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Університет Григорія Сковороди в Переяславі
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E-mail: info@ue-bulletin.com.ua
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Address for contacts:
Hryhorii Skovoroda University in Pereiaslav
08400, 30 Sukhomlynsky Str., Pereiaslav, Ukraine
E-mail: info@ue-bulletin.com.ua
https://ue-bulletin.com.ua/en

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The impact of changes in the demographic structure of the national labour market on macroeconomic indicators of Ukraine

Serhii Maidaniuk*
PhD in Economics, Associate Professor
Odesa Military Academy
65009, 10 Fontanska Doroha Str., Odesa, Ukraine
https://orcid.org/0000-0003-1993-5837

Abstract. The full-scale invasion of Ukraine by Russian troops on 24 February 2022 led to significant changes in the Ukrainian labour market, which require a detailed analysis and understanding of their further dynamics. The purpose of this paper is to find out how the changes in the demographic structure of the national labour market have affected Ukraine's macroeconomic indicators. Using such methods as statistical analysis, comparison, synthesis and forecasting, the study of current demographic and economic indicators was conducted. The study obtained and analysed statistics on the forced displacement of refugees both within Ukraine and abroad, taking into account age, gender, education and other demographic indicators – at least 12 million Ukrainian citizens were relocated, 75% of whom are able-bodied and more than half of whom have high professional qualifications. Separately, information on young people and students who continue or start studying abroad was studied and conclusions were drawn on their assimilation in the new society and the likelihood of their return to Ukraine. In the process of analysing the conditions for the growth of unemployment, the number of enterprises that ceased operations due to hostilities or temporary occupation was calculated – both geographically, by region, and by type of ownership. It turned out that in eastern Ukraine, the number of closed business entities reaches 80%, and almost a third of individual entrepreneurs have ceased their activities. The study also forecasts the conditions for post-war reconstruction of Ukraine, taking into account the fate of returning refugees and the country's prospects for joining the European Union. The practical significance of this study is to assess the impact of changes in the structure of the labour market on the Ukrainian economy. The results may be useful for government agencies that are already formulating a strategy for Ukraine's post-war recovery

Keywords: macroeconomic indicators of Ukraine; gross domestic product; index of business activity recovery of Ukraine; labour market; demography

INTRODUCTION

Since the beginning of the full-scale military invasion of Ukraine in February 2022, the life of Ukrainian society has changed radically. All spheres of social and economic life have been negatively affected by the war waged against Ukraine – education, culture, healthcare, everyday life, etc. The analysis of the national labour market deserves special attention, as it has suffered the most since the beginning of the war. A number of factors combined to cause the Ukrainian human capital market to experience a devastating cumulative effect, including the forced migration of millions of able-bodied citizens, the mobilisation of men and women of military age for war, and the actual destruction of businesses and damage to agricultural land where people worked. Such changes could not leave the country's economic development unaffected – macroeconomic indicators in 2022 and 2023 differed significantly from the plans that had been calculated before the outbreak of full-scale war. In the current realities, it has become crucial to review and adjust Ukraine's planned macroeconomic indicators to make economic activity predictable, even in the face of the crisis. A number of Ukrainian scholars have devoted their research to this issue.

For example, L. Drobiazko (2023) analysed structural shifts in the occupational and qualification employment of the Ukrainian population and assessed the transformation of this market. It was noted that after the first shock in

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*Corresponding author

early 2022, when the labour market literally froze, a gradual adaptation to the conditions of war began to take place. However, according to the author, the existing destructive processes and the general uncertainty of the population in the future indicate the absence of systemic factors for the structural restructuring of the national labour market and the restoration of the demographic balance. G. Chepurko (2022), in turn, notes the hereditary nature of the Ukrainian economic crisis, as the full-scale invasion began immediately after the end of the acute phase of the COVID-19 pandemic. The only difference is that for the rest of the world, it was an opportunity to finally restore their national economies and return to full social life, while for Ukraine, one crisis immediately turned into another, even more severe and destructive one. Accordingly, it is crucial for the Ukrainian labour market to create a clear system of employment priorities, including the export of services, simplification of rules common to all participants, and the preservation and development of human capital. The imbalance of the labour market in Ukraine and the existing imbalances in supply and demand were highlighted by Vasylyeva *et al.* (2023). Among the most significant negative factors, the authors named obstacles to the free movement of labour, the loss of production capacity due to the war, and a general decline in living standards. Measures that could improve the demographic structure of the regions include the introduction of special youth employment programmes, the creation of conditions for continuous vocational education, and the introduction of state standards for certain professions.

Another dimension of the problem of changing demographics is the increase in unemployment. Many representatives of small and medium-sized businesses have lost their usual earning opportunities in the frontline area and are forced to look for new livelihoods. As noted by O. Nosova (2023), service sector entrepreneurs suffer from the decline in the population of cities and villages on the contact line. A. Rumiantsev *et al.* (2023) wrote about the decline in the level of economic education, which manifests itself in the training of insufficiently qualified specialists during the war. Such graduates cannot meet the existing demand even in the national labour market, not to mention the more demanding standards of EU countries. This problem can be solved, according to the authors, with the help of modern digital technologies, remote access to education and, accordingly, a greater coverage of potential applicants. Z. Smutchak (2023) calls the current demographic situation in Ukraine even more categorically – "collapse" and confirms the existence of a deep demographic crisis and a number of acute socio-economic problems in the country. In her opinion, regardless of whether or not forced migrants return after the election, Ukraine will face depopulation.

Thus, demographic issues have become extremely acute since the beginning of the full-scale war in Ukraine. However, few scholars have considered the direct relationship between the changing demographic structure of human capital and macroeconomic indicators. The purpose of this study is to find out how the changes in the demographic structure of the Ukrainian labour market have affected Ukraine's macroeconomic performance.

MATERIALS AND METHODS

In the course of this study, the peculiarities of the demographic structure in Ukraine during the full-scale war and their impact on the country's economic development were considered. In particular, the method of statistical analysis was used to analyse migration processes and the conditions of youth outflow, and the method of comparison was used to compare current indicators with pre-war statistics. The indicator was the number of applicants in Ukraine, and additional factors were the total number of people registered to take the national multi-subject test and the number of people willing to take the test abroad. To obtain objective data on the losses of the national labour market, the demographic composition of citizens who were forced to migrate abroad with the outbreak of full-scale hostilities was considered – in terms of gender, age, education, etc. A separate analysis was conducted of the plans of forced migrants regarding the desire and conditions of returning to Ukraine.

The study also analysed the challenges faced by the national economy in the human capital market. The structure of employment and unemployment in the context of existing demographic changes by occupational groups was also investigated. Since official unemployment data calculated in accordance with the International Labour Organization methodology have not been published since February 2022, expert opinions and the results of sociological surveys were used to assess this indicator up to date. The materials used for this study included, in addition to the above, operational data from the Information and Computing Centre of the Ministry of Social Policy of Ukraine (2024), the annual NBU inflation report (2022), monthly surveys of enterprises from the Institute for Economic Research and Policy Consulting (2023), and statistics from Solidarity Fund PL in Ukraine (2024). As for the prospects for the national labour market, the study analysed the general economic environment and derived a business recovery index that illustrates plans to restore and expand the activities of Ukrainian enterprises. Separately, the index of changes in the number of employees was presented by month, starting in May 2022 and ending in January 2024.

Based on disparate information from the National Institute of Sociological Research (2022) and other open sources, a holistic picture of the impact of the war on the demographic situation was formed by synthesis, especially in terms of child protection and the problem of the forced removal of Ukrainian children to the aggressor country. At the same time, official statistics on the number of children born in Ukraine over the past few years were provided. Also, using the method of economic forecasting, based on the used statistical data and expert opinions, the author forecasts and describes options for further development

of the demographic structure of the labour market in the context of the involvement of foreign specialists in the economic recovery of Ukraine.

RESULTS

The deterioration of the demographic structure of the national labour market has been observed since the outbreak of the war in 2014 and the occupation of Crimea and partial occupation of the eastern Ukrainian regions. However, since February 2022, the situation has significantly worsened. Thus, Ukraine has experienced a significant outflow of labour, which has not yet been observed in the country's modern history. According to the Office of the United Nations High Commissioner for Refugees (2024), as of 15 February 2024, more than 6 million Ukrainians have moved to Europe alone, and almost half a million more have moved to other countries. Adding to these figures almost 5 million more internally displaced persons, we can draw a conclusion about the existing human resource potential of Ukraine. Moreover, according to a survey conducted by the Office of the United Nations High Commissioner for Refugees, forced migration processes have had the greatest impact on the most productive age groups of the population: in Eastern Europe, almost half (47%) of refugees are aged 35-59, and a quarter (25%) are aged 18-34.

In terms of other demographic indicators, 85% of IDPs are women, almost half (47%) have higher education, and 20% have vocational education. Obviously, the outflow of such a large number of educated people of working age has had a significant impact on the amount of human capital in Ukraine. However, the most important demographic threat is the outflow of young people as representatives of human capital who are at the stage of forming their social environment and habits of «adult life». Unlike those aged 30+, children and young people who receive a quality education in Europe, form a social circle, learn the language of the host country and get used to high standards of living will have little incentive to return to post-war Ukraine. The experience of the Yugoslav wars (1991-2001) shows that only about half of forced migrants return home after the war, mostly those who could not find a job and stopped receiving social assistance. In most cases, the application of programmes to provide a migrant with a one-time financial assistance on condition of returning to their home country results in the migrant receiving this money, leaving for their home country, and then returning to the country of protection after a short period of time. Accordingly, based on this experience, it can be predicted that the number of refugees who will return to Ukraine after the end of the war will not exceed 50%.

According to the website of the Educational ombudsman of Ukraine (2022), in the first academic year of the full-scale war, more than half a million Ukrainian children were integrated into the school systems of EU countries. According to a survey of parents of such students, 40% of children in 2022 studied simultaneously in two institutions: full-time in a foreign school and remotely in a Ukrainian school, another 35% studied remotely in Ukrainian schools, and another 11% only in foreign schools. It is noteworthy that only 40% of parents in 2022 had a clear intention to return to Ukraine with their children after the end of hostilities. This figure will continue to decline over time and as the child's socialisation in the new place deepens. These risks also apply to students who were forced to continue or start their studies in Europe due to the full-scale war. According to the Ukrainian Centre for Educational Quality Assessment, while in 2021 the number of applicants in Ukraine was 390,000, in the spring of 2022 the system registered only 229,000 applicants, a 40% decrease. Another indicator of the migration of student youth – Report on the results of the national multi-subject test in 2022 (2022). According to this document, among those registered to take the test in 2022, almost 14% (28,000 out of 201,000) of future students took it while in 23 European countries. Another danger factor should be taken into account: developed countries are interested in increasing their own human capital at the expense of donors, and thus the risks of skilled young people not returning after completing their studies abroad are increasing significantly.

In general, to consider the impact of changes in the demographic structure of the national labour market on Ukraine's macroeconomic indicators, it is worth focusing on three of these indicators: the number of enterprises that were forced to cease operations, the Ukrainian business recovery index, and the size of the gross domestic product. Since February 2022, in addition to the brain drain, Ukraine's economy has been affected by a significant reduction in employment. The temporary occupation of the territories in 2022-2024 and the expansion of the war zone led a large number of successful and profitable businesses to shut down completely or to significantly reduce their business activities and lay off employees. According to the Labour Market Observatory portal, a fifth of non-budget enterprises closed in the second quarter of 2022. The closer the region was to the frontline, the more companies ceased operations: 77% of enterprises in Luhansk region closed in the second quarter of 2022, 56% in Donetsk region, 51% in Kherson region, 39% in Kharkiv region, 30% in Zaporizhzhia region, 28% in Mykolaiv region, 15% in Kyiv region, 14% in Chernihiv region, and 12% in Sumy region. This led to the fact that in Ukraine as a whole, even taking into account enterprises that were relocated from their regions to safer areas, the total number of employees in the non-budget sector decreased by 15% in 2022, and among employees of individual entrepreneurs, this figure reached 28%.

To understand the structure of the labour market during the war in more detail, Solidarity Fund PL in Ukraine, in cooperation with the State Employment Service of Ukraine (2023), conducted a special survey of Ukrainian employers. According to its results, currently, on average, 60% of the staff of an enterprise, regardless of its size or profile, are professionals and skilled workers. A diagram of the survey results is shown in Figure 1.

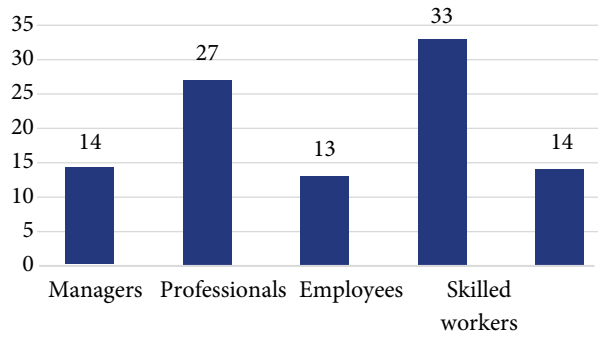

Figure 1. Professional structure of the surveyed enterprises, %

Source: developed by the author based on data from the State Employment Service of Ukraine (2023)

According to the employers' survey, amid the labour market contraction caused by the hostilities, skilled workers were in the highest demand, which indicates an increase in the overall professional level of the Ukrainian labour market during the war. Similar conclusions can be drawn from the analysis of unemployment in 2022 and 2023. Since official statistics based on the ILO methodology have not been published since February 2022, these indicators can be calculated indirectly, based on sociological surveys and qualified expert opinions (Fig. 2). According to the annual NBU inflation report (2022), in the first year of the full-scale war, the unemployment rate is likely to have exceeded 30%, which is extremely disruptive for the national labour market and has serious negative consequences (including delayed ones) for the national economy. When studying demographic changes in Ukraine during the large-scale war, it is also worth considering that since February 2022, official information on births and deaths has also not been published for security reasons. However, a number of companies and projects, such as Opendatabot (2024), analyse information from open sources and use it to generate statistical reports and track the dynamics of changes in indicators. These data, along with official reports, are shown in Figure 3.

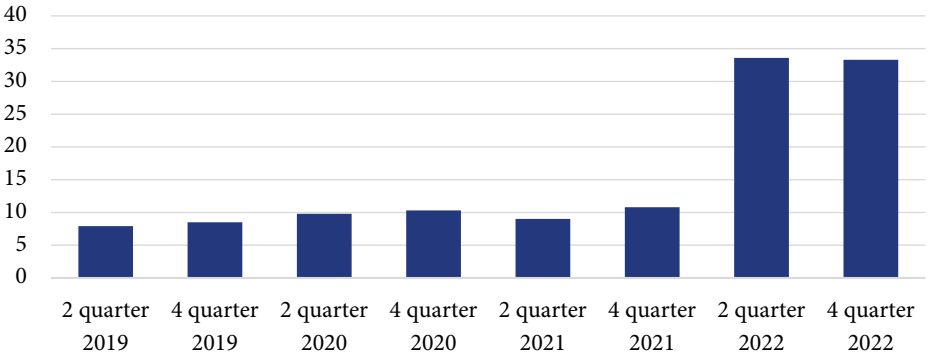

Figure 2. Dynamics of changes in the unemployment rate, %

Source: developed by the author based on NBU inflation report (2022)

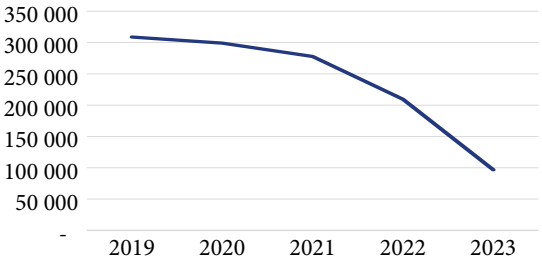

Figure 3. Birth rate in Ukraine by years, children

Source: developed by the author based on data from the State Statistics Service of Ukraine (2022) and Opendatabot (2024)

If we compare the figures for 2022 and 2023 obtained from open sources with the dynamics of the previous few years, we can note a significant decline in the birth rate, which, strategically, is also a negative factor in terms of labour supply. To understand the overall trends in the national economy in the context of changes in demographic indicators, it is also worth analysing the dynamics of business recovery. According to the Monthly Enterprise Survey for December 2023 by the Institute for Economic Research and Policy Consulting (2023), starting in May 2023, there has been a certain stabilisation of the activity recovery index with a slight upward trend (Fig. 4).

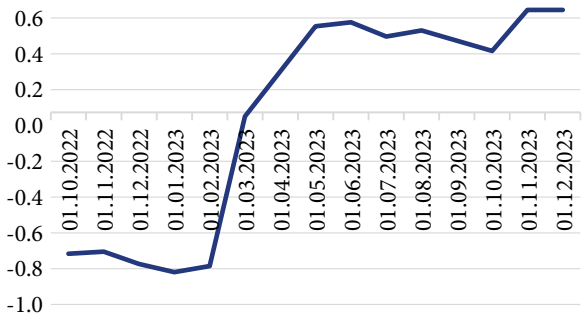

Figure 4. Index of business activity recovery

Source: developed by the author on the basis of monthly reports of the Institute for Economic Research and Policy Consulting (2023)

As can be seen from the infographic, the most severe challenge to this macroeconomic indicator in the analysed period occurred at the end of 2022 and beginning of 2023, when the Index reached negative values, but as of the end of 2023, the situation levelled off. At the same time, only 13.2% of the surveyed businessmen, describing the current state of affairs at their company, indicated a deterioration in the situation, 63.6% stated that the situation had improved, and the share of those who believe that business activity has not changed was 20.2% at the end of the year. Translating the expectations of Ukrainian businessmen for the future into the labour market, the statistics on changes in the number of employees will be indicative. Since statistics were not processed in the first months of the full-scale war, the analysis was conducted from May 2022. The data in Figure 5 shows that the indicators stabilised throughout 2023 and demonstrates that the surveyed managers do not expect significant changes in the number of employees in the first months of 2024. The share of business owners planning to increase staff increased from 2.8% to 5.1%, while 6.7% of entrepreneurs predict a reduction in the number of employees (previously 6%). All of this indicates a relative fixation of the range of labour market indicators, but not a significant improvement or recovery of the economy.

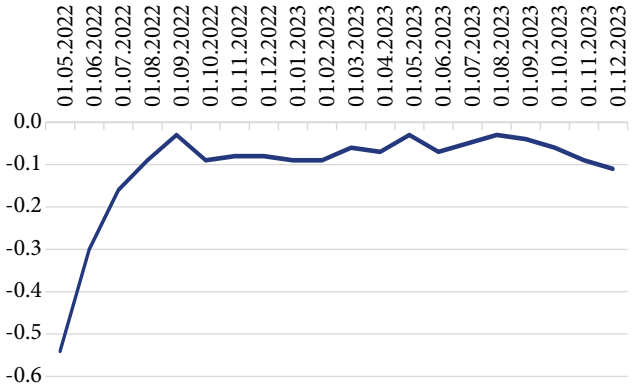

Figure 5. Index of changes in the number of employees
Source: developed by the author on the basis of monthly reports of the Institute for Economic Research and Policy Consulting (2023)

When talking about the imbalance in the labour market caused by demographic factors, it is important to take into account not only the actual, current impact on the economy, but also the long-term consequences. In this context, the situation with childhood protection is of utmost importance. The statistics on schoolchildren who were forced to migrate abroad with their parents and no longer plan to return to Ukraine were mentioned above. In addition, there are a large number of children who have remained in the country but have been subjected to psychological pressure or even physical violence by the occupiers. Formally, the right to protection and care for children affected by armed conflict is defined in Articles 38 and 39 of the UN Convention on the Rights of the Child (1989). In particular, Article 39 of the Convention requires States Parties to take all appropriate measures to promote the physical and psychological recovery and social integration of child victims of war. However, in practice, children whose homes were destroyed by the occupiers and whose parents were often killed do not always have the opportunity for psychological recovery. Moreover, with the further development of the war and regular enemy air attacks throughout Ukraine, the psychological state of children affected by the war is deteriorating. In the future, this will have an impact on the quality of human capital, educational and professional opportunities of the "children of war".

There is a separate issue of deportation of Ukrainian children to the occupying country, which is prohibited by a number of conventions. According to the Radio Liberty website, the number of children actually abducted from Ukraine has already reached 700,000 (Over 700,000 Ukrainian..., 2023). Even if all perpetrators of these war crimes are punished in the future, the prolonged psychological pressure on children in a hostile environment will affect their personal development in the future, which will also call into question the ability and willingness of these citizens to return to Ukraine in the future. All of the above factors of changes in the demographic structure of Ukraine have a significant impact on the national labour market, and, as can be seen, it is mostly negative. Accordingly, the current state of the economy – one of the most objective macroeconomic indicators, gross domestic product (GDP) – is shown in Figure 6.

