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## Retail food sales in Ukraine: From pre-war period to recovery prospects

**Abstract.** Retail food sales serve as a key indicator of a society's socio-economic condition. Its dynamics reflect the population's level of well-being, influence tax revenue generation, and reveal trends in economic development. This study aimed to identify the main factors affecting the operations of food retailers and to formulate recommendations for enhancing the competitiveness of food retailers in Ukraine. The findings indicate that the COVID-19 pandemic triggered global shifts in food consumption patterns and stimulated the growth of e-commerce. At the same time, the

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war in Ukraine led to a sharp decline in sales volumes due to infrastructure destruction, economic instability, and population displacement. The most significant sales reductions were observed in categories of fresh products, such as fruit, vegetables, meat, and fish. Despite the adverse effects of the war, Ukraine's food retail sector has demonstrated considerable resilience and is experiencing rapid post-crisis growth, surpassing the global average recovery rate. An analysis of per capita income from food retail indicates strengthening purchasing power and shifts in consumer habits. Particular attention is given to the differences in the growth rates of online and offline retail, where global trends outpace those in Ukraine. Structural changes in the sector are highlighted, including the decline in the number of small retail operators in favour of large chains. A competitive analysis reveals that food retailers are focusing on optimising pricing strategies, expanding product assortments, and implementing digital solutions. To enhance competitiveness, measures have been proposed to improve customer service, develop online sales channels, diversify product offerings, and integrate environmental initiatives. The practical significance of the study lies in its recommendations for strategic directions to strengthen the competitiveness of food retailers in Ukraine, particularly through the adoption of innovative solutions, support for small businesses, and the development of logistics infrastructure

**Keywords:** e-commerce; competitiveness; retailers; assortment; innovation

## INTRODUCTION

Retail food sales are a critical component of Ukraine's economy, directly impacting food security, employment, and the development of small and medium-sized enterprises. However, the full-scale war has triggered significant disruptive changes in this sector: the breakdown of logistical supply chains, a reduction in effective consumer demand, the loss of retail infrastructure in affected regions, and a shift in consumer priorities. In this context, research into the development dynamics of retail food sales, from the pre-war period to current challenges and recovery prospects, is extremely relevant. Examining these processes has enabled the identification of effective mechanisms for industry support, adaptive strategies for businesses, and areas of government policy that will contribute to its stabilisation and further growth in the post-war period.

Scholars O.M. Petukhova & L.M. Zakrevska (2023) have emphasised that the volume of food sales serves as a crucial indicator of a nation's socio-economic standing. This is because the sale of this category of goods significantly impacts overall financial circulation, generates tax revenues for the budget, and is reflected in several key macroeconomic indicators. The dynamics of food sales allow for the assessment of changes in the population's welfare and the analysis of broader economic development

trends. In normal circumstances, the development of retail organisations is characterised by a high degree of inertia. Therefore, when situations arise that necessitate change, the business strategies of market participants undergo substantial transformations. As noted by P. Hrynyko *et al.* (2021), such changes are most often triggered by external factors, including general economic crises, sudden shifts in state regulation within the studied economic sector, or the emergence of powerful competitors. In today's environment of globalisation and technological change, market competition in food retail is becoming increasingly dynamic and intense. Enhancing competitive effectiveness is a key objective for retailers, demanding attention at both theoretical and practical research levels. According to A. Zhanbozova *et al.* (2024), consumer preferences and business practices have significantly evolved between 2018 and 2024, driven by digitalisation and constantly changing demand, presenting new challenges for food retailers. The authors have given particular attention to the influence of e-commerce on the development of retailers and the ability of businesses to adapt to changing external environments. Research by T. Hushtan *et al.* (2020) indicates that the core factors remain the flexibility of logistical processes, innovation in sales, and effective marketing strategies. Attention to these aspects

allows businesses to strengthen their competitive positions, meet consumer demands, and contribute to the overall development of the sector. O. Kovalenko & L. Yashchenko (2024) noted that transformations that fostered positive changes in food retail, under conditions of macroeconomic stability and favourable market conditions, will create opportunities for business development and expanded market presence in the future. However, this will require professional planning, consideration of market specificities, and continuous improvement of management processes. V. Pavlova (2022) identified several pathways for the development of Ukrainian food retail in the post-war period, aiming to achieve the expected socio-economic level as a segment of the national economy. These include: the digitalisation of core trade and technological processes; building and improving logistics; optimal integration of offline and online formats; development of private label brands; and customer base formation based on consumer behaviour analysis. Previous research has not conducted a detailed analysis of food retail across major food product categories, both globally and in Ukraine, nor has it performed a competitive analysis of the main food retailers in Ukraine.

This research aimed to identify the key factors influencing the operations of food retailers and to develop practical recommendations for enhancing their business process efficiency. The objectives of this study are to analyse changes in the structure and sales volumes of food products in Ukraine and globally across different periods: pre-COVID, COVID, the period of full-scale invasion, and post-war recovery; to examine the competitive landscape of the market; and to analyse the impact of emerging technologies on retail strategies.

## MATERIALS AND METHODS

The research period covered the following phases: pre-COVID (2018-2019), COVID (2020-2022), and the period of Russia's full-scale invasion of Ukraine (from 2022 onwards), as well as considerations for the post-war reconstruction period. The grouping method was employed to categorise goods or objects based on similar characteristics or properties. In this instance, food products were classified according to their

purpose and attributes, simplifying the analysis and providing a more structured framework for further investigation or comparison. Specifically, to streamline analysis and align with the commonly accepted layout of most Ukrainian stores, food product categories were organised by grouping items with similar properties and purposes into broader categories. For example, fruits and vegetables were combined into a single category, meat and fish into another, grocery items encompass cereals, oils, sauces, and spices, ready-made meals were separated, and specialised goods such as baby food and pet food were also categorised distinctly.

Methods of absolute and relative values were used to analyse changes in retail food sales in Ukraine, comparing them with global indicators. The following indicators were examined: the volume of retail food sales in monetary terms in Ukraine and globally; and per capita income from retail food sales in Ukraine and globally. Additionally, for Ukraine, further indicators were investigated: the number of business entities in the retail food sector; the volume of retail food sales in physical terms; and per capita consumption of food products. The analysis of these indicators was essential for a comprehensive study of the food market's dynamics, identifying its development trends, and formulating recommendations for enhancing the efficiency of retail food sales.

Time-series analysis in the study of retail food sales was a methodological approach that allowed for the examination and forecasting of market development trends based on data collected over a specific period. This method involved studying changes in: sales volumes of food products; per capita income from retail food sales; the number of business entities in the retail food sector; the volume of retail food sales in physical terms; and per capita consumption of food products, enabling the identification of seasonal, cyclical, and trend components. The development dynamics of online and offline retail in the global and Ukrainian markets were compared.

The selection of forecasting methods was based on the behaviour of the relevant market. It is important to note that the study employed data analysis for the period from 2018 to 2024, utilising statistical data (Food – Ukraine (consumer), n.d.; Food – Worldwide (consumer), n.d.;

Food – Ukraine (ecommerce), n.d.; Food – Worldwide (ecommerce), n.d.). Forecasting methods were applied for the period from 2025 to 2029. To forecast the food market with projected consistent growth, the exponential smoothing trend model was used, which allowed for the consideration of gradual changes in market behaviour:

$$Y_t = \alpha X_t + (1 - \alpha) Y_{t-1}, \quad (1)$$

where  $Y_t$  is the smoothed value of the forecasted indicator at time  $t$ ;  $X_t$  is the actual value of the indicator at time  $t$ ;  $Y_{t-1}$  is the smoothed value for the previous period;  $\alpha$  is the smoothing coefficient ( $0 < \alpha < 10$ ), which determines the influence of current and previous data.

Taking into account the main factors (GDP per capita  $GDP_t$  and consumer spending per), the model took the following form:

$$Y_t = \alpha(\beta_1 GDP_t + \beta_2 C_t) + (1 - \alpha) Y_{t-1}, \quad (2)$$

where  $\beta_1$  and  $\beta_2$  are the regression coefficients of the factors' influence.

This model allowed for the adaptation of the forecast to changes in economic conditions, particularly the impact of macroeconomic indicators, and reduced the influence of random fluctuations.

Competitive analysis in retail food sales research was a vital tool for examining the market situation and determining the competitive advantages and weaknesses of market participants. The method involved evaluating key competitors, their strategies, products, pricing policies, and marketing approaches. Within the competitive analysis, aspects such as market share, brand positioning, consumer loyalty, innovation, and technologies used by competitors were investigated. This allowed for the identification of opportunities to improve one's own market position and to identify potential threats from competitors. The competitive analysis method also included an assessment of competitors' strengths and weaknesses, enabling the formulation of strategies to enhance business efficiency in a highly competitive environment. To create a competitive analysis of the main food retailers in Ukraine (ATB-Market, Fozzy Group (Silpo, Fora, Le Silpo), Novus, Varus, Metro Cash & Carry Ukraine,

Retail Group (Velyka Kyshehnia, Velmart), Tavria V, Auchan Ukraine), the following aspects were considered: scale and market presence (number of stores, geography); pricing policy (premium, mid-range, low segment); product range and specialisation (private label brands, exclusive goods); innovation and additional services (online stores, delivery, loyalty programmes); and financial indicators (revenue, growth rates). The application of this method facilitated the development of more precise and effective strategic directions for enhancing the competitiveness of food retailers in Ukraine, aimed at attracting new customers and retaining existing ones.

The bibliographic method in this retail food sales research involved the systematisation and analysis of scholarly sources (Shtal & Proskurnina, 2018; Chorna *et al.*, 2019; Nikishyna & Shcherbak, 2023), statistical data and market trends (Food – Ukraine (consumer), n.d.; Food – Worldwide (consumer), n.d.; Food – Ukraine (ecommerce), n.d.; Food – Worldwide (ecommerce), n.d.), and analytical reports (ATB's revenue for the first half..., 2024; IMF estimates Ukraine's population..., 2024; Revenue of retail leaders in Ukraine..., 2024; Ukrainian food retail market..., 2024; Unbreakable: Ukraine's retail..., 2024). Logical generalisation allowed for the formulation of broad theoretical and practical conclusions, based on specific facts and observations, that can be applied to wider categories or conditions.

## RESULTS AND DISCUSSION

Retail is a dynamic system that requires continuous study and improvement. The issue of food retail is particularly critical during wartime and the post-war period. Table 1 presents an author's categorisation of food products, based on the principle of simplifying consumer perception and aligning with the commonly accepted layout of stores. The core idea is to group items with similar properties and purposes into broader categories. For example, fruits and vegetables are combined into one category because they are predominantly located together in store departments and have similar usage (fresh or processed). Similarly, meat and fish are grouped together, as these products are protein sources and consumers often choose them

interchangeably. Grocery items, including cereals, oils, sauces, and spices, are collected into a single group due to their long shelf life and use in food preparation. Categories of ready-made meals, confectionery and snacks, and specialised

goods like baby food or pet food are separated due to their specific consumption patterns. This approach renders the structure clear and convenient for both analysis and practical application, and was used in the conducted research.

**Table 1.** Correlation of main food product categories

According to Statista		Most store categories
Segments	Subsegments	
Fruits and nuts	Fresh fruits, processed and frozen fruits, and nuts	Fruits and vegetables
Vegetables	Fresh vegetables, processed and frozen vegetables	
Meat	Fresh meat, processed meat, and meat substitutes	Meat and fish
Fish and seafood	Fresh fish, fresh seafood, and processed fish and seafood	
Dairy and eggs	Milk, milk substitutes, yoghurt, cheese, eggs, and other dairy products	Dairy and eggs
Bread and cereal products	Bread, pasta, rice, breakfast cereals, and other grain products	Grocery
Oils and fats	Butter, margarine, cooking oils, and other oils and fats	
Sauces and spices	Tomato ketchup, other sauces, spices, and culinary herbs	
Semi-finished products	Soups and ready-to-eat meals	Ready-made products
Confectionery and snacks	Confectionery products and snacks	
Spreads and sweeteners	Spreads and sweeteners	
Baby food	Food intended solely for infants and young children	Specialised products
Pet food	Food intended solely for use by domestic animals	

**Source:** developed by the authors based on data from the Food – Ukraine (consumer) (n.d.) and own research

Prior to the COVID-19 pandemic, retail food sales globally and in Ukraine demonstrated steady growth, driven by urbanisation, increasing household incomes, and evolving consumer habits. Globally, large supermarket and hypermarket chains dominated, and online retail was actively developing, particularly in European countries, the USA, and China (Food – Worldwide (ecommerce), n.d.). In Ukraine, the situation differed: traditional markets prevailed in rural areas, while national chains like ATB, Silpo, and others expanded their presence in cities. Simultaneously, consumers were price-sensitive and actively supported local producers, especially in the fresh produce segment (Kovalenko & Yashchenko, 2024).

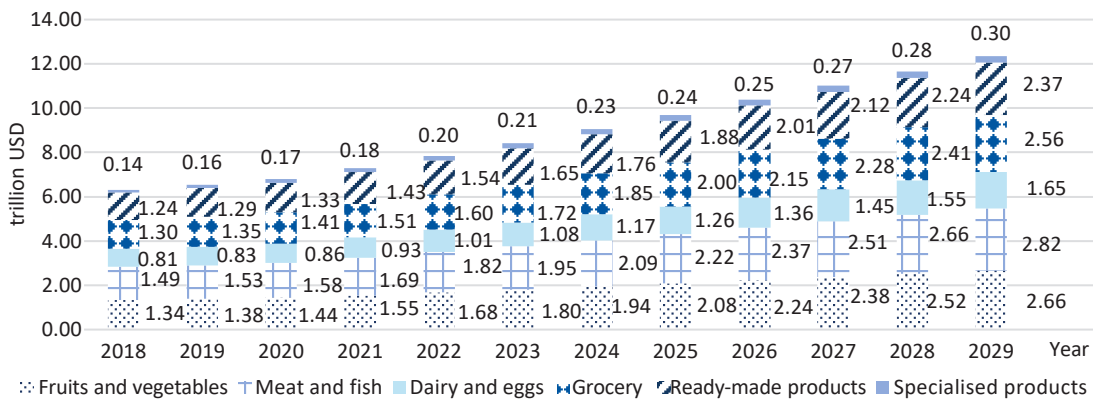
The COVID-19 pandemic triggered significant changes in retail food sales (Chernychko et al., 2018). Globally, online ordering and home delivery of groceries surged in popularity due to store visit restrictions. The penetration rate of e-commerce increased annually. In nations with high digitalisation levels, a boom in e-commerce development was observed. In Ukraine, the pandemic spurred online retail growth even among

small grocery stores, although the infrastructure was less developed than in Western Europe, as noted by M. Ilchuk et al. (2023). The authors also highlighted that Russia's full-scale invasion of Ukraine in 2022 created new challenges for wholesale and retail food sales. It caused severe problems in the wholesale food trade, disrupting logistical chains, driving up prices, and reducing product ranges. Problems in the wholesale trade had a ripple effect on the retail sector, ultimately impacting the end consumer. Due to hostilities, infrastructure destruction, and population migration, many stores were forced to close, especially in frontline regions. The logistics of food supply chains were significantly disrupted, leading to price increases and shortages in certain product categories. During this period, volunteer organisations, humanitarian foundations, and national chains, which adapted their logistical processes, played a crucial role in providing food to the population (Dankeieva, 2023). Total direct losses to Ukrainian retail are estimated at 2.1 billion USD, while combat operations severely damaged 2,903 retail facilities with a total area of 1.6 million square meters. Indirect sector losses

are approximately 22.6 billion USD (Guliaieva *et al.*, 2024). In 2022, over 29,000 small businesses ceased operations in the food retail sector. In addition to the negative impact of the war, this was also influenced by the pressure from large chains that, due to their expanded scale, were able to lower prices on essential products. Simultaneously, the proportion of small businesses that opted to develop online retail and operate outside traditional stores showed growth, demonstrating adaptation to new market conditions (Kovalenko, 2024). To restore retail, even to its pre-war format, an initial investment of 3.9 billion USD is necessary. However, in safer regions of Ukraine, trade began to recover rapidly, and online sales remained an important procurement channel due to ongoing risks associated with visiting physical stores. In 2023, the market showed positive trends: the number of retail outlets increased by 12%, a stark contrast to the 18% decrease in 2022 caused by territorial occupation and infrastructure destruction (Guliaieva *et al.*, 2024). Despite the destruction, food retail is recovering faster than other retail sector

stores in Ukraine, due to the constant demand for food products (Kosar & Vintoniak, 2023).

