livestock producers, and new farmers prefer direct sales. Researchers see the solution to the problematic issues in appropriate policy decisions, while a number of studies have revealed the pivotal role of technological means of optimizing direct supply. J.K. O'Hara & S.A. Low (2020) concluded that online marketplaces are a key tool for facilitating the development of DTC. It allows increasing competitiveness, as well as reducing the cost of finding customers and transportation. The researchers pointed out that online marketing offers great potential not only for metropolitan farms, but also for remote ones, for which access to customers depends on distance. J.L. Durant *et al*. (2023) found that online marketing and online sales increase farm resilience, particularly after the start of the global pandemic. The researchers emphasized that supporting small farmers engaged in direct-to-consumer sales is a strategic policy direction in the face of constant long-term and short-term disruptions in the agricultural sector. Other innovative solutions to support direct sales have been identified in some studies. M. Sitaker *et al*. (2020) described the Farm Fresh Food Box market innovation, which involved the sale of boxes of farm products directly to consumers. The researchers noted that this approach is an alternative way to expand the customer base and strengthen the brand for small producers.

In summary, direct sales are a promising choice for restaurants and farmers due to a number of the above advantages. However, it will take time and the implementation of effective solutions to overcome the barriers that hinder the development of this area. One of the important ways to optimise this is through the use of modern technologies and innovative solutions. The purpose of this study was to explore the possibilities of using alternative supply channels for restaurants and manufacturers and to identify areas for optimizing direct supply through the introduction of new technologies: Direct Trade Foundation, Sample Box Marathon and Rgand Prime Fulfilment. The objectives of the study were to determine the role of large distributors and wholesalers in the supply chain in the US restaurant industry and identify the market potential for manufacturers using direct supply; to analyse the marketing costs faced by manufacturers and the obstacles to the implementation of same-day delivery logistics; to investigate the impact of wholesalers and distributors on manufacturers' profits and characterize the additional costs they bring to the supply chain (Boston Consulting Group (BCG), 2022); to summarize the benefits that manufacturers receive from direct supply.

MATERIALS AND METHODS

The study used a system of scientific methods that allowed for the relevant analysis and description of the results. Economic and statistical analysis was the main method used to analyse the role of large distributors and wholesalers in the supply chain of the US restaurant industry. In addition to traditional methods, the integration of advanced technologies such as Artificial Intelligence (AI) and Blockchain has the potential to significantly enhance supply chain efficiency (Deloitte, 2023). AI can improve demand forecasting, automate inventory management, and streamline logistical operations, reducing costs and minimizing waste. Blockchain, on the other hand, provides transparency and security in tracking product movements, improving quality control and reducing risks associated with food safety. These technologies are becoming essential elements for further optimizing supply chain operations.

This method allowed us to analyse the structure of food distribution companies in the US by business type, the structure of food distributors' customers by business type, and the food service market shares covered by companies in the US. In addition, the article uses economic and statistical analysis to show changes in the values of the market capitalization and value of Sysco and US Foods over time. The method allowed comparing the results of the mentioned companies, which contributed to a deeper understanding of their role in the market. In addition, economic and statistical analysis was used to characterize the DTC Food Market size, including forecast values, which supported the conclusions about the market's potential and factors hindering its development. In addition, the method was used to analyse the percentage of companies (by volume of goods or services sold) that provide express or same-day delivery services. This made it possible to draw conclusions about the level of implementation of these delivery methods and confirm the existence of problems in this area in the DTC sector. The study compared the advantages and disadvantages of direct and indirect distribution channels. This comparison made it possible to evaluate distribution channels based on such criteria as control capabilities, impact on costs and profits, customer relations, impact on logistics, and delivery time. The use of the descriptive method allowed for a detailed and thorough description of the results. This method played a special role in characterizing the key technologies studied, namely the Direct Trade Foundation, Sample Box Marathon and Rgand Prime Fulfilment. The method allowed us to explain how these technologies work together to increase the chances of direct sales success, and what tools and tactics are used to do so.

The information base of the study was based on scientific and marketing articles, as well as information available in the public domain on the following resources: IFDA (The Economic Impact of the..., 2023), Seeking Alpha (Brink, 2022), Yahoo Finance (2024a; 2024b), GourmetPro (The Top 16 Food Distributors in the USA, 2024), Meticulous Research (DTC Food Market by Type, 2024), At the Margins (Anderson, 2022), Zoom2u (Effective Strategies for..., 2024), Investopedia (Ross, 2024), Masson International (Masson, 2024), McKinsey & Company (2023), The Food Institute (Wiklund, 2020), Rgand (2024). In addition, the study was based on the results presented in analytical reports, including The State of the Direct-to-Consumer (DTC) Industry – 2022 (Naceva, 2024) and State of Rural Enterprise Report (NICRE, 2024).

RESULTS

The role of large distributors and wholesalers in the supply chain in the US restaurant industry. These large distributors often serve as middlemen, offering restaurants a broad selection of goods while taking over logistical

operations. However, reliance on such intermediaries leads to higher costs and less control over marketing and logistics processes, limiting producers' direct access to customers. The food distribution industry in the United States generates about $382 billion in sales per year and makes a significant contribution to the country's gross domestic product (GDP), which reaches $87 billion (The Economic Impact of the..., 2023). When looking at the industry by type of distributor, it is worth noting that most companies are multidisciplinary distributors that provide their customers with a wide range of services (Fig. 1). Such companies offer a diverse range of products for different foodservice establishments. This state of affairs suggests that the US food distribution industry is able to meet a wide range of customer needs. The high share of multi-product distributors indicates a desire to minimize the number of supplies and simplify the procurement process, which reduces logistics costs and saves time.

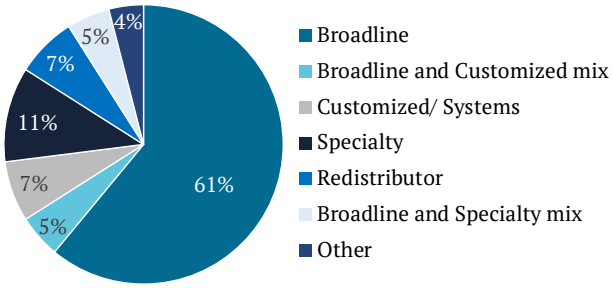

Figure 1. Breakdown of food distribution companies in the US by business type
Source: compiled by the author on the basis of The Economic Impact of the U.S. Foodservice Distribution Industry (2023)

Due to the fact that multidisciplinary distributors provide comprehensive services and can meet virtually any customer need, these companies are usually highly competitive in the market. The main customers of food distributors are independent restaurants, which account for more than half of the distributors' customer base (Fig. 2). Chain restaurants are second, accounting for almost 22% of the total number of customers. The differences in the provision of services to independent and chain restaurants may be that the former ones require a more personalized approach, including the need to provide a wide range of products. Therefore, food distribution companies in the US must meet high standards and be flexible and proactive enough to meet the needs of their key customers.

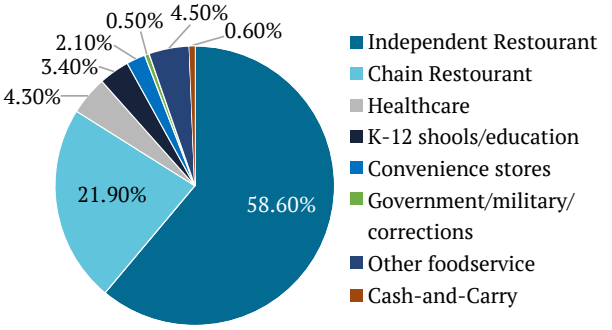

Figure 2. Breakdown of food distributors' customers by business type
Source: compiled by the author on the basis of The Economic Impact of the U.S. Foodservice Distribution Industry (2023)

Sysco and US Foods are the largest multiservice food distributors in the US. As shown in Figure 3, together these companies cover about a quarter of the foodservice market.

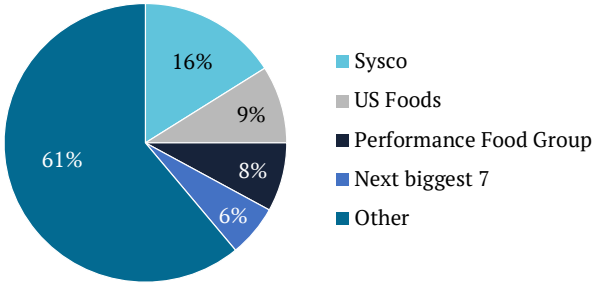

Figure 3. Foodservice market shares held by companies in the US
Source: compiled by the author on the basis of J.J. Brink (2022)

The Profit Margin for Sysco is 2.48%, while for US Foods this indicator reaches 1.42%. The Return on Equity (ROE) for Sysco reaches 99.41%, while for US Foods it is 10.86% (Yahoo Finance, 2024a; 2024b). Thus, both of these companies are profitable, but Sysco is much more efficient in using its equity to generate profits. Sysco's market capitalization and value are also significantly higher than US Foods', as can be seen in Figure 4. Sysco and US Foods combined cover over 25% of the U.S. foodservice market. Sysco, the larger of the two, maintains a competitive edge in terms of market share and profitability, with a 2.48% profit margin compared to US Foods' 1.42%. The return on equity (ROE) for Sysco reaches 99.41%, while US Foods stands at 10.86%.