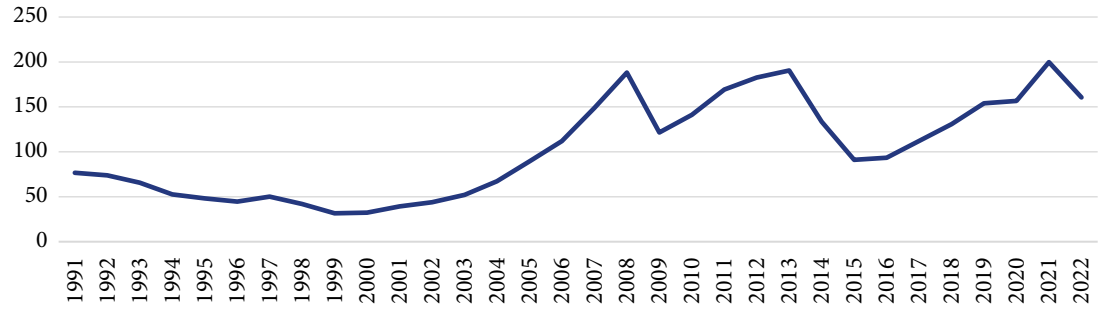

Figure 6. GDP of Ukraine, billion USD
Source: developed by the author based on data from The World Bank (2022)

The graph in Figure 6 shows the key dramatic changes in the Ukrainian economy in recent decades: gradual growth from 2000 until the global crisis in 2008; then a new stage of recovery, which ended with the outbreak of war and the temporary occupation of part of the country's territories in 2014; economic growth again, reaching a historic GDP peak in 2021, followed by a new wave of external aggression and, consequently, another economic downturn in 2022. Thus, it can be reasonably concluded that the demographic imbalance that is inevitable in a country at war has a significant impact on the labour market, national human capital, and all economic indicators without exception. It is noteworthy that the formation of reasonable plans and forecasts in such a situation is extremely difficult due to the inability to predict the end of hostilities.

However, it is already possible to predict that when the war ends and Ukraine begins its recovery, the country will face a personnel issue. Former military personnel returning to their pre-war professions will need some time to restore their skills and master the technological changes that have taken place during the war. Many citizens who have already become accustomed to their new places of residence will refuse to return, and a large number of guest workers and labour migrants from countries with predominantly low economic levels and possibly different cultural values will claim their place. Moreover, some citizens of the aggressor country will also express their desire to live and work in Ukraine. Accordingly, the authorities and public associations should already be shaping legislation and preparing society for such developments in advance.

DISCUSSION

The impact of demographic changes caused by various reasons on the volume and quality of human capital is quite significant, as can be seen from the materials of this study. Understanding the cause-and-effect relationship in this area, it is possible to formulate forecasts of further development and manage the growth of the national economy. At the same time, Ukraine is a certain research area for observing various social and economic phenomena, as military operations of this scale have not been seen on the European continent for eighty years.

T. Boeri (2022), studying the prospects for labour market recovery in Ukraine, believes that the war, for all its tragedy, is a good reason not only to rebuild, but also to radically reformat the principles of human resource management. The author believes that when planning the post-war reconstruction of Ukraine, it is necessary to take into account all the mental and physical consequences that will affect former military personnel who will return to their civilian professions. A similar vision is presented in this paper, since during the war years almost all professional fields have undergone updates and improvements that need to be mastered by veterans. Accordingly, this will reduce their competitiveness in the labour market for a certain period.

Predicting the impact of a full-scale invasion, H. Kulu *et al.* (2022) in their article in March 2022 predicted a 16% reduction in Ukraine's population and an increase in its average age. Emphasising that the greatest demographic changes would affect the working-age population and children, the authors were confident of significant human and economic losses in Ukraine and long-term negative demographic consequences. The statistics above confirm this assumption, and there are no detailed and comprehensive programmes for the return of refugees to their homeland after the war. The most worrying thing is that the current situation will inevitably lead to another demographic hole in the next generation – in 20-25 years.

P. Strzelecki *et al.* (2022), in turn, studied the other side of the flow of forced labour migrants from Ukraine – its impact on the economies of recipient countries. Using Poland as an example, they examined the situation when an unprecedented flow of highly skilled and educated labour migrants faced high demand for labour, which led to a rapid and powerful positive effect on the Polish economy. As noted above, professional placement in a new location is a factor that reduces the likelihood of a migrant's return to their home country, and this may have a negative impact on the future recovery of the Ukrainian economy. The peculiarity of the demographic structure of Ukrainian refugees in Poland was also noted by M. Duszczyk & R. Kaczmarczyk (2022). According to their research, the composition of migrants differs significantly from previous waves of guest workers in that they have a large number of children, which has an impact on their mothers' work schedules. However, over time, this problem will become much less of an issue as children are enrolled in local kindergartens and schools. Consequently, after such in-depth assimilation, it will be even more difficult for refugees to return to Ukraine.

The issue of the conditions for refugees to return to Ukraine from Europe, which is raised in this paper, was previously studied by U. Dadush & R. Weil (2022). Having analysed the statistics of voluntary return of refugees to their poor countries, the authors conclude that Ukrainian emigration will bring short-term costs to Europe, but long-term economic benefits and advise migration services to show additional loyalty to war victims. However, it is worth noting that if a large number of skilled Ukrainian workers receive preferences abroad and stay there, Ukraine's recovery from the war will be complicated. It is necessary to realise that in this matter there is a conflict of interest between the Ukrainian state and friendly countries that have agreed to shelter refugees during the war. How to resolve this conflict without complicating relations with them is a future subject for discussion with all stakeholders.

The impact of war-related stress on the socio-demographic factors mentioned in this paper was studied by S. Fel *et al.* (2022). According to their conclusions, one of the preventive measures against the development of post-traumatic stress is continuing education and related socialisation. Thus, improving one's professional level in crisis situations is not only an economic but also a psychological factor. A study of the psyche of Ukrainians in the first, most difficult weeks of the full-scale invasion was

conducted by W. Xu *et al.* (2022). The tests showed that out of a sample of 800 adult Ukrainians, almost 53% showed symptoms of psychological distress and 47% showed signs of depression. Accordingly, such large-scale mental changes in citizens have significantly affected the quality of human capital and, ultimately, the demographic structure of the labour market. As can be seen from the materials of this study, the problem is significant, but with sufficient support from the state, it can be solved.

V. Vus & I. Esterlis (2022), considering a plan for the psychological recovery of Ukrainian civilians after a large-scale invasion, believed that this war has a much greater impact on demographic indicators than any conflict in previous decades. The authors noted that the modern developed information space ensures the instantaneous dissemination of information, including negative information, which affects the ability of each individual to work and the labour market in general. According to the above materials and this study, almost all citizens of Ukraine have gone through several stages of acceptance of the new reality, from despair to fatalism. Since a large number of internally displaced persons have not been able to overcome the psychological deadlock and have lost the ability to engage in socially and economically useful activities for some time, this has had negative consequences for the labour market in Ukraine as a whole.

The closed nature of certain statistics in Ukraine and the ways in which they can be obtained through the indirect open sources mentioned above have been the subject of a study by D. Leasure *et al.* (2023). Using data from social media, in particular Facebook, combined with pre-war data, the researchers built a real-time monitoring system that allowed them to track the movement of people by age and gender and, accordingly, extrapolate conclusions about demographic changes to the national level. Similar calculations based on social media data with similar results were also made by F. Rowe *et al.* (2023). This experience of "bypassing" the blocking of official information can also be used by the enemy, so it is worth considering additional ways to ensure the protection of demographic data during war.

Post-war reconstruction, without which Ukraine's continued existence as a state is impossible, will be a serious challenge for Europe and the world, as many things have to be created from scratch. The planning of the country's revival, which is the subject of this paper, and the development of algorithms for rebuilding entire economic sectors are actively discussed in the scientific community. For example, J. Grävingholt *et al.* (2023) believe that Ukraine's reconstruction is beginning now, even before the end of hostilities. By granting Ukraine the status of a candidate for membership, the European Union has demonstrated to the world the priorities for further joint development. Financial and technological assistance in reconstruction can give an additional impetus to the country's "green transformation" and achievement of sustainable development goals. A well-known Swedish-American economist and diplomat, a leading international expert on national economies of the former USSR, A. Åslund (2023), in his article on the reconstruction of post-war Ukraine, emphasises the importance of financing such work and predicts that the labour market will flourish to the point where it will require specialists in all sectors.

When planning the recovery of the labour market in Ukraine and the return of macroeconomic indicators at least to pre-war levels, it is very important to take into account the specifics of the national agro-industrial complex (AIC) and the working conditions of its employees. S. von Cramon-Taubadel and O. Nivievskyi (2023) estimate that as of autumn 2022, the total losses from the war in Ukrainian agriculture reached almost USD 42 billion. Since the full restoration of Ukrainian agricultural land is possible only after complete demining and reclamation, this should be taken into account when planning the timing of the normalisation of the demographic structure of the agricultural labour market.

CONCLUSIONS

The situation in which Ukraine and its economy found themselves at the end of February 2022 was close to critical. The will of the citizens, the Armed Forces of Ukraine and the assistance of partner countries helped the country to survive the first, most difficult months and prevent the destruction of its statehood. However, the demographic structure of Ukraine's labour market was affected by extremely powerful negative factors. More than 6.5 million people were forced to go abroad, and about 5 million more lost their homes and jobs and became internally displaced. At the same time, 75% of migrants to European countries are able-bodied individuals, half of whom have higher education, which means that their skilled labour strengthens the macroeconomic performance of the recipient countries, not Ukraine. Of particular concern is the large number of children and young people who are forced to adapt to new living and educational conditions during forced migration.

The study reasonably leads to the conclusion that changes in the demographic structure of the national labour market have affected Ukraine's macroeconomic indicators as follows: the number of enterprises that were forced to cease operations – 15-30%; Ukraine's business activity recovery index – 0.5 (as of 01.12.2023); GDP – USD 160.5 billion (as of 2022). Regarding the economic features of the post-war recovery and the immediate prospects, it should be taken into account that, firstly, as mentioned above, about 50% of refugees will no longer return to Ukraine, and, secondly, experts predict Ukraine's accession to the EU in 2029-2033. As a result, Ukrainian citizens will have the opportunity to move freely within the EU and be legally employed, which will also have a significant impact on both demographics and the country's economy.

When formulating plans for post-war recovery, it is also very important to take into account the significant inflow of foreign labour migrants who will participate in the country's recovery and the fact that most workers who will

enter Ukraine under state programmes to attract immigrants will see Ukraine solely as a "springboard" to Europe or the United States. In addition to white-collar workers from developed countries, this wave will inevitably include the vast majority of low-skilled workers from developing countries, who will bring their own habits and cultural codes to Ukrainian society. Accordingly, it is necessary to think in advance about programmes for assimilating this human capital into the Ukrainian labour market so as not to further disrupt the demographic structure. The development of theses for such rules of coexistence could be the subject of a future study.

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CONFLICT OF INTEREST

None.

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Вплив змін демографічної структури національного ринку праці на макроекономічні показники України

Сергій Майданюк
Кандидат економічних наук, доцент
Військова академія (м. Одеса)
65009, вул. Фонтанська дорога, 10, м. Одеса, Україна
https://orcid.org/0000-0003-1993-5837

Анотація. Повномасштабне вторгнення російських військ в Україну 24 лютого 2022 року призвело до суттєвих змін на українському ринку праці, що потребують детального аналізу та розуміння їх подальшої динаміки. Мета цієї роботи – з'ясувати, як вплинули зміни демографічної структури національного ринку праці на макроекономічні показники України. Завдяки таким методам, як статистичний аналіз, порівняння, синтез та прогнозування, було проведене дослідження актуальних демографічних та економічних показників. У результаті дослідження була отримана та проаналізована статистика вимушеного переміщення біженців як у середині України, так і за її кордон з урахуванням віку, статі, освіти та інших демографічних показників – всього було релоковано, мінімум, 12 мільйонів українських громадян, 75 % з яких є працездатними, а більше половини мають високу професійну кваліфікацію. Окремо було вивчено інформацію щодо молоді та студентства, які продовжують або починають навчання за кордоном, та сформовано висновки щодо їх асиміляції у новому суспільстві та вірогідність їх повернення в Україну. У процесі аналізу умов зростання показників безробіття, була порахована кількість підприємств, що припинили свою діяльність через бойові дії чи тимчасову окупацію – як у географічному розрізі, по областях, так і по формі власності підприємств. Виявилось, що на сході України кількість закритих суб'єктів підприємницької діяльності сягає 80 %, та, в тому числі, майже третина фізичних осіб-підприємців припинили свою діяльність. Також було спрогнозовано умови повоєнної відбудови України з урахуванням долі біженців, які повернуться, та перспектив вступу країни до Європейського Союзу. Практична значимість цього дослідження полягає в оцінці впливу змін структури ринку праці на економіку України. Результати роботи можуть бути корисні державним структурам, що вже зараз формують стратегію повоєнного відновлення України

Ключові слова: макроекономічні показники України; валовий внутрішній продукт; індекс відновлення ділової активності України; ринок праці; демографія

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Guarantees of electricity origin as a financial mechanism to increase investment attractiveness in the energy sector

Yaroslav Kotyk*
Postgraduate Student
Drohobych Ivan Franko State Pedagogical University
82100, 24 I. Franko Str., Drohobych, Ukraine
https://orcid.org/0009-0000-6629-0547

Abstract. In modern environment, ensuring the development of the renewable energy sector is significant for achieving the country's sustainable development goals. The introduction of a mechanism for guaranteeing the origin of electricity is one of the most effective ways to develop renewable energy, and therefore its study is relevant. The purpose of this study was to analyse the approaches to the functioning of the market of guarantees of electricity origin in the EU countries and compare them with the situation in Ukraine. The principal methods of the study were forecasting (prospects for the implementation of energy origin guarantees in Ukraine) and comparison (approaches to the formation of the mechanism of energy origin guarantees in Ukraine and the EU). The study noted the overall role of renewable energy for the development of any country and Ukraine specifically. All the main positive components that arise in countries in the development of this area were described in detail. The instrument of guarantees of energy origin stays effective for achieving the goals of renewable energy development in Ukraine. Considering the specific features of the rules for selling renewable energy guarantees, the study concluded that they are useful both for stimulating the development of the sector and for disseminating information about the need to improve the state of the renewable energy sector in Ukraine and globally. The study assessed what steps has Ukraine taken to adopt and implement this mechanism. Information on EU countries was also examined. The gradual increase in demand for such instruments every year since 2019 indicates not only the popularity of this practice, but also its need among all market players. It was shown that, after the start of Russia's full-scale invasion of Ukraine, the foreign trade balance turned negative, i.e., the volume of electricity purchases exceeded the volume of sales. The findings of this study can be used to formulate a long-term strategy for the development of a mechanism for guaranteeing the origin of electricity in Ukraine by public authorities

Keywords: social responsibility; sustainable development; crisis resilience; green economy; strategic security

INTRODUCTION

The development of green energy plays a vital role in promoting sustainable development: it is the key to ensuring this concept, as it allows meeting the needs of modern society without harming the environment and future generations. The development of green energy also helps to reduce dependence on coal and other limited energy sources, reduce greenhouse gas emissions such as carbon dioxide and methane, create new jobs, and increase energy independence. The development of this concept ensures a comprehensive improvement of the country's development level.

Considering the above factors, the production of this kind of energy and support for its producers becomes an essential issue. For this, various mechanisms are being created, one of which is the guarantee of energy origin: it allows renewable energy companies to sell certificates on the secondary market and thus assure their consumers that the energy they will consume will come from renewable sources. In Ukraine, this area is only beginning to develop, while in the EU it is much more widespread. More active work in this area could allow for greater cooperation with EU countries in the context of exporting renewable electricity. Considering of this, the study of the specifics of this system in the European Union and Ukraine stays important.

O. Chumachenko (2022) investigated the role of renewable energy sources in the energy balance of Ukraine. Based on the analysis of statistical data, the researcher

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*Corresponding author

concluded that the country should pay much greater attention to the development of renewable energy to achieve the relevant sustainable development goals than it currently does. A.V. Voronin & P.I. Panasyuk (2022) also noted that renewable energy in Ukraine is developing steadily and has promising prospects. Particular attention was paid to the prospects of biomass energy, considering the large number of agricultural enterprises in Ukraine. With this in mind, the researchers called for a much larger flow of investment in the sector to ensure its more rapid development.

K.O. Kuznetsova & O.O. Boyko (2023) also noted that the introduction of renewable energy sources in Ukraine is a crucial step in ensuring energy security and sustainable development, especially during and after the war. The researchers noted the need to assess the impact of each type of renewable energy and investigate the nature of their interaction to increase the possibilities for sustainable development in Ukraine. P.D. Lezhdenyuk & A.V. Sytnyk (2022) noted the growing role of guarantees of energy origin to ensure cleaner electricity production in Ukraine. Attention was also paid to the problems that exist in this area, namely the inaccuracy and non-transparency of green energy certification. Nevertheless, the study paid little attention to the possibilities for improving the situation. B.O. Burykin *et al.* (2022) considered approaches in the context of guarantees of origin of renewable energy in the European Union, but also did so rather briefly, focusing primarily on the significance of introducing this kind of technology.

I. Matyushenko *et al.* (2022) studied the investment climate of the EU and Ukraine. They showed that Denmark, Sweden, the Netherlands, Germany, and Finland had the highest scores on the selected indices analysed, while Croatia, Greece, Bulgaria, Romania, and Ukraine had the lowest scores. Based on the analysis conducted, the researchers also made certain recommendations for improving the situation in Ukraine: they most often focused on anti-corruption measures, restarting and reforming the judicial system, creating financial incentives for investors, simplifying bureaucratic procedures.

The literature analysis suggests that although Ukraine is actively researching the role of renewable energy sources, little attention has been paid to the mechanisms of energy origin guarantees, their capabilities, and benefits for the state. Considering this, the purpose of this study was to analyse approaches to the development of a mechanism for guaranteeing the origin of energy in the European Union and Ukraine. This allows identifying the areas where Ukraine is still falling behind the rest of the world and offer recommendations for government officials on how to improve the situation.

MATERIALS AND METHODS

The research period was defined as 2019 to 2024. The study also used some statistical data for the analysis, namely, those related to the number of transactions in the trade in guarantees of origin in the European Union. This information was taken from the website of the Association of Issuing Bodies (2024), an association that promotes the use of the standardised system of the European Energy Performance Certificate System. The data on the number of transactions of guarantees of origin was disaggregated, which made it possible to estimate both the total number of transactions and the number of transactions by individual categories, such as export, import, issue, transfer. Furthermore, it is worth noting that the data for 2024 is provided only for the period up to June. The study also generated annual data for this period under the assumption that the average transaction volume for these three months would stay the same for the entire 12 months.

The study also used certain components of the regulatory framework, namely Resolution of the Cabinet of Ministers of Ukraine No. 227-2024-p "On the Introduction of Guarantees of the Origin of Electricity Produced from Renewable Energy Sources" (2024). It describes the mechanisms of the procedure for maintaining a register of guarantees of origin of renewable energy, registration of electricity facilities and power plants for obtaining guarantees, issuance, circulation, and redemption of guarantees of origin, and inspections of facilities to confirm renewable energy production. It sets out the principles for confirming the origin of energy in a very comprehensive manner to prove that it was produced from renewable sources.

The information from Directive of the European Parliament and of the Council No. 2009/28/EC "On the Promotion of the Use of Energy from Renewable Sources and Amending and Subsequently Repealing Directives 2001/77/EC and 2003/30/EC" (2009) was analysed. The Directive explains a considerable number of principles related to the development of renewable energy. It establishes a general framework for the promotion of renewable energy, including binding national targets for the share of renewable energy in energy consumption and transport, explains the rules for the transfer of statistical data, joint projects with other countries, administrative procedures, information dissemination, training and grid access for renewable energy sources; it also describes the principles of operation of guarantees of origin within the association.

This study employed a considerable number of scientific methods. The comparison method was used to assess the approaches to the development of the mechanism of guarantees of energy origin in Ukraine and the EU countries. The analytical method was also used to assess the situation with the development of the market of guarantees of origin in the EU to assess the possible course of events in Ukraine. The forecasting method was used to form an understanding of the possible future course of events in the context of the development of this mechanism in the country based on the available information about it in the current conditions, as well as on the example of EU countries.