The analysis of Figure 1 demonstrates a consistent growth in global retail food sales over the past decade, with projected further increases in volume up to 2029. Sales volumes have risen from 6.32 trillion USD in 2018 to a projected 12.36 trillion USD in 2029, indicating an average annual growth rate of 5-6%. The highest growth rates are observed in the fruit, vegetable, and meat categories, driven by increased demand for healthy eating and protein products. Groceries and ready-made meals also exhibit significant growth due to the popularity of convenience and preprepared ingredients for home cooking. Specialised goods remain the smallest category due to their narrow consumer segment. Overall, stable market growth is attributed to factors such as urbanisation, the expanding middle class, the development of e-commerce, and shifting consumer preferences. The forecast for the coming years suggests continued growth across all categories, particularly considering global economic and environmental challenges.



**Figure 1.** Global retail food sales, trillion USD

**Note:** 2025-2029 – forecasted data

**Source:** developed by the authors based on data from the Food – Worldwide (consumer) (n.d.)

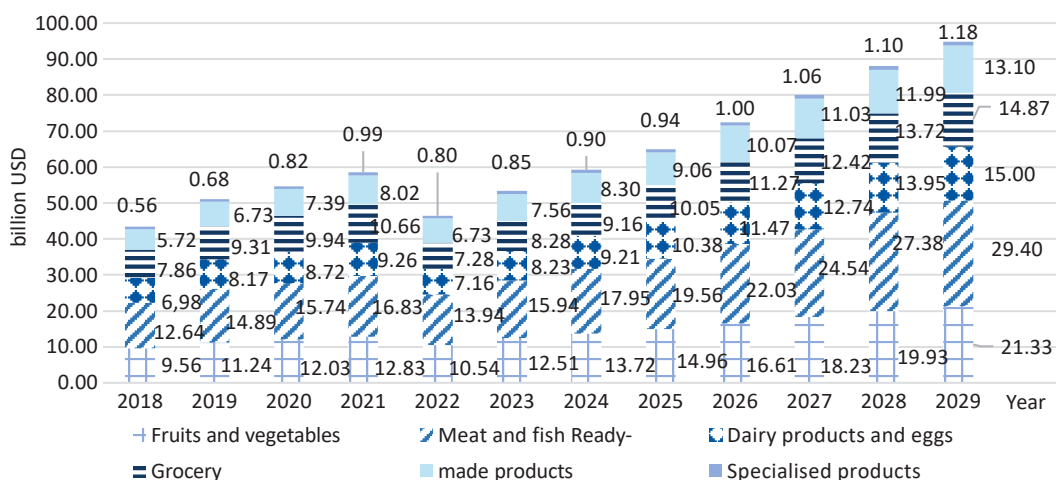
Based on the presented data, it can be concluded that global retail food sales are demonstrating consistent growth in both monetary value and physical volume (billion kg). The global food market exhibits steady growth in trade volumes from 2018 to 2029, with a projected increase of 33.8%. The largest growth is observed in the fruit

and vegetable (+35.5%), dairy and egg (+31%), and specialised goods (+46.6%) categories. This reflects changing consumer preferences, increased demand for healthy eating and convenience foods, as well as the individualisation of dietary needs. The indicators forecast further growth up to 2029, attributed to both demographic factors

(population growth) and increases in average income levels, urbanisation, and the diversification of demand for various product categories.

The data in Figure 2 illustrates the dynamic development of retail food sales in Ukraine from 2018 to 2029, showcasing both actual figures and projected trends. The period from 2018 to 2021 saw steady growth driven by gradual increases in household incomes, rising consumer demand, and the development of retail infrastructure, resulting in an increase in total sales from 43.32 billion USD to 58.59 billion USD. However, 2022 marked a period of sharp decline, with sales volumes dropping to 46.45 billion USD due

to the war, economic instability, population migration, and the destruction of production and logistics infrastructure. A significant decline in retail food sales in Ukraine was noticeable in 2022. Specifically, sales of fruits and vegetables decreased from 12.83 billion USD in 2021 to 10.54 billion USD in 2022 (a reduction of 17.9%), meat and fish from 16.83 billion USD to 13.94 billion USD (a decrease of 17.3%), and dairy products and eggs from 9.26 billion USD to 7.16 billion USD (a reduction of 22.6%). This indicates a significant economic shock caused by the war, leading to reduced consumer spending, inflationary pressures, and disrupted logistics chains.



**Figure 2.** Retail food sales in Ukraine, billion USD

**Note:** 2025-2029 – forecasted data

**Source:** developed by the authors based on data from the Food – Ukraine (consumer) (n.d.)

However, following 2022, a recovery in sales is observed across all categories as early as 2023, indicating a gradual economic recovery, improved access to products, and stabilisation of domestic consumer demand. In 2023, the market began to recover gradually, and forecast data for 2025-2029 indicate steady growth to 94.88 billion USD by 2029, with an average annual growth rate of over 10%. The main drivers of this growth are the meat and fish categories, as well as fruits and vegetables, which demonstrate a significant increase in demand. Specifically, meat and fish sales are projected to grow by 133.2%, and fruits and vegetables by 123.5% by 2029. Dairy products, groceries, and ready-made

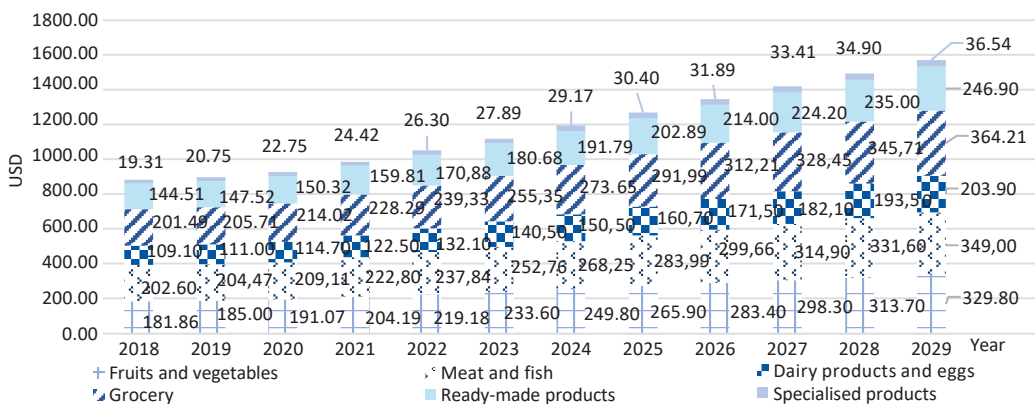
meals also show positive momentum, although their growth is less pronounced. Specialised goods have the smallest increase, but also note a stable rise in demand. Forecasting further development to 2029, a gradual increase in retail food sales can be expected, driven by the stabilisation of the economic situation, recovery of domestic demand, and improved access to goods. However, challenges may still remain in the market, particularly due to political and economic instability, inflationary processes, and changes in consumer priorities, requiring attention from both the government and retail businesses.

Based on the conducted research on retail food sales in Ukraine and globally, the following

comparisons and conclusions can be drawn. The global food market demonstrates steady growth in sales volumes; for example, from 2018 to 2029, overall figures are expected to increase from 6.32 trillion USD to a projected 12.36 trillion USD, indicating an almost doubling of the market. In Ukraine, growth rates up to 2022 were similar to global trends, but due to the impact of war and economic difficulties, a decline was observed in 2022. Since 2023, a recovery has been observed, and projected growth rates up to 2029 are expected to exceed global rates. Ukraine is experiencing rapid post-crisis growth after 2022 (53.37 billion USD in 2023 compared to 46.45 billion USD in 2022), which exceeds global averages, while the global economy demonstrates greater stability and consistent development due to more developed infrastructure and less dependence on regional conflicts. The 2029 forecast shows that the market volume in Ukraine (94.88 billion USD) will constitute about 0.8% of the global market (12.36 trillion USD), indicating significant potential for further development, particularly through adaptation to global standards and integration into international trade. Thus, the Ukrainian food market, although smaller in scale, demonstrates dynamic growth, especially in post-crisis recovery, and while reflecting

global trends, retains its own regional specificities in consumer preferences.

As of 1 June 2023, the actual population according to the State Statistics Service was 32,953,432 (State Statistics Service of Ukraine, n.d.b). Therefore, since the start of the full-scale invasion, the population of Ukraine has decreased by 20%. Significant internal migration is also observed: as of May 2024, over 4.7 million internally displaced persons (IDPs) are registered in Ukraine. There is no observed trend for population increase: according to International Monetary Fund (IMF) forecasts, the population of Ukraine will only increase to 36 million by 2028 (Ukrainian food retail market..., 2024). However, even under these conditions, the sector demonstrates resilience, as food retail has been able to return to pre-war levels. As of the end of 2023, the number of operating food stores constituted 104% of the pre-war level (Unbreakable: Ukraine's retail..., 2024). The conducted analysis showed that in Ukraine, per capita income from food retail is growing at a faster rate than globally, indicating changes in consumer habits, price increases, and strengthening consumer purchasing power. The most notable differences are observed in the meat and fish and fruit and vegetable categories, which are priorities for Ukrainian consumers (Figs. 3 and 4).



**Figure 3.** Average per capita income from global retail food sales, USD

Note: 2025-2029 – forecasted data

Source: developed by the authors based on data from the Food – Worldwide (consumer) (n.d.)

The higher per capita income from food retail in Ukraine compared to global figures can be attributed to several key factors. Firstly,

in Ukraine, a significant portion of household expenditures is directed towards food products due to lower overall income levels and

limited spending on other consumption categories, which elevates the economic role of this sector. Research indicates that the market share of essential goods exceeds 50% (Gamova et al., 2024). Secondly, due to the specific characteristics of the state’s agricultural sector and food industry, there is a high level of local consumption of goods with higher added value, particularly meat, fish, fruits, and vegetables. According to research by O. Kovalenko & L. Yashchenko (2024), between 2012 and 2021, the average monthly consumption of food products by the population decreased across almost

all food groups, except for meat products and fruits, whose consumption in the monthly diet of the population increased by 2% and 5%, respectively. Thirdly, inflationary processes, currency exchange rate fluctuations, and dependence on imports of certain products also contribute to price increases, and therefore, income in the sector. Additionally, the increasing demand for higher quality and more expensive products due to changing consumer habits, combined with increased production costs, stimulates the formation of higher income indicators than the global average.

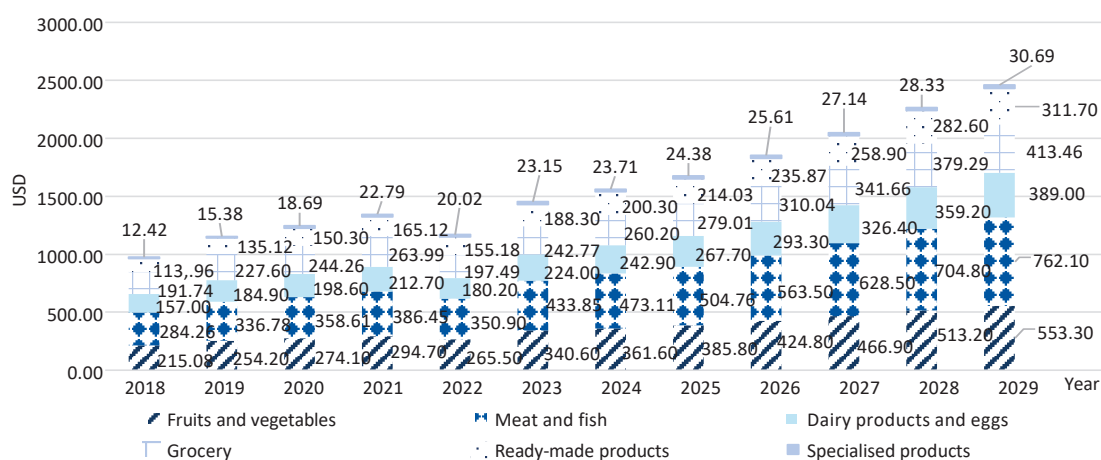


Figure 4. Average per capita income from retail food sales in Ukraine, USD

Note: 2025-2029 – forecasted data

Source: developed by the authors based on data from the Food – Ukraine (consumer) (n.d.)

Retail food sales in Ukraine are demonstrating mixed trends, notably a significant reduction in volumes in 2022 (to 12.51 billion kg) due to the economic and social consequences of the war. However, in 2023, a recovery is observed, and further steady growth in volumes to 17.11 billion kg is projected by 2029. The largest categories by volume remain bread and cereal products, vegetables, and dairy products with eggs, which hold leading positions in the Ukrainian diet. Simultaneously, the market for categories

such as sauces, spices, fish, and seafood will remain relatively stable. A significant increase in demand is expected for meat, semi-finished products, and confectionery, indicating the adaptation of consumer preferences to modern trends and the growth of consumer purchasing power in the forecast period.

In the research, not only monetary but also quantitative indicators were used, which take into account the sales volume and per capita consumption of basic food products (Table 2).