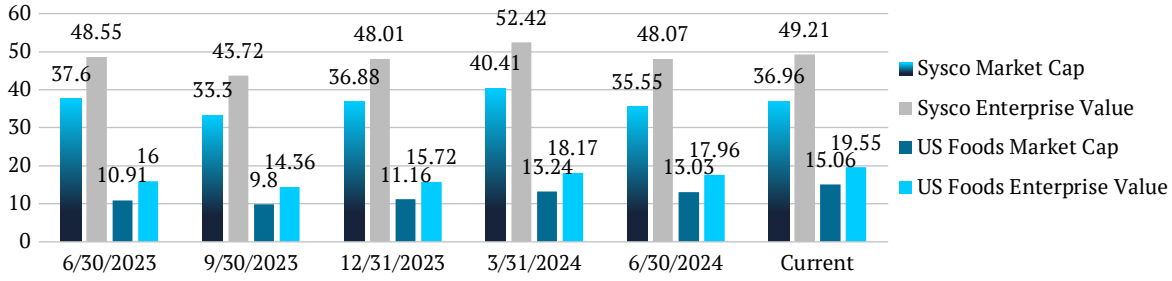

Figure 4. Market capitalization and valuIJe of Sysco and US Foods (USD billion)
Source: compiled by the author on the basis of Yahoo Finance (2024a; 2024b)

Sysco's annual revenue reaches USD 68 billion, while US Foods' figure is USD 28.1 billion. Sysco's customer base includes more than 700 000 customers and 333 distribution facilities, while US Foods has 300 000 customers and 70 distribution centres (The Top 16 Food Distributors in the USA, 2024). Sysco's success factors include high-quality service, an efficient supply chain, and a wide range of products offered to its customers. This range includes not only fresh and frozen food and beverages, but also equipment. US Foods has the advantage of offering its customers quality products under its own brand. A significant asset of the company is its high attention to environmental aspects, which is very relevant and important in today's environment.

When searching for supply channels, two options are most often focused on: direct and indirect supply (Rucabado-Palomar & Cuéllar-Padilla, 2020; Shi *et al.*, 2020). Indirect supply involves the involvement of distributors and wholesalers who can perform delivery and other tasks for a fee (Fowler, 2023). This effectively relieves producers of responsibility for the logistics process, but leads to additional costs due to the need to pay for intermediary services. Restaurants thus receive a wide range of products, but do not have sufficient control over the transparency of pricing and quality control processes. Direct supply eliminates intermediaries from the supply chain (González-Azcárate *et al.*, 2021; Paciarotti & Torregiani, 2021). Among all forms of direct marketing, the most popular is direct-to-consumer (DTC), which is used by about 77% of companies (Dorn, 2022). Direct procurement involves selling products directly to customers using online platforms (websites or mobile apps) or through stores or kiosks (Rivera *et al.*, 2020). Direct deliveries leave control over the logistics process to producers, allowing them to retain more of their profits and build better customer relationships. A relevant advantage for restaurants is access to high-quality farm products and the ability to choose more favourable prices (Pesci & Brinkley, 2021). At the same time, direct supply is associated with certain challenges, such as high initial costs and difficulties with same-day delivery. Therefore, choosing an approach to determining the supply channel is a crucial task for both producers and restaurants (Roy & Ballantine, 2020). Modern approaches emphasize the need for a thorough analysis before making such a choice, as well as the benefits of using the latest technologies (Bumblauskas *et al.*, 2020; Liu *et al.*, 2021).

These companies and other players in the food distribution market play a critical role in the US supply chain. They facilitate the work of restaurants by providing them with a wide range of products of the right quality, and provide additional services, optimizing their costs and logistics. At the same time, cooperation with distributors can pose certain challenges, in particular, restaurants become highly dependent on their suppliers and have limited ability to control the quality of the products supplied (Shtal *et al.*, 2024). Equally relevant is the issue of paying for distributors' services, which entails additional costs for restaurants – especially if the pricing policy is not transparent enough. The latter problem is particularly acute for small businesses, which may not have sufficient funds to pay for the services of distributors. In this case, businesses are increasingly turning to an alternative supply option – direct purchases from producers. The most popular form of purchasing directly from manufacturers is DTC. This option allows shortening the supply chain by eliminating intermediaries (wholesalers and distributors) from it (Fig. 5). Accordingly, restaurants do not pay for intermediary services, which not only helps to reduce costs but also allows them to manage their pricing policy more freely.

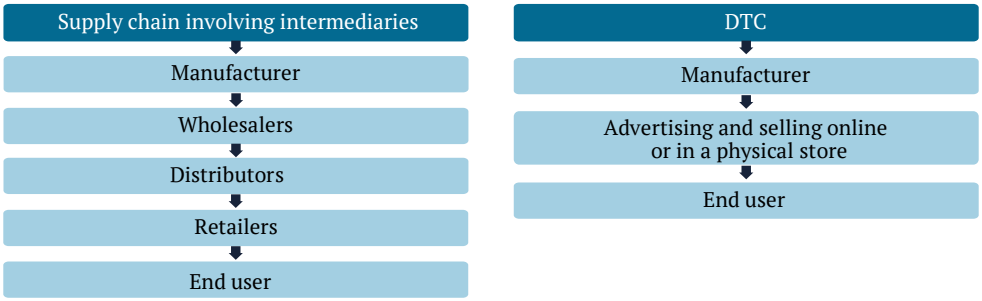

Figure 5. Differences in the intermediary and DTC supply chain
Source: compiled by the author based on data from J. Wiklund (2020)

Moreover, cooperation with producers can have a positive impact on brand building through greater quality control. The use of healthier farm products in cooking can increase the loyalty of modern consumers and meet their high demands. In order to explore the advantages and disadvantages of each of the supply options – cooperation with distributors and wholesalers or direct supply from producers – it is advisable to focus on the following aspects: analysis of producers' marketing costs and identification of challenges to implementing same-day delivery logistics; study of the role of distributors and wholesalers in the context of their impact on producers' costs; identification of the potential of direct supply for producers.

Analysis of marketing costs of manufacturers and obstacles to the implementation of same-day delivery logistics. Overall, the direct supply market is forecast to grow gradually until 2031 (Fig. 6). This can be attributed to the growing popularity of convenience foods, the increase in online shopping, and the growing number of DTC food brands. At the same time, a number of factors are hampering market growth, including lack of awareness of DTC brands, limited product range, quality issues, and delays in deliveries. The main opportunities for market growth come from sales of premium and personalized products. However, the key obstacle to market development is the high level of competition from other distribution channels (DTC Food Market by Type, 2024).

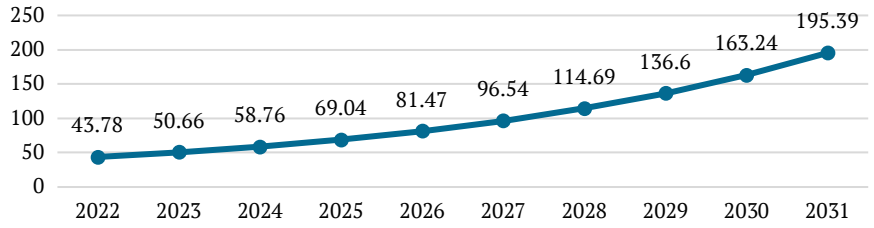

Figure 6. DTC Food Market size (USD billion)
Source: built by the author according to DTC Food Market by Type (2024)

In addition, high marketing and other costs are a significant obstacle to DTC's development. DTC appears to be more profitable than wholesale, as evidenced by the high gross margins. However, the operating margin in the case of DTC is often lower than that of wholesale. The main factors contributing to higher DTC costs are: high marketing costs – DTCs have to spend a lot on advertising to attract customers, which is not necessary in the case of wholesale channels, as stores attract their own customer base; technology costs, including technology platforms, CRM and analytics; human capital costs – DTC marketing programmes require numerous specialists to raise awareness, which also reduces operating margins (Anderson, 2022).

Speaking in more detail about marketing costs, it is impossible to ignore digital channels of promotion, as modern consumers often research products and various offers online. Today, searching on a search engine is the main way to get an online experience, preferred by more than 68% of users. Before making an online purchase, about 85% of consumers do some form of online product research. Google Ads is one of the most popular promotion tools, but more than 60% of companies in the DTC sector do not use this method. Those companies that do use Google Ads spend less than $5,000 per month on it, while receiving less than 500,000 visitors in the relevant period. However, for 7% of companies, marketing costs range from $10,000 to $50,000 per month (Naceva, 2024). This suggests that most DTCs do not fully utilize the potential of online promotion.