RESULTS

For Ukraine, like all other countries, renewable energy is one of the key areas for further development. The development of renewable energy sources helps to reduce the

country's dependence on energy imports, especially oil and gas, which increases the country's energy security. The use of such energy sources helps to reduce emissions of harmful gases and other pollutants into the atmosphere, which contributes to improving the quality of the environment and public health. The development of the renewable energy sector is contributing to the creation of new jobs in the areas of production, installation, maintenance, and research (Alper & Oguz, 2016; Zhang *et al.*, 2021). However, the key thing is that the use of clean energy from renewable sources allows businesses and the government to increase their social responsibility to society by reducing the negative impact on the environment and public health. Ukraine has considerable potential for renewable energy development due to its abundant natural resources, such as solar and wind energy, biofuels, hydropower, and even geothermal energy. The development of this industry is somewhat problematic in the context of the war: moreover, a significant amount of resources has been lost. Considering this, the use of various approaches to stimulate the development of this industry is still important in Ukraine's current strategy. This also applies to the use of such a mechanism as guarantees of electricity origin.

Guarantees of energy origin are an essential financial mechanism for increasing investment attractiveness in the energy sector. It is used to stimulate the production and consumption of "green" electricity, i.e., energy generated from renewable sources such as wind, solar, hydropower (Kyzym & Rudyka, 2018). The basic idea is that energy companies that produce green electricity receive special certificates for each megawatt-hour of such energy produced. These certificates can be sold on the internal or external market. This approach generates additional income for green energy producers, making their projects more attractive to investors. Guarantees of origin also contribute to the transparency of the electricity market and help consumers to be informed about the source of electricity, allowing them to make an informed choice in favour of clean energy. These mechanisms help to reduce dependence on coal and other harmful energy sources, promote the production of green energy and contribute to the overall improvement of the environment.

The popularity of this instrument within the European Union is only growing. This is evidenced by some statistics. Specifically, the volume of transactions in this area is growing rapidly, as presented in Figures 1, 2.

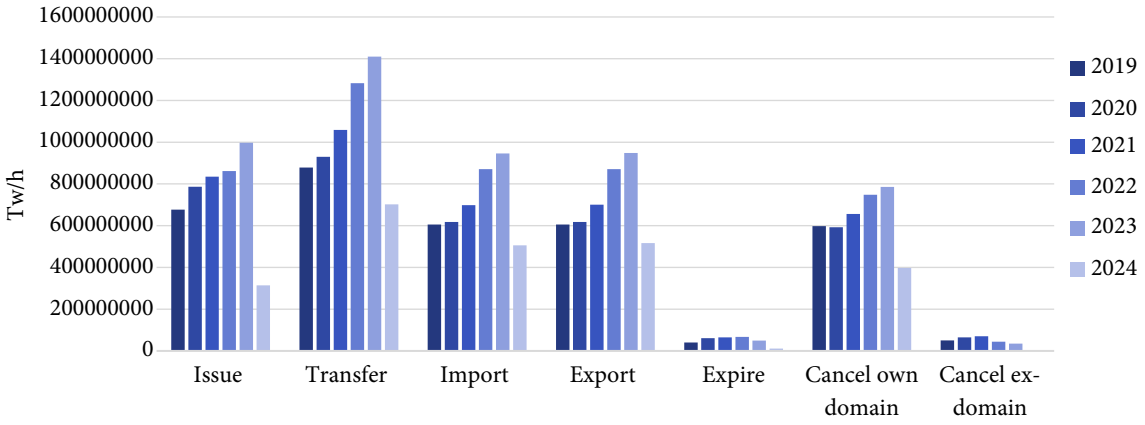

Figure 1. The number of transactions of energy guarantees in the European Union in 2019-2024, mln Tw/h
Notes: data for 2024 is provided for a period of 3 months
Source: compiled by the author of this study based on data from Association of Issuing Bodies (2024)

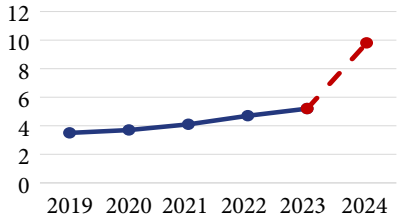

Figure 2. Data on the number of transactions of guarantees of origin in the European Union in 2019-2024, bln Tw/h
Notes: data for 2024 are provided for a period of 3 months; dashed line values indicate projected data for the whole year, based on the data for the first three months
Source: developed by the author of this study based on data from Association of Issuing Bodies (2024)

As Figures 1, 2 show, the number of transactions of diverse types related to the purchase or sale of guarantees of energy origin is constantly growing. This demonstrates the effectiveness of this initiative, as well as the benefits for all market participants, including renewable energy producers. It is also important to analyse data related to the purchase and sale of energy abroad, particularly in the EU countries. Data broken down by import and export volumes is presented in Tables 1-3. As Tables 1-3 show, for different countries, Ukraine becomes an exporter and an importer, respectively, at different times. Thus, before 2023, Ukraine was more of an exporter of electricity to Europe, while since 2023, due to Russia's strikes on the energy infrastructure, the country has increasingly needed to import electricity to supply consumers. The

solution to avoid being so vulnerable to attacks on key critical infrastructure is to decentralise the energy system and transition it to renewable sources. The price of energy for energy trade between Ukraine and other countries was roughly estimated using day-ahead market indices (DAM) (Table 4). Using the data in Table 4, one can roughly estimate Ukraine's losses from electricity imports. This information is presented in Figure 3.

Table 1. Data on electricity exports by Ukraine to selected European countries in 2020-2024, MWh

Year	2020	2021	2022	2023	2024*
Hungary	2,110,181	1,570,433	192,840	0	43,959
Slovakia	41,279	301,453	461,668	150,052	27,465
Romania	868,262	642,412	337,687	14,698	46,291
Poland	1,489,718	811,506	1,079,790	53,370	76,508
Total	4,509,440	3,325,804	2,071,985	218,120	194,223

Notes: * – data are based on information until June 2024
Source: developed by the author of this study based on Energy Map (2024)

Table 2. Data on Ukraine's electricity imports from selected European countries in 2020-2024, MWh

Year	2020	2021	2022	2023	2024*
Hungary	516,096	66,449	25	0	416,193
Slovakia	1,473,699	308,149	4,245	558,574	296,506
Romania	89,397	40,608	2	103,062	245,908
Poland	0	0	0	60,678	114,446
Total	2,079,192	415,206	4,272	722,314	1,073,053

Notes: * – data are based on information until June 2024
Source: developed by the author of this study based on Energy Map (2024)

Table 3. Electricity trade balance of Ukraine with European countries in 2020-2024, EUR

Year	2020	2021	2022	2023	2024*
Hungary	1,594,085	1,503,984	192,815	0	-372,234
Slovakia	-1,432,420	-6,696	457,423	-408,522	-269,041
Romania	778,865	601,804	337,685	-88,364	-199,617
Poland	1,489,718	811,506	1,079,790	-7,308	-37,938
Total	2,430,248	2,910,598	2,067,713	-504,194	-878,830

Notes: * – data are based on information until June 2024
Source: developed by the author of this study based on Energy Map (2024)

Table 4. DAM prices in selected EU countries and Ukraine in 2020-2024, EUR/MWh

Year	2020	2021	2022	2023	2024*	Change
Hungary	39	113.85	271.7	106.82	71.04	82%
Slovakia	34.01	102.75	264.94	104.73	70.57	107%
Romania	39.47	111.42	265.3	103.74	72.71	84%
Poland	46.65	87.03	166.72	111.65	82.66	77%
Ukraine	42.17	56.61	78.23	85.42	79.11	88%

Notes: * – data are based on information until June 2024
Source: developed by the author of this study based on Energy Map (2024)

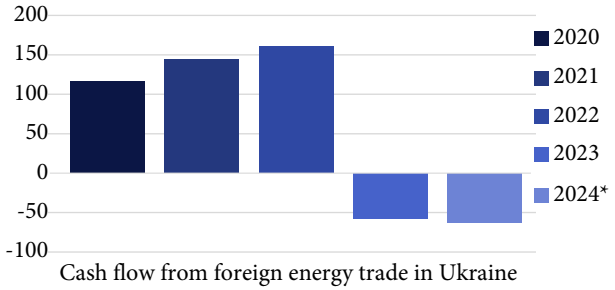

Figure 3. Data on Ukraine's losses/income from electricity trade (deduction of electricity imports from exports) in 2020 to 2024, mln EUR

Notes: * – data are based on information until June 2024

Source: developed by the author of this study based on Energy Map (2024)

As Figure 3 shows, Ukraine has had a negative balance of foreign trade in electricity since the beginning of Russia's full-scale invasion of Ukraine: the values were -57.3 mln EUR in 2023 and -62.5 mln EUR in 2024, which could have been saved if renewable energy sources had been better developed in the country. In the European Union, the principles of application of guarantees of energy origin are described in the Directive of the European Parliament and of the Council No. 2009/28/EC (2009). It describes that guarantees of origin are primarily used to prove to customers that energy comes from renewable sources, preventing double counting and other analogous errors (Bekun, 2022). Guarantees of origin can be transferred between holders but should not be sold: the Directive also describes that the sale of such certificates can support energy producers and increase the efficiency and widespread use of energy among other countries. Improving the quality of information for consumers on the distribution of energy between countries and enterprises is also considered significant (Šurić *et al.*, 2021).

The specifics of this mechanism are described in detail in Article 15 of Directive of the European Parliament and of the Council No. 2009/28/EC (2009). It states that EU Member States must ensure that guarantees of origin will be issued upon request by renewable energy producers, with each guarantee representing 1 MWh of energy and cannot be duplicated for the same unit of energy. Energy from renewable sources is counted only once, which prevents double counting. The guarantee is valid for 12 months and is cancelled thereafter; the relevant authorities oversee the issuance, transfer, and cancellation of guarantees, ensuring accuracy and independence from production and supply activities. The guarantees themselves should contain details such as energy source, production dates, energy type, production capacity information, support scheme benefits, operating dates, issuance details, and a unique identifier. Importantly, all Member States should recognise guarantees of origin issued by other Member States as proof of certain elements, with the possibility of refusing recognition based on reasonable doubts as to accuracy, reliability, or veracity. The EU, among other things, has a system of certificates introduced by the Association of Issuing Authorities. This system harmonises the issuance, sale, and cancellation processes, facilitating cross-border trade through a single European electronic centre. To take part, governments must develop protocols that follow the rules of the European Energy Performance Contracting System and obtain approval. The Guarantee of Origin is usually issued after opening an account in the national electronic registry, certifying renewable energy generation devices and contacting the registry operator. Auctions for these guarantees are held based on the volume of electricity production, and the winners are determined by the maximum bid prices. The proceeds from the sale are also used as a method of supporting renewable energy producers. All operations are carried out electronically within a specially created platform (Phan *et al.*, 2020).

In Ukraine, there is a relevant Resolution of the Cabinet of Ministers of Ukraine No. 227-2024-p (2024). Its purpose is to ensure the conditions for the functioning of the register, which would be designed to confirm the origin of energy produced from the relevant sources, the process of registration of the electricity industry itself, as well as the issuance, circulation, and redemption of these guarantees, and inspections of facilities producing such energy. The governing body is the National Energy and Utilities Regulatory Commission (NEURC). Within the framework of this register, the issuance, transfer, redemption, and cancellation of guarantees is performed exclusively between users of the register by means of electronic requests. At its core, it should ensure a safe, efficient, and transparent governance system within the market for energy guarantees. The NEURC is also the registry administrator, which is responsible for the proper functioning of the software, the accuracy of the information in it, manages account creation, access rights, and supports the process of issuing, transferring, and redeeming guarantees. Therewith, by 31 December, the administrator must publish the indicator of the environmental value of electricity for the next year. Users of this technology also have corresponding obligations, namely, to enter only true and complete information when using the register.

The Resolution also describes the conditions for registration of the relevant electricity generating facilities. For this, the user must provide detailed information about the generating facility, including the date of its start of operation, location, details of grid connection, technology and type of renewable energy, capacity, commercial metering data, and some others. The administrator reviews the information within ten business days: if the data is complete and accurate, the registration is confirmed, and if not, users receive a notification to correct and resubmit the information. Subsequently, one can request to change individual

data on power units, if necessary, or request to remove a unit from the register. In this case, each renewable energy unit must be separately registered if the user owns or has legal grounds for several units. The commercial metering administrator uploads certified commercial metering data to the register by the 20th day of the month following the operational period: guarantees of origin are automatically generated based on this certified data, confirming the amount of electricity supplied to the grid or used for own consumption. The content of the guarantees should include the type of renewable energy source, dates of energy release and production, location, capacity, and characteristics of the plant, date of commissioning, country of issue and date, environmental value, and a unique identification number. Such a guarantee certifies the owner's rights to the environmental value and benefits of renewable energy production. Any registry user can be a warranty holder, except where legal restrictions apply; they are valid for 12 months after production and must be redeemed within 18 months. Outstanding warranties will be cancelled after 18 months. Users can transfer guarantees of electricity origin using the registry's functionality by creating an electronic request, detailing the number and unique identifiers of guarantees, registration numbers of the sender's and recipient's accounts. If both users agree to the transfer, it takes place, but can be cancelled within 24 hours. The purchase and verification of guarantees of origin of renewable energy in Ukraine is also formed according to a certain algorithm, which also includes verification by the responsible authorities in case of complaints, appeals, or any violations.

The approaches used in both the EU and Ukraine are quite similar. It can be observed that all the approaches and mechanisms described in the regulations are comparable, and thus can be easily applied in the future after the country's accession to the EU. Although the mechanism of guarantees of energy origin has only just been launched in Ukraine, given the practices of EU countries, one should expect quite positive results from it in the context of ensuring the development of this area. Furthermore, the harmonisation of the practices of guarantees of origin will subsequently open the large EU market for the country in the context of cross-border trade in renewable energy certificates, which will create new incentives for the development of the sector. Overall, the implementation of the principles and practices of the system of guarantees of energy origin will lead to the modernisation of Ukraine's energy sector, promote its economic development and allow it to more effectively withstand the crises that often arise in the current environment.

DISCUSSION

The development of renewable energy sources is crucial for Ukraine's energy security and environmental sustainability, considering the possibility of reducing energy imports from other countries, lowering carbon dioxide emissions, creating jobs, and other positive components. In turn, guarantees of origin are a new and effective mechanism to support renewable energy companies. These guarantees ensure transparency in the electricity market and inform consumers about the source of their energy, promoting the use of clean energy. The EU principles on energy origin guarantees are consistent with Ukraine's goals and practices. Both systems aim to prevent double counting, facilitate cross-border trade, and support renewable energy producers. The similarities between the EU and Ukraine's approaches suggest future integration and cooperation, potentially opening new markets and new opportunities for Ukraine in the EU energy market. Such harmonisation of practices could lead to modernisation of Ukraine's energy sector, economic growth, and improved resilience to crises.

Scientists conclude in their studies that the development of renewable energy sources is crucial for ensuring the country's effective economic development. Thus, L. Yuping *et al.* (2021) conducted a study based on data from Argentina in the period from 1970 to 2018. They have shown that renewable energy consumption and globalisation reduce CO_2 emissions, reduce dependence on fossil fuels, and allow for an active investment. Scientists noted the significance of further implementation of relevant policies aimed at developing renewable energy in Argentina and other countries. A. Sharif *et al.* (2020) also concluded that the use of this type of energy reduces the ecological footprint in the long run based on data from Turkey. This is primarily due to a reduction in dependence on fossil fuels, which leads to some other positive effects, including increased economic resilience to crisis situations. The researchers recommended that the government should continue to pursue a policy of reducing dependence on fossil fuels, promote investment in the industry and strive to achieve sustainable development goals.

A. Anwar *et al.* (2021) conducted an analogous study based on data from the Association of Southeast Asian Nations (ASEAN) countries. The findings showed that the consumption of non-renewable energy increases carbon emissions, which is why it is important to switch to renewable energy sources in all countries. Particular attention was paid to developing countries, as the rapid development of the economy creates a need to increase energy capacity in the country. Considering this, the rapid introduction of renewable sources will allow not to increase the burden on the country's environmental state by increasing the rate of economic growth, which was also noted in E. Dogan *et al.* (2020).

There is also a certain synergy with the development of the stock market, as described in V. Zeqiraj *et al.* (2020). Notably, for Ukraine, the development of renewable energy sources stays the principal area of the country's development. A country can gain a noteworthy number of benefits from implementing such systems, both in terms of economic development and environmental protection, as well as some other variables. For instance, this will allow Ukraine to achieve a greater level of energy independence, which is essential in times of crisis. Furthermore, this allows for decentralisation of the system, which reduces its

dependence on the failure of individual large nodes. However, the question arises as to whether this system can be developed in times of war: that is why the circulation of guarantees of energy origin can be one of the most effective tools to support renewable sources.

M. Mulder & S. Zomer (2016) and also A. Wimmers & R. Madlener (2023) assessed trade under uncertainty in the European market for green energy guarantees. Guarantees of origin were designed to disclose information about the production of clean electricity, but do not have the effect of incentivising increased production. To have a positive impact on producers' decisions, prices should be higher than current EU prices: this should be influenced by the government, among other things, as the formation of a more efficient market for guarantees of origin can lead to better conditions for the development of renewable energy. The study achieved somewhat different results: considering the increase in the exchange of guarantees of origin, a conclusion was made about the effectiveness of this initiative. If it had not been effective, there would have been no increase in volumes: the instrument is arguably in demand. Although there are challenges in the context of developing renewable energy sources within the association, their development of guarantees of origin has proven to be one of the most effective approaches to stimulate the development of the sector.

U. Calikoglu & M.A. Koksal (2022) analysed the demand for green electricity and guarantees of renewable energy origin in the Turkish market. The researchers conducted a survey among industrial consumers, producers, and suppliers of electricity and showed that companies generally prefer green energy, while another 20% are willing to overpay for it. They are also particularly focused on this, considering the renewable energy goals of the Paris Agreement, which are a priority in the context of the country's long-term policy. With this in mind, the researchers concluded that it is necessary to develop infrastructure for the development of renewable energy, one of which they define as built around guarantees of origin. Analogous results were obtained when assessing the situation on this market in EU countries: it was shown that transactions with guarantees of energy origin are gradually increasing, which suggests an increase in their popularity among market players.

T. Martinsen & M. Mouilleron (2020) assessed the analysis of the potential of guarantees of origin for increasing new renewable energy sources in the Nordic energy system. They noted that the success of the model depends on stable market development, which ensures sufficient demand for additional issues of this type of guarantee. The analysis compares the production of renewable energy, specifically wind and solar energy, forecasting the growth and viability of the sector. Showing the growing demand for guarantees of energy origin, the researchers pointed to the need to create new and diverse facilities to meet the growing demand. It was concluded that the policy of introducing such guarantees does have the potential to increase the share of renewable energy use and reduce CO_2 emissions in countries.

A. Petryk & P. Adamik (2023) investigated guarantees of origin as a market mechanism for energy transition in Poland. They noted the presence of a strong positive correlation between prices for guarantees of origin and electricity prices in the country. Thus, according to the model, an increase in the price of electricity by PLN 1 leads to an increase in the price of guarantees of origin of electricity by PLN 0.0049. Therewith, the price increase does not affect the dynamics of trade in this instrument, which is constantly growing. This demonstrates the effectiveness and growing popularity of the mechanism of Directive of the European Parliament and of the Council No. 2009/28/EC (2009) in Poland. Researchers also noted that the introduction of such a market mechanism as guarantees of energy origin has led to better results in the development of agricultural production and certain processing sectors, which also confirms the effectiveness and role of stimulating the introduction of renewable energy in enterprises. Overall, conclusions on the popularity of this directive in the EU countries were also made in the study. Considering this, it can be assumed that the popularity of the instrument will likely increase in Ukraine over time, and thus the possible effectiveness of the instrument of guarantees of energy origin in the country as a whole.

CONCLUSIONS

The study concluded that the development and use of renewable energy sources is a key area for Ukraine's future growth, reflecting global trends towards sustainable energy practices. Considering this, it becomes important to use new mechanisms to support and develop it, to achieve more effective results in the context of its future development.

To achieve these goals, the energy guarantee instrument was developed to serve as a catalyst for investment in the energy sector, stimulating the production and consumption of green electricity from renewable sources. The study showed that the issuance and sale of renewable energy certificates contribute to market transparency and enable consumers to make a choice in favour of sustainable energy. This is especially true in EU countries, where the demand for this instrument is growing rapidly in the current environment. This trend reflects the mutual benefits for both market participants and renewable energy producers. The study also assessed data on electricity trade between Ukraine and the EU. Based on the analysis of export and import data, it was concluded that with greater opportunities for independent electricity production (the most effective approach to which is renewable energy in times of war), the country could save quite a lot of money (EUR 57.3 mln and EUR 62.5 mln in 2023 and 2024, respectively) due to the lack of energy imports.