Table 2. Quantitative indicators of retail food sales and food consumption in Ukraine

Product categories	Year											
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Fruits and vegetables												
Sales volume, billion kg	5.76	5.59	5.78	5.68	4.21	4.59	4.76	4.98	5.20	5.40	5.61	5.68

Table 2, Continued

Product categories	Year											
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Consumption per capita, kg	136.5	133.4	138.9	137.9	122.0	135.0	142.5	150.9	152.0	156.5	162.6	164.6
Meat and fish												
Sales volume, billion kg	2.15	2.07	2.15	2.11	1.50	1.60	1.70	1.79	1.92	2.03	2.19	2.23
Consumption per capita, kg	50.9	49.4	51.7	51.2	43.5	47.1	50.9	54.2	56.1	58.8	63.5	64.6
Dairy products and eggs												
Sales volume, billion kg	3.27	3.12	3.24	3.17	2.19	2.24	2.37	2.52	2.67	2.83	2.96	3.04
Consumption per capita, kg	77.5	74.5	77.9	76.9	63.5	65.9	71.0	76.4	78.1	82.0	85.8	88.1
Grocery												
Sales volume, billion kg	5.23	4.96	5.16	5.05	2.95	3.09	3.25	3.43	3.63	3.77	3.96	4.06
Consumption per capita, kg	123.9	118.4	124.0	122.6	85.5	90.9	97.3	103.9	106.1	109.3	114.8	117.7
Ready-made products												
Sales volume, billion kg	1.80	1.72	1.83	1.81	1.34	1.39	1.45	1.52	1.59	1.64	1.71	1.76
Consumption per capita, kg	42.7	41.1	44.0	43.9	38.8	40.9	43.4	46.1	46.5	47.5	49.6	51.0

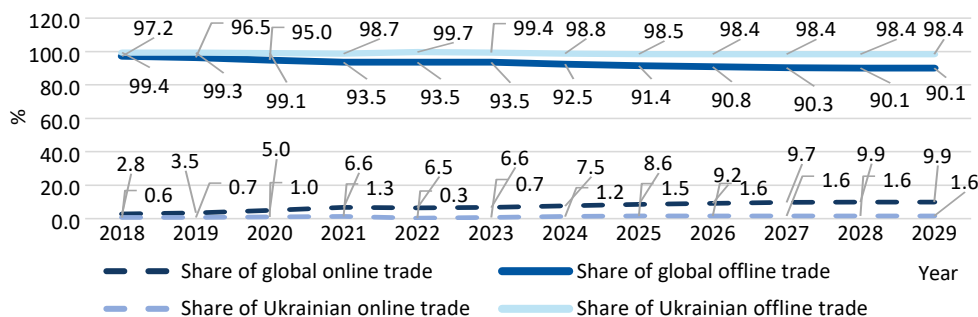
**Note:** 2025-2029 – forecasted data

**Source:** developed by the authors based on data from the Food – Ukraine (consumer) (n.d.), State Statistics Service of Ukraine (n.d.b), IMF estimates Ukraine's population... (2024)

According to the conducted research, there is a significant decrease in the consumption level of basic food products in 2022, which is associated with the full-scale invasion of Ukraine and the resulting crises. Specifically, per capita consumption of fruits and vegetables in 2022 decreased to 122 kg, which is below the recommended norms (160-200 kg), although gradual recovery is projected in subsequent years. A similar situation is observed in the meat and fish product category: in 2022, consumption fell to 43.5 kg per person (with a norm of 80-90 kg), but by 2029, it is projected to increase to 64.6 kg. Consumption of dairy products and eggs also significantly lags behind the recommended 200-250 kg: in 2022, it decreased to 63.5 kg and may only reach 88.1 kg by 2029. The largest decline in 2022 was recorded in grocery consumption – only 85.5 kg per person, which is half the normative indicators (180-220 kg), although gradual growth is projected in the future. Analysing the trends, it can be concluded that the consumption level in Ukraine in recent years has been significantly lower than the recommended norms, and although recovery is expected, full achievement of normative values in the near future is not projected.

The recovery of online food retail is closely linked to the positive development dynamics of the offline sector. The events of 2020-2024 served as a trigger for the accelerated growth of e-commerce: in 2021, amid the coronavirus pandemic, the revenue of the Ukrainian e-commerce market in the food category reached 753.90 million USD, and in 2023, the category's revenue was 345.50 million USD. The revenue of the Ukrainian online food retail market will steadily increase over the next four years. According to Statista's forecast, a full recovery of the sector's profitability in e-commerce is expected in 2025 (Ukrainian food retail market..., 2024).

A comparison of the development dynamics of online and offline food retail in the global and Ukrainian markets reveals significant differences, particularly in growth rates and the shares occupied by each channel. The global market shows a continuous increase in the share of online sales, indicating a significant transformation of shopping in the context of globalisation and digital technology development. Specifically, in 2020, the share of online retail globally reached 5%, and by 2029, it is projected to increase to 9.9%, which is a result of e-commerce development, changing consumer behaviour, and growing trust in online stores (Fig. 5).



**Figure 5.** Share of global and Ukrainian online and offline food retail, %

**Note:** 2025-2029 – forecasted data

**Source:** developed by the authors based on data from the Food – Ukraine (ecommerce) (n.d.), Food – Worldwide (ecommerce) (n.d.)

In Ukraine, the development of online food retail lags behind global trends: online sales remain at a low level, starting from 0.6% in 2018, and only by 2029 is it projected to reach 1.6%. Although a gradual increase in the share of online retail is observed, economic, technological, and social factors, such as uneven internet access in regions, distrust of online platforms, and insufficient logistical development, significantly hinder this process. In conditions of economic instability and high competition in the offline sector, Ukrainian consumers often prefer traditional channels of food procurement, which contributes to the slow growth of the online market. Most consumers continue to make purchases in physical stores, especially in the food segment, where the ability to directly inspect the product is important.

Thus, while trends in the global market indicate a clear shift towards online sales channels, in Ukraine this is happening much more slowly due to several internal factors. In the future, with the development of infrastructure and technology, a gradual increase in the share of online

retail in Ukraine is expected, but offline channels will remain the primary method of purchase for the coming years.

Table 3 reflects significant changes in the dynamics of the number of operating businesses engaged in retail food sales during 2010-2023. Overall, there is a significant reduction in the number of enterprises and individual entrepreneurs in all analysed trade segments. Specifically, in non-specialised stores, the number of enterprises decreased by 47.09%, and individual entrepreneurs by 46.23%. In specialised stores, these figures are less significant but also negative: the reduction in the number of enterprises was 16.55%, and individual entrepreneurs 15.03%. The largest drop was recorded in street stall and market trade: the number of enterprises decreased by 63.21%, and individual entrepreneurs by 63.06%. Thus, these data indicate structural changes in retail food sales, particularly a decrease in the significance of traditional distribution channels such as markets and stalls, amidst the transformation of the economic environment.

**Table 3.** Dynamics of the number of operating businesses in retail food sales in Ukraine, units

Indicator	Year						Absolute change from 2023 to 2010	Relative change from 2023 to 2010, %
	2010	2015	2020	2021	2022	2023		
Retail in non-specialised stores, mainly with food products, beverages and tobacco products								
Enterprises	173,900	130,922	112,324	107,111	86,642	92,013	-81,887	-47.09
of which: individual entrepreneurs	164,640	124,447	108,151	102,186	83,526	88,534	-76,106	-46.23

Table 3, Continued

Indicator	Year						Absolute change from 2023 to 2010	Relative change from 2023 to 2010, %
	2010	2015	2020	2021	2022	2023		
Retail in food products, beverages and tobacco products in specialised stores								
Enterprises	41,724	38,041	36,203	35,428	30,731	34,819	-6,905	-16.55
of which: individual entrepreneurs	40,275	37,096	35,359	34,573	30,240	34,221	-6,054	-15.03
Retail from stalls and markets with food products, beverages and tobacco products								
Enterprises	63,319	39,228	29,953	27,163	22,847	23,296	-40,023	-63.21
of which: individual entrepreneurs	62,991	39,147	29,904	27,113	22,823	23,269	-39,722	-63.06

**Source:** developed by the authors based on data from the State Statistics Service of Ukraine (n.d.a)

Large retail chains are gradually absorbing smaller retail operators, and the role of supermarkets and hypermarkets is growing, as evidenced by the increase in the retail space of these store formats. Among retail operators, those that sell food products are developing most dynamically (Shtal & Proskurnina, 2018). These store formats have expanded the product selection for consumers, creating more convenient shopping conditions. Supermarkets have become more accessible, which has increased their competitiveness compared to traditional markets and small stores. Hypermarkets, located on the outskirts of cities, have allowed consumers to purchase large volumes of goods at favourable prices. At the same time, chains of small specialised grocery stores have maintained their popularity, especially in small towns and rural areas (Kovalenko & Yashchenko, 2024). Among retailers specialising primarily in the sale of food products, the largest in Ukraine in 2024 were: ATB-Market, Fozzy Group (Silpo, Fora, Le Silpo), Novus, Varus, Metro Cash & Carry Ukraine, Retail Group (Velyka Kyshenia, Velmart), Tavria V, and Auchan Ukraine (ATB's revenue for the first half..., 2024).

Conducting a competitive analysis of food retailers in Ukraine was justified given the dynamic changes in the economic situation, the impact

of geopolitical factors, and shifting consumer preferences, including the growing demand for environmentally friendly products and the development of online sales. Increased competition, notably through the expansion of discount chains, the entry of new players, and company mergers, necessitates an assessment of competitors' market positions and strategies. Simultaneously, the development of technologies, automation of business processes, and digitalisation create new opportunities for innovation. Additional influence is exerted by regulatory changes, including the strengthening of food safety standards and government policies. All these factors require detailed analysis to assess the strengths and weaknesses of companies, identify promising market niches, adapt to new conditions, and ensure the long-term competitiveness of retailers in the dynamic Ukrainian market.

To create a competitive analysis of the main food retailers in Ukraine, the following aspects were considered: scale and market presence (number of stores, geography); pricing policy (premium, mid-range, low segment); product range and specialisation (private label brands, exclusive goods); innovation and additional services (online stores, delivery, loyalty programmes); and financial indicators (revenue, growth rates). The findings are presented in Table 4.

Table 4. Competitive analysis of food retailers in Ukraine in 2024

Parameter	ATB-Market	Fozzy Group (Silpo, Fora)	Metro Cash & Carry	Novus	Varus	Auchan Ukraine	Retail Group Velyka Kyshenia/Velmart	Tavria V
Number of stores	1,500+	600+	26	90+	100+	40+	40+	80+

Table 4, Continued

Parameter	ATB-Market	Fozzy Group (Silpo, Fora)	Metro Cash & Carry	Novus	Varus	Auchan Ukraine	Retail Group Velyka Kyshenia/ Velmart	Tavria V
Geography	All Ukraine	All Ukraine	Major cities	Major cities	Major cities	Major cities	Regional centres	Southern Ukraine
Pricing policy	Low segment	Mid-range, premium	Mid-range, wholesale	Mid-range, premium	Mid-range	Mid-range	Mid-range	Mid-range
Product range	Wide, Private Label	Wide, premium, exclusive	HoReCa focused	Imports, Private Label	Wide	Imports, Private Label	Wide	Local, seasonal
Innovations	Online delivery, app	App, delivery, loyalty	Business services	Delivery, app	Loyalty, promotions	Loyalty, limited delivery	Loyalty programmes	Limited
Revenue, billion UAH	97.5 (+14.3%)	64.6 (+3.3%)	12.8 (+11.2%)	13.4 (+25.9%)	9.5 (+13.9%)	6.3 (-6.2%)	5.1 (+2.0%)	6.8 (+4.5%)
Strengths	Scale, pricing	Quality, exclusivity	Wholesale, business focus	Quality, imports	Growth dynamics	Product range	Local products	Stable position in the south
Weaknesses	Limited premium	Less accessibility	Limited retail network	Small network	Locality	Network reduction	Small network	Regional market dependence

**Source:** developed by the authors based on data from the Ukrainian food retail market... (2024), Unbreakable: Ukraine’s retail... (2024), Revenue of retail leaders in Ukraine... (2024), ATB’s revenue for the first half... (2024)

Summarising the conducted research, the following general conclusions can be drawn regarding the current state of the retail market in Ukraine. The ATB network dominates in scale and low prices, attracting the economy segment. Fozzy Group, in turn, maintains stable competitive advantages in the premium segment due to high product quality and a wide range. Metro and Novus networks are positioned as retailers focused on business clients and consumers who prefer a high level of service and product quality. Varus and Velyka Kyshenia demonstrate positive development dynamics, but to strengthen their market positions, they need to expand their scale of operations. Tavria V remains a local player. Auchan remains a strong brand for buyers looking for a large selection of goods. However, its competitive position has weakened due to a reduction in market share and increased competition from fast-growing Ukrainian retailers, particularly ATB and Fozzy Group.

Among the main reasons, the following can be highlighted:

- the presence of the store in the aggressor country’s market is one of the reasons for the decline in Auchan Ukraine’s revenues. This can be explained by the fact that public opinion in Ukraine increasingly influences consumer behaviour, which may boycott companies with business activities in the aggressor country. This public stance causes reputational risks, which reduce customer loyalty and, consequently, the retailer’s revenues. This factor is particularly important in the context of increased corporate social responsibility and patriotic sentiments of the population, which shape consumer choices;
- it is positioned as a universal supermarket, but focuses more on the mid-range segment, which is less competitive compared to ATB’s low prices and Silpo’s premium quality;
- it has a weaker localisation of its product range compared to Ukrainian networks.

Based on its own research, the following strategic directions are proposed to enhance the competitiveness of food retailers in Ukraine (Table 5)

**Table 5.** Strategic directions for enhancing the competitiveness of food retailers in Ukraine

Category	Subcategory	Specific measure
Retail innovation strategies	Digital technology implementation	Development of e-commerce platforms, mobile applications, delivery services, and use of big data for personalised customer offers
	Process automation	Installation of self-checkout tills, implementation of electronic shelf labels, automated inventory management, and demand forecasting systems
	Loyalty systems	Discount, bonus, and cashback programmes for regular customers with an emphasis on personalisation
Enhancing product quality and accessibility	Product range expansion	Engagement of local producers, development of organic product sections, gluten-free, vegan, and other specialised goods
	Quality control	Ensuring supply chain transparency, product certification, and providing consumers with information on product origins
	Competitive pricing	Optimisation of costs and engagement of suppliers with favourable cooperation terms
Infrastructure development	Optimisation of retail space	Use of multifunctional store formats (convenience stores, supermarkets, hypermarkets) that meet the needs of various consumer categories
	Location strategy	Opening stores in high-traffic locations, new residential areas, or near key transport hubs
	Eco-friendliness	Use of energy-efficient technologies, reduction of plastic use, implementation of food waste recycling policies
Expanding cooperation with local producers	Small business support	Simplifying cooperation terms with farms and micro-producers
	Development of partnership programmes	Conducting promotions to popularise local products
Corporate social responsibility and branding	Social initiatives	Participation in charitable events, providing discounts to socially vulnerable population groups
	Marketing campaigns	Use of national identity to promote Ukrainian products, emphasis on safety and quality
Staff training and management	Skill development	Continuous professional development of employees in sales, customer service, and business process management
	Employee motivation	Implementation of bonus programmes, corporate social packages, and other incentive mechanisms
Government support and regulatory measures	Tax incentives	Simplification of the tax burden for retail working with Ukrainian producers
	Subsidy programmes	Support for small and medium-sized businesses aimed at developing retail
	Antitrust policy	Ensuring fair competition among retailers
Customer orientation	Consumer preference research	Regular analysis of customer needs, satisfaction, and demands regarding prices and product ranges
	Interactivity	Use of feedback, surveys, and integration with social networks

**Source:** developed by the authors based on own research and study by O. Okunyeva (2012), L. Scheers (2016), N. Krasnokutska *et al.* (2019)

According to the conducted research, with the improvement of infrastructure and technology, the share of online food retail in Ukraine will gradually increase in the future. However, offline formats will remain the primary shopping channel for the coming years. This aligns with the opinion of T. Pashkuda & A. Afendi (2022), who argued that under unchanged conditions, the growth of e-commerce will continue, but it will be difficult to reach the indicators of previous periods due to occupied territories, low purchasing

power of buyers, and population migration abroad. Research by I. Gamova *et al.* (2024) indicated that if the level of external threats does not increase, it is possible to forecast the achievement of the most successful year – 2019 – in this indicator only in 2026. Alongside this, it is worth noting the need to develop an innovative retail strategy, particularly e-commerce platforms for food retailers in Ukraine. This is confirmed by O. Kovalenko (2024), who argued that despite the crisis situation, another trend in the

development of food retail in Ukraine was the orientation towards the European management system of modern food retail, which is defined by the key factor – the development of online retail through chain stores and own delivery services, which are becoming the main sales channels.