At the same time, even moderate investments in this area can solve a number of problems with customer acquisition and awareness. In addition, online promotion (depending on specific approaches and channels) is often cheaper than traditional advertising, which can help reduce marketing costs. Therefore, marketing costs in the case of DTCs can be high, but they solve a number of problems, including: providing new marketing opportunities and increasing gross margins, allowing for better control over sales, diversifying income and reducing risks, etc. The key barriers to the development of DTC marketing activities are lack of economic opportunities, low demand, lack of relevant knowledge and skills, lack of time, lack of labour with the required qualifications, and underdeveloped market, transport or technological infrastructure (NICRE, 2024). Along with marketing, same-day delivery costs can be a significant cost item in the DTC context. According to statistics, less than half of DTC merchants of any size offer express delivery services. Only for sellers whose size reaches more than USD 100 million (in terms of goods or services sold), this figure is 56%. The share of companies offering same-day delivery services is even lower (Fig. 7).

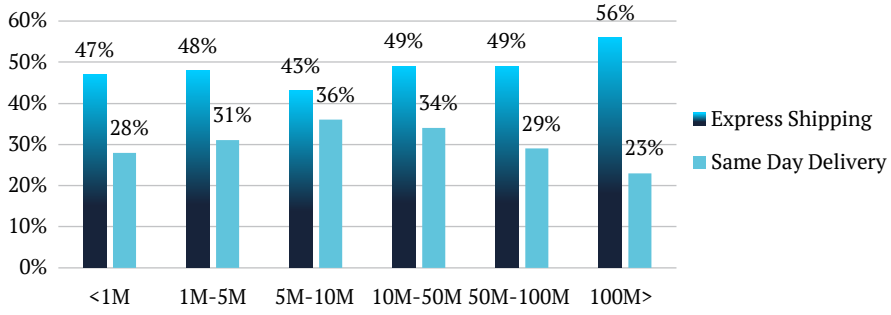

Figure 7. Percentage of companies (by volume of goods or services sold) providing express or same-day delivery services
Source: compiled by the author based on data from N. Naceva (2024)

At the same time, same-day delivery is an essential competitive advantage for DTC and one of the main expectations of modern consumers. Challenges to the effective implementation of same-day delivery include a limited number of staff (including drivers), high delivery costs, and inefficient logistics solutions. The process is becoming increasingly complicated as the distance between warehouses and customers grows, and as the need to track the movement of goods in real time increases.

The strategic use of technology is crucial to improving the overall delivery process, as well as same-day delivery. Such technologies include artificial intelligence, which allows optimizing delivery routes by identifying the most efficient and least costly ones in terms of fuel savings and reduced operating costs. Another effective technology is Geofencing, which identifies delivery zones, saving time and resources for deliveries outside these zones. In addition, significant results can be achieved by automating

dispatch processes, which allows managing the delivery schedule and assigning orders to drivers based on their location and other factors. For customers, an important option is the ability to track their orders, which increases their loyalty and reduces the workload of the customer support team (Effective Strategies for..., 2024). The use of these means of improving logistics efficiency should be guided by the principles of integrity, flexibility, and adaptability.

Study of the impact of wholesalers and distributors on producers' profits and costs. As noted above, distributors, wholesalers and other intermediaries simplify the delivery process, but other problematic aspects accompany their involvement. On the one hand, the use of intermediaries can help reduce start-up costs and relieve the company of responsibility for certain stages of the process. On the other hand, the use of intermediary services entails additional costs, which, among other things, may increase the cost of goods for consumers. Also, indirect supply may slow down the delivery process. Therefore, producers should be careful when choosing a distribution channel, taking into account that the latter should serve as a means of increasing value for customers and meet the producer's goals. Table 1 compares direct and indirect distribution channels.

Table 1. Comparison of direct and indirect distribution channels

Comparable aspect	Direct channel	Indirect channel
Control options	The manufacturer fully controls and is responsible for delivery	Reduces control and increases dependence on intermediaries
Impact on costs and profit	Initial costs are usually higher than for an indirect channel, but may increase with efficiency and decrease over time. Higher profits can be achieved by retaining a larger share of the profit with the producer	In this case, the initial costs are usually lower, but additional costs are incurred due to intermediary fees, which vary depending on the range of services provided. Profit is shared with others (intermediaries)
Customer relations	More opportunities to build trusting and strong relationships with customers, which helps to increase their brand loyalty and receive meaningful feedback	Interaction with clients is indirect, which can lead to problems that are difficult to control if intermediaries act inappropriately
Impact on logistics	Producers are responsible for their own logistics	Logistics issues are transferred to intermediaries
Delivery time	It is usually lower due to the construction of a direct route	May be longer and depends on the third party

Source: summarized by the author according to S. Ross (2024)

Thus, with direct deliveries, producers gain more control and opportunities to build good relationships with customers, which leads to increased brand loyalty. As for costs, in the case of direct deliveries, they may be higher in the initial stages, while paying for intermediary services requires ongoing financial investments. Looking more closely at the costs associated with indirect distribution, the average margin of intermediaries in the B2B sector selling to the end consumer is between 30 and 40 per cent (Masson, 2024). However, this is only an estimate, and the percentage may vary depending on the industry, final price, sales volume, services provided by the intermediary, and other factors. In general, the distributor's markup (margin) is the percentage that characterizes the difference between the cost of goods and the selling price.

As it is known, the average profit margin for a restaurant is between 3 and 5%. At the same time, the large distributors mentioned above earn much higher profits. This may be due to a number of tactics used by distributors to increase their own profitability, including: overpricing – selling goods to restaurants at a price that is significantly higher than the market price; mismatching the quantity of goods – refers to cases when an intermediary delivers goods in quantities less than the restaurant's order without warning; replacing products with cheaper analogues; adding hidden fees; pressure from the distributor to enter into an exclusive contract, which limits restaurants from finding other suppliers, that may subsequently lead to additional forced costs; the use of various unfair marketing techniques, such as attracting the restaurant's attention with favourable offers and then urging them to buy more expensive products after signing the contract; low transparency, which makes it difficult to verify payments; encouraging the purchase of more products than the restaurant needs, which leads to the formation of surplus products. Therefore, restaurants should be very careful when entering into agreements with intermediaries and consider their reputation. Various technological solutions can be a great advantage in this case, allowing to compare the distributor's prices with the market average, analyse contracts, store information in an orderly manner in the cloud.

Summarizing the benefits that producers gain from direct supply. It is worth summarizing the potential of direct sales for manufacturers. The main advantages of DTC encompass: greater opportunities to build trusting relationships with customers and increase their loyalty, personalization, and feedback; the ability to collect customer data, in particular, using the Google Ads tool described above (Wiklund, 2020); positive impact on brand reputation; the ability to earn higher profits, increase their share in the price of the final product; greater control over price, promotion, customer service, logistics (Feher & Macsai, 2009); possible reduction of logistics time; usually higher product quality, environmental friendliness; shorter distance to the consumer, which allows for the supply of fresh and high-quality products without preservatives; diversification of income sources and risks.

Application of Direct Trade Foundation, Sample Box Marathon and Rgand Prime Fulfilment technologies for successful direct sales. As noted, modern technologies and innovative approaches are being successfully applied to improve various aspects of direct sales. The Direct Trade Foundation, Sample Box Marathon and Rgand Prime Fulfilment allow modern manufacturers to be visible, recognizable and achieve high sales. The Direct Trade

Foundation, founded by Rovshan Rasulov, CEO of Rgand, is a programme that allows manufacturers and hospitality companies to trade directly and accelerate their development by eliminating all intermediaries. The programme includes practical experience in direct trade. In addition to investments, the Fund provides a direct access network, automated product promotion technology and logistics infrastructure that significantly reduces costs and generates more profit from each sale.

The programme offers manufacturers the opportunity to digitize and automate their marketing, sales and logistics processes with a fully automated product promotion solution. It enables manufacturers to automate sample testing to attract new direct customers without having to spend on expensive distributors, showrooms, and fairs with product reviews from restaurants and hotels that make the decision. Restaurants can try new products with each Rgand Sample Box and purchase them with one click. The programme's key offerings include direct sales training and mentoring; access to the Rgand Marketplace platform; tools to automate product promotion; reliable logistics support and order fulfilment; and investments to facilitate market entry. Samplebox Marathon is a practical implementation of training programmes. Within 90 days, the company helps manufacturers test and improves their strategies, achieving significant results in a short time. Rgand Direct-to-Buyer Marketplace allows manufacturers to manage their catalogue, orders, and transactions on a dedicated platform. Restaurant operators discover new brands from all over the world thanks to direct sales prices and promotions from manufacturers. It works like this: manufacturers send their Rgand Marketplace product range directly to Rgand fulfilment centres. When customers purchase products on Rgand.com, the company receives the order, collects, packs and ships them directly to the manufacturer's customers. Rgand Prime Fulfilment provides an integrated warehousing and same-day fulfilment solution that reduces storage and shipping costs for manufacturers. It fulfils and delivers all orders for restaurants, hotels, and cafés across the US (Rgand, 2024). The key concept of this programme is that any product must go through three main stages: visibility – the product must be visible in the market; recognition – the product must be recognizable among potential buyers; and marketability – only after achieving visibility and recognition does the product become marketable.