The study concluded that the structure of the EU Directive on Guarantees of Energy Origin should serve as a model for the development of an analogous mechanism in Ukraine in the future. This is caused by many reasons, including the proven effectiveness of these approaches and the benefits that the country can gain from their implementation. This is another step towards the unification of

renewable energy markets between international economic actors, which could lead to an influx of new investments in the industry from European companies. If the country could provide itself with electricity on its own, including from renewable sources, this situation could have been avoided and considerable amounts of funds could have been saved. Despite the war, Ukraine has taken the first steps towards this by creating a relevant resolution.

Nevertheless, further work needs to be done in this area, providing opportunities for further deeper interaction of these markets between the EU and Ukraine. Further research is needed to analyse the possibility of introducing other mechanisms to support renewable energy in Ukraine, especially in times of war.

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None.

CONFLICT OF INTEREST

None.

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Гарантії походження електроенергії як фінансовий механізм підвищення інвестиційної привабливості в енергетичній галузі

Ярослав Котик
Аспірант
Дрогобицький державний педагогічний університет імені Івана Франка
82100, вул. І. Франка, 24, м. Дрогобич, Україна
https://orcid.org/0009-0000-6629-0547

Анотація. У сучасних умовах забезпечення розвитку сфери відновлювальної енергетики є важливим для виконання цілей сталого розвитку країни. Впровадження механізму гарантій походження електроенергії є одним із дієвих способів розвитку відновлювальної енергетики, а отже його дослідження є актуальним. Ціллю роботи стало проаналізувати підходи до функціонування ринку гарантій походження електроенергії в країнах ЄС та порівняти їх з ситуацією в Україні. Основними методами дослідження стали прогнозування (перспектив впровадження гарантій походження енергії в Україні) та порівняння (підходів формування механізму гарантій походження енергії в Україні та країнах ЄС). У розвідці була визначена загальна роль відновлювальної енергетики для розвитку будь якої країни та України зокрема. Детально описані всі основні позитивні складові, що виникають в країнах при розвитку цієї сфери. Інструмент гарантій походження енергії залишається дієвим для досягнення цілей розвитку відновлювальної енергетики в Україні. Зважаючи на особливості правил продажу гарантій відновлювальної енергії, зроблено висновок стосовно їхньої корисності як для стимулювання розвитку сектору, так і розповсюдження інформації про потребу покращення стану галузі в Україні та світі. Оцінено, які кроки були зроблені з боку України для прийняття та впровадження цього механізму. Також досліджувалася інформація і стосовно країн ЄС. Поступове щорічне підвищення попиту на такого роду інструменти починаючи з 2019 року говорить не лише про популярність даної практики, але й про її потребу серед усіх гравців ринку. Було показано, що після початку повномасштабного вторгнення Росії в Україну сальдо зовнішнього торговельного балансу стало від'ємним, тобто обсяги закупівлі електроенергії перевищили обсяги продажу. Висновки, отримані в рамках дослідження, можуть бути застосовані для формування довгострокової стратегії розвитку механізму гарантій походження електроенергії в Україні з боку представників державної влади

Ключові слова: соціальна відповідальність; сталий розвиток; кризостійкість; «зелена» економіка; стратегічна безпека

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Pricing in the medical sector: Theoretical foundations and practical aspects

Serhiy Inozemtsev*
Poctgraduate Student
National University of Kyiv-Mohyla Academy
04070, 2 Skovoroda Str., Kyiv, Ukraine
https://orcid.org/0009-0005-2534-9158

Abstract. Pricing is one of the components of ensuring competitive conditions in the market: it has its own specificity in the healthcare market, which is characterized by various forms of operation of enterprises, access to goods and services. The purpose of the study was to investigate the methods and approaches to this process in Ukraine, taking into account the peculiarities of the country's development related to the full-scale invasion of the Russian Federation. The methods used in the study were formal and legal (to form logical links between individual regulatory documents) and comparison (to assess the specifics of pricing in the medical sector in different countries). The study assessed the pricing process as such and described the factors that influence it in practice in general and in the medical sector. It was also concluded that understanding the role of this process for both the state and potential clients is important, as it affects economic stability, quality of medical services, social justice. Particular attention was paid to such approaches as "cost+markup" and "market-based". Based on the models built in this paper, it was concluded that these approaches should be used in symbiosis (to focus on both market conditions and the company's goals for forming a margin). Attention was also paid to the Value-Based Pricing approach: it was concluded that it is inherently different from the other two approaches, as it requires much more complex estimates, since it is based on the expected utility of the created product. The study also highlighted the problem of non-transparent pricing as one of the main ones that prevents the formation of effective market conditions. The results obtained in the study can be used both to formulate public policy and to create strategies for individual companies in the Ukrainian market of medical goods and services

Keywords: microeconomics; healthcare; public policy; innovation; market configurations

INTRODUCTION

The process of pricing, which is essentially the formation of a single fair price for a particular good or service, is essential to the existence of any market good. Without the existence of this process, economic agents could not be sure whether the price formed for the good they buy is fair. In Ukraine, the study of this issue is particularly relevant, as the country has certain problems in this sector. They are primarily related to the war and its consequences: the country is suffering from economic difficulties that lead to a decline in living standards and higher prices for healthcare products; at the same time, the demand for medicines and services in this sector is only growing, which leads to a double effect, making it increasingly difficult for the population to afford quality treatment. That is why research into pricing is so important in Ukraine today. There are certain variables in the healthcare industry that should also be taken into account. These include the specifics of the regulatory environment, complex logistics, high research and development costs, certain ethical aspects. This is also the case in Ukraine.

Quite a few scholars have assessed the current state of development of the healthcare sector in Ukraine in their own research, although few works have focused on pricing issues. V.I. Borshch (2020) identified the main features of the functioning of the healthcare market in Ukraine, assessed its current state and inherent trends. This helped to identify certain patterns in the market, such as the dependence of prices and sales on real incomes, the need for further reform, the lack of qualified personnel in the industry. I.O. Kizikova *et al.* (2020), in turn, assessed the difficulties

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*Corresponding author

of determining profitability and pricing in the healthcare sector. They noted that such difficulties arise due to differences in the functioning of public and private institutions in this area. They proposed to carry out reforms in the healthcare sector aimed at improving the efficiency of the industry as a whole, including the pricing component, but did not specify what kind of reform this should be. A.Yu. Palamarchuk & V.A. Samchuk (2022), in turn, drew attention to the role of marketing in the pricing of medical products, and also described the trend towards an increase in the role of price changes for such goods for the local population as a whole. No clear approaches to the formation of a pricing strategy have been proposed in any work.

T. Demchenko & M. Slatvinskyi (2023) also examined the peculiarities of pricing in the Ukrainian medical sector in some detail. The authors described in detail the peculiarities of the pricing policy of companies in this sector, and also paid a lot of attention to the impact of the 2018 healthcare reform. The peculiarities of marketing in the healthcare sector were considered by Ya. Malyarenko & T. Pulina (2020), drawing attention to the differences that exist in the medical sector compared to others. The changes observed in this area with the development of new technologies and in connection with certain global trends were also studied. Some recommendations were also formulated in the context of such activities, but no significant attention was paid to pricing. Analysis of the effectiveness of the affordable medicines programme in Ukraine as one of the main approaches to providing the population with cheap medicine was carried out by V. Dobrova *et al.* (2023). The authors noted that this programme has indeed had a significant impact on health policy in the country, improving access to medicines among the population, albeit at the expense of budgetary funds. They also expressed some doubts whether the overall effect of the programme was positive or negative. It is therefore important to conduct additional research in this regard in the future. It may be relevant to investigate the impact of the programme on pricing in the healthcare sector. I. Vlasenko & L. Davtian (2023) described in their study the problems associated with rising drug prices due to Russia's full-scale invasion of Ukraine. They concluded that, in general, the country's healthcare system proved to be quite resilient, as the negative consequences could have been much worse.

The purpose of this study is to describe the main characteristics of approaches to healthcare pricing in Ukraine.

MATERIALS AND METHODS

The paper depicts certain peculiarities of pricing in the field of medicine using certain models. One of the models describes the characteristic components in a free market, when the price is formed only on the basis of the interaction between supply and demand, i.e., D (Demand) equals S (Supply); in this context, P (Price) and Q (produced volume in the case of Supply and consumed volume in the case of Demand) remain important. This is not the only approach to price formation that is actively used today: others are characterized by the "cost+markup" approach. Its schematic representation was formed on the basis of the concept of aggregate long-term average costs (ATC), i.e., costs that include both variable and fixed costs (1):

$$ATC = AFC + AVC, \quad (1)$$

where: AFC – the long-term fixed average cost; AVC – the long-term variable average cost.

According to microeconomic theory, the market price should be formed at the lowest point of the ATC indicator, since in such conditions the market will be most efficient and there will be no competition. Given that the medical products market is not perfectly efficient, an approach based on monopolistic competition has been proposed. The main fundamental difference in this context is that each of the companies in the market is a kind of monopolist, since its products have their own characteristics and, therefore, have unique direct demand. This leads to different prices for products, different production, sales and profits, despite the fact that the companies actually operate in the same industry. The features of the Value-Based Pricing method were also analysed, without depicting models, given the peculiarities of this approach and the difficulties of its application in real conditions.

The study used a comparative approach to examine the pricing situation in different countries and regions to understand similar and different trends in this area globally. The graphical method was used to illustrate the models developed in the study, which described the specifics of pricing in the market.

RESULTS

Pricing itself is the process of determining the price of a product or service. From a theoretical point of view, it is formed on the basis of the interaction between supply and demand for a product, i.e., through the interaction between various forces in the market. In practice, there are many other variables that influence the formation of the price for a particular product. Important variables include production costs (raw and pack materials, labour, energy, equipment, transport costs), the competitive environment (companies that exist in the market and their capabilities to produce the product), and, in fact, the supply and demand for the product (Gregson *et al.*, 2005). There are other variables that influence price, such as the brand for which people are willing to overpay to gain a "higher status" in society, although this is not economically justified from the point of view of classical economic theory.

The medical sector as such plays an important role in the development of a country. It ensures the health of the nation, which is one of the main indicators of human capital and quality of life (Keehan *et al.*, 2020). Healthy people are more able to work, have more opportunities for learning and development, which contributes to economic growth and social welfare of the country. In addition, a healthy nation reduces the cost of treating illnesses and the loss of

productivity: an effective healthcare system enables faster diagnosis and treatment of illnesses, which reduces treatment costs in the long run (Incze *et al.*, 2022). High-quality healthcare services can attract foreign patients, which stimulates medical tourism and generates additional revenue for the country. Affordable and high-quality healthcare system helps to increase the level of trust between the government and citizens, which contributes to social stability and development of the country as a whole (Jommi *et al.*, 2020; Vogler *et al.*, 2021). Nevertheless, its development is quite complex, as it requires significant investments in innovation and research, as well as infrastructure development.

Understanding the specifics of the pricing structure for healthcare products and services is important for both patients and public authorities responsible for healthcare governance. Patients need to understand what they are paying for and what the difference is between using different types of medicines (Hernandez *et al.*, 2020; Mattila *et al.*, 2021). A clear understanding of the pricing structure also helps patients assess their ability to obtain the healthcare services or products they need and choose the most affordable options. Understanding the benefits of services can also help patients assess the value for money of healthcare services and choose the best treatment options. As for government agencies, their needs are somewhat different. Understanding the price structure allows them to plan the state healthcare budget more effectively and allocate resources according to the needs of the population and expected economic effect. Information on the price structure helps to develop policies and regulatory measures aimed at ensuring accessibility and equity in healthcare, as well as to introduce price control mechanisms to guarantee that healthcare services are affordable for the population. On the other hand, the government can use price information to provide social support to vulnerable groups by ensuring access to essential healthcare products and services. Price structure transparency also serves to more effective investments in development of new and innovative treatments.

There are several main approaches to product pricing in the healthcare sector (Nemchenko, 2022). The first is the cost+markup method, which is a strategy for pricing goods or services based on determining the cost of production or provision of services and adding a certain percentage of markup to this cost, which determines the profit for the enterprise or supplier. The basic idea behind this method is to ensure the profitability of the business by including in the price of a good or service the cost of its production together with an additional amount, which is the profit. If the cost of producing a unit of goods is 100 units of currency and the markup is set at 50%, the selling price of this unit of goods will be 150 units of currency.

Another method of pricing is the market-based method. In essence, it is a strategy for determining prices for goods or services based on supply and demand in the market. The main idea behind this method is that prices for goods or services are formed in accordance with changes in supply and demand, rather than based on the costs of production or provision of services. The features of "market-based" pricing include flexibility, as prices can vary depending on the level of supply and demand in the market. When demand for goods or services increases, an entity may increase prices, and when demand decreases, it may decrease prices to increase consumer interest and sales. In addition, "market-based" pricing takes into account the needs and capabilities of consumers. Prices are set in such a way that they are acceptable to the target audience and help to increase demand. This method also allows companies to respond to changes in market conditions and meet competitive requirements; it also encourages companies to introduce the latest technologies, improve the quality of goods and services, update marketing strategies. The use of both methods can be depicted graphically. Thus, the "from the market" method can be depicted by the interaction of known direct supply and demand, as shown in Figure 1.

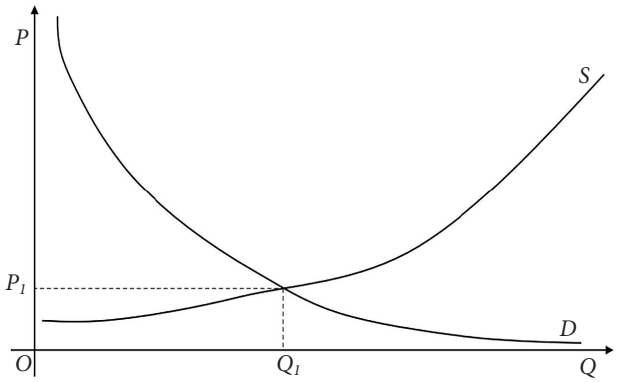

Figure 1. Model of supply and demand interaction as a representation of the "market-based" method

Notes: Q_1, P_1 – price and output at market equilibrium; S – supply; D – demand

Source: compiled by the author

As can be seen from Figure 1, pricing under this methodology is effectively market-based, and is entirely based on the principles of supply and demand, which form the price. The "cost+markup" approach is also common. A pricing model based on this approach is shown in Figure 2.

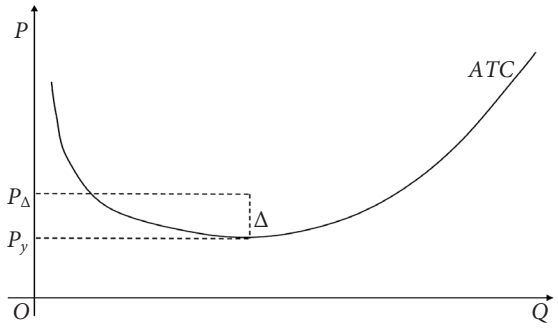

Figure 2. Depiction of the "cost+markup" approach to pricing

Notes: P_Δ – markup price; Δ – markup level; P_y – price level at which the company will not make a profit

Source: compiled by the author

Figure 2 shows that the price at which a company will be willing to sell its products at a certain volume of output is equal to the ATC level (i.e., the long-term average cost plus a markup). Setting such a markup based solely on a plan and without assessing the market situation is risky, as it can result in either a price that is too low (resulting in a loss of potential profit) or too high (which will reduce demand for the product or, in a perfectly competitive environment, eliminate it altogether). That is why assessing market trends in this context is important. Pricing based on these two approaches is shown in Figure 3. As can be seen in Figure 3, setting the price, including the markup, in this context should be based on analysis and finding the point of interaction between supply and demand to ensure the highest possible profit. The price eventually set may still differ from the true market price (both due to the inefficiency of the analysis and a certain lag between the companies' reaction to changes in the market and the actual situation), but it will be closer to the real market price and thus will achieve the most efficient result. In reality, modern markets, including those for medical products, are not characterized by absolute competition. More often they are similar to monopolistic competition, although there are also oligopolistic or completely monopolistic ones. For the purposes of this study, it is worth considering the situation characteristic of a monopolistic competition market, as shown in Figure 4.

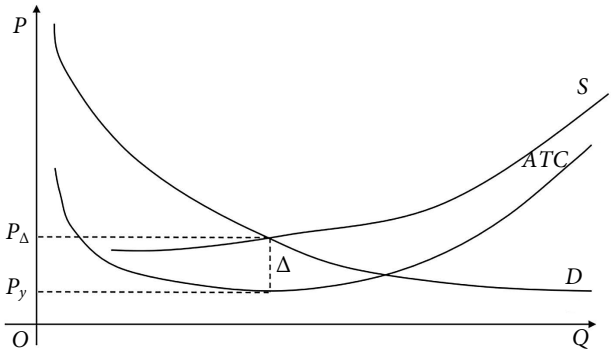

Figure 3. Interaction between market-based and cost+markup pricing approaches
Source: compiled by the author

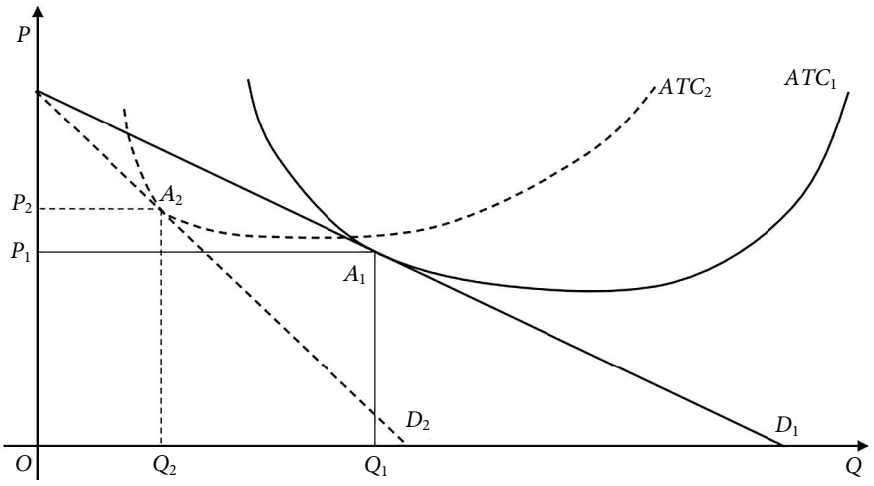

Figure 4. Pricing model within the monopolistic competition model
Notes: the lines D_1 and D_2 show the level of demand for the product produced by the market player, and the lines ATC_1 and ATC_2 show the level of long-term average production costs; the points P_1 and P_2 are the corresponding prices for each company under these conditions; Q_1 and Q_2 are the corresponding production volumes under these conditions; A_1 and A_2 are the points of intersection of the direct demand with the direct aggregate average costs
Source: compiled by the author

As can be seen from Figure 4, different companies producing a similar, but different in certain respects, product in the market will have different aggregate average cost curves, as well as different demand for their products. This may result in different prices for the products, as well as different profits, as shown by the area of the corresponding rectangles $P_1A_1Q_1O$ and $P_2A_2Q_2O$. In the context of selling goods or services in the healthcare sector, it is worth considering how the demand from potential customers for products in this sector may differ.

The use of the Value-Based Pricing method is also relevant in healthcare. At its core, this is a strategy where prices are set based on the perceived value to a client or a patient. It's easier to understand this with an example: if a marketing agency that spends £25,000 on a campaign and wants to make 100% profit – it will charge £50,000 for its services ((50/25 – 1) *100 = 100%). If making an estimate according to Value-Based Pricing, it is worth evaluating the benefits that this marketing campaign will bring to the client: if it will bring the company an additional million pounds in sales with profitability more than 5%, then a price of 50 thousand pounds may be considered a fair price for the provision of such services. This approach is also relevant in medicine, as innovative treatments are expensive, but they bring significant benefits to public health, among other things. In practice, it is quite difficult to use this method, as

it is not easy to estimate the benefit that customers will gain from the acquired products. There are several approaches to this assessment. One of them is the assessment of willingness to pay, which is based on customer surveys. Another approach is to study cost-effectiveness by comparing the economic benefits of a product versus competitors. In each case, the use of this approach is complex, as it requires additional resources for research and surveys but justified in pricing for innovative treatments. Therefore, in the medical sector, pricing using the Value-Based Pricing method should also be supported by additional research.

Sometimes pricing can be controversial: for example, the distribution of COVID-19 vaccines had a significant ethical component, as the pandemic led to a global crisis and resulted in significant casualties in many countries. The companies that produced the vaccines also spent significant resources on their development. From an ethical point of view, the vaccine should have been given to low-income countries almost for free, while from a market point of view, they should have charged a fair price for it, which they could not actually do, that could have caused significant human losses (Ezekiel *et al.*, 2021). In the end, the distribution was carried out through a multilateral approach, which should have guaranteed equal access to the vaccine in low- and middle-income countries. In addition, some international organizations purchased vaccines for further distribution to low-income regions.