Enhancing the competitiveness of food retailers in Ukraine through product range expansion involves engaging local producers and developing sections for organic, gluten-free, vegan, and other specialised products. Furthermore, it includes focusing on environmental sustainability, namely through the use of energy-efficient technologies, reducing plastic usage, and implementing food waste recycling policies. O. Dankeieva (2023) noted in her research that to ensure the further sustainable development of food retail, it is necessary to develop effective scenarios for its future operations. The method of searching for development scenarios chosen in this study, the Thomas Saaty Analytical Hierarchy Process, allowed for the construction of a hierarchical representation of the problem. Among the guidelines for food retail, the following were highlighted: eco-trend, flexibility of assortment policy, and ecological relationships between retail and consumers.

One of the proposed strategic directions for enhancing the competitiveness of food retailers in Ukraine is government support and regulatory measures, which include antitrust policy. O. Nikishyna & A. Shcherbak (2023) emphasised in their research that the system of state regulation of retail should guarantee transparent and predictable conditions for conducting trade activities, ensure equal opportunities for all market participants, protect competition, prevent abuse and discrimination, and promote the development of small and medium-sized enterprises and scientific and technological progress. O. Bokiyy (2023) reached similar conclusions, arguing that an effective tool of food policy aimed at overcoming modern challenges is legal regulation, as legislative acts, norms, and standards either promote or hinder the development of the economy and business activities. Another important strategic direction for enhancing the competitiveness of food retailers in Ukraine is staff training and management. As H. Guliaieva *et al.* (2024) highlighted that a weak link

in trade management still remains the block of managing the formation and use of labour resources. Regarding the marketing component of the proposed strategic directions, it is advisable to use national identity to promote Ukrainian products, with an emphasis on safety and quality. N. Kosar & A. Vintoniak (2023) agreed with the importance of this approach, insisting on the formation and implementation of an effective marketing policy, which trading enterprises need to constantly adjust under the influence of changes in the factors of their marketing environment.

The conducted research complements the existing scientific knowledge base on retail food sales and provides strategic directions for enhancing the competitiveness of food retailers in Ukraine.

## CONCLUSIONS

The research revealed that retail food sales in Ukraine underwent significant transformations across three key periods: pre-COVID, COVID, and the period of Russia's full-scale invasion. Before the pandemic, and even during it, the market demonstrated steady growth (from 43.32 billion USD to 58.59 billion USD in 2018-2021), driven by urbanisation and rising household incomes. The COVID-19 pandemic accelerated the development of online retail (in 2021, amid the coronavirus pandemic, the revenue of the Ukrainian e-commerce market in the food category reached 753.90 million USD), but complicated the operation of traditional stores. Russia's invasion in 2022 led to significant losses in the sector due to infrastructure destruction and reduced demand, but the adaptation of large chains helped to partially stabilise the situation. After 2023, retail food sales in Ukraine are characterised by high growth dynamics (53.37 billion USD in 2023 compared to 46.45 billion USD in 2022), despite the impact of external and internal crises. In particular, the Ukrainian market demonstrates higher recovery rates compared to global indicators, driven by postcrisis economic recovery, increased demand, and rising per capita retail sales revenues. The main factors driving the sector's development are the significant share of household spending on food products, the growth of local product consumption, especially in the meat, fish, fruit, and vegetable segments, as well as changes in consumer

preferences. The projected further growth in per capita retail food sales revenues indicates a strengthening of Ukrainian purchasing power, despite the challenging demographic situation. Important aspects for further development remain adaptation to global standards, expansion of the range of quality products, support for the agricultural sector, and stabilisation of the economic environment.

The recovery of online food retail in Ukraine proves to be challenging, although there is a gradual increase in the popularity of this channel. A growth in share from 0.3% in 2022 to 1.2% in 2024 is observed, with a forecast of 1.6% in 2029. Even though globally, online sales are gaining momentum, in Ukraine this trend remains less pronounced, particularly due to economic and technological barriers. The main problem is the insufficient development of infrastructure and logistics, as well as distrust of online platforms. According to forecasts, against the backdrop of global transformation and the development of digital technologies, the Ukrainian market is expected to grow steadily, but offline channels are likely to remain dominant for several more years.

The food market in Ukraine is characterised by a variety of business entities, from large supermarket chains to small retail outlets and

online platforms, which define their competitiveness through price, quality, logistics, and level of service. Key measures to enhance retailers' competitiveness include investing in innovation and technology, optimising logistics, developing loyalty programmes, implementing environmental practices, and flexibility in adapting to consumer trends. Enterprises that actively respond to market changes can strengthen their positions, ensuring sustainable growth even in a competitive environment. Further development of retail will depend on investments in infrastructure restoration, support for small businesses, the development of online trade, and adaptation to changing consumer priorities.

Prospects for further scientific research are related to the study of the development of retail in organic food products and the analysis of their impact on the human body – both beneficial and harmful.

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## **Роздрібна торгівля харчовими товарами в Україні: від довоєнного періоду до перспектив відновлення**

**Анотація.** Роздрібна торгівля харчовими товарами є важливим індикатором соціально-економічного стану суспільства. Її динаміка відображає рівень добробуту населення, впливає на формування податкових надходжень та демонструє тенденції розвитку економіки. Метою роботи було виявлення основних чинників, які впливають на функціонування продуктових ритейлерів, а також формулювання пропозицій щодо підвищення конкурентоспроможності роздрібних торговців харчовими товарами в Україні. Результати дослідження свідчать, що пандемія COVID-19 спричинила глобальні зрушення у структурі споживання харчових продуктів, а також стимулювала розвиток електронної торгівлі. Водночас війна в Україні спричинила різкий спад обсягів продажів через руйнування інфраструктури, економічну нестабільність та міграцію населення. Найбільше скорочення обсягів продажів спостерігалось в категоріях свіжих продуктів, таких як фрукти, овочі, м'ясо та риба. В Україні, незважаючи на негативний вплив війни, сектор харчової торгівлі виявив значну стійкість і демонструє швидке післякризове зростання, перевищуючи середньосвітові темпи. Аналіз доходу на душу населення від торгівлі харчовими товарами свідчить про зміцнення купівельної спроможності населення та зміну споживчих звичок. Особливу увагу приділено відмінностям у темпах розвитку онлайн і офлайн торгівлі, де глобальні тренди випереджають українські. Висвітлено структурні зміни в галузі, зокрема скорочення кількості малих роздрібних операторів на користь великих мереж. Конкурентний

аналіз виявив, що продуктові ритейлери зосереджуються на оптимізації цінової політики, розширенні асортименту та впровадженні діджитал-рішень. Для підвищення конкурентоспроможності продуктових ритейлерів запропоновано заходи, спрямовані на вдосконалення обслуговування, розвиток онлайн-каналів продажу, диверсифікацію асортименту й інтеграцію екологічних ініціатив. Практична цінність дослідження полягає в пропозиціях стратегічних напрямів підвищення конкурентоспроможності ритейлерів харчових товарів в Україні, зокрема через впровадження інноваційних рішень, підтримку малого бізнесу та розвиток логістичної інфраструктури

**Ключові слова:** електронна торгівля; конкурентоспроможність; ритейлери; асортимент; інновації



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## Innovative strategies for the development of personnel management on the example of the construction sector

**Abstract.** The growing complexity of construction projects combined with the digital transformation of the industry makes it necessary to modernise personnel management systems, which is a key factor in ensuring the competitiveness of construction enterprises. The purpose of the study was to develop a comprehensive digital human resources (HR) management system designed to increase the efficiency of HR processes in the context of dynamic technological changes. The methodological foundation of the paper was based on the analysis of corporate documentation of 8 international construction companies for the period 2020-2023, which served as a basis for evaluating and implementing innovative HR strategies. Among the critical achievements, the integration of artificial intelligence into recruitment processes is notable, which reduced the recruitment time by 32% and substantially improved the quality of candidate selection (an increase of 45%). The use of virtual reality (VR) simulations in training programmes reduced the error rate when performing complex production operations by 45%. In addition, the developed competence monitoring system, based on 15 parameters of construction processes, contributes to the formation of reference profiles of specialists. The transformation of the workspace based on the activity-based working principle had a positive impact on the level of professional burnout, reducing this indicator by 18%, and increasing labour productivity by 16%. The implemented well-being support programmes recorded a 22% reduction in the number of sick days, and the development of cross-functional teams accelerated the introduction of innovations by 35%. The combination of these results creates a practical basis for the modernisation of HR processes in the construction industry. The study materials can be used to develop professional development programmes, adapt innovative HR management methods, and form digital transformation strategies in the context of the specifics of the construction industry

**Keywords:** digital transformation; professional competencies; cross-functional teams; predictive analytics; well-being programmes

### INTRODUCTION

The modern construction industry is at the stage of substantial transformation due to the active introduction of digital technologies, automation

of work processes, and innovative approaches to labour organisation. The complexity of construction projects, increased competition and

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growing quality requirements create new management challenges, especially in the field of human resource management. This determines the relevance of developing and implementing innovative human resources (HR) management strategies aimed at attracting, professional development, and long-term retention of highly qualified specialists.

According to the study by M. Omelianenko & Y. Krychevska (2024), Ukraine is experiencing substantial changes in the management systems of construction enterprises. In particular, more than 35% of Ukrainian companies in the construction sector have integrated automated project management systems, such as enterprise resource planning (ERP) solutions and resource management systems. Thereby, in the UK and Germany, more than 40% of such companies use artificial intelligence-based analytics technologies to optimise management processes. However, a publication of P. Budhwar *et al.* (2023), offers a fundamentally new perspective on the impact of generative artificial intelligence on HR processes. As part of a large-scale analysis covering a sample of 8,370 employees in 10 countries, the authors showed interesting results: 50% of employees surveyed actively use artificial intelligence (AI) technologies in their work, while 64% stated a higher degree of trust in AI solutions compared to traditional management approaches. In this context, the model of integration of artificial intelligence into HR systems proposed in the study was important, including the development of digital competencies and the use of predictive approaches to talent management.

A revolutionary approach to the introduction of artificial intelligence was highlighted in the paper of S. Chowdhury *et al.* (2023). Developed by the authors, the AI capability framework, based on interdisciplinary analysis, identifies five key organisational resources that are crucial for successful transformation based on artificial intelligence. Attention should be paid to a set of practical tools for self-assessment of organisations' readiness for change and recommendations for gradually acquiring the necessary competencies. The fundamental changes caused by the impact of the concept of Industry 4.0 on the field of human resource

management are justified in the study by L.B.P. da Silva *et al.* (2022). Based on the analysis of 93 scientific papers, the authors identified 13 fundamental areas of change – from the introduction of the principle of digital culture to the creation of adaptive learning systems of a new generation. The main conclusion is the need to develop multidisciplinary competencies and implement comprehensive digital literacy programmes.

The importance of HR management in times of crisis was emphasised by S. Hamouche (2023). Analysing the practices of 150 companies during the COVID-19 pandemic, the author presented an innovative model of personnel management in crisis situations. The proposed solutions cover the introduction of flexible forms of employment, the active development of digital skills of employees, and the formation of psychological support systems to ensure the resilience of employees to stressful factors. K. Wasilkiewicz Edwin *et al.* (2024) concentrate on the critical link between project management and occupational health in the Norwegian construction industry. By applying benchmarking tools and analysing incident statistics, the authors created an innovative model for integrating security into all stages of construction projects – from planning to financial resource management.

Management problems in the construction sector are reviewed from a new perspective by V. Kulba *et al.* (2016). Using scenario modelling, the researchers identified systemic problems in the industry, including inefficient government regulation and income inequality. The proposed mechanisms for increasing transparency in management and financial processes are designed to become the basis for the transformation of the industry. J.F. Molina-Azorin *et al.* (2021) presented a new approach to environmental management in the context of human resources management. The authors summarised the relationship between environmental management approaches and HR strategies, highlighting that companies with efficient ecosystems demonstrate higher team productivity. Special attention was paid to the role of “green teams” in the implementation of environmental initiatives. The aspect of transforming HR processes through the use of project management was considered in a study by C.E. Oehlhorn *et al.* (2020).

After analysing 71 articles, the authors identified the defining role of HR departments in achieving strategic harmony between business and IT processes. The study highlighted the need for HR to move from an administrative to a strategic function in the context of digital transformation.

An inclusive approach to talent development was stressed by M. Kaliannan *et al.* (2023). Based on a systematic review of the literature from 1997 to 2020, the authors demonstrated the advantages of inclusive talent development methods over traditional elite approaches. The results showed that external hiring costs are 18-20% higher than internal recruitment costs. Revolutionary approaches to security management are determined by C. Okonkwo *et al.* (2023). Based on a survey of 52 construction project managers with an average experience of more than 18 years, the authors identified the main obstacles to implementing smart safety systems and outlined practical recommendations for overcoming them.

A valuable contribution to the examination of psychological aspects of management was presented in the paper of T.C. Dodanwala & D.S. Santoso (2024). Based on data from 274 project-level employees, the researchers determined a complex dynamic between personality traits and role stress, suggesting modern approaches to stress management in the construction industry. A special place in resource management is occupied by the findings of L. Hasselsteen *et al.* (2024). Combining systematic literature analysis and in-depth interviews with ten industry experts, the authors presented a framework for bridging the gap between scientific knowledge and the practical needs of the construction industry.

The analysis of the study indicates insufficient attention to the specifics of implementing innovative HR management strategies in the construction industry of Ukraine. There are still issues of digital transformation and new requirements for the professional competencies of employees. The aim of this study was to create a comprehensive approach to the development of innovative HR management strategies focused on the construction sector of Ukraine, considering international experience. The following tasks are planned to achieve this goal: evaluate

current trends and key challenges in personnel management in the construction industry; analyse the best practices of applying innovative HR strategies in leading international construction companies; offer recommendations for adapting these practices to the realities of Ukrainian construction companies.