As a result of the study, it is advisable to summarize the opportunities provided by the use of new technologies in the restaurant business in terms of optimizing the supply process. Firstly, it is worth noting the automation of supply processes, which can be implemented through the introduction of Supply Chain Management (SCM) systems. The capabilities of such systems help to reduce delays and costs in the supply process. In addition, restaurants can use inventory management software. This allows for real-time updates on available inventory and reminders to order products that are running low in time. Another easy-to-implement and effective solution is to use online platforms that allow placing orders with suppliers in a convenient format. The advantage of this approach is the convenience of electronic payments, as well as the ability to choose local suppliers, which will minimize the transportation route and ensure the freshness of the products. Data analytics is a useful tool for analysing and forecasting demand and analysing feedback. In this way, a restaurant can significantly improve its supply planning in line with current market requirements. Another useful technology in terms of achieving a high level of product quality is the Internet of Things. This method uses special devices to assess the condition of ordered goods as they move along the supply chain. As for other new technologies that enable effective product tracking, it is worth highlighting the use of QR codes. This technology makes it possible to determine the origin of goods, which, among other things, ensures greater transparency of supply. For restaurants that have sufficient funds at their disposal, the use of equipment that integrates with software, such as an inventory management system, as well as equipment with smart sensors (temperature, etc.), can be a useful tool. Thus, the introduction of these technologies into a restaurant's operations not only optimizes the supply process, but also improves customer service by ensuring the availability and high quality of food.

DISCUSSION

This study confirms the significant impact of large distributors and wholesalers on the food market. On the one hand, these business entities simplify the supply process for producers and restaurants, but cooperation with them is accompanied by a number of disadvantages. One of the most significant is the increase in costs caused by intermediary fees. At the same time, direct supply opens up wider opportunities for restaurants and producers: for the former, it means increased independence in choosing prices and products, improved transparency, access to fresh farm products, and higher quality control. For producers, it means retaining a larger share of profits and reducing costs associated with paying for services, better customer relations, and brand development (Teta & Xhafka, 2023). However, the use of direct sales also has a downside and is accompanied by problems with same-day delivery and high marketing costs. The study proposes an approach aimed at mitigating such problems through the use of Direct Trade Foundation, Sample Box Marathon and Rgand Prime Fulfilment technologies, which allow manufacturers to be visible, recognizable and achieve high sales. This approach offers producers a wide range of opportunities through mentoring, access to a specialized e-platform and automation tools, as well as reliable logistics and investment support.

The conclusions of the study are consistent with the results of other authors on the importance of developing direct sales in modern economic conditions. A. Bolo (2020) noted the growing importance of direct sales in Guadeloupe in the context of the COVID-19 pandemic. The scientist found that in the context of the pandemic, when restaurants and other food establishments were closed, farmers began to adapt to the situation through the use of direct sales. In the future, according to the scientist, this trend should be maintained by preserving the initiatives launched during the quarantine period. This can be done by raising awareness of agroecological approaches, informing about the benefits and quality of farm food, and promoting local production through the implementation of

appropriate policy decisions (Shahini *et al.*, 2023). According to the study by A. McLeod & J.M. Halstead (2020), it can be summarised that the purchase of products directly from farmers by restaurants increases their competitive advantage. The researchers found that modern consumers do not always want to buy their own food from farmers, but still want to consume high-quality and environmentally friendly food. In this case, restaurants can strengthen their brand and increase customer loyalty through direct cooperation with farmers. At the same time, researchers in New Hampshire have found that restaurants offering less than 750 meals per week and establishments that have been making food-purchasing decisions for more than two years do not show a tendency to buy local products. Scientists see the solution to the lack of popularity of direct purchases of local food in raising awareness of the importance of knowing where the food comes from and what quality it is.

Meanwhile, in the above-mentioned studies, researchers did not note the potential of using new technologies to increase the demand for purchases directly from farmers. In the author's work, this approach is identified as a priority, which is supported by the findings of other researchers. For example, E. Horská *et al*. (2020) investigated the factors influencing the sale of local farm products in Slovakia. The researchers found that farmers seek to optimize their supply chains by selling their products via the shortest possible routes. The most commonly used sales tools are on-farm sales and telephone orders. Scientists have noted that in this way, farmers may miss out on certain benefits that are revealed by other tools, such as farmers' markets or e-commerce. S. McKee *et al*. (2023) and N.L. Kim *et al*. (2021) also noted the benefits of selling directly to consumers through electronic channels, exploring the determinants of consumer attitudes towards direct sales and factors influencing the decision to repeat a purchase.

A number of works emphasize that both direct and indirect sales have their advantages and disadvantages, so the choice of a particular channel (or a combination of several) depends on the specific situation. The results of the work of S. Azima & P. Mundler (2022) prove that both the choice of a channel involving intermediaries and direct supply have their own strengths. The researchers studied the potential social and economic benefits that farmers receive through the use of short food supply chains in Canada. For example, the involvement of intermediaries reduces the workload of farmers, as it frees them from the obligation to handle marketing and logistics tasks themselves. At the same time, direct sales allow for better control over these processes, although they may have lower profitability due to high logistics and marketing costs (Galkin *et al.*, 2019), which was also emphasized in the author's work with some ways to solve the problems. X. Pu *et al*. (2020) studied different strategies for distributing their products by manufacturers – direct sales, reselling (selling products by the manufacturer through an online store) and agency sales. The authors showed that, given the low transaction costs (compared to online sales and agent commissions), direct sales are the optimal channel for a manufacturer. Accordingly, selling through an online store is the preferred option, provided that the online channel has low operating costs. Agent sales can be chosen in case of low commission fees (Sinoimeri *et al.*, 2024). At the same time, the conclusions of the author's work somewhat differ from these results. In the author's study, cost reduction is not the only criterion for choosing a supply channel, as the quality of services provided by intermediaries, the ability to build relationships with customers, increase brand awareness, etc. also play an important role for manufacturers. Therefore, a multi-criteria approach is advisable before making a decision on the choice of a supply channel.

Some studies give preference to wholesale sales. In contrast to the author's study, B. Lee *et al*. (2020) concluded that wholesale is a more profitable option for farms in Taiwan. The researchers focus on the link between farm profitability and the choice of marketing channels, while noting that the government supports direct sales as the demand for safe food is growing. One might agree with these conclusions if one takes into account the choice of marketing channel only for reasons of increasing sales. However, the approach proposed in the author's article allows ensuring high sales volumes even if direct supply channels are chosen, which is possible with the use of the technologies described in this paper. In addition, it is difficult to achieve a long-term positive effect for manufacturers based on sales volume alone, since their development depends on other factors, including increasing customer loyalty, brand building, quality of services, etc. (Artyukh *et al.*, 2023)

A comparison of the author's research with other works has revealed both common and distinctive features in the conclusions drawn. This may be due to the fact that the impact of the advantages and disadvantages of direct and indirect supply significantly depends on the context, industry, implementation approaches, etc. However, the author is inclined to argue that it is in the restaurant business industry that direct sales can have the great advantages described in the paper. Moreover, the innovative approach proposed in the paper regarding the use of Direct Trade Foundation, Sample Box Marathon and Rgand Prime Fulfilment technologies can be a significant step forward in terms of its complexity and ensuring the implementation of the concept of "being visible, recognizable and achieving high sales".

CONCLUSIONS

Direct supply offers a number of benefits for restaurants, producers, and consumers. First and foremost, it offers opportunities for these supply chain participants by cutting out intermediaries – cost savings, better control over the distribution process, positive brand exposure and improved product and service quality. This paper outlines the role of large distributors and wholesalers in the supply chain of the US restaurant industry. These intermediaries play a pivotal role by simplifying the distribution process for restaurants and manufacturers, but their involvement is associated with several challenges. One of the main problems is the increase in the cost of paying for intermediary services, especially in the case of non-transparent pricing and insufficient control over product quality. On the other hand, direct supply offers significant potential for producers and restaurants, which is reflected in the development of customer relationships, brand strengthening, better control over marketing and logistics, and the ability to retain a larger share of profits.

In turn, direct deliveries are not without their drawbacks. The paper notes the high marketing costs associated with direct deliveries, as well as the problems that arise when implementing same-day delivery. High marketing costs are driven by the need to pay for advertising, the cost of using technology platforms, CRM and analytics, and labour costs. Barriers to the development of same-day delivery include a shortage of staff (drivers), high delivery costs, and inefficient logistics solutions. Additional problems are caused by the considerable distance from warehouses to customers and the need to track goods in real-time. The paper proposes solutions to these problems based on the use of modern technologies. In particular, a positive contribution is expected from the use of digital promotion channels and the strategic use of technologies in general, such as artificial intelligence, geofencing, and automation.

The study focused on the use of Direct Trade Foundation, Sample Box Marathon and Rgand Prime Fulfilment technologies for successful direct sales. These technologies allow the implementation of the concept of "being visible, recognizable and achieving high sales". The practical application of the proposed approach can provide farmers with comprehensive support – from mentoring to providing technological solutions for direct sales. Further research could focus on a more detailed study of ways to reduce producers' marketing costs using new technologies and suggest the most effective online promotion strategies. In addition, future research could explore the integration of blockchain technology and advanced logistics management tools, such as artificial intelligence and IoT, to further enhance the transparency and efficiency of direct supply chains. Developing sustainable strategies for reducing delivery costs and overcoming logistical challenges, especially related to same-day delivery, will be crucial in optimizing direct supply methods. Producers and restaurants stand to benefit from implementing these advanced technologies, as they offer more streamlined processes, lower operational costs, and better adaptability to market demands. The broader application of these findings in international markets should also be studied to assess the generalizability of these solutions beyond the U.S. Limitations of the study include the fact that it focused exclusively on the US market, so the conclusions may differ slightly in other regions of the world.