One of the problems that also exists in the healthcare sector is the lack of price transparency, which prevents patients from making optimal decisions when selecting a particular drug. More effective disclosure of information on all components of the price formation for a particular product or service in the healthcare sector, as well as its advantages or disadvantages, could bring many benefits to patients and economy overall. This would increase competition in the market and thus lead to lower costs while improving quality. Achieving this is difficult given the variability and heterogeneity that exists in the healthcare sector. In other words, it is difficult to achieve standardization of products or services, and therefore difficult to make comparisons between them. In addition, ensuring something like this would require direct and active involvement of government officials, which is a difficult, sometimes harmful process in general (including due to bureaucracy), and especially in times of war.

DISCUSSION

Based on the analysis, options for improving the situation in the context of pricing can be formulated. One of the options is to ensure a higher level of transparency (Russo *et al.*, 2021). In other words, all market participants should understand the basis on which other players are pricing the market. In addition, online platforms that provide up-to-date information on prices for medical products and services can be developed and maintained. The state, for its part, should also develop a more effective and simplified regulatory framework that would encourage more transparent pricing of medical products. This includes the fight against monopolies and the application of strict antitrust laws in the healthcare sector to prevent price manipulation and ensure a competitive market. It is also effective to support innovations in the industry as a whole, but questions arise as to when such changes can be implemented, given the situation in Ukraine with the full-scale invasion and its consequences.

The current study also drew attention to the fact that there is a problem in the context of insufficient information on the prices of medical goods and services. It was shown that Ukraine is on the way to this, but there are currently a significant number of problems, including the consequences of a full-scale invasion of the country, that will not allow solving this problem at the moment, although such opportunities may arise in the future. Similar problems were noted in their study by A.D. Ambtman *et al.* (2020), who studied the peculiarities of pricing in Dutch hospitals. They noted that there is a significant difference in the prices of medical products in Dutch hospitals, which contradicts conventional economic theory. The researchers concluded that there is a non-transparent pricing system, which is exacerbated by the lack of awareness of each other's prices among hospitals. In view of this, they propose to significantly increase attention to the pricing process in local hospitals, controlling the procurement process and other key components that influence the price of goods.

The current study also drew attention to the possibility of pricing medical goods and services through market forces: this approach is generally quite effective, but it can cause certain problems and difficulties, especially among the most vulnerable segments of the population. The pricing of pharmaceuticals in the context of the impact on the healthcare sector was considered by S.G. Morgan & H.S. Bathula (2020). The scientists noted that despite the key role of pharmaceutical innovation in healthcare, price increases are becoming increasingly disproportionate to the ratio of price to research investment, which is becoming a problem for citizens of countries and those with financial difficulties. The authors concluded that market-driven pricing of pharmaceuticals poses a threat to the sustainability of health systems and equitable access to essential medicines. They highlighted innovation and market power as key contributors to the current pricing problems. They also mentioned the existence of phenomena such as "confidential price discounts", which further exacerbate existing inequities. The article also examined the dynamics of pricing for old medicines, noting cases of significant price increases due to market monopolies and lack of competition.

A.J. MacNeill *et al.* (2020) considered the possibilities of reducing the prices of medical products in their study. They concluded that there is a need to move to a circular health economy to address the unsustainable effects of current practices. The researchers wrote that this transition requires the integrated work of many public services, and interaction with businesses and citizens. Given that the introduction of such practices is generally beneficial for the economy, the researchers write about the possibility of achieving the effect of reducing the prices of medical

products in countries. The current research has not paid much attention to the approaches that can reduce the price of medical products. The methods used within the framework of the circular economy concept can indeed have a positive impact on this situation. It is worth noting that this is not the only way to reduce the price of medical products: in Ukraine, price aggregators have helped to achieve this. The development of such approaches is also effective for the purpose of reducing the cost of healthcare products.

The impact of volume and price contracts on pharmaceutical prices was studied by Z. Li *et al.* (2021). The study evaluated the impact of the volume contracting initiative on the unit price of cardiovascular drugs in 35 hospitals over two years. Using a generalized linear regression model, the study found that the initiative led to a significant reduction in unit prices, especially for brand-name drugs and those supplied by leading Ukrainian suppliers. The results underline the effectiveness of volume-based pricing contracts in reducing drug costs, although the impact varies across suppliers and types of drugs. In other words, the formation of collective tenders and volume-based procurement has reduced administrative and transaction costs, leading to an overall reduction in product prices. The current study also drew attention to the need to minimize the price of healthcare services, if possible, especially for the poorest segments of the population. This approach may also be relevant in the Ukrainian context.

The study paid particular attention to value-based pricing, concluding that it is theoretically effective, but that there are many difficulties in implementing it in practice. While it is fair enough to price products based on how they will benefit society, it should be possible for most companies to price their products more clearly. The peculiarities of pricing in terms of cost-effectiveness for pharmaceutical companies were noted in their study by G. Hyeraci *et al.* (2023). They drew attention to the fact that cost-effectiveness is increasingly the basis for choosing the price of a product and estimating the cost of its production. The scientists noted that for innovative products, the price is estimated based on the cost and compared with the proposed price and the threshold of society's willingness to pay. The scientist pointed out the need for a clearer method of existing pricing methods in the medical products market.

The difference between the prices of pharmaceutical products in the Yangtze River Delta in China was studied by L. Li and B. Liu (2023). They noted that there was a significant gap between the prices of such products between regions, with Shanghai having the highest prices, followed by Anhui, Zhejiang and Jiangsu provinces. These price differences were not consistent with the socio-economic status of these regions. Unlike conventional markets, healthcare prices in China are set by the government for the public welfare, which potentially explains this discrepancy. The current study did not analyse how the price of healthcare products differs in countries with different standards of living. It can be concluded that highly developed countries will have more expensive prices for products and services of the same nature as in developing countries. This is one of the reasons for the development of the insurance sector in highly developed countries, as it allows them to cover expensive treatment costs in the event of an emergency. In Ukraine, however, it is still in its infancy.

CONCLUSIONS

Pricing in the healthcare industry is complex: in theory, prices are determined by market forces, but in practice, various other factors come into play, such as production costs, the competitive environment and the unique characteristics of the healthcare industry. This paper describes the main approaches to product pricing: cost-plus pricing and market-based pricing. Cost-plus pricing ensures that companies cover their production costs and make profit by adding a markup to the product cost. This method provides a simple approach to ensuring profitability, but can be risky if it does not take into account market dynamics, potentially leading to prices that are too high or too low. Market-based pricing is more flexible and responsive to changes in supply and demand, aligning prices with consumer willingness to pay and competitive conditions, promoting efficiency and innovation in the market. By adjusting prices in line with market conditions, companies can better meet consumer needs and maintain competitiveness. This method requires an in-depth understanding of market trends and consumer behaviour, which can be resource-intensive.

The study showed that value-based pricing is gaining popularity, especially for innovative treatments and medical technologies. This approach sets prices based on the perceived value to the customer, taking into account the benefits and outcomes of a product or service. Value-based pricing is difficult to implement due to the difficulty of quantifying the value and benefits perceived by patients. The use of behavioural economics methods may be relevant to address the problem of non-transparent pricing. For example, a "nudging" approach could be used to encourage healthcare providers to be more transparent in their price disclosures. This could include creating simple and easy-to-use price comparison tools, providing information on average market prices, or using "default" options that automatically provide patients with price information. Healthcare facilities should consider a significant number of factors and variables when pricing the products they manufacture and sell. The state and patients also need to be aware of how the price of such goods or services is formed in order to make informed decisions on healthcare-related issues.

It would be relevant for future research to assess the pricing in other sectors of Ukraine, such as agriculture or IT, which have been considered the main drivers of the Ukrainian economy in recent years.

ACKNOWLEDGEMENTS

None.

CONFLICT OF INTEREST

None.

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Ціноутворення в медичній сфері: теоретичні основи та практичні аспекти

Сергій Іноземцев
Аспірант
Національний університет "Києво-Могилянська академія"
04070, вул. Г. Сковороди, 2, м. Київ, Україна
https://orcid.org/0009-0005-2534-9158

Анотація. Ціноутворення є однією зі складових частин забезпечення конкурентних умов на ринку медичних послуг: воно має свою специфіку, що характеризується різними формами функціонування підприємств, забезпечення доступу до товарів і послуг. Ціллю роботи було дослідити методи та підходи до даного процесу в Україні, зважаючи на особливості розвитку країни, пов'язані з повномасштабним вторгненням російської федерації. Методами, що використовувалися в рамках дослідження, стали формально-юридичний (для формування логічних зв'язків між окремими нормативно-правовими документами) та порівнянльний (для оцінки особливостей ціноутворення в медичній сфері в різних країнах). У рамках дослідження було оцінено процес ціноутворення як такий та описано фактори, що впливають на нього на практиці загалом, та у сфері медицини зокрема. Також було зроблено висновок про те, що розуміння ролі даного процесу як для держави, так і для потенційних клієнтів, є важливим, оскільки це впливає на економічну стабільність, якість медичних послуг, соціальну справедливість. Особлива увага була приділена таким підходам, як «собівартість+націнка» та «від ринку». На основі побудованих у роботі моделей було зроблено висновок про потребу використання їх у симбіозі (орієнтуватися як на ринкові умови, так і на цілі компанії стосовно формування націнки). Також увага була приділена підходу Value-Based Pricing: було зроблено висновок, що за своєю суттю він значно відрізняється від двох інших, оскільки потребує складніших оцінок, оскільки базується на очікуваній користі від створеного продукту. Також було виділено проблему непрозорості ціноутворення як одну з основних, що не дає змоги формувати ефективні умови функціонування ринку. Результати, отримані в рамках дослідження, можна використовувати як для формування державної політики, так і створення стратегій окремих компаній на українському ринку медичних товарів і послуг

Ключові слова: мікроекономіка; охорона здоров'я; державна політика; інновації; ринкові конфігурації

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Artificial intelligence technologies in international management

Tetiana Aizenberh*
Postgraduate Student
Taras Shevchenko National University of Kyiv
01033, 60 Volodymyrska Str., Kyiv, Ukraine
https://orcid.org/0009-0003-2389-9135

Abstract. The study aims to investigate the effectiveness of artificial intelligence (AI) and determine its impact on the management processes of international companies. A methodology was created to optimise international business processes, including introducing AI to improve management efficiency, automate strategic planning, and analyse market data and forecast trends. The study addressed various aspects of AI technologies in international management, covering key areas such as business process automation, document processing, inventory management, logistics, customer communications, analytics and forecasting, and human resources management. Automation of processes has reduced costs and improved the quality of service. Machine learning algorithms in logistics and inventory management have simplified demand forecasting and optimised the supply chain. Communication with customers was automated via robots and chatbots, which improved service. Analytics and forecasting based on data collected and processed by AI allow companies to make informed decisions and plan strategies effectively. The use of AI has significantly increased the efficiency of management processes. These technologies assist companies in adapting to market changes faster and increase their competitiveness in the global business environment. The study determined that the ability of AI systems to analyse large amounts of data, predict market trends, automate routine tasks and reduce decision-making risks enables companies to respond more quickly to market changes, improve the accuracy of strategic planning and ensure a high level of competitiveness in the global business environment. The practical value of this study is to provide businesses with a detailed understanding of how to integrate AI into various aspects of international management

Keywords: process automation; algorithms; optimisation; business processes; demand forecasting

INTRODUCTION

Artificial intelligence (AI) technologies are substantial in international management, facilitating innovation and improving the efficiency of business processes. One of the main areas of AI application is the automation of routine tasks and optimisation of internal processes. Machine learning algorithms allow the automation of repetitive operations, which increases the efficiency of using human resources and the company's resources in general. In logistics, AI is used to optimise transport routes and manage the supply chain. Analytical models can forecast demand, plan deliveries and use resources with maximum efficiency. This is especially important in a globalised world where the speed and accuracy of logistics operations are key competitive advantages. In addition, AI data analysis allows international management companies to effectively predict market trends, respond to changes in the economic environment, and minimise risks. Intelligent analytical tools can be used to manage business on sound data and support strategic decision-making at all levels of the organisation. Therefore, exploring the potential applications of artificial intelligence in business management is currently both relevant and promising and it is generating significant interest within the scientific community.

One of the main existing problems in the field is the difficulty of integrating AI technologies into international management, considering various cultural, economic and legal aspects. I. Zadorozhna (2022) focused on the prospects of using AI in management. As determined, AI can significantly improve management processes, optimise resources, and increase the efficiency of organisations.

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*Corresponding author

O. Okhotnikova & R. Okhotska (2022) studied the introduction of AI in legal management, focusing on foreign experience and emphasising the importance of legal aspects in the implementation of AI, in particular, ethical compliance and data protection. However, it is necessary to study the impact of cultural peculiarities on the integration of AI into international management, assess the effectiveness of AI adaptation to different legal systems, and consider the ethical aspects of AI application in management.

Another problem is the lack of understanding of the principles of AI, the possibilities of its application, ethical issues and the integration of these technologies into business processes, which limits its potential benefits in international management. A. Piskun & M. Sierov (2023) determined that AI can significantly improve decision-making processes, optimise resources, and increase the efficiency of management processes. A. Sestino & A. De Mauro (2022) determined that AI helps to improve the efficiency of business processes, increase the competitiveness of companies, and reduce costs. The main results of their research show that AI can increase productivity, automate routine tasks, and improve customer service using AI. Gaps that need further study include the ethical use of AI, its impact on the workforce, and the adaptation of different cultural contexts. M. Artar *et al.* (2022) studied the application of AI in human resources management, finding that it can significantly improve the recruitment and management processes. Y. Pan *et al.* (2023) found that successful AI adoption depends on cultural, organisational, and technological factors. Therefore, it is necessary to study the adaptation of AI to different cultural contexts in international management and the long-term impacts of AI adoption on strategic management and planning in multinational companies.

The use of AI technologies is becoming increasingly relevant due to the need to improve cybersecurity. Research by S. Zeadally *et al.* (2020) showed that employing machine learning methods helps detect and prevent cyber threats in real-time, significantly reducing the risk of cyberattacks. B. Naik *et al.* (2022) conducted a comprehensive review of AI methods used to strengthen cybersecurity and assessed their effectiveness as high due to their ability to quickly detect and respond to threats. It is necessary to address the technical challenges and limitations of integrating AI into cybersecurity systems.

A common challenge is the need to effectively integrate these technologies in complex cross-cultural and international business environments. N. Jayawardena *et al.* (2022) explored how AI can analyse large amounts of market data and provide deep insights into customer behaviour. M. Barriga (2019) determined that the use of AI in marketing helps automate many routine tasks, personalise customer interactions, and predict market trends. This improves the effectiveness of marketing campaigns and contributes to a better understanding of customer needs. However, attention should also be given to the impact of artificial intelligence on employment and workers' skills, as well as the integration of AI into existing business processes, to ensure its harmonious implementation without negative effects on human capital and social responsibility.

This study focuses on several key aspects. First, it is adaptation to the global market environment, which involves the development of flexible management strategies to ensure the competitiveness of companies. Further, it is necessary to analyse how AI technologies can contribute to effective data management and risk mitigation in international business. The cross-cultural aspects of implementing such technologies also require attention, as cultural diversity can affect the success of their integration and adoption. Ethical standards for the use of AI in international management are also an important topic, especially in the context of employee and customer relations. There is a need to explore how AI can improve the efficiency of management processes through data analysis and strategic decision support. The aim of the research is to explore the potential of AI to enhance management processes in international companies, identify opportunities for using AI to manage cross-cultural communications, optimize decision-making, and improve competitiveness in international markets.

MATERIALS AND METHODS

A mixed approach that combines qualitative and quantitative methods was used to conduct a comprehensive analysis of process automation at enterprises using AI. A variety of sectors, including document processing, inventory management, logistics, customer relationship management (CRM), marketing, financial management, human resources and cybersecurity, were covered.

To address the use of AI in business process automation, a detailed analysis of scientific and professional literature was conducted, which identified the main research areas and current issues in this area. The available publications, reports and research materials on the use of AI in business processes were studied (Davenport, 2018). Documents on AI implementation in companies published in specialised publications were analysed as well (Cam *et al.*, 2019). Analysis of examples of successful AI implementation in various business areas published in industry reports and analytical articles. Key documents include Gartner Magic Quadrant Reports, which provide overviews of AI leaders in various markets, including data analytics, CRM, and process automation (Gartner: Magic quadrant..., 2022). Forrester Wave Reports offer detailed analyses of AI solution providers in areas such as natural language processing (NLP) and marketing automation (Evelson, 2020). McKinsey & Company Industry Reports examine the impact of AI on business models, strategies, and results in specific industries such as finance, healthcare, and retail (Artificial intelligence in..., 2021).

The study focused on the use of AI to automate document processing, including text recognition, document classification, and automation of routine tasks, which helped to increase efficiency and reduce costs. For this purpose, NLP and optical character recognition (OCR) methods were used. NLP was used to analyse textual data

such as CVs, customer reviews, and contracts, which allowed for the automatic extraction of key information and text classification. OCR was used to convert text from paper documents into digital format, which automated the processing of physical documents. The statistics used to evaluate this automation included measurements of document processing speeds before and after AI implementation, the number of errors, and the cost of document processing (The Future of..., n.d.).

An econometric method was used to evaluate the use of AI to optimise inventory management and procurement automation, including an analysis of the accuracy of demand forecasting, changes in inventory levels and storage costs before and after the introduction of the technology. The analysis of the impact of AI on business process performance included measuring information processing time, task completion speed, and the overall impact on performance. For this purpose, internal corporate data was used to record the speed and efficiency of tasks before and after the introduction of AI technologies. The quality assessment included determining improvements in accuracy, error reduction, and customer satisfaction. This was investigated by examining feedback on web pages and analysing customer loyalty indicators such as Net Promoter Score (Gillis, 2006). Difficulties and obstacles in AI integration were identified by analysing technical limitations, problems with staff adaptation, and other challenges identified in the process of implementing AI in organisations.

Statistical methods were used to analyse large amounts of data on the use of AI, which assessed the impact of these technologies on the performance of companies. This included an analysis of changes in costs, productivity and efficiency of management processes before and after the introduction of AI. A SWOT analysis of the strengths, weaknesses, opportunities, and threats associated with AI implementation identified the main advantages and challenges facing companies. This method was used to assess the potential risks and opportunities of AI integration in various business environments. A comprehensive study of all aspects of AI implementation included technical, economic, and organisational aspects. This allowed to gain a holistic view of the impact of AI on business processes and identify key components for successful technology integration.

RESULTS

Enterprise management automation using AI technologies covers a wide range of processes aimed at increasing efficiency, reducing costs, and improving the quality of tasks. AI document processing is a critical element of modern business process management, as it facilitates and speeds up the processing of large amounts of information. The first key aspect is text recognition. AI systems use natural language processing algorithms to automatically analyse documents such as invoices, contracts or reports. This efficiently extracts important data such as dates, amounts, and names of goods or services, which simplifies accounting, analysis and reporting processes. The second aspect – document classification and indexing – allows AI systems to automatically group documents by their type and importance. For instance, the system can recognise invoices, contracts, or reports and assign them to the appropriate categories depending on their content. This simplifies the subsequent management of documents, providing quick access to the necessary information without the need to manually review a large amount of documentation. Indexing helps to structure and organise documents for quick search and access to the data required, which is key to increasing productivity and reducing time spent on administrative tasks.

Inventory management with AI is becoming a necessary element of business process optimisation in today's environment, especially in the face of increasing complexity and competition in the market (Gonçalves, 2022). Key aspects include demand forecasting and inventory optimization, which are crucial for efficient supply chain management and cost reduction. The use of machine learning algorithms for demand forecasting allows companies to analyse large amounts of data, including sales history, the impact of external factors (e.g. environmental conditions, weather) and consumer behaviour. This helps to more accurately determine future demand for goods and services, which is critical for production planning and inventory management. For instance, systems can automatically analyse demand trends and respond to them by changing production volumes or ordering new batches of goods. Inventory optimisation involves automatic management of stock levels based on demand forecasts and optimal service levels. AI analyses data on demand, spending rates, and inventory availability to strike the right balance between minimising inventory and ensuring high availability of goods to customers. This can avoid cost overruns and maintain optimal stock levels, which supports production efficiency and customer satisfaction. The use of AI in inventory management also helps to improve the accuracy of forecasting and optimising inventory strategies in real-time, making it a key tool for modern companies seeking to achieve competitive advantage in challenging market conditions.