## MATERIALS AND METHODS

The empirical foundation of the study was built on the basis of corporate documentation of eight international construction companies for the period from 2020 to 2023. The analysis included data from leading industry representatives such as Vinci Construction (2023), Hochtief (2023), Skanska (2023), Balfour Beatty (2023), and Strabag (2023), each of which has an annual turnover of more than 10 billion euros. In addition, the practices of PORR (2023), Ferrovial (2023), and Bouygues Construction (2023) were assessed. The study was based on materials such as annual company reports, corporate presentations, official press releases, and internal documentation from HR departments.

The technical documentation for implementing artificial intelligence in HR processes described in the paper of P. Budhwar *et al.* (2023) was analysed to examine recruitment systems. The analysis of materials for optimising work processes covered the transformation of office space according to the activity-based working principle in concert with the data of K. Wasilkiewicz Edwin *et al.* (2024), which included an analysis of the practices of leading construction companies in Norway and the results of employee surveys on the effectiveness of new formats for organising workspaces. The developments of L. Hasselsteen *et al.* (2024), which included ten in-depth interviews with industry experts on workflow optimisation, were also utilised. Well-being programmes were also investigated, including Hochtief reports on the implementation of a comprehensive programme to support staff physical and psychological health.

The methodological basis of the study was founded on a comprehensive approach to analysing the transformations of HR processes in the construction industry. Methods of comparative analysis of key indicators before and after digital integration were used to assess the

effectiveness of recruitment procedures. The quality of recruitment was assessed by calculating the success rates of completing the trial period and the degree of compliance of candidates with the established position profile. The analysis of the development of professional competencies was carried out through the evaluation of the effectiveness of training programmes.

The study used quantitative analysis methods, in particular, the analysis of data on participation in certification programmes, the results of testing technical skills, and labour productivity after completion of training. Statistical data was processed using the SPSS Statistics 27.0 software for analysing the dynamics of performance indicators. The examination of personnel retention strategies included an analysis of the structure of compensation packages and motivation systems. Economic analysis methods were used to calculate the profitability of training programmes (ROI) and evaluate the effectiveness of investments in employee development. The effectiveness of well-being programmes was assessed by analysing the level of professional burnout and overall employee satisfaction.

The processes of digital transformation of HR functions were examined through the analysis of documentation on implemented technological solutions. The effectiveness of VR technologies in training programmes was evaluated by comparing training results before and after using virtual simulators. Evaluation of the performance of neural network systems for recruitment was based on an analysis of the accuracy of predicting the success of candidates, followed by validation of results using historical data. The productivity of project teams and the dynamics of implementing innovative solutions were analysed to assess the effectiveness of cross-functional teams. System analysis methods were used to measure the impact of digitalisation on the overall effectiveness of HR processes, and predictive analytics in HR management was reviewed through the consideration of data processing algorithms and applied results. The data triangulation method was used to increase the reliability of the obtained conclusions, which involved comparing information from different sources. The economic efficiency of HR strategies was evaluated using a comprehensive

analysis of financial indicators and development dynamics. The proposed methodology provided a systematic understanding of the processes of transformation of the personnel management system in the construction sector.

## **RESULTS**

### **Strategies for finding and attracting talent in the construction industry: an analysis of international practices**

The practices of five leading international construction companies, such as Vinci Construction, Hochtief, Skanska, Balfour Beatty, and Strabag, for the period 2020-2023 exhibited the active introduction of digital technologies in recruitment processes. Analysis of the use of artificial intelligence in HR processes by Vinci Construction (2023) shows a reduction in recruitment time by 32% and an increase in the quality of candidate selection by 45% due to multi-factor competence analysis. In turn, S. Chowdhury *et al.* (2023) confirmed similar trends, demonstrating how the integration of AI systems has substantially changed the approach to evaluating candidates through in-depth analysis of technical skills, behavioural characteristics, and developmental potential. Analysis of the practice of Vinci Construction demonstrated the results of implementing the SAP SuccessFactors platform for personnel management. The system reduced the time required to process personnel documents from 5 to 2 days along with the cost of managing HR processes. However, there are difficulties with integrating data from old systems and the need for additional training of personnel to work with the new platform. The practice of Hochtief (2023) was distinguished by the introduction of an integrated predictive analytics system for evaluating candidates. Such a system considers a wide range of parameters: technical and managerial skills, experience in international projects, and professional growth prospects. Hochtief introduced the workday HR management platform, which allowed centralising employee recruitment and adaptation processes. As a result of the implementation, staff turnover among technical specialists decreased by 15%. The main implementation challenges included resistance to change among mid-level management and the need for parallel

documentation management in the two systems during the transition period.

The transformation of HR processes in the construction industry took place through the introduction of various types of HR management strategies. The digital transformation of HR included recruitment automation, learning management systems, predictive analytics, and digital document management. Staff development was implemented through technical training, corporate educational platforms, and competence assessment systems. Talent retention strategies were based on employee support programmes and the modernisation of motivation systems. Performance management was carried out through measurable performance indicators and project team development.

Skanska (2023) introduced a digital recruitment process monitoring platform that provides performance monitoring at every stage of interaction with candidates – from the initial screening to the end of the probationary period. The Cornerstone OnDemand training

platform for staff development was implemented. The system provided for the creation of individual development plans and tracking the progress of training. The results included increased employee engagement and an improved team atmosphere through a transparent professional growth system. Among the disadvantages, there are limited opportunities for offline training and technical difficulties when working with large video files. In general, the introduction of digital tools has radically transformed approaches to evaluating the effectiveness of recruitment in the construction industry. Integration of analytical systems allowed tracking key metrics in real time and optimising recruitment processes based on the data obtained. A detailed analysis of fundamental recruitment performance indicators illustrates a comprehensive approach to evaluating the effectiveness of recruitment (Table 1). Monitoring systems covered all stages of working with candidates – from the first contact to the successful completion of the probationary period.

**Table 1.** Metrics of recruitment performance in the construction industry

Metric category	Indicators	Measurement methods	Optimisation tools
Hiring quality	Successful completion of the probationary period, compliance with the position profile	Manager's assessment, KPIs of new employees	AI-scoring candidates
Closing speed	Time from opening to closing of the vacancy, speed of completion of stages	Automatic tracking, milestone analysis	Process automation, predictive search
Cost of attraction	Costs per employee hired, ROI of recruitment channels	Financial analytics, attribution models	Channel diversification, targeting
Talent retention	Percentage of retention after a year of work, level of engagement	Regular surveys, layoffs analysis	Adaptation programmes, development systems
Quality candidate experience	NPS candidates, process satisfaction	Feedback, automated surveys	Digital interfaces, personalisation of communication

**Note:** target values vary depending on the category of personnel and the market situation

**Source:** created by the author

The integration of digital technologies into human resource management processes has become a critical factor in the development of multi-level search systems and in attracting qualified specialists in the construction industry. Automation of the first stages of candidate screening and evaluation has radically changed the functioning of HR departments, allowing

them to focus on in-depth communication with applicants and detailed assessment of professional competencies. Routine tasks were transferred to automated systems, which tripled the number of processed applications without expanding the staff of HR specialists.

At Balfour Beatty (2023), the introduction of digital technologies was based on the use of

integrated machine learning systems to optimise the personnel evaluation process. The developed algorithms analysed an extensive amount of data on successful employees to form reference profiles for the main professional specialisations in the construction sector. In turn, in Strabag (2023), the use of predictive analytics tools contributed to modelling the career development trajectories of employees based on historical data on the professional path in the company. PORR (2023) has integrated a candidate assessment system into its practices, which provides for a comprehensive test of technical knowledge and management and communication skills. Technical evaluation of candidates included performing practical tasks in the design and calculation of building structures, while soft skills analysis focused on identifying the ability to work effectively in cross-functional teams. The company has also implemented the

TalentLMS training platform for technical training of personnel. The system provided access to training materials via mobile devices, which increased employee engagement in training by 40%. Among the challenges, the difficulty of creating high-quality VR content for technical trainings and the high cost of developing simulations of construction processes were noted.

Bouygues Construction (2023), in turn, has developed its own methodology for assessing the adaptability of applicants through modelling complex production situations and then analysing their decisions. Analysis of the effectiveness of implemented technological innovations and modern methods of evaluating candidates indicates high efficiency in solving the personnel needs of the construction industry (Table 2). Each methodology is aimed at identifying specific characteristics of individuals and predicting professional success for specific positions and tasks.

**Table 2.** Innovative methods for evaluating candidates in the construction industry

Evaluation method	Estimated parameters	Technological solutions	Field of application	Efficiency
Digital simulations	Technical skills, decision-making, stress tolerance	VR/AR platforms, AI analytics	Engineering and technical personnel	High accuracy of technical assessment
Behavioural analysis	Leadership skills, communication, adaptability	ML algorithms, video analytics	Management positions	Forecasting leadership potential
Professional testing	Specialised knowledge, methodologies	Adaptive test systems	All categories of specialists	Objective assessment of qualifications
Soft skills rating	Teamwork, emotional intelligence	AI assistants, psychometrics	Project teams	Identifying team potential
Digital footprint analysis	Professional development, activity	Big data analytics	All position levels	Comprehensive assessment of experience

**Note:** the effectiveness of methods is determined by the ratio of predicted and actual success indicators of candidates

**Source:** created by the author

Cooperation programmes with educational institutions have become integrated personnel development systems. Leading construction companies have implemented integrated educational ecosystems that combine theoretical training with practical training on real construction sites. Due to the use of dual education and the creation of corporate universities, it was possible to train highly qualified specialists in accordance with current market

needs. Digital metrics have substantially transformed the approach to HR management, enabling the move from a reactive to a proactive approach. Integration of personnel development systems with recruitment processes has formed a single ecosystem of human capital management. This systematic approach has become the foundation for long-term HR strategies, which are reflected in educational and career programmes (Table 3).

**Table 3.** Talent development systems in construction companies

Direction of development	Educational programmes	Practical component	Terms of preparation	Career trajectories
Technical specialists	Specialised courses, certifications	Project work, technical internships	6-12 months	Leading specialist
Project managers	Management programmes, MBA	Small project management	12-24 months	Project manager
BIM specialists	Digital modelling, programming	Development of digital models	8-16 months	BIM Coordinator
Design engineers	Engineering programmes, calculations	Designing elements	12-18 months	Chief designer
HR specialists	HR analytics, psychology	Recruitment, personnel development	6-12 months	HR director

**Note:** development programmes are adapted to the specifics of projects and strategic goals of companies

**Source:** created by the author

Digital technologies have opened up new opportunities in the formation of the personnel reserve. Talent management systems have created dynamic databases that allow tracking the professional progress of employees and planning their career growth. Predictive analytics help to identify potential leaders in time and create individual development trajectories. The formation of the HR brand of construction companies has received a holistic structure through a harmonious combination of digital and traditional communication channels. Professional content, in particular, virtual tours of construction sites and educational webinars, effectively demonstrates to potential candidates the technological level of the company and the scale of projects.

The development of a corporate culture focused on innovation and professional growth becomes a substantial factor in the attractiveness of the employer. The introduction of flexible work formats has substantially expanded the possibilities for attracting highly qualified specialists. The use of digital platforms for coordination allowed creating distributed teams that can work on joint projects regardless of the geographical location of participants. This opens up access to a global talent pool, increases the competitiveness of companies in the labour market, and contributes to the formation of effective project teams. The development of young professionals has acquired progressive consistency due to the introduction of comprehensive

professional growth programmes. Well-defined career trajectories, reinforced by educational modules and practical tasks, ensure a stable replenishment of the industry with new talents. Mentoring and coaching programmes promote the effective transfer of knowledge and experience from senior professionals to younger generations. International experience confirms the effectiveness of integrating modern and traditional models of personnel search and development in the construction sector. An integrated approach that combines digital technologies, educational initiatives, and investments in the HR brand allows consistently attracting qualified specialists and building strong project teams.

#### **Development of professional competencies and talent management in construction**

The examination of professional competencies in the construction industry revealed substantial changes in structural approaches to the development of human capital due to the introduction of digital technologies and increasing the complexity of modern construction projects. The analysis of the practices of international construction companies displayed the transition from conservative training models to integrated development systems that harmoniously combine technical expertise with managerial competencies. The methodology for assessing professional skills has also undergone substantial modernisation due to the use of digital tools for analysing and monitoring the

professional growth of employees. The formation of cross-functional teams in the construction sector has caused the need to develop interdisciplinary competencies among personnel. The experience of leading corporations in the industry shows the introduction of comprehensive educational programmes that cover technical, managerial, and digital competencies.

The integration of project management concepts into the training system develops practical skills through real participation in construction projects. The transformation of the construction industry associated with the introduction of BIM technologies and automated process management systems has substantially affected the structure of professional competencies. The results of the analysis of market requirements showed an increase in the need for specialists with thorough knowledge of working in a digital environment. The emergence of new construction technologies has set the task of creating systems of continuous professional development that will support and update the professional knowledge of employees. An empirical test confirmed the effectiveness of updating the personnel development system in the construction sector. According to M. Kallianan *et al.* (2023), an inclusive approach to talent management contributed to a 25% increase in

curriculum effectiveness. Systematisation of best practices and the creation of digital archives of project documentation ensured the formation of a single information space that simplifies the exchange of experience between different divisions of companies.

Innovative approaches such as structured knowledge bases and virtual laboratories have transformed PORR's teaching methods. The use of digital construction operations simulators provided for the modelling of complex technical processes in a safe environment and the development of digital doubles of construction equipment opened up new opportunities for remote training of technical personnel. According to the data of L. Hasselsteen *et al.* (2024), such measures resulted in a 40% reduction in the time required to find technical solutions. The analysis of the international practice of developing professional competencies allowed identifying key areas of educational transformation in the construction industry. The integrated professional training system focuses on technical design, construction project management, innovative technologies, engineering systems, and quality assurance. Table 4 details the structuring of educational programmes, digital tools, and approaches to assessing skills depending on the career trajectory of staff.

**Table 4.** Comprehensive system of professional competence development in the construction industry

Direction of development	Educational programmes	Digital tools	Evaluation methods	Career development
Technical design	BIM certification, design calculations	VR modelling, digital doubles	Technical tests, project portfolios	Chief designer
Construction management	MBA in construction, PMP	Project management systems, AI planning	Project KPIs, team evaluation	Project manager
Engineering systems	Specialised courses, certifications	Simulators, IoT platforms	Practical tasks, system audit	Technical director
Innovative technologies	R&D programmes, scientific research	Prototyping laboratories, AI analytics	Innovative projects, patents	Director of innovation
Quality management	ISO certification, lean practices	Quality control systems, big data	Audits, quality metrics	Quality Director

**Note:** development programmes are adapted to the strategic goals of companies and the specifics of projects

**Source:** created by the author

The digital transformation of Skanska's (2023) educational programmes has covered various aspects of staff training, with an emphasis on integrating modern technologies into the educational process. The use of VR simulations

for modelling construction processes increased the efficiency of mastering practical skills by 40%, which provided a substantial improvement in the quality of professional training. The organisation of specialised development centres

has helped accelerate talent training by combining technical expertise with managerial competencies. In addition, the introduction of agile methodology in learning processes has ensured the adaptability of educational programmes to dynamic changes in the technological requirements of the industry. In turn, Balfour Beatty integrated the Oracle HCM Cloud Platform for HR management. Automation of performance evaluation processes has reduced the cost of managing HR procedures by 18%. The system standardised the process of setting goals and evaluating their achievement. During the implementation, the need for additional investments in training HR specialists and technical support of the platform was revealed.