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CONFLICT OF INTEREST

None.

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Оптимізація прямих ланцюгів постачання в ресторанному бізнесі: Вирішення ключових проблем за допомогою технологічних інновацій

Анотація. Це дослідження мало на меті вивчити потенціал різних каналів постачання в ресторанній індустрії, з акцентом на оптимізацію прямого постачання з використанням передових технологій. Застосовуючи економічні та статистичні методи, в дослідженні проаналізовано роль великих дистриб'юторів та оптових торговців у ланцюгу постачання продуктів харчування в Сполучених Штатах. Хоча ці учасники ланцюга поставок підтримують діяльність ресторанів і виробників, вони також можуть збільшувати витрати, знижувати маркетинговий і логістичний контроль і перешкоджати розвитку відносин з клієнтами. Прямі поставки мають значні переваги, такі як підвищення лояльності до бренду, збільшення прибутку та доступ до високоякісних продуктів. Однак його зростання стримується такими проблемами, як високі маркетингові витрати та впровадження доставки в той самий день. Ці витрати включають інвестиції в рекламу, технологічні платформи, CRM-системи та оплату праці персоналу. Основними перешкодами для доставки в день замовлення є нестача персоналу (особливо водіїв), висока вартість доставки та неефективна логістика. Дослідження припускає, що технологічні рішення, включаючи розвиток мереж прямого доступу, автоматизованих інструментів просування та логістичної інфраструктури, можуть допомогти пом'якшити ці проблеми. Платформи Sample Box Marathon та Rgand Prime Fulfilment проаналізовані як практичні рішення, що зменшують витрати та підвищують прибутковість. Результати цього дослідження можуть стати цінною інформацією для виробників і ресторанів, які прагнуть оптимізувати свої ланцюги поставок

Ключові слова: дистриб'ютори; оптовики; доставка в день замовлення; технології; лояльність клієнтів; розвиток бренду

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Assessment of the economic value of physiotherapy treatment for economically effective results

Abstract. The purpose of the study was to compare the pricing of physiotherapy treatment in various countries of the world. A comparative analysis of the cost of physiotherapy was conducted in the United Kingdom, Germany, Slovenia, Spain, Switzerland, Ireland, Canada, Indonesia, New Zealand, and Australia. The cost of physiotherapy was calculated considering 10 sessions per course of treatment in each clinic. The study determined that the cost of physiotherapy and massage varied substantially depending on the region and the medical institution. In the London clinic, the cost of 10 sessions of physiotherapy ranges from USD 721.62 to USD 1,818.49, depending on the duration of the procedures, and

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10 massage sessions – from USD 787.23 to USD 1,115.24. In Switzerland, the same 45-minute course of physiotherapy costs USD 1,150, and an hour-long massage – USD 1,100. Financial costs for these procedures are substantially lower in Slovenia and Indonesia. In a Slovenian clinic, a course of 10 sessions of physiotherapy costs from USD 331.1 to USD 551.83, and massage – from USD 364.21 to USD 540.79. In Indonesia, the same course of physiotherapy is offered for USD 590.21-780.95, and massage – for USD 394.75-592.12. The cost of physiotherapy and massage procedures was directly related to the level of life and economic conditions in the country. In the United Kingdom and Switzerland, high health costs are explained by a high level of life and a developed medical infrastructure, while in Slovenia and Indonesia, services are more accessible to the public. Based on this, the most economically profitable solution for physiotherapy and massage is the introduction of batch sessions, which reduces the cost per session overall. In addition, financial costs are reduced due to reduced time for the procedure and the use of telemedicine during the rehabilitation session. This study helps to assess the pricing of physiotherapy procedures and further optimise national schemes with the formation of the most financially effective programmes

Keywords: cost of rehabilitation; financial benefits; therapy costs; return on investment; reduced costs

INTRODUCTION

The analysis of the economic prospects of physiotherapy treatment is becoming increasingly important in the field of medicine, where attention is paid, in particular, to cost optimisation. For example, physiotherapy can substantially increase the quality of life of patients, but for the development of effective physiotherapy programmes, it is important to consider its economic value, which is especially important against the background of growing health costs. This subject requires in-depth analysis to identify the most effective methods of physiotherapy in terms of costs and clinical results. The relevance of analysing the economic prospects of physiotherapy treatment is also due to the increasing burden on healthcare systems, especially in conditions of increasing life expectancy and chronic diseases. Such patients require long-term treatment and rehabilitation, which increases costs. In this regard, researchers around the world are examining economically effective solutions that will improve treatment outcomes while reducing the financial burden on the patient and healthcare.

A study by L.G. Oestergaard *et al*. (2020) evaluated the economic efficiency of rehabilitation with the participation of a specialist in patients after lumbar spinal fusion. Intervention costs amounted to EUR 3,984 (USD 4,375), which was offset by a partial reduction in hospital treatment costs by EUR 1,716 (USD 1,884). The disability index and quality of life indicators did not indicate an improvement, despite additional efforts in rehabilitation. The overall probability that this intervention was economically effective did not exceed 56%. Physiotherapy was more economically effective compared to arthroscopic partial menisectomy (APM) in patients with non-obstructive meniscus rupture. As indicated by V.A. van de Graaf *et al*. (2020), after 24 months, the cost of physiotherapy was substantially lower than for APM, with a difference of EUR 1,803 (USD 1,979.96). The probability that physiotherapy was economically effective was 100%.

A group of researchers, headed by N. Oldridge & R.S. Taylor (2020) established that physical exercises in patients with ischaemic heart disease, chronic heart failure, and a body weight index of ⩾25 kg/m^2 showed high economic efficiency in 63% of cases. In 26% of cases, interference was recognised as "not economically effective". Differences in the probability of economic efficiency ranged from 23% to 100%. A paper of Q. Louw *et al*. (2020) examined the economic value of post-stroke rehabilitation. It was calculated that early rehabilitation has a high ratio of costs and benefits for state structures. The cost of the programme was 3,322.21 per patient, while the potential economy based on return to work was estimated at USD 76.1 million for five years.

Group and individual physiotherapy after corticosteroid injection for subacromial impingement was considered in a paper by I. Ryans *et al*. (2020), evaluating its efficiency and economic integrity. The study involved 136 patients who measured their shoulder pain index and disability at week 26. Group physiotherapy was cheaper per patient. C. Merino-Osorio *et al*. (2020) evaluated the economic effectiveness of round-the-clock physiotherapy (24/7-PT) administration in the intensive care unit. Cost and benefit analysis was performed for 697 hypothetical hospitalisations of adult patients with cardiovascular and respiratory diseases. The results showed that the introduction of 24/7-PT allowed saving USD 16,242 in the first year and USD 69,351 in 5 years. Of the 30 scenarios reviewed, 87% demonstrated a clean economy. C.M. Orndahl *et al*. (2021) analysed the cost and value of physiotherapy among patients after knee arthroplasty. The results showed that physiotherapy was more expensive for the subgroup with a negative outcome: in the period of 2-6 months, the cost of improving 1 unit of the pain scale and physical function was USD 5,181.22, compared to USD 437.87 for the group with a good outcome. By 12 months, the indicators had worsened for the group with negative results.

Economic efficiency with specific cases in physiotherapy has been examined by many researchers, but general data on pricing for rehabilitation services and the most favourable financial approaches in this field were not considered. The purpose of the study was to compare the costs of physiotherapy treatment in different countries to better understand the pricing of this service in the world and optimise the choice of rehabilitation complexes, followed by the formation of national rehabilitation programmes.

MATERIALS AND METHODS

For the study, information was sought with pricing for physiotherapy and other related services in private clinics in the United Kingdom, Slovenia, Germany, Switzerland, Spain, Ireland, Canada, New Zealand, Indonesia, and Australia. Private clinics that provide physiotherapy services, the prices of which were publicly available, were selected for analysis. Table 1 shows the clinics and their services

used in this study. As a standard treatment programme, a course of 10 sessions of physiotherapy treatment and 10 sessions of massage was taken. The lowest and highest cost of physiotherapy treatment and massage was calculated, depending on the time (30, 45, 60 minutes of therapy) and the cost per session. The cost calculations of the rehabilitation course are presented in the original currency and the main results were converted to the US currency for a better understanding of the difference in prices. During the study, both individual and package offers for physiotherapy sessions and massage were compared to determine the benefits of buying packages in comparison with individual sessions. Package offers often included a certain number of sessions with a discount. In addition, the study paid attention to financial availability for physiotherapy with the use of telemedicine and visits of a specialist to the patient's home.