Logistics in modern business includes the efficient management of transport routes and the supply chain, where AI plays a key role in optimising processes and costs (Sharma *et al.*, 2022). AI algorithms are used to optimise transport routes, which avoids congestion, reduces fuel costs and shortens delivery times. These systems analyse a large amount of data, such as traffic information, weather forecasts and traffic schedules, to automatically determine the most optimal routes. This approach helps companies effectively manage their fleet and ensure timely delivery of goods and services to customers. Automation of supply chain processes using AI includes the automatic management and coordination of orders, production, and delivery. AI systems analyse demand, stock levels, lead times and other factors to optimise order planning and execution. This helps to avoid delays and increase efficiency in the supply chain, which is critical to maintaining high-quality customer service and reducing overall company costs.

The application of AI in logistics allows companies to achieve significant improvements in productivity and efficiency, which is an important factor in competitiveness in the modern market. In the context of international management, where companies operate in international markets, the use of AI to automate communication processes with customers is a critical element (Gillis, 2006; Meyer *et al.*, 2020). Key aspects include automating query responses, providing 24/7 customer support and improving the overall customer experience.

Robots and chatbots are used to automatically process and respond to customer queries via websites, mobile apps or social media platforms. They are programmed to recognise keywords or phrases and provide answers to popular questions. This provides a quick and efficient way to resolve standard customer queries, such as product information, order status, or return procedures. Chatbots allow companies to provide customer support services around the clock, without human intervention. They can answer questions, even during hours when human operators are not available, which improves service availability for customers in different time zones and reduces response times. The use of robots and chatbots in customer service also helps to reduce service costs and increase customer satisfaction. They provide a quick response to queries and standardise service processes, making them an essential tool for modern businesses seeking to maintain a high level of customer service and engagement.

AI technologies are becoming a key tool in modern international management, especially when processing large amounts of data (Duan *et al.*, 2019). They are used to analyse trends, forecast demand and assess risks, allowing companies to make informed decisions and plan their strategies effectively. AI is used for the automated processing and analysis of large amounts of data, commonly referred to as "big data". This data can be collected from a variety of sources, including transactional data, social media data, sensor data. AI systems use machine learning algorithms to automatically detect dependencies and patterns in this data, which allows them to draw meaningful business conclusions. AI can be used to develop forecasting models that analyse historical data on demand for goods or services, as well as account for external factors such as economic conditions, changes in consumer behaviour, and market trends. This allows companies to reduce the risks of stock-outs and overstocks, and plan production and deliveries with greater accuracy and preparedness for market changes. AI is also used to assess risks in business processes, financial transactions, and decision-making (Davenport, 2018). The systems analyse information from various sources and address data history to identify potential risks and take the necessary measures to mitigate or avoid them.

Predictive analytics using machine learning models is a powerful tool that allows companies not only to respond to current market trends but also to predict future events and trends with high accuracy. Machine learning models for sales forecasting are based on the analysis of a large amount of data about sales history, their dynamics and relationships with other factors, such as advertising campaigns, pricing, seasonality and economic conditions. Machine learning algorithms, such as regression models, neural networks, or ensemble methods, can be used to build predictive models that can accurately predict future sales volumes based on this data. This helps companies reduce the risk of overproduction or underproduction, optimise inventory, and plan production based on realistic demand forecasts. In marketing and sales, it is necessary to determine what factors influence consumer behaviour and purchase decisions. Machine learning models analyse large amounts of data about customers, their purchases, interests, demographics, and other important parameters. Based on this data, personalised predictive models can be developed to predict future customer actions, such as product preferences or responses to marketing campaigns. This allows companies to optimise communication strategies and offers for each customer, improving marketing efficiency and increasing conversions.

By analysing large volumes of market data, machine learning models can identify key trends and changes in consumer preferences, technology, or competitive strategies. This allows companies to adapt to market conditions, introduce new products or services in a timely manner, and respond to competition with effective strategies. Predictive models help reduce risks and increase competitiveness, enabling companies to maintain a strong market position (Fig. 1).

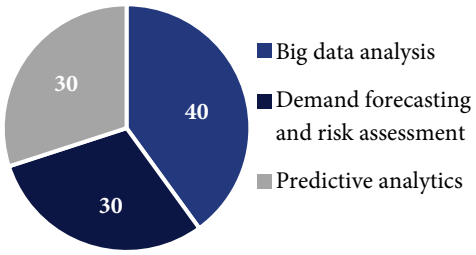

Figure 1. The role of AI in analytics and forecasting in international management
Source: created by the author based on M. Haenlein *et al.* (2019)

In the modern environment, HR management is actively using AI technologies to automate recruitment and candidate selection processes, which significantly reduces the influence of the human factor and increases the efficiency of these processes (Cam *et al.*, 2019). The main aspects in which AI is involved:

1. Automation of resume analysis. AI systems use natural language processing algorithms to analyse and classify candidates' CVs, automatically identify the key skills, experience and education that match the job.

2. Evaluation of candidates. AI creates predictive models based on historical data on successful employees and candidates, which objectively assess potential applicants for vacant positions.

3. Analysis of interview results. AI systems can analyse audio or text recordings of interviews to identify key points, assess candidates' communication skills, and ensure consistency in assessment.

These technologies significantly reduce the time needed for talent selection, enhance the accuracy of candidate assessments, and allow for more efficient use of human resources. Additionally, they open up new opportunities in personalised learning and development for companies seeking to improve their employees' knowledge and skills. The main advantage is the creation of adaptive learning platforms that utilise machine learning algorithms. These platforms analyse each employee's individual skills, progress, and preferences to suggest further learning steps that best meet personal needs. AI can also be used for automated assessment of learning outcomes, identifying weaknesses, and recommending further development. This enables faster adaptation of training programs to individual employee needs and improves learning effectiveness. Moreover, data analytics can identify key areas for developing necessary employee competencies and focus training programs on addressing specific challenges and goals of the company. These AI-based approaches to HR management help improve the level of knowledge and competencies of staff, which is critical to increasing the competitiveness and sustainability of organisations in today's business environment.

CRM uses AI to more accurately segment customers based on their behavioural data (Gartner: Magic quadrant..., 2022; Chatterjee & Chaudhuri, 2022). This is an important aspect of ensuring efficient and personalised customer interactions. CRM systems collect and analyse customer information from a variety of sources, including websites, social media, transactions, and customer communications. The use of AI allows for in-depth analysis of customer behavioural data to identify patterns and predict customer needs. This personalises communications by providing tailored offers, recommendations and services, which increases customer satisfaction and loyalty. AI-powered analytics in CRM also helps predict future customer behaviour, which contributes to more optimised sales strategies. Personalised advertising is used by companies to create individual approaches to each customer, which significantly improves the effectiveness of marketing campaigns. AI plays a key role in this context, enabling the automation of the analysis of large amounts of data about customers, their preferences, purchases, interests, and behaviour. With the help of machine learning and NLP algorithms, CRM systems can create detailed customer profiles, and analyse their online behaviour, reactions to advertising campaigns and other marketing influences. This allows not only to predict customer behaviour but also to create personalised offers that best suit their individual needs and interests. For instance, CRM systems can automatically recommend products or services that may be of interest to customers based on their previous purchases or browsing habits, personalise emails or social media posts with individual offers, and customise website interfaces for each visitor individually. This approach increases the conversion rate of marketing campaigns, reduces losses due to misdirected communications, and makes customer interaction more effective.

AI-enhanced financial analytics plays an important role in modern financial management, enabling companies to analyse financial statements more accurately, forecast cash flows, and assess financial risks with high accuracy and efficiency. The main aspects of using AI in financial analytics include automating the processing of large amounts of financial data, such as accounting records, income statements, budgeting, and investment data (Schmitt, 2020). AI systems use machine learning algorithms to identify and analyse patterns in financial data, which allows them to identify trends, risks, and opportunities to optimise financial processes. AI-powered predictive models help managers forecast future cash flows and profits based on data history and other factors, such as economic conditions, changes in market conditions, and strategic decisions. This helps to avoid financial risks, increase the accuracy of planning and strategic decisions, and ensure the financial stability and growth of the company. Financial risk assessment using AI includes the analysis of information on credit risk, investment opportunities, and financial stability of counterparties and partners, as well as forecasting the impact of changes in the macroeconomic environment on the company's financial position. This helps managers make informed decisions on financial management and investment of resources to achieve the company's strategic goals (Fig. 2).

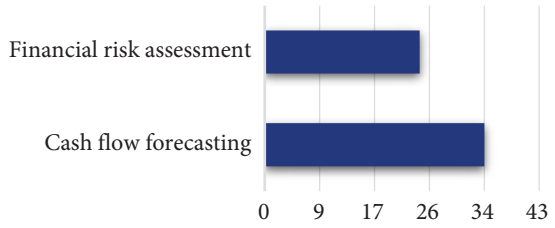

Figure 2. Application of AI in financial management in international management
Source: created by the author based on M. Hidayat *et al.* (2024)

AI-assisted accounting automation is a key trend in the modern business environment aimed at optimising processes, reducing errors, and improving the efficiency of financial management of an enterprise (AlKoheji & Al-Sartawi, 2022). AI is used to automate routine accounting operations, such as data entry, transaction classification, reporting, and financial data analysis. AI systems equipped with machine learning algorithms can independently recognise and process financial data, which significantly reduces the time required to perform accounting procedures and the cost of their maintenance. One of the key benefits of using AI in accounting is the reduction of the likelihood of human error. Machine learning algorithms can accurately analyse and interpret large amounts of financial data, and detect anomalies and errors in accounts, which can be used to quickly identify potential problems and take the necessary

measures to resolve them. In addition, the use of AI helps to increase the efficiency of accounting departments by automating internal processes, such as formulating financial forecasts, calculating tax liabilities, and controlling costs. This allows financial analysts and accountants to focus on strategic tasks and analysis instead of performing monotonous manual operations.

Enhancing cybersecurity is a crucial task for modern organisations, as threats in the digital world are becoming increasingly complex and multifaceted. Using AI to detect cyber threats and anomalous activity in real-time is becoming a key element of an effective cybersecurity strategy (Abdullahi *et al.*, 2022). The machine learning algorithms underlying AI systems can analyse huge amounts of data that are constantly coming from various sources, such as network logs, user activity data, server logs, and other sources of information. Through this analysis, AI can detect deviations from normal behaviour that may indicate the presence of cyber threats. This includes detecting unusual patterns of network access, abnormal changes in software, or unexpected activity that could be a sign of intrusion or malicious activity. One of the main advantages of using AI in cybersecurity is the ability to detect threats in real-time. This means that the system can immediately respond to potential threats by automatically taking measures to prevent or neutralise the threat. For example, the system can automatically block suspicious activity, isolate affected areas of the network, or send notifications to security administrators for immediate intervention. In addition, AI can learn from historical data and continuously improve its threat detection models. This means that the system is becoming increasingly accurate in detecting new types of threats and adapting to changes in attacker behaviour. As a result, companies can be better prepared for new cybersecurity challenges and respond more quickly to potential threats. Using AI to improve cybersecurity helps organisations reduce the risk of confidential information leakage, financial losses, and reputational damage. It can also significantly reduce cybersecurity costs, as the automation of threat detection and response processes reduces the need for manual labour and increases the effectiveness of security measures.

Data protection using AI is an important aspect of modern cybersecurity (Martinelli *et al.*, 2020). AI can be used for the automatic monitoring and analysis of large amounts of data in real-time, identifying suspicious activity and preventing potential threats. AI can detect abnormal behavioural patterns that may indicate attempts at unauthorised access to data or other types of cyberattacks. Machine learning algorithms analyse user and system behavioural data to detect any deviations from normal functioning. For example, if the system detects unusual activity with a user's account, such as access attempts from unusual locations or at unusual times, it can immediately block that access and notify the appropriate specialists for further investigation. AI is also used to detect and prevent phishing attacks. By analysing many emails and websites, AI systems can identify the telltale signs of phishing and block them before users can become victims. This includes analysing text, URLs, and metadata to help identify fake or malicious resources.

AI can help prevent data breaches by analysing user and system activity to identify potential threats before they can cause damage. For example, AI systems can detect unauthorised copying or transfer of confidential data, proving quick response and data loss prevention. Thanks to their ability to learn, AI systems are constantly improving and becoming more effective in detecting and preventing new threats. They can analyse data from previous attacks and use this knowledge to predict and prevent future threats. This renders them substantial in the fight against cybercrime and ensuring high-level data protection. The use of AI to improve data protection and prevent cyberattacks is an important element of modern cybersecurity, enabling organisations to effectively protect their data and reduce the risk of cyber threats. The introduction of AI technologies in international management contributes to a significant increase in data privacy. Thanks to advanced encryption algorithms and anonymization methods, companies can more effectively protect the personal information of customers and partners. This allows them to comply with international data protection standards, such as the General Data Protection Regulation, and ensure a high level of trust in the company. One of the important results of ethical AI applications is the development and implementation of algorithms that minimise bias. Through regular audits and algorithm adjustments, companies can avoid discrimination based on gender, race, age, and other factors. This contributes to a fairer and more transparent decision-making process.

Companies implementing AI are actively working on the development of ethical data use policies. This includes informing customers about how their data is collected and used and obtaining consent to the processing of such data. Such approaches help to ensure that customer rights are respected and reduce the risk of ethical conflicts. The introduction of transparent algorithms is another important outcome of an ethical approach to AI. Companies are developing methods to explain the decisions made by algorithms, allowing users to understand how and why certain decisions were made. This increases the trust in AI technologies and contributes to the greater acceptance of these technologies in society. The introduction of AI in international management is accompanied by the development of responsibility and accountability mechanisms for the results obtained with the help of AI algorithms. Companies create internal ethics committees that control the use of AI and ensure compliance with ethical norms and standards. This helps to avoid negative consequences and ensures the responsible use of AI. Consideration of cultural peculiarities when implementing AI in international companies is an important aspect that contributes to the successful integration of technologies and ensures efficient operation on a global level. Intercultural differences affect various aspects of business, including communication, human resources, marketing strategies, and decision-making. Implementing AI requires taking these differences into account to ensure

that technologies are adapted to specific cultural contexts and avoid potential conflicts.

One of the key aspects is language adaptation. AI that works with text or voice information must consider the language differences and nuances of each country or region (Evelson, 2020). This includes translating and localising interfaces, analysing the tone and meaning of words, and considering language idioms and phrases. This ensures that information is understood and interpreted correctly and improves the quality of interaction with users from different cultural backgrounds. Cultural characteristics also affect the perception of technology and readiness to use it. Some cultures may have strong traditions and conservative views that affect the adoption of new technologies. Therefore, it is necessary to address cultural values and preferences when conducting relevant research and analysis. For example, the introduction of AI may require additional educational campaigns or training to raise awareness and readiness of staff to use new technologies. Human resources should also take cultural sensitivities into account when using AI. This includes adapting recruitment and selection algorithms to consider cultural nuances, as well as developing training and development models that consider different learning styles and cultural preferences. The use of AI in international companies also requires considering cultural differences in approaches to motivation, communication, and team management. Marketing strategies that use AI should also be adapted to the cultural characteristics of target markets. This includes personalisation of marketing messages, considering cultural preferences, customs, and traditions. For example, the use of AI to analyse consumer preferences and behaviour should consider different cultural contexts to ensure that marketing campaigns are relevant and effective.

DISCUSSION

This study examines in detail the implementation of AI in various aspects of business management at the international level. The use of AI in today's environment can significantly increase efficiency, reduce costs and improve the quality of tasks. AI can be used to automate routine business processes, including text recognition, classification and indexing of documents. This can significantly reduce the time required to process large amounts of information and improve the accuracy of analysis. Technologies such as NLP and OCR help automate document processing tasks (The Future of..., n.d.). Thanks to these technologies, companies can process information quickly and accurately, which increases labour productivity and reduces administration costs. Machine learning algorithms allow for forecasting demand for products and optimising stocks. This helps companies manage their supply chains more efficiently, reducing the risk of overstocking or shortages. For example, demand forecasting based on the analysis of sales history data and seasonal fluctuations allows for accurate production and delivery planning. This ensures optimal inventory management, which helps reduce costs and improve customer service.

K. Bhavsar *et al.* (2019) came to a similar conclusion that AI can significantly improve the efficiency of management processes in software projects. They emphasised that automating routine tasks such as monitoring project progress and managing risks can reduce errors and increase overall productivity. A.K. Namir *et al.* (2022) confirmed the importance of AI for inventory management, particularly through demand forecasting and inventory optimisation. They found that the use of machine learning and combinatorial optimisation allows for accurate production and supply planning, reducing the risk of overstocking or shortages. The study confirms that AI is used to optimise transport routes and automate processes in the supply chain. This helps to reduce delivery times, cut fuel costs, and improve overall logistics efficiency. In particular, the use of route optimisation algorithms allows for determining the fastest and most cost-effective routes for the delivery of goods. AI also helps automate the processing of customer requests using chatbots and virtual assistants. This ensures round-the-clock support, quick response to requests, and increased customer satisfaction. The use of chatbots allows processing many requests simultaneously, which significantly reduces the workload of the support team. R. Akerkar (2019) analysed the introduction of AI in supply chain management and logistics and found that the use of machine learning algorithms for demand forecasting helps companies plan production and supply more accurately, which reduces the risk of overstocking or shortages.

The ability of AI to quickly process and interpret complex data sets makes it indispensable for identifying trends, forecasting demand, and assessing risks. Similar conclusions were reached by V. Sohrabpour *et al.* (2021), who investigated the use of AI to forecast export sales. They found that AI can significantly improve the accuracy of export sales forecasts compared to traditional methods. The use of machine learning algorithms helps to analyse large amounts of data and identify patterns that affect sales. B. Hmoud (2021) explored the application of AI to business, focusing on how these technologies can be implemented to increase operational efficiency, optimise processes, and improve strategic management. The study found that AI technologies help in analysing large amounts of data and identifying trends and anomalies, which facilitates informed business decision-making and improves strategic planning.

M. Potwora *et al.* (2024) showed that AI helps automate routine marketing tasks such as content creation and distribution, advertising campaign management, and customer data processing, which increases efficiency and reduces costs. AI has a significant impact on marketing personalisation, allowing companies to create unique and targeted marketing campaigns for each customer. Using machine learning algorithms and big data analysis, AI can learn customer behavioural patterns, preferences, and purchase history. This ensures that personalised offers can be created that best meet the needs and expectations of each consumer. S. Lee's (2020) research on use of chatbots in

customer communication found that AI enables personalised interactions by providing tailored recommendations and solutions based on the analysis of previous interactions and customer preferences.

AI also plays an important role in financial analytics, providing more accurate and faster analyses of financial data. (Artificial intelligence in..., 2021). The use of machine learning and big data analytics algorithms allows companies to manage their finances more efficiently, identify trends and make informed decisions. One of the main applications of AI in financial analytics is forecasting financial indicators. Machine learning algorithms can analyse historical financial data and predict future revenues, expenses, and profits. This allows companies to better plan their budgets and determine optimal development strategies. J. Xu *et al.* (2024) investigated the use of AI technologies to predict and optimise risks in financial services. They found that AI-based technologies help to reduce financial losses through more accurate forecasting and early detection of risks, which allows for action to be taken before risks escalate into serious problems.

The use of artificial intelligence in cyber security and ethical and cultural management are important topics to consider in the context of the research topic. AI enables faster and more accurate detection of threats and anomalies thanks to machine learning algorithms and big data analysis. At the same time, ethical and cultural considerations must be taken into account when implementing it. Ethical issues include fairness, transparency and accountability in decision-making. It is important to ensure that algorithms are not biased and operate according to ethical standards. In a cultural context, AI technologies need to be adapted to different cultural characteristics, such as language barriers and social norms, to ensure their effectiveness and acceptability in different regions. A similar problem was studied by R. Trim & Y.-I. Lee (2022). They considered the possibility of combining sociocultural intelligence with AI to improve the cyber security of organizations. Sociocultural intelligence involves understanding the cultural and social factors that can influence user behaviour and potential threats. The results of their research showed that the combination of these two factors helps to increase the resilience of organizations to cyber threats.

Overall, the research results show that the use of artificial intelligence in international companies significantly enhances the efficiency of business processes. This is supported by numerous scientists in their studies. AI enables the automation of routine tasks, improves forecasting accuracy, and optimizes management decisions, leading to substantial cost reductions and increased productivity. Additionally, the integration of AI promotes personalized customer service and enhances communication in a multicultural environment, helping companies better adapt to varying market conditions

CONCLUSIONS

The study showed that the automation of processes with the help of artificial intelligence significantly contributes to increasing the efficiency of the enterprise. The areas examined include document processing, inventory management, logistics, CRM, marketing, financial management, human resources, and cybersecurity. The study confirmed that cybersecurity is significantly strengthened by AI's ability to detect threats in real-time, detect anomalies and automatically respond to them, ensuring reliable data protection and reducing the risk of cyberattacks. The ability of AI to process large amounts of data facilitates trend analysis, demand forecasting and risk assessment, which facilitates informed decision-making in international management.