Hochtief's management competence development programmes (2023) were implemented in accordance with the levels of project responsibility. The developed system included advanced training modules on resource management, contractor coordination and risk management, which allowed for more structured training of project managers. The integration of practical cases from real construction projects contributed to the acquisition by participants of the necessary practical skills for effective management of construction processes. In addition, the implemented mentoring system ensured a combination of the transfer of managerial experience with the applied use of acquired knowledge in solving specific project tasks. The Learning Management System has become a catalyst for changes in the organisation of training at Vinci Construction (2023). Due to the introduction of artificial intelligence, it became possible to form personalised development trajectories based on the results of evaluating participants and the specifics of specific project tasks. As part of this system, Bouygues Construction (2023) developed a mobile application for accessing short training modules lasting 5-15 minutes, which contributed to the integration of training into the daily professional activities of employees.

The development of digital educational platforms has laid the foundation for the systematic introduction of innovative teaching methods in the construction industry. The Strabag practice (2023) demonstrated the high efficiency of regular innovative hackathons, during which project teams found new technical solu-

tions to optimise construction processes. The implemented system of innovation grants stimulated the creation and testing of new working methods, promoting innovation in the company. Strabag also deployed the SuccessFactors Learning platform for enterprise training. The implementation of the system has increased the completion rate of compulsory training programmes from 65% to 89%. Automation of certification processes has reduced the time spent on personnel evaluation by 25%. The main difficulties included the need to adapt content for mobile devices and ensure stable access to the system on construction sites. The Balfour Beatty competence matrix (2023) has optimised the career planning process by establishing clear criteria for employee professional growth. A regular assessment of the achievement of goals and the development of key skills was conducted on a quarterly basis and was based on an analysis of achievements in the implementation of project tasks. The automated digital progress tracking system contributed to the effective monitoring of the professional development of specialists and provided recommendations for further training. International certification of construction industry workers has opened up new opportunities for professional growth by standardising competence requirements according to ISO 17024.

The global experience exchange programme initiated by Vinci Construction (2023) attracted more than two thousand specialists from different regions to rotate between international projects, which ensured the dissemination of best practices and experience in the industry. Training in international competence centres contributed to the development of innovative BIM technologies and methodologies for managing complex infrastructure projects. The competence assessment process at Strabag's Assessment-center (2023) has undergone substantial changes due to the integration of integrated development metrics.

The improved assessment system provides for a multidimensional analysis of technical skills in fifteen key parameters of construction activities, assessment of managerial abilities through the implementation of specialised project tasks and measurement of innovation potential based on practical cases. Regular moni-

toring of results has created an objective array of data necessary for the strategic planning of staff development programmes. Therewith, the use of a digital assessment platform helped automate the processes of collecting and analysing data on the professional development of specialists. The formation of cross-functional teams for professional development has become a tool that has substantially strengthened the interdisciplinary exchange of knowledge in various areas of construction.

Cooperation between designers, engineers, and technical specialists on the implementation of innovative solutions has ensured the synergy of professional competencies. The activities of such teams demonstrated an increase in the speed of integration of new technical solutions by 35%, which indicates a high efficiency of cross-functional interaction. Measures to develop digital competencies of employees, due to the active introduction of the latest construction technologies, have become a priority. Training programmes focused on mastering BIM systems, IoT platforms and automated construction management systems ensured the readiness of personnel for technological changes in the industry. Certification in the field of digital technologies was integrated into the mandatory component of the professional development of builders, which contributed to the formation of a highly competitive staff.

The growing impact of digital competencies has led to the introduction of new approaches to evaluating the effectiveness of training programmes. Continuous development monitoring systems have become a crucial tool in the evolution of evaluating such programmes. The use of digital platforms to track progress made it possible to collect data on the practical application of knowledge gained during training in specific project tasks. The methodology for calculating the ROI of training initiatives was based on an analysis of the impact of competence growth on productivity and project implementation quality. The digitalisation of learning effectiveness assessment has created an information framework for integrating predictive analytics into talent management systems. This has substantially optimised career planning, especially in the construction industry.

For example, Strabag (2023) introduced machine learning algorithms that analysed historical data on employees' professional development and created forecasts to determine the most effective career growth trajectories. Combining data from project management systems and competence assessment allowed creating mathematical models that identify potential leaders among project team specialists. The use of augmented reality technologies in the Bouygues Construction (2023) training programmes has substantially expanded the possibilities of transferring practical skills. Interactive AR-based instructions integrated into mobile devices offered step-by-step algorithms for performing construction tasks directly on objects. The library of standard technical solutions, implemented in the format of AR models, provided standardisation of training approaches for production personnel. The use of these technologies in the installation of engineering systems has reduced the number of errors by 45% and accelerated the equipment installation process by 30%. Bouygues Construction has also developed its own talent management system based on the Talentsoft platform. Implementation has reduced the search time for internal candidates for project teams from 15 to 5 days. The system has improved the transparency of career opportunities, which has had a positive impact on the retention of key specialists. Among the disadvantages, the difficulty of integrating with existing project management systems was identified.

Neural network technologies have revolutionised the field of competence assessment by automating the analysis of learning outcomes. The artificial intelligence algorithms developed by Balfour Beatty processed data on the implementation of practical tasks and formed personalised recommendations for improving development programmes. Predictive analytics integrated into talent management processes has provided the ability to accurately predict the need to develop specific skills per construction project implementation plans.

### **Innovative strategies for retaining key employees in the construction sector**

The examination of international construction companies demonstrates substantial changes in

approaches to personnel management, reflecting the integration of digital technologies and personalised development programmes. The practice of Vinci Construction has shown efforts to implement a multi-level motivation system that combines financial incentives related to the achievement of strategic project indicators and long-term professional development programmes. Motivation tools included basic wages, project completion bonuses, and long-term incentive programmes through stock options. The implementation of this strategy reduced staff turnover by 15% during the first year and contributed to the formation of stable project teams.

In the context of the digital transformation of management processes, Balfour Beatty has developed an integrated career planning platform that allows automating the processes of collecting data on employee competencies, creating individual training plans, and monitoring the achievement of professional goals. In turn, Bouygues Construction focused on analytical capabilities by implementing a comprehensive system for monitoring staff engagement. The use of algorithms for analysing activity in corporate systems, task performance, and quality of teamwork has reduced the number of unplanned layoffs by 18% due to the introduction of predictive analytics.

In terms of supporting employee well-being, Hochtief has implemented a comprehensive well-being programme that covers the areas of physical and psychological health. The programme included regular medical check-ups, access to sports facilities, psychological counselling, and stress management training. Further development of this area at Strabag was realised through the creation of a work-life balance system based on flexible work schedules and the ability to perform remotely. This approach has reduced the level of professional burnout by 18% and reduced the number of sick days by 22%.

The transformation of workspaces was particularly noticeable in Skanska's practice due to the introduction of the activity-based working concept. Recreation areas and meeting spaces were created on construction sites, and zoning was introduced in offices for individual work and team interaction. These measures contributed to a 16% increase in productivity and a 20% improvement in interagency communication, as quarterly surveys showed. A synthesis of the experience of implementing comprehensive personnel retention programmes in international construction companies during the study period is given in Table 5.

**Table 5.** Effectiveness of comprehensive personnel retention programmes in international construction companies (2020-2023)

Programme type	Key components	Performance metrics	High-quality results
Medical support and well-being	Corporate health insurance; psychological counselling; fitness programmes; stress management programmes	Reduction of sick days: 22%; reduction of professional burnout: 18%; increased satisfaction: 24%	Improving team spirit; increasing employee energy; increasing stress tolerance
Workspace transformation	Flexible work areas; ergonomic solutions; spaces for teamwork; recreation areas	Productivity growth: 16%; communication improvement: 20%; office space savings: 25%	Strengthening collaboration; Increasing creativity; Improving knowledge sharing
Digital engagement monitoring	Predictive analytics; Regular pulse surveys; Feedback system; AI analysis of behavioural patterns	NPS growth: +8 points; Retention increase: 12%; Unplanned layoffs decrease: 18%	Early detection of problems; Improved communication; Increased trust
Career development programmes	Individual development plans; mentoring system; cross-functional rotation; training programmes	Internal appointments: +25%; Turnover reduction: 15%; Upskilling: 35%	Formation of a personnel reserve; Development of leadership qualities; Growth of expertise

**Note:** NPS (Net Promoter Score) – Index of readiness to recommend a company as an employer; data are given on average for the companies under study

**Source:** created by the author

The development of professional competencies in the construction industry has become systematic due to the introduction of programmes for rotating specialists between projects of varying complexity, in particular, PORR. Focusing on digitalisation trends, the centres focus on investigating BIM technologies and automated control systems. Practical classes on virtual modelling of construction processes have substantially improved the quality of technical training of specialists. The integration of international standards has also made an important contribution to the development of professional competencies. Thereby, Ferroviál focused its efforts on implementing training programmes in sustainable (or “green”) construction and energy-efficient technologies, expanding the possibilities of implementing certified projects in the context of environmental responsibility. The company also introduced the graduated platform for personalised employee training. The system provided the formation of individual development trajectories based on the analysis of competencies. Implementation resulted in a 22% increase in staff engagement rates. The main challenges included the need to localise content and adapt training programmes for different regions of the company’s presence.

The introduction of analytical tools in HR processes has substantially transformed approaches to decision-making in the field of HR management. Analysing employee development data allowed companies to develop more accurate forecasts of training and professional development needs. The use of digital technologies for personnel evaluation has contributed to the timely identification of needs for professional growth, as well as optimisation of educational programmes. The practice of forming project teams through rotation between construction sites has shown a number of advantages in training multidisciplinary specialists. This approach allows not only to expand both technical and managerial competencies of employees but also to open up new career prospects.

Mentoring programmes have demonstrated high efficiency in preserving industrial knowledge and accelerating the professional development of young professionals. The introduction of international standards in the personnel

training system reorients the content of professional training in the construction industry. Training centres of construction companies focus on training specialists in accordance with the global requirements of project management. Environmental construction and energy efficiency programmes have created new opportunities for implementing projects that meet the goals of sustainable development, thereby strengthening the industry’s position in the context of environmental transformation.

### **Adaptation of international HR practices in Ukrainian construction companies**

Improving personnel motivation and development systems in Ukrainian construction companies requires profound changes focused on applying the successful experience of international corporations. Progressive mechanisms of surcharges for the duration of work were introduced to reduce the turnover of engineering and technical personnel, as well as bonuses depending on the results of construction projects completion. The retention of key specialists provided for the implementation of long-term professional development programmes, which included co-financing training in leading higher education institutions and payment for obtaining international certificates.

Strengthening the technical professionalism of employees was ensured by the creation of corporate educational centres on the basis of existing construction sites. Improving the quality of construction work was achieved through the introduction of internal technical standards and the introduction of regular personnel certification. A structured adaptation programme was developed to integrate young professionals into production processes, which provided for gradual involvement in project teams under the supervision of experienced engineers. Systematisation of technical knowledge took place through the creation of databases of standard solutions and documentation of effective construction practices. The development of managerial competencies of project managers was implemented through internships in various departments of the company with a gradual increase in the complexity of the objects they managed. The training of the personnel reserve was accompanied by

individual development plans and regular rotation between projects of various scales and complexity. In parallel to that, the digitalisation of construction processes took place with the involvement of BIM systems and training of personnel on the example of real projects of the company.

A comprehensive approach to staff supports included measures to prevent professional burnout, including additional rest after completing difficult stages of work. Psychological support programmes and training sessions on load management were introduced to increase the stress tolerance of employees. Medical care was expanded due to the improvement of insurance coverage and the organisation of regular preventive examinations, considering the specifics of work in the construction sector. Attracting young professionals to the industry was based on creating long-term partnerships with specialised educational institutions and a system of paid internships for final-year students. The growth of career attractiveness in the construction sector was ensured by transparent criteria for professional growth and an effective mentoring system. The exchange of international experience was organised through internship programmes of Ukrainian specialists in leading European companies with further integration of the experience gained into local projects. Using these recommendations, Ukrainian construction companies will be able to improve their own management practices based on the experience of global companies.

## DISCUSSION

The conducted research revealed patterns in the transformation of personnel management in the construction industry under the influence of innovative HR strategies. The experience of leading international construction companies shows the transition from a traditional approach to integrated digital solutions and automated personnel assessment systems. H. Nazarova *et al.* (2022) and G. Taher (2021) established that the implementation of Industry 4.0 technologies requires the acquisition of new professional competencies. According to the data, 74% of construction companies faced the problem of insufficient qualification of personnel during the implementation of innovations. The examples of Skanska and VINCI demonstrate the

effectiveness of investing in digital learning through the creation of corporate educational centres and distance learning systems. As a result, these companies achieved a 40% increase in productivity and a 25% reduction in project implementation time. K. Piwovar-Sulej (2021) reviewed the relationship between HR strategies and the competitiveness of construction organisations, confirming in the practices of leading companies. For example, Hochtief uses a staff assessment system based on 15 key parameters, supplemented by cross-functional training and individual career development programmes. This resulted in a 35% reduction in staff turnover and a noticeable improvement in the quality of project execution.

Papers of P.C. Bahuguna *et al.* (2023) and R. Paulet *et al.* (2021) indicated an increase in the importance of “green” HR practices. Construction companies have adapted these approaches through environmental training and motivation systems. Bouygues Construction successfully implemented the employee environmental certification programme and bonus systems for environmental impact reduction initiatives, which led to a threefold increase in submitted eco-initiatives and the involvement of 65% of employees in the programme. PORR has created specialised “green teams” that implement environmental innovations 40% more efficiently. Analysis of the use of artificial intelligence in HR processes presented by A.M. Votto *et al.* (2021), confirmed its value in the construction industry. For example, Vinci Construction automated the initial selection of candidates using AI systems, optimising recruitment time by 32%. Balfour Beatty uses analytical platforms to create reference profiles of employees for key specialisations.

Remote and hybrid control models described by N. Malyarchuk (2024) and G.V. Sereda & V.A. Nesteruk (2024), adapted to the specific features of project activities in construction. The transition of administrative staff to flexible working hours has reduced office maintenance costs without losing efficiency. Digital coordination platforms and hybrid work formats were introduced for project teams. Turner Construction has implemented a flexible schedule model, increasing staff satisfaction by 45%. The findings of O.A. Doronina &

D.S. Polgul (2021) draw attention to the transformation of HR processes, which is becoming relevant in the construction sector. This process was manifested in the integration of new approaches to the motivation and professional development of personnel. The analysis showed a change in the values of employees, who increasingly prefer opportunities for professional growth over the level of wages. An example is BAM Group, which introduced a 360-degree assessment system that provided comprehensive feedback and allowed effectively planning the individual development trajectory of employees.