Table 1. Clinics and physiotherapy services provided

Country	Services
East London Physiotherapy and Sports Medicine Clinic in the United Kingdom	Physiotherapy of various levels (+packages of 5 and 10 sessions) and duration from 30 to 60 minutes; deep tissue massage; sports massage.
Floramare Health Resort clinic in Slovenia	Physiotherapy of various duration from 30 to 60 minutes; manual therapy; body massage of various duration from 15 to 45 minutes; massage packages of 3 and 5 sessions.
Health Centre at Maximiliansplatz Physiotherapy and Training Clinic in Germany	Physiotherapy of various duration from 30 to 60 minutes; classic massage of various duration from 20 to 60 minutes.
Zenith Physio Pilates clinic in Switzerland	Physical therapy with face-to-face meetings from 30 to 45 minutes; physical therapy from a virtual meeting; therapeutic massage from 60 to 90 minutes.
Valencia Physio clinic in Spain	Physiotherapy with different session duration from 30 to 60 minutes; package of 5 physiotherapy sessions 30-45 minutes; sports massage for 45 minutes; relaxing massage lasting 60 minutes; package of 5 massage sessions.
Nextlevel Physiotherapy Clinic in Ireland	Physiotherapy with different duration from 30 to 40 minutes; home visit of a physiotherapist lasting 45 minutes; online consultation of a physiotherapist with a 30-minute session; sports massage – 40 minutes.
Toronto Physiotherapy clinic in Canada	Physiotherapy with different directions with different duration from 30 to 60 minutes; massage with a session from 30 to 90 minutes.
Physio Melbourne clinic in Australia	Physiotherapy with telemedicine consultation of various duration from 25 to 60 minutes; classical and sports physiotherapy; restorative massage with sessions from 45 to 60 minutes.
The Studio Move Well clinic in New Zealand	Physiotherapy of various duration from 30 to 60 minutes in personal and group sessions; massage lasting 30 and 60 minutes.
Physioactive clinic of Indonesia	Physiotherapy with a visit to the clinic or a home visit of a specialist; online consultation with a physiotherapist or telemedicine treatment; classical massage.

Source: compiled by the authors

For the subsequent analysis, studies that examined the economic effectiveness of physiotherapy, massage, and rehabilitation were considered. Economic assessment of programmes and specific exercises and the addition of physiotherapy in parallel with classical treatment were considered.

RESULTS

Physiotherapy treatment in private clinics is conducted in a wide range. From the services provided in many clinics, rehabilitation is performed after surgical intervention, for headaches and migraines, neck and back pain, chronic pain, the consequences of injuries, osteoporosis, osteoarthritis, and other pathologies. Depending on the patient's condition and disease, a rehabilitation plan is drawn up indicating the number of necessary sessions. Payment for the physical therapy assistance provided can be made at the expense of the patient or the insurance company with which the patient has a contract. Investing in physiotherapy, even at a relatively high cost, reduces the need for expensive medical intervention in the future, which is economically justified from the standpoint of a long-term perspective.

Table 2 shows the pricing of physiotherapy treatment at the East London Physiotherapy and Sports Medicine Clinic in the United Kingdom, considering the different levels and times per session. Based on the table, the minimum cost for 10 rehabilitation sessions of 30 minutes is GBP 550 (USD 721.62), and the maximum cost for 10 sessions of 60 minutes is GBP 1,386 (USD 1,818.49). For 10 massage sessions of 30 and 60 minutes, the cost ranges from GBP 600 to GBP 850 (USD 787.23-1,115.24), respectively.

Table 2. Price list for physiotherapy treatment in a private clinic in the United Kingdom

Physiotherapy (add. data)	30 minutes/GBP	45 minutes/GBP	60 minutes/GBP
Level 1	55	70	80
Tier 2	60	75	85
Tier 3	65	85	95
Tier 4	73	95	105
Tier 4 – Package of 5	347	451	499
Tier 4 – Package of 10	657	855	945
Tier 5	77	116	154
Tier 5 – Package of 5	366	551	732
Tier 5 – Package of 10	693	1,044	1,386
Massage			
Deep tissue massage	60	75	85
Sports massage	60	75	85

Source: compiled by the authors

In Slovenia, in the clinic Floramare Health Resort, a course of physiotherapy from 10 sessions of 30 minutes is EUR 300 (USD 331.1), which is the minimum indicator. The maximum cost for 10 sessions of 60-minute procedures is EUR 500 (USD 551.83). For 10 massage sessions of 30 minutes, EUR 330 (USD 364.21) is charged, and for 10 sessions of 45 minutes – EUR 490 (USD 540.79). In this clinic, the maximum time for a massage session is 45 minutes. Table 3 shows the pricing of rehabilitation services in this clinic.

Table 3. Price distribution for physiotherapy and massage in the clinic Floramare Health Resort in Slovenia

Types of treatment	Time	Cost
Special procedures		
Physiotherapy treatment	60 min	EUR 50
Physiotherapy treatment	45 min	EUR 45
Physiotherapy treatment	30 min	EUR 30
Manual therapy		
Body massage	15 min	EUR 22
Body massage	30 min	EUR 33
Body massage	45 min	EUR 49
Therapeutic massage-a package of 3 massages	3×15 min	EUR 55
Therapeutic massage-a package of 5 massages	5×30 min	EUR 90

Source: compiled by the authors

Table 4 shows the price list for physiotherapy and massage treatment in a German clinic. For 10 sessions of physiotherapy treatment for 30 minutes at the Health Centre at Maximiliansplatz Physiotherapy and Training Clinic in Germany, the cost will be EUR 450 (USD 496.64), for 10 sessions of 60 minutes – EUR 900 (USD 993.29). The cost of ten massage sessions for 30 minutes is EUR 400 (USD 441.46), for 60 minutes – EUR 800 (USD 882.92).

Table 4. Price list for physiotherapy and massage at the Health Centre at Maximiliansplatz Physiotherapy and Training Clinic in Germany

Name	Time	Price
Physiotherapy		
Physical therapy session	30 minutes	EUR 45
Physical therapy session	45 minutes	EUR 68
Physical therapy session	60 minutes	EUR 90
Massage		
Classical massage	20 minutes	EUR 27
Classical massage	30 minutes	EUR 40
Classical massage	40 minutes	EUR 54
Classical massage	60 minutes	EUR 80

Source: compiled by the authors

The Swiss clinic Zenith Physio Pilates has a price distribution for services in the following range: for 10 sessions of physiotherapy for 30 and 45 minutes, the cost varies from USD 850 to USD 1,150, respectively. The cost of a massage for 10 sessions of 60 minutes is USD 1,100, while for 90 minutes – USD 1,350. Pricing for these services is shown in Table 5.

Table 5. Price list for physiotherapy and massage at Zenith Physio Pilates clinic in Switzerland

Service type	Session	Price
Physiotherapy		
Initial assessment	45 minutes	USD 115
Subsequent treatment	45 minutes	USD 115
Subsequent treatment	30 minutes	USD 85
Virtual meeting	45 minutes	USD 115
Massage therapy		
Therapeutic massage	60 minutes	USD 110
Therapeutic massage	90 minutes	USD 135

Source: compiled by the authors

In Spain, the Valencia Physio clinic provides services for a large number of rehabilitation methods, but Table 6 shows prices for physiotherapy and massage. For 10 sessions of physiotherapy treatment for 30-45 minutes, the cost is EUR 400 (USD 441.46), for 60 minutes – EUR 500 (USD 551.83). Ten massage sessions of 45 or 60 minutes have a price range from EUR 450 (USD 496.64) to EUR 600 (USD 662.19).

Table 6. Cost of physiotherapy and massage clinic "Valencia Physio" in Spain

Name	Session	Price
Physiotherapy		
Assessment and treatment	60 minutes	EUR 50
Session	30-45 minutes	EUR 40
5 sessions of physical therapy	30-45 minutes	EUR 180
Massage		
Sports massage	45 minutes	EUR 45
Relaxing	60 minutes	EUR 60
Offer 5 massages	60 minutes	EUR 250

Source: compiled by the authors

The physical rehabilitation clinic in Ireland Nextlevel Physiotherapy also provides services for recovery from various diseases. Table 7 shows the cost of therapy in this clinic. For 10 sessions of physiotherapy procedures for 40 minutes, it is EUR 650 (USD 717.38). The maximum cost for physiotherapy is noted for a session of 45 minutes home visit, which is EUR 1,000-1,200 (USD 1,103.65-1,324.39). This clinic performs massage only for 40 minutes, which for 10 sessions is EUR 650 (USD 717.38).

Table 7. Pricing for physiotherapy and massage at Nextlevel Physiotherapy Clinic in Ireland

Service	Duration	Price
Assessment and treatment of a physiotherapist	40 minutes	EUR 65
Subsequent appointment at the physiotherapy clinic	40 minutes	EUR 65
Online video consultation on physiotherapy	30 minutes	EUR 60
Sports massage	40 minutes	EUR 65
Visit to home physiotherapy	45 minutes	EUR 100-120

Source: compiled by the authors

The cost of physiotherapy treatment at the Toronto Physiotherapy Clinic in Canada is shown in Table 8. For recovery using 10 sessions of 30 minutes, the cost is USD 960, and for sessions of 60 minutes – USD 1,490. The price for a massage for 30 and 60 minutes in the amount of 10 visits has fluctuations from USD 690 to USD 1,120.