The study demonstrated that the ethical application of AI, including minimising bias, algorithmic transparency, and responsible use of data, is critical to maintaining trust and adherence to international standards. Considering cultural differences when implementing AI ensures effective global operations, from language adaptation to marketing strategies tailored to cultural contexts. The widespread use of AI in business process automation across various sectors demonstrates its key role in increasing efficiency, reducing costs, and improving the quality of tasks. The integration of AI technologies allows businesses to achieve competitive advantage, optimise resource utilisation, and increase overall productivity and efficiency in complex and rapidly changing market conditions.

Prospects for further research include the adaptation of AI to different cultural contexts, the study of ethical aspects of its use, and integration with other advanced technologies. Other important areas include the development of methods for training and adapting AI, its use in strategic and human resources management, enhancing cybersecurity, and developing new AI-based business models. The limitations of the study stem from the insufficient amount of data available for analysis and the difficulty of considering cultural differences in the use of AI technologies in different countries.

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CONFLICT OF INTEREST

None.

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Технології штучного інтелекту в міжнародному менеджменті

Тетяна Айзенберг
Аспірант
Київський національний університет імені Тараса Шевченка
01033, вул. Володимирська, 60, м. Київ, Україна
https://orcid.org/0009-0003-2389-9135

Анотація. Мета роботи полягала в дослідженні ефективності використання штучного інтелекту (ШІ) і визначенні його впливу на управлінські процеси міжнародних компаній. Було створено методологію для оптимізації міжнародних бізнес-процесів, яка охопила впровадження ШІ для підвищення ефективності управління, автоматизації стратегічного планування, аналізу ринкових даних та прогнозування трендів. У роботі досліджено різноманітні аспекти застосування технологій ШІ в міжнародному менеджменті, охоплюючи ключові напрями, зокрема автоматизацію бізнес-процесів, обробку документів, управління запасами, логістику, комунікації з клієнтами, аналітику та прогнозування, а також управління персоналом. Автоматизація процесів дала змогу знизити витрати і покращити якість обслуговування. Використання алгоритмів машинного навчання у логістиці та управлінні запасами спростило прогнозування попиту і оптимізувало ланцюг поставок. Комунікацію з клієнтами було автоматизовано за допомогою роботів і чат-ботів, що покращило обслуговування. Аналітика та прогнозування на основі даних, зібраних та оброблених за допомогою ШІ, допомагають менеджерам приймати обґрунтовані рішення та ефективно планувати стратегії. Використання ШІ значно підвищило ефективність управлінських процесів. Ці технології допомагають компаніям швидше адаптуватися до змін на ринку і підвищувати свою конкурентоспроможність в глобальному бізнес-середовищі. Дослідження встановило, що здатність систем ШІ аналізувати великі обсяги даних, прогнозувати ринкові тенденції, автоматизувати рутинні завдання та зменшувати ризики прийняття рішень, дають змогу швидше реагувати на зміни на ринку, підвищувати точність стратегічного планування і забезпечувати високий рівень конкурентоспроможності в глобальному бізнес-середовищі. Практична цінність цього дослідження полягає в наданні підприємствам детального розуміння того, як інтегрувати ШІ у різні аспекти міжнародного менеджменту

Ключові слова: автоматизація процесів; алгоритми; оптимізація; бізнес-процеси; прогнозування попиту

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Viability of local communities: Theoretical analysis and review of scientific research

Karyna Trostianska*
PhD in Economics
Oles Honchar Dnipro National University
49010,72 Nauky Ave., Dnipro, Ukraine
https://orcid.org/0000-0002-7970-9367

Abstract. The study of the viability of local communities is critical both for Ukraine and for any country that strives for sustainable economic development, stability, and improving the quality of life of its citizens. It helps to prepare communities for challenges, promotes effective resource management, investment attraction, and social cohesion, which is the foundation for sustainable and harmonious community functioning and progress. The purpose of the study was to clarify the concept of the viability of a local community and identify key economic aspects to substantiate the areas of further research on the mechanism for ensuring it. In the course of the study, theoretical methods of analysis were used, in particular literature review and conceptual generalisation, to identify the resources of the viability of local communities. The definition of a viable local community as a complex socio-economic system capable of remaining functional in the long term, providing for the psychological and social needs of its members and promoting their development in conditions of limited resources, adapting to changes in the economic environment is formulated. A conceptual model is constructed that provides a general idea of the key components that affect the ability of a local community to survive and develop. The proposed model highlights the importance of integrated viability analysis, considering the relationship between different resources and conditions that contribute to the sustainable development of local communities. The results show that the combination of economic, information, financial, material, organisational, and human resources is critical to ensuring the viability of communities. The practical value of the study is to substantiate the need for an integrated approach to the management of local communities, which is aimed at the effective use of all available resources to achieve maximum effect. This will ensure coordination of efforts at all levels and will contribute to the creation of a holistic economic development strategy that involves long-term planning and consideration of the specific needs and challenges of each community, thereby achieving harmonious and balanced progress

Keywords: conceptual model; viability of complex systems; resources for ensuring viability; socio-economic system; sustainable development

INTRODUCTION

A local community is a socio-economic system consisting of many interdependent components that cover social, economic, cultural, political, and environmental aspects. It requires an integrated approach to managing its development, because consideration of all factors and relationships allows creating conditions for sustainable development, improving the quality of life of the population and ensuring the stability and prosperity of society. The key integral characteristic of a complex system is its viability, which reflects the possibility of its functioning for an unlimited time.

The study of the conditions for the viability of communities and the management of their development is extremely relevant today. Communities that are able to adapt to modern challenges (climate change, economic inequality, migration, pandemics, geopolitical instability) and develop further ensure the stability and prosperity of their residents. Decentralisation reforms, which are actively carried out in Ukraine and many other countries and involve the transfer of a significant part of power from central authorities to local communities, primarily in the management of economic development and the management of

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*Corresponding author

financial resources, require a new approach to the management of local units. This helps to improve the investment climate, support the development of local businesses and create new jobs, which is especially important for economic growth and poverty reduction. The community viability study will enable the development of programmes and policies that promote optimal resource allocation, ensuring their effective use where necessary, which maximises the positive impact on the overall state of communities and contributes to their further development. For Ukrainian local communities (called territorial communities) affected by wars and crises, the study of viability is a key to developing recovery strategies that will contribute to long-term stability and prosperity of communities.

Many researchers covered various disciplines and areas of knowledge, which allows getting a more complete picture of the viability of communities. This includes economic, social, cultural, and environmental aspects that are important for a comprehensive understanding of community development. The ability of local communities to change for development was investigated by T.A. Kapsalis & V.C. Kapsalis (2020). They considered the inability of local communities to cope with the demanding and extremely changing environment a threat to the sustainable development of humanity and emphasised the importance of implementing important bottom-up social changes, starting with studying the needs and interactions of people in local communities. The paper highlighted the main factors that influence the community's desire for change and their willingness to adapt to development challenges: the degree of dissatisfaction, the presence of a common vision of the future, trust in the methodology of change, and the degree of resistance to them. The model for assessing community readiness for change proposed by the authors allows researchers to better understand how different aspects affect community viability, and this is important for developing strategies to improve it. The model also highlights the importance of an integrated approach, where each factor plays a role, and the weakness of one can lead to the overall failure of the initiative. The authors' approach can be used as a diagnostic tool to assess the community's ability to change and identify aspects that require increased attention to ensure its viability.

L. Casini *et al.* (2021) examined the viability of communities through the well-being of residents, as well-being is a comprehensive indicator of quality of life, combining social, economic, and environmental aspects. The assessment of well-being, according to the authors, helps to better understand the effectiveness of the community in meeting basic needs, ensuring security, promoting economic development, which is the foundation for its long-term viability, and opens up opportunities for targeted improvements. The study is essential for achieving community viability through the development of a well-being assessment methodology that includes detailed monitoring of key aspects of quality of life, such as economic status, safety, environmental quality, and educational opportunities. Their approach to identifying and measuring components of well-being through questionnaires, using factor analysis and verifying the reliability of results helps to accurately identify critical factors affecting the viability of rural areas, and implement effective solutions to improve living conditions.

The results of many studies focus on the economic components of community resilience. In particular, D. Tarasenko *et al.* (2021) based on statistical data analysed in detail the socio-economic conditions that affected the development of united territorial communities in Ukraine, identified a significant gap between "rich" and "poor" regions, and substantiated the need for targeted support for less developed communities to reduce the imbalance. The researchers emphasised the importance of entrepreneurship development as the main driver of economic growth and social stability of communities and suggested developing various development strategies according to the type of territories (adaptive, innovative, and anti-crisis). This will better respond to the specific needs of communities and increase their viability.

The monograph by T.A. Sakhno (2023) provides a comprehensive overview of the theoretical and practical aspects of the development of territorial communities, in particular, focuses on the economic and organisational components that contribute to their viability. It offers new theoretical and methodological approaches to assessing financial support and the effectiveness of forming financial flows in communities, which are a key to ensuring their economic viability and development. The conceptual models and methodological approaches proposed by the researcher help to understand the importance of integrating business, the population, and authorities into community development strategies, and consider modern challenges, such as war and economic crises.

The research by P.R. Payne *et al.* (2021) is useful for investigating the viability of communities, as it highlights the importance of a multidimensional approach to assessing its internal characteristics. For an adequate understanding of viability, it is important to consider various aspects of the state of the community and their perception by the local community, which is not fully reflected in statistics. This provides a more accurate understanding of the true viability of the community, focusing on the local context and the opinions of its members, which helps to develop more effective and realistic development strategies.

Approach of N. Shafieisabet & F. Karimi marezi (2022) to quantify community viability based on a large-scale survey deserves attention. The researchers identified and provided an index assessment of social factors that affect the sustainable viability of rural settlements: social awareness, trust, social cohesion, social networks and connections, and participation in the activities of various organisations and groups. They concluded that these social factors are vital for coordinating actions and building the capacity of rural communities needed to achieve rural development and viability. The researchers emphasised that no development can take place without awareness, participation and mutual

social trust, and focusing on social factors can help eliminate social inequality and reduce migration by improving living conditions in rural settlements.

Analysis of publications shows that despite the existence of significant scientific and practical interest, there is a lack of clarity in defining the concept of the viability of a local community, and research focuses on certain aspects, mainly social or environmental. The impact of economic factors on the viability of communities remains insufficiently investigated, and there are practically no approaches to its comprehensive assessment. Such fragmentation does not allow creating a complete picture of the state of local communities, which reduces the possibilities of effective management influence and making informed decisions to ensure their sustainable development.

The purpose of this study was to clarify the concept and define the key economic aspects of the viability of a local community, analyse the interaction and mutual influence of its elements based on scientific literature, and develop a conceptual model that will provide a systematic view of the viability of a local community.

The study was organised in several stages. At the first stage, 95 English-language and Ukrainian-language publications in journals indexed in scientometric databases such as Scopus, Web of Science, and Google Scholar were selected and critically analysed, mentioning the terms "viability", "resilience", "community", and "sustainable development" without limitation of the period and type of publication. This allowed reviewing modern theoretical approaches to the concept of viability of local communities and developing a list of resources that provide it. In addition, the author conducted interviews with the heads of the united territorial communities of the Dnipropetrovsk Oblast in 2020-2021. The author confirmed that participation in the interview was voluntary, and data confidentiality was preserved.

At the second stage, based on the theoretical analysis of existing concepts, considering cybernetic approaches to determining the viability of complex systems, the author proposed their own vision of the content of the concept of "viability of a local community" and identified the conditions for its achievement. At the third stage, the resources of the viability of local communities were systematised in relation to the conditions of viability that they provide, and a conceptual model was built that provides a comprehensive understanding of the viability of a local community. At the fourth stage, the results obtained were summarised and recommendations were formulated for further research and practical application.

PHENOMENON OF COMMUNITY VIABILITY IN SCIENTIFIC RESEARCH

Understanding the viability of a community, in particular, the reasons why some communities are resilient, adaptable to change, and innovative, while others are not, is an urgent research issue. The phenomenon of the viability of local communities first attracted the attention of sociologists and economists in the context of sustainable community development. In the paper "Northern people, northern resources, and the dynamics of carrying capacity" by R. Weeden, one of the first researchers on this topic, defined a viable community as one that "sees itself as an entity that wants to stay with its uniqueness, which looks forward to the future with hope and believes that it can make decisions and take action to correct perceived bad things" and considers the development of the community to be any change that strengthens viability (Weeden, 1985).

Scientific research on the phenomenon of community viability began with the analysis of communities that survived in the difficult conditions of the Arctic north, the deserts of Australia or the ocean coast and remain identical. Authors of the 21st century draw attention to the fact that the loss of viability by communities is not always associated with extreme living conditions, isolation of settlements, or resource poverty. A. Dale *et al.* (2010) pointed out that the viability of communities has been severely affected in the industrial world by suburbanisation in the second half of the 20th century, pointing to the massive destruction of both urban areas and rural settlements in the second half of the 20th century. J.D.R. de Raadt (2011), examining communities in Europe, including Sweden, Spain, Italy, France, Austria, and Australia, noted that most communities have found themselves in distress as a result of numerous challenges, including growing individualism, a decline in education, ethics, and charity, a lack of meaning in professional activities, and a managerial approach that harms humanity and nature. These factors are not unique to economically developed countries, but, on the contrary, occur in different regions of the world. In addition, these factors are interrelated and create destabilising feedback that undermines and contributes to their disintegration. And given that the number of abandoned settlements continues to grow, systematic studies of the conditions for ensuring the survival and development of communities do not lose their importance.

A. Dale *et al.* (2010) examined the role of communities in sustainable development, emphasising that their viability provides the necessary resilience to address economic, social, and environmental changes. They found that partnerships and teamwork are important for solving community problems and ensuring innovation. The researchers emphasised the need for interdisciplinary study to restore communities. Through a meta-analysis of thirty-five Canadian communities, the paper reveals how community viability interacts with the concept of sustainability, and notes the need for further research to clearly define this concept. The researchers also noted that improving the viability of communities can be a strategic area for governments, which helps to combine local initiatives with national and international programmes.

The book "Community Vitality: from Adaptation to Transformation" by A. Dale *et al.* (2014) was a significant contribution to community viability research. The authors' idea was that viability is a critical factor that allows moving from a state of simple survival to prosperity. They emphasised that any assessment of viability should consider

elements that first meet the basic needs of the community, and then create conditions for creativity, adaptation and innovation. This approach is closely related to the hierarchy of needs developed by psychologist A. Maslow in 1943. Application of the Maslow approach provides the community with a structured way to prioritise and consistently meet needs. The researchers noted that Maslow's concept, while individual in nature, can be extended to apply to communities. This allows considering the community as an independent organism, where the satisfaction of basic needs creates the foundation for further development. The use of this hierarchy allows allocating resources efficiently, focusing on the most urgent needs and avoiding spending on less important projects until the main problems are solved.

J.D.R. de Raadt & V. de Raadt (2014) in the book "From multi-modal systems thinking to community development: Regaining our humanity through community" approached the study of community viability from the perspective of a multi-modal systems approach, offering a comprehensive approach to community analysis that includes various models and methods of systems thinking. This provides a deeper understanding of the economic and social interactions and interdependencies between different aspects of community life. The researchers propose practical strategies and approaches that help increase the viability of communities by strengthening connections, collaboration, and shared values.

In many studies, the concept of viability is closely related to the desire of residents to be part of a particular settlement, while maintaining identity and self-determination. A viable community can be described as one where "people feel that they can remain residents for a certain period of their lives, where they find sources of income and a meaningful life" (Aarsæther *et al*., 2004). S. Martin *et al.* (2008) examined community viability through the prism of the impact of migration and fuel costs on community stability, identifying the main reasons for migration as the search for economic and educational opportunities.

Studies that examined residents' willingness to stay in a particular community have identified several motivation factors. In particular, K. Sorlie (2009) pointed to the importance of belonging to a place and identity, and the social environment and access to economic benefits, as motivations for continuing to live in a locality. The researcher's suggestions are based on the idea that when basic needs such as work and housing are met, people are more likely to stay for the sake of a quality of life related to the area, environment, and social connections.

The viability of a community can be determined by its ability to maintain its economic, social, and environmental sustainability. An integrated approach to community development, including ethical management, cohesion, human capital development, and sustainable development of natural resources, is important. The main elements of viability, according to J.D.R. de Raadt (2011), are social cohesion, environmental responsibility, and economic sustainability that together contribute to the long-term prosperity of communities.

The viability of communities is interpreted as the ability to maintain the quality of life in all its aspects (economic, social, environmental). The researchers suggest that the unsatisfactory level of well-being observed in many rural communities is the reason for the phenomenon of rural abandonment and curtailment of farming activities in different countries, regardless of their level of development (Casini *et al*., 2021). Critical aspects of community well-being considered in the literature include economic indicators (employment, income, economy), community services (education, leisure, transportation, and infrastructure), the state of the environment (quality, sustainability, and appearance), social factors (safety, community cohesion, engagement), politics, health, and attachment to place and community (McCrea *et al*., 2014).

A. Dale *et al.* (2010) examined factors that contribute to encouraging communities to jointly address sustainability issues, using examples from Canadian communities. These factors include: openness and trust in the community, which promote partnerships of various types and encourage innovation and creativity; connection with people and place; continuity and stability of funding and leadership; the possibility of change that encourages innovation and creativity, but is not excessive and does not lead to instability. According to A. Dale *et al.* (2014), community viability is defined as its ability to not only survive, but also thrive, anticipate changes of various kinds, implement new ideas, and prevent problems, not just respond to them.

Viability is increasingly seen as a complex and multifaceted concept that encompasses harnessing the skills, knowledge and abilities of local residents, strengthening relationships and communications, enhancing community initiative, increasing responsibility and adaptability, and creating sustainable, healthy ecosystems and a diverse, healthy economy that brings many benefits to the community.

The concepts of "viability" in publications are used to describe various systems and situations in which systems must operate within certain limits to survive or function effectively. In accordance with the generally accepted approaches described by H. Bossel (2001), any complex system is viable if it:

- able to exist in a normal state of the environment, has available resources necessary to maintain the system (material, energy, and other resources);
- in the long run, is able to be effective in its efforts to provide the necessary limited resources and can have an impact on the environment when necessary;
- has the freedom to choose ways to solve problems related to environmental diversity;
- has the ability to protect itself from the harmful effects of changing and unpredictable conditions outside the normal state of the environment;
- can learn, adapt, and organise itself to generate more adequate responses to challenges associated with changing environments;
- it can change its behaviour to respond appropriately to the behaviour of other systems in its environment.

In addition, for social systems that are human communities, an additional condition for viability is the ability to meet the psychological needs of community members. In the context of generally accepted approaches, the viability of a local community can be defined as its ability to maintain and develop its functionality in the long term, despite changing conditions. The analysis of existing approaches allowed specifying the list of conditions for the viability of communities and building its conceptual model (Fig. 1).

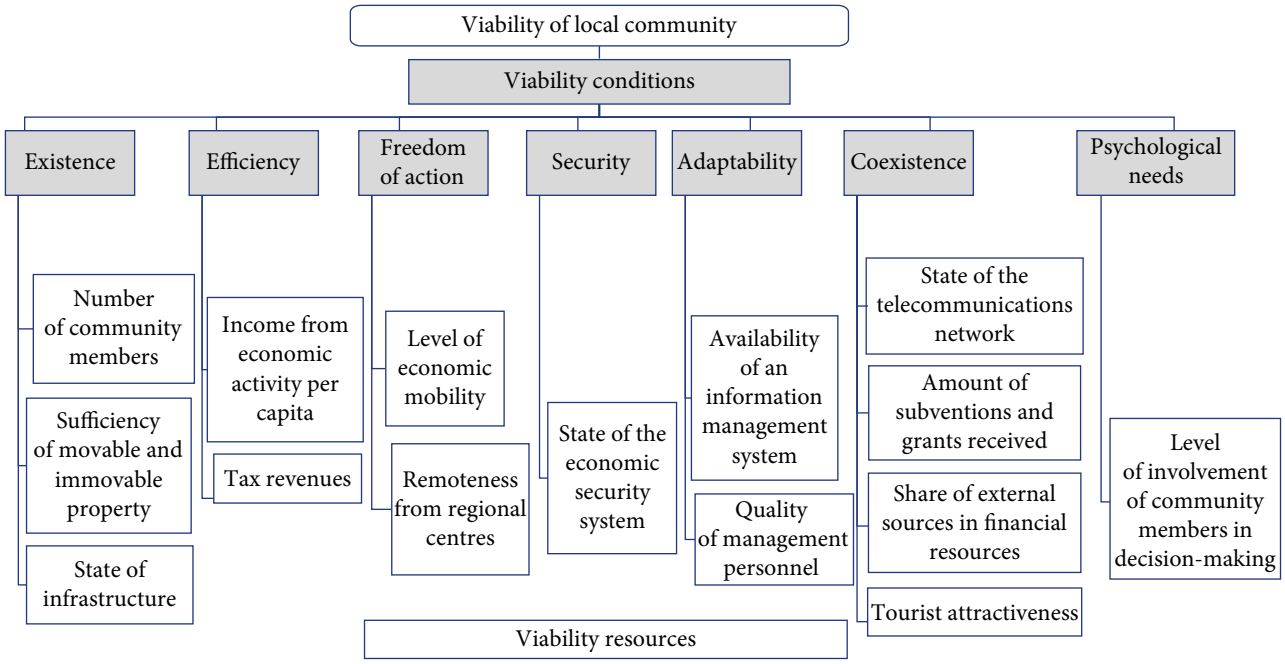

Figure 1. Conceptual model of local community viability (economic aspect)
Source: developed by the author

The basic conditions for the viability of a local community are ensured by the availability of appropriate resources, primarily economic ones, which are the foundation for sustainable development and social prosperity. The proposed model shows the relationship between these conditions and the required resources, which allows characterising each basic aspect considering the basics for its implementation.