Of special importance were the issues of labour safety, which became the object of a detailed examination by K. Wasilkiewicz Edwin *et al.* (2024) and L. Hasselsteen *et al.* (2024). In the construction industry, the introduction of VR technologies for safety training, as Bouygues Construction did, has reduced the number of errors by 45%. The combination of regular trainings, mentoring programmes, and digital instructions has reached more than 3,000 technical specialists, providing training for the use of new safe approaches in construction.

The results of a study on digital transformation of HR processes in the construction industry revealed a correlation with the results published by F.L. Cooke *et al.* (2020) and L.B.P. da Silva *et al.* (2022). The mentioned authors, after analysing 93 scientific articles, identified 13 key areas of transformation of human resource management in the context of the Fourth Industrial Revolution (Industry 4.0). The approaches to implementing digital platforms for personnel training and development in construction companies identified in this study confirm the importance of these areas but demonstrate the specific features of their application in the construction sector. In particular, enterprises in this industry face the need for a longer period of adaptation of digital tools, which is due to the technical features of production processes.

Equally important was the study by C. Tanova & S.W. Bayighomog (2022), which found a correlation between “green” HR practices and organisational performance. The environmental transformation of the construction industry has been reflected in the introduction of energy-efficient construction training programmes,

as Ferrovia did, reaching 65% of employees. Digitalisation has become a strategic tool for improving productivity, which has been analysed in detail by B. Nikmehr *et al.* (2021). The introduction of BIM technologies and IoT systems in construction organisations such as Skanska has reduced the duration of project implementation by 25%. This confirms the value of an integrated approach to digital transformation. Issues of implementing HR practices starting from the planning stage were analysed by J. Trullen *et al.* (2020). The researchers focused on the importance of interaction between HR departments and line managers for successful innovation adoption. The experience of involving employees in implementing changes in construction projects has shown an increase in productivity by a third.

A paper of V. Pereira *et al.* (2023), which covered more than 13 thousand publications, highlighted the use of artificial intelligence in HR management. Construction companies actively use predictive analytics to forecast personnel needs. Digital training platforms have implemented individualised approaches to developing competencies, and AI systems for recruiting have reduced the recruitment time by half. Similarly, the study conducted by S.A. Alerasoul *et al.* (2022), devoted to organisational learning and knowledge management, identified analogous trends in systematising and documenting best practices. However, in contrast to the generalised conclusions of the authors, the results of this study indicate that in the construction industry, structuring the accumulated experience requires the creation of specialised industry classifiers and evaluation methods. In addition, the empirical experience of Royal BAM Group in using knowledge-sharing platforms aimed at accelerating the integration of new employees confirms the relevance of the results obtained. This experience highlights the need for substantial localisation of such platforms following the characteristics of regional construction markets.

A survey of 505 builders conducted by X. Meng & A.H.S. Chan (2024), underlined the importance of safety culture in shaping employee behaviour. In the practical activities of construction companies, this was implemented through trainings and safety monitoring systems. The

development of mentoring programmes at Balfour Beatty has helped raise awareness of the importance of complying with safety standards. Social interaction between employees was identified to be a key factor in shaping the safety culture. The analysis indicated the substantial importance of innovative HR strategies for the development of the construction industry. The results demonstrate a close relationship between technological innovations, professional growth of employees, and the overall efficiency of construction organisations, which creates the basis for further improvement of human resource management practices.

## CONCLUSIONS

The examination of the transformation of HR processes in the construction industry for the period 2020-2023 revealed substantial changes in personnel management systems due to the integration of digital technologies. The results of the introduction of artificial intelligence in recruitment processes showed a reduction in recruitment time by 32% and an improvement in the quality of candidate selection by 45%. Automation of primary screening contributed to a threefold increase in the number of high-quality processed resumes with the same composition of the HR team. The analysis of measures for the development of professional competencies established the effectiveness of using VR simulations and digital doubles in training programmes for personnel. The use of virtual simulators for technical operations reduced the number of production errors by 45% and reduced the training period by 30%. In addition, cross-functional personnel development programmes accelerated the implementation of new technical solutions by 35%. The introduction of cross-functional teams also ensured the accelerated adoption of innovative technologies.

The study on motivation systems has shown the effectiveness of a multi-level approach to employee incentives. Integration of project bonuses and long-term incentive programmes, in particular, through options, reduced staff turnover by 15%. The transformation of the workspace founded on the activity-based working principle helped to reduce the level of professional burnout by 18% and increase labour

productivity by 16%. The development of well-being programmes, which included regular medical examinations and psychological consultations, reduced the number of sick days by 22%. The results obtained allowed creating a methodological basis for implementing innovative HR strategies in the construction industry. The developed recommendations include a plan for step-by-step digital transformation of HR processes for construction companies. In particular, these include the introduction of artificial intelligence systems for automating recruitment, the formation of digital training platforms, and the development of predictive HR management. Integrated Personnel Development programmes were based on the integration of VR technologies and approaches to cross-functional training. The use of digital competence monitoring tools allowed creating an objective database for personnel development planning.

Competence assessment systems covered the analysis of technical skills in 15 key parameters of construction processes and the assessment of managerial abilities through the implementation of project tasks. The introduction of regular competence monitoring contributed to the creation of a database for targeted curriculum planning. In addition, the organisation of the international exchange of experience between construction projects strengthened knowledge exchange and accelerated the introduction of innovative approaches in construction. Therewith, the focus of the study mainly on the practices of large international construction companies narrowed the opportunity to highlight the specifics of small and medium-sized businesses in the industry. Further research requires attention to the implementation of HR strategies in medium and small construction enterprises, considering organisational and financial characteristics.

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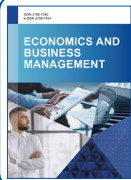
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## Інноваційні стратегії розвитку управління персоналом на прикладі будівельної сфери

**Анотація.** Зростання складності будівельних проектів у поєднанні з цифровою трансформацією галузі зумовлює необхідність модернізації систем управління персоналом, що є ключовим фактором забезпечення конкурентоспроможності будівельних підприємств. Метою дослідження була розробка комплексної цифрової системи управління людськими ресурсами (HR), покликаної підвищити ефективність HR-процесів в умовах динамічних технологічних змін. Методологічне підґрунтя роботи базувалося на аналізі корпоративної документації 8 міжнародних будівельних компаній за період 2020-2023 рр., яка послужила основою для оцінки та впровадження інноваційних HR-стратегій. Серед найважливіших досягнень – інтеграція штучного інтелекту в процеси рекрутингу, що дозволило скоротити час набору персоналу на 32 % та суттєво покращити якість відбору кандидатів (зростання на 45 %). Використання симуляцій віртуальної реальності (VR) у навчальних програмах знизило рівень помилок при виконанні складних виробничих операцій на 45 %. Крім того, розроблена система моніторингу компетенцій, заснована на 15 параметрах будівельних процесів, сприяє формуванню референтних профілів фахівців. Трансформація робочого простору на основі діяльнісного принципу роботи позитивно вплинула на рівень професійного вигорання, знизивши цей показник на 18% і підвищивши продуктивність праці на 16 %. Впроваджені програми підтримки благополуччя зафіксували скорочення кількості лікарняних на 22 %, а розвиток крос-функціональних команд прискорив впровадження інновацій на 35 %. Сукупність цих результатів створює практичне підґрунтя для модернізації HR-процесів у будівельній галузі. Матеріали дослідження можуть бути використані для розробки програм професійного розвитку, адаптації інноваційних методів управління персоналом та формування стратегій цифрової трансформації в контексті специфіки будівельної галузі

**Ключові слова:** цифрова трансформація; професійні компетенції; крос-функціональні команди; предиктивна аналітика; well-being програми



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## Financial security system of agricultural enterprises in Ukraine: Role of banking and insurance services in minimising financial risks

**Abstract.** The study aimed to assess the impact of banking and insurance services on the financial security of agricultural enterprises in Ukraine. During the research, the methods of comparative analysis and SWOT analysis were used. The mechanisms of financing the agricultural sector, including credit programmes and insurance services, were analysed. The study determined that PrivatBank's loan programme "Agraseason" allowed farmers to receive from 200 thousand to 5 million UAH at 5% per annum, while Oschadbank provided loans to small and medium-sized enterprises in the amount of up to 12.5 million UAH secured by a guarantee from the Partial Loan Guarantee Fund. The government programme "Affordable Loans 5-7-9%" helped finance the agricultural sector by more than 50 billion UAH, which significantly reduced the financial risks of enterprises. The survey results showed that bank loans are a key source of financing for agricultural enterprises, but the high cost of credit and difficulty in accessing it for small farms remained major problems. Insurance services provided additional protection against risks, including weather-related disasters, but the low level of agricultural insurance development and limited government support reduced the effectiveness of this mechanism. The study determined that insurance subsidies contributed to the financial security of enterprises, but the coverage of the programme remained insufficient. The study analysed the international experience of the financial security of farmers, in particular that of Canada, and developed recommendations for Ukraine to improve insurance, income compensation, financing and cybersecurity programmes to enhance the stability of the agricultural sector. The findings confirmed the need to expand access to financial resources for the agricultural sector by improving lending mechanisms, stimulating

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the development of agricultural insurance, and increasing government support. Optimisation of these instruments will help to reduce the financial risks of enterprises and ensure their resilience in the face of economic instability

**Keywords:** agriculture; credit programmes; management; solvency; economic crises

## INTRODUCTION

The research relevance is determined by the importance of the agricultural sector for the economic stability of the country. In the context of economic and political instability, as well as constant changes in the market, agricultural enterprises face numerous financial risks that may threaten their sustainability and development. The low level of financial security of these enterprises negatively affects their ability to adapt to changing environmental conditions, which increases the importance of developing effective protection mechanisms. Banking and insurance services are among the main tools for minimising financial risks, providing farmers with access to finance to invest in development, as well as mechanisms to protect them from unforeseen financial losses.

The complexity of risk management in the agricultural sector is determined by increased vulnerability to numerous uncertainties. L. Kostyrko *et al.* (2024) investigated financial strategies and risk analysis methodologies to overcome these uncertainties. The authors determined that the financial strategy of agricultural enterprises should include risk assessment tools to ensure long-term stability in the face of unpredictable market changes. Their study highlights the importance of a comprehensive approach to risk analysis that considers both internal and external factors that affect the sustainable development of agricultural enterprises. However, their study does not fully address the impact of external factors, such as natural disasters or global market changes, on financial strategies in an uncertain environment.

The crisis in the financial and economic stability of agricultural enterprises is caused by economic instability and reduced state support. Y. Kucherenko (2018) studied financial security, emphasising the importance of financial stability for sustainable development and the role of financial transactions and insurance as risk protection instruments. However, there are gaps in

the study of the integration of new financial instruments with management systems to minimise risks, particularly those associated with climate change and agricultural price fluctuations.

Strengthening the economic security of agricultural enterprises has been an important task due to the global economic crisis and increased risks. S. Vasylyshyn *et al.* (2021) analysed analytical support for economic security management, emphasising the importance of an integrated approach to assessment, accounting for financial, social, resource and environmental aspects. The study showed the need to improve assessment methods through integrated approaches for effective management decisions. However, gaps remained in terms of adapting methods for small and medium-sized enterprises and determining the impact of social and environmental factors on economic security in an uncertain environment.

The financial and economic security of agricultural enterprises is critical for their development in the face of economic change. N. Sirenko *et al.* (2021) investigated the level of financial and economic security of the agricultural sector, identifying key elements such as financial resources, stability, and profitability. The authors emphasise the importance of assessment through key indicators. However, there are gaps in the study of the impact of external economic factors, such as the exchange rate and external debt, which need to be further explored to increase the resilience of enterprises.

In the context of constant changes in the market, the financial security of agricultural enterprises requires special attention. O. Kovalenko & L. Yashchenko (2021) studied the diagnostics of financial security of agricultural enterprises proposing a methodological approach to assessing the state of financial security by analysing the dynamics, structure and financial ratios. The authors identified the main factors affecting financial security, such as solvency and financial

stability, and proposed a system of indicators for assessing financial security. However, there are gaps in the study due to insufficient study of the impact of state support on the financial security of SMEs. These aspects require further research to develop more effective mechanisms to support domestic agricultural enterprises.

In the study of the financial security of agricultural enterprises, the question of how changes in environmental conditions can affect their financial stability is important. J. Berežnicka (2020) studied the financial security of medium-sized agricultural enterprises, focusing on the importance of subsidies and their impact on financial sustainability. The author noted that farmers in the Czech Republic and Poland will be most affected by additional environmental requirements, as subsidies are an important source of income for them. However, the gaps in the study relate to the insufficient study of the impact of changes in EU policy on environmental requirements on financial security in agricultural countries with different levels of agricultural development.

Increasing the economic stability of personal finances through agricultural initiatives is becoming an important aspect of the current economic environment. S.P.B.B. Hasib (2024) explored the potential of agricultural initiatives to improve financial security, including through growing domestic food, organic farming, and other agricultural practices. The author determined that such practices can significantly reduce food costs, generate additional income, and improve overall financial stability. However, gaps in the research include insufficient attention to the different social and economic contexts in which these practices can be implemented, as well as the investment attractiveness of such initiatives for the general population.

The study of the financial and security model of management accounting of agricultural enterprises focuses on the use of digital technologies to ensure financial stability. A. Livinskyi *et al.* (2024) showed the importance of integrating innovative solutions into management processes for transparency and risk minimisation, in the context of digital transformation. The study confirmed the need for enterprises to adapt through automated management systems. However, the

gaps relate to the insufficient study of the impact of specific technologies on the management accounting of small and medium-sized agricultural enterprises.

The study aimed to examine the role of banking institutions and insurance companies in supporting agricultural enterprises to ensure their financial security. The study objectives were to assess the effectiveness of financial services provided by banking institutions and insurance companies to agricultural enterprises in the context of minimising financial risks; to analyse the possibilities of integrating insurance and credit products into the financial security strategy of agricultural enterprises to reduce their vulnerability to external economic changes.

## MATERIALS AND METHODS

The presented study is applied research, as it addresses the practical application of financial instruments to reduce the financial risks of agricultural enterprises in Ukraine. The research was based on data from banking institutions such as PrivatBank and Oschadbank, which offer specialised financial products for farmers (PrivatBank offers farmers..., 2018; Guarantee of the Partial..., n.d.). In addition, the Report on the implementation of the development plan of the Ministry of Agrarian Policy and Food of Ukraine for 2024 (2025), the 2023 annual report (National Bank of Ukraine, 2024), as well as scientific literature on the development of financial security of the agricultural sector, were analysed (Shah *et al.*, 2021; Sun *et al.*, 2021; Draft Law No. 12372, 2024).

The research methodology included a systematic analysis to identify the key elements of the financial security of agricultural enterprises and their interaction. A comparative analysis was used to assess the effectiveness of various financial programmes, such as bank loans, insurance policies, government subsidies and other instruments. Particular attention is paid to the mechanisms of state incentives, in particular, the "Affordable Loans 5-7-9%" programme, the "Agraseason" loan (n.d.), the Guarantee of the Partial Guarantee Fund for agricultural and industrial complex loans (n.d.), state agricultural insurance programmes and the

system of subsidies for agricultural insurance following the Law of Ukraine No. 4391-VI "On Specifics of State-Supported Insurance of Agricultural Products" (2012) (Privatbank, n.d.; Smakota, 2023). The level of accessibility of these financial instruments for different categories of agricultural enterprises, especially for small and medium-sized farms with limited financial resources, was evaluated.