Table 8. Price list for physiotherapy and massage clinic Toronto Physiotherapy in Canada

Name and time	Prices
Physiotherapy (Ortho/Sports, Neurology, Cancer)	
Initial assessment (60 minutes, including treatment)	USD 135
30 minutes	USD 96
40 minutes	USD 115
60 minutes	USD 149
Massage	
30 minutes	USD 69
45 minutes	USD 92
60 minutes	USD 112
90 minutes	USD 149

Source: compiled by the authors

Table 9 shows the prices for rehabilitation in the clinic Physio Melbourne Australia. Spending on 10 sessions of 30 minutes of physiotherapy and telemedicine was USD 980, for 60 minutes – USD 1,650. The cost of 10 massage sessions of 45 minutes is USD 1,100, 60 minutes – USD 1,200.

Table 9. Cost of physiotherapy and massage at the Physio Melbourne clinic in Australia

Type of consultation	Duration	Cost
TELEMEDICINE CONSULTATIONS		
Physiotherapy – Primary	30 minutes	USD 98
Physiotherapy – Review	25-30 minutes	USD 88
Sports physiotherapy – Primary	30 minutes	USD 98
Sports physiotherapy-review	20-30 min	USD 88
Extended physiotherapy consultation (2 or more injuries)	55-60 minutes	USD 165
MASSAGE AND SOFT TISSUE THERAPY		
Restorative massage	45 minutes	USD 110
Restorative massages	60 minutes	USD 120

Source: compiled by the authors

New Zealand also provides rehabilitation and recovery services after injuries; the cost of these services is shown in Table 10. Ten sessions of physiotherapy treatment for 30 minutes will cost patients from USD 490 to USD 950, and for a session of 60 minutes – from USD 890 to USD 1,910. A massage of 10 sessions in 30 minutes is USD 920, and 60 minutes – USD 1,850. Table 11 shows prices for physiotherapy and massage in the Indonesian Clinic Physioactive. For 10 sessions of physiotherapy sessions, the cost ranges from IDR 9,300,000 (USD 590.21) to IDR 1,240,000 (USD 780.95). The cost of massage varies from IDR 6,200,000-9,300,000 (USD 394.75-592.12).

Table 10. Cost of physiotherapy and massage at the Studio Move Well in New Zealand clinic

Service type	30 minutes	40 minutes	60 minutes
Physiotherapy			
Group session	USD 49	USD 58	USD 89
Personal session	USD 95	USD 129	USD 191
Massage			
Personal session	USD 92	-	USD 185

Source: compiled by the authors

Table 11. Price list of physiotherapy and massage at the Indonesian Clinic Physioactive

Service	Price
Physiotherapy	
Initial assessment and treatment	IDR 9,300,000
Subsequent treatment	IDR 6,200,000-9,300,000-1,240,000
Home visit	IDR 1,860,000
Online physiotherapy-telemedicine	
Initial assessment and treatment	IDR 9,300,000
Subsequent treatment	IDR 6,200,000-9,300,000
Clinical massage	
1 session	IDR 6,200,000-9,300,000

Source: compiled by the authors

These data indicate that prices for physiotherapy treatment vary substantially depending on the country, which is related to the level of life and the cost of medical services. For example, the minimum costs for 10 sessions of physiotherapy in clinics in Eastern Europe (Slovenia – from USD 331) and South-East Asia (Indonesia – from USD 590) are much lower than in clinics in Western Europe (Great Britain – from USD 722) and North America (Canada – from USD 960). Indonesia, Slovenia, and Germany offer equally economically favourable conditions for patients. For example, in Germany and Slovenia, the cost of 10 sessions of physiotherapy varies from USD 331 to USD 552, which makes treatment affordable compared to the United Kingdom or Switzerland, where the cost can reach USD 1,818. Clinics use different treatment options that allow patients to choose between individual sessions and packages. Packages, as can be seen from the results in the tables, offer some benefit that increases the overall economic effectiveness of treatment. In Indonesia and the United Kingdom, payment options are offered for package services, thus reducing costs for patients who are prescript comprehensive treatment. In the context of the growing popularity of online physiotherapy, the cost of telemedicine services also varies. In Indonesia, an online

session is rated at USD 61, which is quite affordable compared to traditional visits.

In many clinics, including the United Kingdom, Indonesia, and Ireland, home visits have a substantially higher cost (from USD 118 in Indonesia to USD 1,324 in Ireland). This is due to additional costs for the departure of a specialist, which increases the cost of treatment. However, for patients with limited mobility, home visits can be an important option, despite their high price. Sessions of different duration are also evaluated differently, which affects the overall cost of treatment. For example, in Germany, the cost of one session of physiotherapy for 60 minutes is USD 99, while a 30-minutes one costs USD 50. Since the effectiveness of treatment may depend on the duration of each session, choosing between short and long sessions is an important aspect of the economic value of physiotherapy. That is, as can be seen from the results of the analysis; to improve economic efficiency, it is better to use package offers that help reduce overall costs, and telemedicine services that can reduce transport costs and increase availability. These measures are particularly relevant in countries with high levels of spending on medical services, such as the United Kingdom and Switzerland.

Prices for massage services also vary depending on the country and clinic, which reflects differences in the level of life and cost of medical care. The cost of 10 30-minute massage sessions in clinics in Germany and Slovenia ranges from USD 364 to USD 442, while in the United Kingdom, the same service will cost from USD 787 to USD 1,115. In Indonesia, the cost of massage varies from USD 395 to USD 592 for 10 sessions, which has a positive impact on its economic benefits compared to other countries. Package offers, similar to physiotherapy, can improve economic efficiency, which is beneficial for patients with chronic pain who need long-term massage courses. Clinics in Slovenia and the United Kingdom provide packages for massage sessions, which also helps patients reduce costs compared to individual payments. The cost of massage services increases with increasing session time. In Germany, for 10 sessions of massage for 60 minutes, one will have to pay USD 883, while 10 sessions for 30 minutes will cost USD 442. In Switzerland, the cost of 10 massage sessions is USD 1,100 for 60 minutes and USD 1,350 for 90 minutes. Thus, massage services, despite the difference in cost depending on the country and clinic, are economically effective in the context of long-term improvement of patients' health and quality of life. Package offers and the ability to choose the session time allow reducing total costs and increasing the availability of services for different groups of patients. Thus, to assess the economic value of physiotherapy treatment, it is necessary to consider the prices of services, the duration of sessions, the availability of telemedicine, and the offers of package services. A comprehensive approach to choosing a rehabilitation scheme, focused on reducing overall costs, can contribute to economically effective results and improve the quality of life of patients.

DISCUSSION

Research on the economic effectiveness of physiotherapy is necessary for optimal distribution of health resources and cost reduction. It allows choosing the most economically profitable methods, which increases the availability of treatment for patients and affects the duration of treatment, improving the quality of life. Slowing the progression of Parkinson's disease through early physiotherapy rehabilitation in combination with drug therapy was examined by C. Zotaj *et al*. (2023). The results showed that the age group of 61-70 years was most affected, accounting for 73% of cases. Milder stages of the disease were observed in younger patients. The need to implement a standardised rehabilitation protocol was emphasised since early physiotherapy gave good results in the initial stages of Parkinson's disease. However, this paper did not consider the economic costs of treatment, unlike the current study. A study by S.J. Winser *et al*. (2019) devoted to the economic assessment of fall prevention programmes for Parkinson's disease showed high efficiency of specific exercises. These interventions have helped reduce treatment costs and the number of falls, which indicates the profitability of physical exercises and physiotherapy in the long term. The authors focused on specific programmes to improve the quality of life of patients. Similarity with this study was in the economic benefit from the use of physiotherapy and massage.

Analysis by M. Ambrens *et al*. (2022) of the Standing Tall programme examination showed that the economic effectiveness of balance exercises for the elderly was limited. The cost of implementing the programme for one patient was USD 8,321 and the average cost of preventing a fall reached USD 4,785. The incremental cost for quality-adjusted life year (QALY) ranged from USD 58,039 to USD 110,698, which indicates the dubious economic feasibility of the programme for the entire population. However, another study by M.B. Pinheiro *et al*. (2022) also evaluated exercise programmes to prevent falls among the elderly, which in most cases turned out to be economically effective. Incremental cost-effectiveness ratio (ICER) varied from dominant interference up to USD 279,802 for QALY, which indicated substantial cost fluctuations depending on the type of interference and risk group. For people living in the community, exercise programmes showed a higher price-quality ratio, especially for older people with a high risk of falls. Like this study aimed at assessing the economic value of physiotherapy, attention was focused on the importance of reducing treatment costs and improving the quality of life.

Adding physiotherapy to traditional treatment in the study by J.J. van Summeren *et al*. (2022), it was not an economically effective strategy compared to traditional treatment alone. ICER for successfully treated children was USD 26,376, which indicated a substantial cost. The cost was substantially higher with questionable results. For the chronically used subgroup, ICER was lower – USD 2,339, which made the approach more cost-effective. In the author's paper, physiotherapy demonstrated high economic efficiency under the condition of using 10 sessions. A comparison of two models of physiotherapy treatment of cervical radiculopathy in a study by M.M. Ramirez & G.P. Brennan (2020) identified differences in economic efficiency and cost. Direct access to physiotherapy allowed the patient to save USD 434.3, and third-party payers – USD 3,264.75, while the effectiveness of treatment was 5 times higher in one visit than when contacting a doctor. The improvement in neck disability was also more substantial (16% versus 6%). This confirms the importance of effective use of resources to improve clinical results.