Existence. This is the main condition that provides for the availability of community members, basic physical and material resources to ensure their vital activity. The number of community members is critical to the ability to conduct economic activities, develop infrastructure, and ensure minimum living standards.

Efficiency. The community's resources are limited, so it must be able to use them effectively to meet its needs and achieve its goals. This helps to maximise economic growth and productivity, and attract investment to increase economic returns, which has a positive impact on tax revenues directly to the public budget and, as a result, on the opportunities of the community to improve the standard of living. The community must also have the ability to influence the environment to provide additional economic resources when needed.

Freedom of action. The condition is that the community has the freedom to choose how to solve problems that arise as a result of environmental diversity. This includes expanding opportunities for entrepreneurship, developing alternative economic strategies, and providing economic flexibility that allows the community to respond quickly to market changes and crises. Freedom of action also largely depends on the remoteness of the community from the main administrative and economic centres.

Security. The community must be able to protect itself from the harmful effects of changing and unpredictable environmental conditions, in particular, natural disasters, economic crises, and other threats. From an economic standpoint, this implies the creation of economic stability, insurance mechanisms, diversification of sources of income and reserve funds to prevent economic shocks.

Adaptability. Communities that can adapt to changes in the external and internal environment have a higher chance of long-term success. Community adaptability is determined by the ability to learn and self-organise to generate adequate responses to changes in the environment. Economic adaptability is the ability of a community to innovate, develop new economic skills and knowledge, and quickly reorganise economic resources to respond to market and technological changes.

Coexistence. The community must be able to change its behaviour to respond appropriately to the actions of other systems in its environment, such as other communities, organisations, government institutions, etc. The economic

aspect of coexistence includes not only the availability of state subventions and subsidies, but also participation in interregional and international economic cooperation, the development of partnerships and networks for sharing resources and expanding economic opportunities.

Provision of psychological needs. This is an important condition for the viability of social systems, which implies creating a favourable social climate, maintaining social cohesion and a sense of community. This is possible by creating conditions for economic well-being, ensuring equal economic opportunities and access to resources, which contributes to social cohesion and reduces economic inequality.

Thus, the viability of a local community as a complex socio-economic system is its ability to remain functional in the long term, meet the economic, psychological and social needs of its members, and promote their development in conditions of limited resources, adapting to various changes in the environment.

RESOURCES FOR ENSURING THE VIABILITY OF A LOCAL COMMUNITY

The viability resource of a community as a socio-economic system determines its ability to achieve long-term sustainability, support economic growth, ensure social well-being, and adapt to changing environmental conditions, including economic crises, technological changes, and social challenges. To develop a list of economic resources for the viability of a local community (Fig. 1), the findings of other researchers and their own thoughts on the conditions for ensuring the viability of the local community were combined, including the results of the analysis of interviews conducted by the author with the leaders of the united territorial communities of the Dnipropetrovsk Oblast in 2020-2021.

Maintaining the population is critical to achieving the viability of local communities. Researchers, in particular N. Aarsæther *et al.* (2004), suggested using a simple indicator of population growth or decline to assess the viability of a community, recognising it as a rough but understandable and significant indicator of a decrease in the number of inhabitants of any settlement leading to the loss of resources necessary for its existence, which is most pronounced in small settlements. It is the violation of the socio-demographic balance in individual rural settlements that the researcher T. Zaiats (2017) considered as one of the main reasons for the gradual degradation of the rural settlement network of Ukraine.

Access to sufficient physical capital is crucial for community development and building a sense of place among residents, said G.P. Green (2016). This capital, which includes buildings, infrastructure, and other physical facilities, not only contributes to economic growth, but also improves the quality of life of residents by meeting their basic needs. Investments in physical capital not only provide individual income, but also contribute to the overall economic and social well-being of the community.

Infrastructure plays a crucial role in ensuring the viability of local communities, which was emphasised by C. Turner & D. Johnson (2017), and A. Magomedov *et al.* (2024). Transport, energy, communications, and water supply are important elements that determine the economic development and social cohesion of communities. The developed infrastructure contributes to the efficient functioning of enterprises, improves the quality of life of residents and helps attract investment. Thus, infrastructure resources are the basis for maintaining economic activity and social well-being in communities.

The transfer of a significant share of rights and responsibilities to the local level in the process of decentralisation requires ensuring the economic security of communities. Economic security is critical to the viability of local communities, as it ensures stable development, effective resource management and protection of rights, which contributes to their long-term functioning and well-being. As noted in the National Institute for Strategic Studies (2015), to ensure the economic security of territorial communities, the key is the institutionalisation of their legal personality through state registration of communal property, and the development and implementation of standards of economic rights and obligations. It is also important to strengthen the personal responsibility of government bodies, monitor their activities, and assess the causes of economic insolvency of communities. S. Volosiuk & I. Sirenko (2021) described the key components of the local community's security system, in particular, economic, informational, social and environmental, focusing on economic security as a basic component.

To ensure the viability of a community, it is important to what extent the local community controls or owns material resources. Ownership or control of natural resources can be an important source of financial income and stimulate the economic development of communities through various resource-related projects. Such projects often attract the attention of investors and external partners who can provide additional resources or funding (Aarsæther *et al.*, 2004). However, the focus on generating revenue only from the exploitation of resources, according to I. Tymechko (2020), may pose a threat to the stability of local communities due to the economy's dependence on limited resources, reduced investment in other areas of development, and possible resource depletion.

As noted by T. Zaiats (2017), socio-economic development and viability of rural settlements largely depend on their territorial proximity to economic and administrative centres. The distance from the centre restricts access to financial and investment resources necessary for infrastructure development and implementation of innovative projects. The lack of diversity of economic sectors inherent in remote territories often leads to dependence on one industry, which increases the risk of economic fluctuations, as emphasised by I. Leshchukh (2020). The resource-related instability inherent in remote communities undermines their economic viability (Darko & Halseth, 2023). In addition, remoteness can contribute to the loss of human resources due to population migration in search of

better living and working conditions. Communities located closer to administrative centres have more favourable conditions and better socio-economic prospects (Ilina & Shpyliova, 2021; Kuzyshyn *et al.,* 2024); periphery and unfavourable geographical location affect the competitiveness of territories and their ability to provide a favourable environment for economic activity.

Researchers consider the diversity of economic activities as a factor in the viability of communities; in particular, this was discussed by R. Darko & G. Halseth (2023). J. Olsen *et al.* (2022) in the the article "Barentsburg and Longyearbyen in the Times of socioeconomic transition: residents' perceptions of community mobility" described how economic mobility contributes to community viability. In particular, it was emphasised that in the context of socio-economic changes, such as the transition from traditional sectors of the economy to new ones, the ability of residents to adapt and move between different sectors of the economy is critical. This helps to ensure the community's resilience to economic shocks and supports its long-term viability.

Tourism can have a significant positive impact on the viability of individual communities, contributing to their development and conservation. It contributes to the improvement of infrastructure, the development of human capital, the promotion of unique local products, and the preservation of cultural and historical heritage. According to M. Irfan *et al.* (2024), the development of green tourism can create new jobs and promote economic growth in rural areas. Agrotourism, as emphasised by V. Ohorodnyk & R. Finger (2024), plays an important role in the development of rural communities, ensuring the diversification of farming activities, creating alternative sources of income and stimulating the development of local businesses and tourism infrastructure. Agrotourism promotes food security by strengthening local food systems through the development of sustainable production methods and increasing the economic stability of farms, which reduces their dependence on foreign markets and supports the region›s self-sufficiency (Addinsall *et al.*, 2016). In addition, tourism supports sustainable development goals such as decent work, responsible consumption, and nature conservation (Mnisi & Ramoroka, 2020). Through its integrated impact on the economic and social development of communities, tourism is becoming a key factor in ensuring their sustainability and prosperity. As a result, communities that actively develop tourism activities get the opportunity not only to preserve their uniqueness, but also to ensure sustainable development for future generations.

FACTORS OF EFFECTIVENESS AND LONGEVITY OF PUBLIC INITIATIVES AS RESOURCES FOR COMMUNITY VIABILITY

Given that local communities function as socio-economic systems, studying the effectiveness of community initiatives is crucial for understanding the key resources of community viability. It is important to consider not only financial and material resources, but also human capital, organisational structures, and the level of social cohesion. Studying publications on community initiatives provides a deeper understanding of how the interaction of different resources contributes to the long-term economic development and sustainability of communities.

The study of the effectiveness of community initiatives also highlights the importance of social interaction and participation of residents, as these aspects significantly affect the ability of communities to achieve sustainable development. In particular, the involvement of community members in making decisions about its development is a critical factor for maintaining the viability of the community, as active participation contributes to a deeper understanding of local needs and priorities, which allows making informed and effective decisions. Community members who have the ability to influence decisions feel more responsible for their implementation, which contributes to increased social cohesion and shared responsibility. Social capital generated through the active participation of citizens contributes to better coordination of actions and efficient use of available resources (Boonstra *et al.,* 2023), which ultimately increases the viability of the community.

P. Healey (2014) pointed to the fact that community member initiatives require organisational resources for the implementation and long-term survival of projects. This includes tools to attract attention and ensure visibility of the initiative among a wide audience (information materials, communication channels, and strategies to promote the initiative). Physical assets, a legal organisational structure, and financial resources are also required to organise activities. Together, these resources shape the initiative's ability to fulfil its mission and ensure its sustainable development (Igalla *et al.*, 2020). In turn, by providing vision, developing common ground and motivation, social capital can contribute to the development of organisational resources.

The longevity and effectiveness of public initiatives is determined by the presence of leaders who create a stimulating environment and attract support from other organisations, which is emphasised by S. Berdej *et al.* (2015). According to B. Rivza & M. Kruzmetra (2017), rural economic growth is largely influenced by the quality of local self-government and the willingness of local community residents to take active, innovative, and inclusive actions. Management personnel in a community can include both officials and specialists who manage, coordinate, and ensure the functioning of local self-government. The presence of an effective management system, which is determined by the quality of management personnel, the use of information systems, and the quality of communication, allows quickly responding to challenges and ensure the sustainability of the community (Ingram & Vora, 2024; Niu *et al.*, 2024).

The state of telecommunications infrastructure also plays an important role in maintaining the effectiveness of local self-government and the viability of communities. This issue was investigated by L. Philip & F. Williams (2019), B. Kelley & L. Sisneros (2020), T. Conroy & S. Low (2021). According to their findings, reliable telecommunications

networks help attract business and investment, as businesses need stable Internet and communications to function effectively. A good state of the telecommunications network contributes to better communication between community members, maintaining social connections and organising community events, which can increase the level of social cohesion and activity of residents, according to S. Low *et al*. (2022). Reliable telecommunications networks provide access to a wide range of information resources and online services, including government services, banking, online shopping, and other important services that affect the quality of life in the community and become an important criterion for small communities in the competition to attract residents.

Communities have the opportunity to develop their activities and introduce services that ensure their functioning, invest in communications, and pay for assets through financial resources. The basis of the financial viability of communities is taxes and mandatory payments that go to the budgets of communities. Depending on the country's tax legislation, these may include: personal income tax, value added tax and excise tax, corporate income tax registered in the community, real estate tax, and other payments. The study by A. Sobczyk & D. Budzeń (2022) confirmed the existence of a correlation between the economic activity of residents and the budgets of local authorities. The high share of personal income tax in the community budget revenues indicates its strong dependence on the availability of business structures and official employment of the population. Stable and sufficient financial support helps to develop optimal strategies for using and increasing available resources, while the constant subsidisation of the local budget against the background of insufficient funding and inefficient use of own revenues significantly hinder development processes. This was highlighted by L. Nedilska *et al*. (2023). Financial resources in the community budget can also come from subsidies and external financial funds, but dependence on them makes communities vulnerable, especially if such support is temporary or concerns one-time grants. To increase the independence and longevity of local socio-economic initiatives, according to M. Sharir & M. Lerner (2013), a variety of business models that generate a consistent and secure revenue stream can be used.

Thus, the analysis of a large layer of scientific literature identified the main resources for ensuring the viability of local communities. These resources are linked by complex causal relationships, require additional research, and cannot be fully reflected in the developed conceptual framework. However, this model provides a general idea of the key components that affect the viability of local communities. It can serve as a basis for further research and help determine strategic directions for community development and management.

To ensure the viability of local communities, an integrated approach is necessary, since actions based on only one resource and ignoring others are insufficient. For example, to improve the efficiency of community management, it is necessary to ensure not only the introduction of modern information management systems, but also a reliable telecommunications network that allows optimising communication and data processing processes. However, even the availability of these technological resources will not be sufficient without qualified management personnel who can effectively use these tools to ensure the sustainability and viability of the community. Effective solutions for individual resources that have proven effective in the past and have been successfully applied both in the community itself and in other communities should be integrated into an integrated system of interrelated measures. This combination of best practices will help to achieve a synergistic effect, reduce individual negative manifestations and will contribute, as proved by J.D.R. de Raadt & V. de Raadt (2014), to achieving community viability. An integrated approach to community management directly affects its ability to achieve important social and economic goals. Effective governance not only integrates various aspects of development, but also ensures the implementation of sustainable development goals that set priorities for improving community life. This includes ensuring access to the necessary services and resources, which improves the quality of life, social and economic stability.

Integrated governance contributes to the broader socio-economic goals reflected in global initiatives and programmes. Viable communities contribute to the creation of inclusive and sustainable communities, which is the foundation of many of the 17 Sustainable Development Goals of the United Nations (United Nations, 2020). Viable communities with good governance can provide access to economic opportunities and social services that contribute to poverty reduction (SDG 1). Local governance structures can support the development of agriculture and food security (SDG 2). Strong communities can provide access to health services and implement health programmes (SDG 3) and promote access to quality education for all community members (SDG 4). Viable communities support policies and programmes that promote gender equality and women's participation in decision-making processes (SDG 5) and reduce social and economic inequality (SDG 10). Effective community management ensures access to clean water and adequate sanitation (SDG 6). Local economic strategies can create jobs and stimulate economic development (SDG 8). Strong and viable communities have a direct impact on the creation of safe, inclusive and sustainable human settlements (SDG 11).

The viability of communities is critical to achieving the strategic goals of the European Union, which are detailed in such documents as "The European Green Deal" (European Commission, 2019), "EU Biodiversity Strategy for 2030" (European Commission, 2020a), "The long-term vision for the EU's rural areas" (European Commission, 2020b), "European declaration on digital rights and principles" (European Commission, 2022). Strong and active communities promote social cohesion, reduce inequality and improve the quality of life, which are key EU priorities (European

Commission, 2019). President of the European Commission U. Von der Leyen stressed the importance of effective local government and active citizen participation to increase trust and transparency, which is consistent with the goals of building a democratic society, and for achieving economic sustainability, as viable communities support local entrepreneurship, create jobs and promote innovation (Von der Leyen, 2019). In the field of ecology, viable communities are implementing sustainable practices that help reduce greenhouse gas emissions and preserve biodiversity. Rural communities, in particular, have significant potential to support food security and preserve cultural heritage. Investment in infrastructure development and digitalisation contributes to better connectivity and prosperity in these regions. Thus, viable communities are the foundation for sustainable development and overall prosperity of the European Union.

CONCLUSIONS

The definition of the viability of a local community formulated based on cybernetics and systems thinking approaches allows creating a more holistic and effective vision of community management, which considers the complexity and interdependence of all components of the system. This will facilitate the integration of different types of resources (human, financial, informational, material) to maximise the efficiency and viability of the community.

Based on the theory of the viability of complex systems, the study identified the conditions that ensure the viability of a local community: the existence of residents and basic physical and material resources to ensure their life, the efficiency of using available resources, the freedom of the community in choosing ways to solve problems, security, adaptability to changes in the external and internal environment, the ability to coexist and meet the needs of community members. In addition, economic resources were identified to ensure the viability of the community. Streamlining conditions and resources allowed building a conceptual model of the viability of a local community

The developed conceptual model provides a holistic view of the key components that affect the viability of local communities, which helps to better understand the complexity of their structure and the interaction between different elements. The model promotes effective planning and management by helping to identify priority areas for community development and viability. In addition, it provides an evidence-based framework for decision-making and strategy development at the local and state levels, considering the complex relationships within the community. This conceptual model is an important tool for researchers and practitioners working in the field of local self-government and community development, as it provides a systematic approach to analysing and managing community viability.

As a result of the analysis of studies on the phenomenon of viability of local communities, several key areas for further research were identified. First of all, it is necessary to develop a comprehensive methodology for assessing viability that considers economic, social and environmental factors, allowing for more informed management decisions. Special attention should be paid to the investigation of mechanisms of interaction between communities and other economic entities, and the analysis of the impact of various economic factors and resource management strategies on ensuring long-term stability and prosperity of communities.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the author.

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Життєздатність територіальних громад: теоретичний аналіз і огляд наукових досліджень

Карина Тростянська
Кандидат економічних наук
Дніпровський національний університет імені Олеся Гончара
49010, пр-т Науки, 72, м. Дніпро, Україна
https://orcid.org/0000-0002-7970-9367

Анотація. Дослідження життєздатності територіальних громад є критично важливим як для України, так і для будь-якої країни, що прагне до сталого економічного розвитку, стабільності та покращення якості життя своїх громадян. Це допомагає підготувати громади до викликів, сприяє ефективному управлінню ресурсами, залученню інвестицій та соціальній згуртованості, що є основою для стійкого і гармонійного функціонування та прогресу громад. Метою дослідження було уточнення поняття життєздатності територіальної громади та визначення ключових економічних аспектів для обґрунтування напрямів подальших досліджень механізму її забезпечення. Під час роботи були використані теоретичні методи аналізу, зокрема огляд літератури та концептуальне узагальнення, для ідентифікації ресурсів життєздатності територіальних громад. Сформульоване визначення життєздатної територіальної громади як складної соціально-економічної системи, здатної залишатися функціональною у довгостроковій перспективі, забезпечувати психологічні та соціальні потреби своїх членів і сприяти їхньому розвитку в умовах обмежених ресурсів, адаптуючись до змін в економічному середовищі. Побудована концептуальна модель, яка дає загальне уявлення про ключові компоненти, що впливають на спроможність територіальної громади виживати та розвиватися. Запропонована модель підкреслює важливість інтегрованого аналізу життєздатності, враховуючи взаємозв'язки між різними ресурсами та умовами, що сприяють сталому розвитку територіальних громад. Отримані результати вказують на те, що поєднання економічних, інформаційних, фінансових, матеріальних, організаційних і людських ресурсів є критично важливим для забезпечення життєздатного стану громад. Практична цінність дослідження полягає в обґрунтуванні необхідності комплексного підходу до управління територіальними громадами, який спрямований на ефективне використання усіх наявних ресурсів для досягнення максимального ефекту. Це дасть змогу забезпечити координацію зусиль на всіх рівнях і сприятиме створенню цілісної стратегії економічного розвитку, яка передбачає довгострокове планування та врахування специфічних потреб і викликів кожної громади, завдяки чому досягається гармонійний та збалансований прогрес

Ключові слова: концептуальна модель; життєздатність складних систем; ресурси забезпечення життєздатності; соціально-економічна система; сталий розвиток

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08400, вул. Сухомлинського, 30, м. Переяслав, Україна
Тел.: +38(044)293-11-10
E-mail: info@ue-bulletin.com.ua
https://ue-bulletin.com.ua/uk

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Hryhorii Skovoroda University in Pereiaslav
08400, 30 Sukhomlynsky Str., Pereiaslav, Ukraine
Tel.: +38(044)293-11-10
E-mail: info@ue-bulletin.com.ua
https://ue-bulletin.com.ua/en