The patient-initiated virtual physical therapy (PIVPT) for patients with musculoskeletal diseases was reviewed by F. Chen *et al*. (2023). The analysis showed that PIVPT allowed saving from USD 1,116 to USD 1,523 per person per hour due to early access to physiotherapy and reduced treatment costs. The main economic factors were the accelerated start of therapy and reduced treatment costs. In addition, virtual therapy reduced the number of missed working hours by 6.6 hours per year. Compared to this study, both papers have confirmed the substantial economic value of physiotherapy. However, the author's research focused on the economic effectiveness of traditional physiotherapy, while this study demonstrated the advantages of virtual therapy. In terms of the cost of the service, PIVPT is more profitable, with lower treatment costs. The study by H. Ulfsdottir *et al*. (2023) evaluated the economic effectiveness of various methods of treating patients with intermittent claudication (IC), including a hospital supervised exercise programme (SEP), home-based structured exercise programmes (HSEP), and walking assistance (WA). It was established that SEP is substantially more expensive (USD 5,063.62 per patient) than WA (USD 1,952.44) and HSEP (USD 1,995.19), while the difference in QALY was statistically insubstantial. Compared with current research, it was demonstrated that more cost-effective approaches can be as effective as expensive interventions, and the importance of reducing costs without compromising the quality of treatment was emphasised. However, in the research by H. Ulfsdottir *et al*. (2023) SEP did not justify the cost, which indicates the need to use more affordable alternatives, such as HSEP and WA, for IC treatment.

The economic effectiveness of the cognitive-behavioural approach (CBA) and personalised exercise programme (PEP) for patients with rheumatic diseases described in the study H.Y. Chong *et al*. (2023), showed that both methods were more expensive than usual care. PEP proved to be more effective in improving the QALY compared to CBA. The cost of PEP was USD 743.63, and CBA – USD 1,104.33, while PEP led to an increase of 0.043 QALY. ICER in the size of USD 17,197 for QALY was considered an acceptable threshold for the United Kingdom. Unlike this study, PEP showed a higher cost but was recognised as economically effective in accounting for the health benefits received. The introduction of clinical practice guidelines (CPG) in the management of lower back pain in physiotherapy practice revealed a substantial reduction in direct and subsequent costs (Kosakowski *et al*., 2024). After the introduction of CPG, direct costs for physiotherapy decreased from USD 3,459 to USD 2,863, which demonstrated an economic benefit. An additional reduction was recorded in subsequent expenses for visualisation, medications, and surgical interventions. Convergence with this study was the importance of reducing the cost of medical services and the tendency to reduce the financial burden due to more structured and early intervention. Proper use of physiotherapy and treatment protocols has improved economic efficiency.

In the study by A.T. Burge *et al*. (2024), the economic effectiveness of telehabilitation for patients with chronic respiratory diseases was analysed. It was established that this method is equivalent to traditional rehabilitation in the centre. Economic costs in both groups amounted to about USD 5,650, without substantial differences in the effectiveness of treatment. For the TV rehabilitation of lung diseases, the main focus was on a remote format, which allowed patients to receive treatment at home while maintaining a similar effectiveness compared to the traditional approach. The economic benefits of telemedicine are also briefly indicated in the current study. Both models demonstrated good economic results using state-of-the-art technologies to expand access to treatment and reduce subsequent healthcare costs. The economic efficiency of rehabilitation in inoperable lung cancer showed that the cost of rehabilitation at home was USD 2,319.10, which is lower than usual care (USD 3,628.12) (Edbrooke *et al*., 2021). However, the QALY results was close: 0.30 for rehabilitation and 0.31 for normal care. The ICER was USD 154,694 for QALY, which indicated high uncertainty. The net monetary gain was USD 1,022.27 in favour of interference. Comparing this study with the present one, which assessed the economic value of physiotherapy, there was a similarity in the desire for an economically effective result of treatment.

Physical exercises are an effective supplement therapy for cancer treatment, but their price-quality ratio has remained insufficiently examined (Wang *et al*., 2023). It was established that 50% of cases of economic efficiency of physical activity were recognised in breast cancer. In 83% of the simulated economic estimates, the interference was economically effective. Physical exercises are economically effective in treating various types of cancer, especially when using analytical modelling to consider long-term benefits. This study confirms the importance of forming economically profitable rehabilitation programmes using physiotherapy. Physical exercises and physiotherapy have demonstrated high economic efficiency in the treatment of various diseases. The use of analytical modelling and virtual technologies will increase the economic profitability of interventions and reduce long-term costs. The results confirm the need to implement structured and economically profitable rehabilitation programmes.

CONCLUSIONS

Assessment of the economic value of physiotherapy treatment and massage showed that prices for these services varied depending on the country and clinic. In the United Kingdom and Switzerland, some of the highest prices were noted. In the East London clinic, the cost of 10 sessions of physiotherapy with varying duration ranged from USD 721.62 to USD 1,818.49, and massage – from USD 787.23 to USD 1,115.24 for 10 sessions. In Switzerland, 10 sessions of physiotherapy for 45 minutes were offered for USD 1,150, and a massage lasting 60 minutes cost patients USD 1,100. Slovenia and Indonesia are among the countries with the lowest prices for physiotherapy and massage. In the Slovenian clinic Floramare Health Resort, the cost of a course of 10 sessions of physiotherapy, depending on the time, was from USD 331.1 to USD 551.83, and the cost of the massage was in the range of USD 364.21 to USD 540.79. In Indonesia, the Physioactive clinic offered physiotherapy services for 10 sessions at a price of USD 590.21 to USD 780.95, and massage – for USD 394.75-592.12.

Thus, the cost of physiotherapy and massage services was substantially varied depending on the economic conditions and level of life in the country. High prices in the United Kingdom and Switzerland are associated with

a high quality of lifestyle, health care costs, and payment for the work of medical personnel. In countries with lower income levels, such as Slovenia and Indonesia, services were available at substantially lower costs, which made them more economically profitable for broad segments of the population. In addition, the cost of package courses of physiotherapy treatment and massage had the greatest financial benefit. In addition, reducing the cost of procedures, but maintaining efficiency helps to reduce the time of consultation or meeting and the introduction of telemedicine sessions into practice. The limitations of this study were the different time frames of services provided, which made it difficult to compare the cost of treatment. Future research should be directed to the formation of national programmes that will help optimise the cost of physiotherapy treatment for the population.

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None.

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Оцінка економічної вартості фізіотерапевтичного лікування для отримання економічно ефективних результатів

Анотація. Мета дослідження – порівняти ціноутворення на фізіотерапевтичне лікування в різних країнах світу. Було проведено порівняльний аналіз вартості фізіотерапії у Великобританії, Німеччині, Словенії, Іспанії, Швейцарії, Ірландії, Канаді, Індонезії, Новій Зеландії та Австралії. Вартість фізіотерапії розрахована з урахуванням 10 сеансів на курс лікування в кожній клініці. Дослідження визначило, що вартість фізіотерапії та масажу суттєво відрізнялася залежно від регіону та медичного закладу. У лондонській клініці вартість 10 сеансів фізіотерапії коливається від 721,62 до 1,818,49 доларів залежно від тривалості процедур, а 10 сеансів масажу – від 787,23 до 1,115,24 доларів. У Швейцарії такий самий 45-хвилинний курс фізіотерапії коштує 1,150 доларів, а годинний масаж – 1,100 доларів. У Словенії та Індонезії фінансові витрати на ці процедури значно нижчі. У словенській клініці курс з 10 сеансів фізіотерапії коштує від 331,10 до 551,83 доларів, а масаж – від 364,21 до 540,79 доларів. В Індонезії такий же курс фізіотерапії пропонується за 590,21-780,95 доларів, а масажу – за 394,75-592,12 доларів. Вартість фізіотерапевтичних і масажних процедур безпосередньо пов'язана з рівнем життя та економічними умовами в країні. У Великобританії та Швейцарії високі витрати на охорону здоров'я пояснюються високим рівнем життя та розвиненою медичною інфраструктурою, тоді як у Словенії та Індонезії послуги є більш доступними для населення. Виходячи з цього, найбільш економічно вигідним рішенням для фізіотерапії та масажу є впровадження пакетних сеансів, що дозволяє знизити вартість одного сеансу в цілому. Крім того, фінансові витрати зменшуються за рахунок скорочення часу на процедуру та використання телемедицини під час реабілітаційного сеансу. Це дослідження допоможе оцінити ціноутворення на фізіотерапевтичні процедури та в подальшому оптимізувати національні схеми з формуванням найбільш фінансово ефективних програм

Ключові слова: вартість реабілітації; фінансові вигоди; витрати на терапію; рентабельність інвестицій; зниження витрат

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