Support programmes for war-affected farmers were reviewed to assess their impact on the resumption of agricultural activities and the financial sustainability of agricultural enterprises. These include the Compensation Programme for cultivated land, the Land Demining Programme, and the Compensation Programme for the cost of agricultural machinery (Nemtseva, 2024; Involving partners in..., 2024; Receive compensation for..., n.d.).

The activities of the First Ukrainian Agrarian Fund and farm real estate funds (Real Estate Investment Trust (REIT)), which allow investors to invest in agricultural real estate, including land leased to farmers, were analysed separately (Increase your wealth..., n.d.; Buyanov, 2021). The study examined how these financial mechanisms can contribute to improving the financial security of the agricultural sector by providing long-term investments. The study assessed the prospects for the development of such funds in Ukraine, their attractiveness to domestic and foreign investors, and the level of regulatory support from the state.

For a more in-depth analysis of the conditions for implementing these programmes and their accessibility to farmers, a strengths, weaknesses, opportunities, and threats (SWOT) analysis was applied to identify the strengths and weaknesses of existing financial mechanisms, as well as opportunities for their further development. An important part of the study was to examine the impact of financial instruments on the sustainability of agricultural enterprises in the face of economic instability and their ability to adapt to changes in climate conditions, variations in agricultural prices and political factors.

The study examined the financial security system of farmers in Canada, which includes various tools for managing financial risks, including the AgriStability (2024), AgriInsurance

Program (2024), AgriInvest..., (2024), Advance Payments Programme (2024), Canadian Agricultural Loans Act Program (2022) and specialised cybersecurity measures. In addition, recommendations were developed for the implementation of similar measures in Ukrainian financial security.

The research methods used in the study provided a comprehensive analysis of financial support programmes for the agricultural sector, which formulated recommendations for their improvement and increase of efficiency in the context of minimising financial risks of agricultural enterprises.

## RESULTS AND DISCUSSION

### **Role of banking institutions in creating a system of financial security for agricultural enterprises**

Agricultural enterprises, similar to any other business, face numerous financial risks, including the risk of insolvency due to the seasonality of agricultural production, when enterprises have limited revenues throughout the year but high expenses at the beginning of the season, the risk of changes in raw material and product prices due to market volatility, and risks related to climatic conditions, such as droughts or floods, which may reduce harvests, credit risk due to high dependence on borrowings to finance agricultural cycles, risk of ineffective management due to poor management skills or improper resource planning, and political and economic risks, including changes in government policies, currency fluctuations and changes in tax legislation, which may adversely affect the financial stability of the business and its ability to sustainably develop. Given that agriculture is related to natural, economic and social factors, the identification and management of financial risks is important for agricultural enterprises, as even minor changes can significantly affect their financial position. Agricultural risks have many aspects that require consideration from managers of enterprises banking institutions and insurance companies.

Dependence on natural and climatic conditions is one of the main risks for agricultural enterprises. Natural disasters, such as climate change, droughts, excessive rainfall, frosts,

floods and others, can significantly reduce yields and cause significant financial losses. In addition, changes in the weather can lead to unforeseen costs for irrigation, additional plant shelter or the purchase of protective materials. Agriculture is dependent on natural factors and requires constant assessment and management of these risks to reduce the probability of significant financial losses (Shah *et al.*, 2021).

Changes in supply and demand, changes in global markets and dependence on external economic and political circumstances often lead to significant fluctuations in agricultural commodity prices. Economic crises, political instability, changes in trade with other countries and changes in foreign exchange rates may affect agricultural commodity prices. If the harvest is sold at a significantly lower price than expected, such fluctuations can significantly reduce a company's revenues. On the other hand, agricultural businesses also face the risk of excessive price increases for inputs required for production, such as seeds, fertilisers, fuel and crop protection products. Dependence on suppliers of these goods and services can lead to significant financial problems, especially in times of market volatility (Sun *et al.*, 2021).

Agricultural enterprises often need credit resources to finance seasonal expenses, purchase machinery, lease land, purchase materials for production, etc. However, lending is one of the main risks for a company, especially if interest rates are high and maturities are short. Late repayment of debts due to rising costs or lower revenue from sales can lead to financial instability and even bankruptcy. Small and medium-sized agricultural enterprises face the greatest risk, as they may not have sufficient financial reserves to repay loans in the event of adverse market conditions. Consequently, the company may go bankrupt due to a lack of financial stability (Dadashev & Cheremisina, 2012).

Operational risks arise from mismanagement of internal processes, inefficient use of resources or poor production organisation. In agriculture, low labour productivity, high fuel and energy costs and a lack of proper quality control are some of these risks. In addition, production efficiency may decline due to a lack of funding to support new technologies or

equipment. Management is exposed to risks associated with low skills, lack of adequate business development plans and poor strategic management, which may result in misallocation of resources or poor decisions regarding the development of the company.

Political risks in the agricultural sector are significant due to the impact of government decisions, such as changes in tax policy, subsidies, export quotas, and environmental regulations. Increased production costs or even restrictions on export opportunities may result from changes in legislation. Inflation, exchange rate fluctuations, and changes in foreign trade are other factors that can cause economic risks that particularly affect companies that export agricultural products (Komarek *et al.*, 2020).

PrivatBank's "Agraseason" loan (n.d.) allows farmers to pay for expenses related to the agricultural cycle. The guarantee partially reduces the need to provide additional assets as collateral for the loan. PrivatBank requires a 50% guarantee and 50% hard asset coverage with a coverage ratio of 1.5 for loans up to 18 months. The collateral can be even higher for loans up to 36 months, as hard collateral with a coverage ratio of 1.5 is required, as well as a suretyship from the owner. This programme is particularly useful for farmers, as it allows them to obtain financing to cover the costs of purchasing seeds, fertilisers, fuel and lubricants, labour and other expenses. This type of loan is granted for a term of up to one year, with the possibility of extension.

Oschadbank, for its part, offers loans secured by a guarantee from the Partial Guarantee Fund for Agricultural Loans. These loans can be granted with maturities of up to 10 years and in amounts ranging from 100 thousand to 12.5 million UAH. The Fund's guarantees help reduce the risks for banks when granting loans and facilitate access to finance for small and medium-sized agricultural enterprises with limited creditworthiness (Guarantee of the Partial..., n.d.).

Loans to farmers can vary in terms of conditions, depending on the term, interest rate and the need to provide collateral. An important factor is also the availability of government support programmes for farmers, such as the "Affordable Loans 5-7-9%" programme, which provides for a subsidy of a portion of the interest on loans. This

allows farmers to reduce their financial burden and secure financing on favourable terms

(PrivatBank, n.d.). Table 1 compares the lending conditions of Privatbank and Oschadbank.

**Table 1.** Comparison of lending conditions for farmers in PrivatBank and Oschadbank

Bank	Lending programme	Amount (UAH)	Term (years)	Interest rate (%)	Provision
Privatbank	“Agraseason”	from 200 thousand	Up to 18 months	50% guarantee + 50% security deposit (coefficient. 1.5)	50% guarantee + 50% hard deposit
Oschadbank	Loan guaranteed by the Fund	100 thousand – 12.5 million	Up to 10 years	50% of the principal amount of loan commitments	Guarantee of the Partial Loan Guarantee Fund

**Source:** compiled by the authors based on “Agraseason” loan (n.d.), Guarantee of the Partial Guarantee Fund for agricultural and industrial complex loans (n.d.)

Loans for farmers from PrivatBank and Oschadbank have different terms and conditions, depending on the needs of the borrowers. PrivatBank is suitable for short-term financing but has high collateral requirements. Oschadbank, on the other hand, offers more flexible terms, including long-term loans backed by a government guarantee, making them more affordable for small and medium-sized enterprises. For farmers seeking stable financing over a longer period with lower collateral requirements, Oschadbank is a more favourable option.

Agricultural enterprises can obtain the equipment they need without significant upfront investment through leasing, another important financing tool. This is especially relevant when prices for new agricultural technologies and other fixed asset investments are high. Through leasing, farmers can rent machinery for a fixed period with the option to buy it at the end of the lease or extend the lease. Since the initial cost of the equipment is spread over several years, these conditions allow the company to reduce its financial burden.

For instance, PrivatBank provides farmers with the opportunity to lease agricultural machinery such as tractors and combines, as well as tillage equipment. Leasing allows farmers to purchase machinery without significant upfront investment, which reduces the financial risks associated with investing in new equipment. It also allows companies to upgrade their machinery fleet without having to

spend significant money upfront (PrivatBank offers farmers..., 2018).

Oshchadbank also offers leasing of agricultural machinery with favourable terms that allow farmers to lease machinery for up to 5 years with the option to buy it back after the leasing period. Leasing of machinery is an important tool for farmers, as it provides access to modern equipment without the need for significant financial outlays (Purchase of new..., n.d.).

Bank guarantees are another important financing instrument that helps to reduce financial risks for agricultural enterprises. A bank guarantee is an obligation of a bank to pay a certain amount in case of a farmer’s failure to fulfil its obligations to counterparties or creditors. This reduces the risk for the bank and increases confidence in the company on the part of other market participants.

Bank guarantees are usually provided through government support programmes, such as the partial guarantee programme for agricultural loans. In the case of loans under the state programme or through special partial guarantee funds, banks can provide guarantees to farmers. This reduces the risk for banks and facilitates access to finance for small and medium-sized enterprises in the agricultural sector. Even if farmers do not have a good credit rating, they can still get loans through partial guarantee programmes. For instance, Oschadbank provides loans under government programmes with a partial guarantee of the fund, which

reduces the bank's risks and allows farmers to obtain the necessary funds on more favourable terms. Such programmes greatly facilitate access to finance for agricultural enterprises, reducing risks and increasing productivity (Lending with the use of..., n.d.).

Thus, bank financing instruments are an important tool for farmers seeking to ensure financial stability and growth of their enterprises. They can be used for efficient management of resources, mitigation of financial risks and adaptation to market changes. The development of Ukrainian agriculture is largely dependent on government programmes to support farmers through banking institutions. These programmes increase the financial accessibility of agricultural enterprises, especially small and medium-sized ones, by enabling them to obtain the necessary financial resources to modernise production, cover seasonal costs, purchase machinery and make other investments. Such programmes include compensation for the cost of machinery, grants, concessional lending and subsidies. They increase the competitiveness of farmers and allow them to reduce financial risks.

Concessional lending is one of the most important forms of state support for farmers. Programmes such as "Affordable Loans 5-7-9%" provide farmers with financing at reduced interest rates. Participation in these programmes allows farmers to significantly reduce their loan servicing costs. This is especially relevant for small and medium-sized enterprises, which often face difficulties in accessing cheap credit. Farmers can obtain financing for needs related to agricultural production, such as the purchase of agricultural machinery, construction and modernisation of infrastructure, labour costs and other operating expenses. These programmes help farmers cover these needs. The programme "Affordable Loans 5-7-9%" allows for a significant reduction in the interest rate on loans, which gives farmers access to cheap resources and enables them to develop their businesses steadily even during the crisis (PrivatBank, n.d.).

State support also includes subsidies and grants, which are important for stimulating agricultural development and stabilising farmers' incomes. For farms to be financially stable, money for keeping livestock and cultivating land

is needed. For example, tillage subsidies of up to 4,000 UAH per hectare allow farmers to offset the cost of renting land or cultivating land, which increases profitability and reduces costs. Such actions are particularly important in times of economic challenges or unpredictable events, such as droughts and other natural disasters, which can significantly reduce yields. They provide farmers with additional financial resources, which allows them to withstand seasonal fluctuations in income and maintain stability in their farming operations (Department of Agro-Industrial Development, 2024).

Modernisation of production is an important part of agricultural development, and the government actively promotes this process by compensating part of the cost of machinery. The Ministry of Economy of Ukraine offers compensation of up to 25% of the cost of domestic agricultural machinery for modernisation. This enables farmers to purchase the latest equipment without significant upfront costs, which increases productivity and efficiency. Farmers can reduce the cost of purchasing machinery and use it to increase yields, reduce the cost of cultivating land and perform other technological operations through such programmes. Government compensation allows farmers to modernise their farms, which is an important component for increasing competitiveness in domestic and foreign markets (State support programs..., 2024).

Grant funding is one of the new ways to assist farmers. Programmes such as "eRobota" (eJob, digital job) provide grants for the development of horticulture, berry and wine growing, as well as for the establishment of greenhouses and processing plants. The grants are provided without the need for repayment, making it much easier for farmers to obtain funding for new projects. The development of new areas of agricultural business, such as organic horticulture and processing, is also supported by grant programmes. By doing so, farmers can increase production and add value to their products, which is important for increasing incomes and developing the local economy (Maltseva, 2024). Table 2 compares the main forms of state support for farmers provided through banking institutions, including concessional lending, subsidies and grant funding.

**Table 2.** Comparison of the main forms of state support for farmers

Program	Objective/Purpose	Amount of funding	Terms and Conditions
"Affordable loans 5-7-9%"	Providing access to cheap loans for farmers	From 200 thousand to 12.5 million UAH	Rate: 5%, 7%, 9% depending on the type of activity
Subsidies for livestock-keeping	Support for farmers to keep livestock and cover land cultivation costs	Up to 4 thousand UAH per hectare	Restrictions on land areas and crop types
Compensation for the cost of equipment	Promoting the renewal of farmers' machinery through compensation for the cost of equipment	Up to 25% of the equipment cost	The equipment must be of domestic production
Grant funding	Support for the development of horticulture, berry growing, viticulture and processing enterprises	Different amounts depending on the programme	Requirements for the type of activity (horticulture, greenhouse farming)

**Source:** compiled by the authors based on Privatbank – Participants in the program "Affordable loans 5-7-9%" (n.d.), Department of Agro-Industrial Development (2024), State support programs for farmers in effect in 2024 (2024), M. Maltseva (2024)

Thus, state support programmes for farmers are important for the development of Ukrainian agriculture. They provide financial resources to cover costs, modernise machinery and ensure stable incomes for farmers. At the same time, there is a need to improve the procedures for providing support to ensure that it is more accessible to all farmers in the country (Wahab *et al.*, 2023).

The current study and the one by H.E. Bilali & T.B. Hassen (2024) both address the financial security of agricultural enterprises and the role of risk mitigation instruments. Both studies emphasise the importance of financial support through banking institutions and insurance companies to help farmers protect themselves from financial losses due to climate change or price fluctuations. This study focuses on specific financial instruments, such as soft loans, subsidies and grants, that allow farmers to reduce financial risks and increase competitiveness. H.E. Bilali & T.B. Hassen addressed the impact of climate change on the financial operations of agricultural enterprises and the need to adapt to natural disasters. Both studies emphasise the importance of developing new financial instruments to support farmers in minimising risks.

The current study and D. Li *et al.* (2024) examined the importance of financial support to farmers to stimulate innovation and development of the sector, through concessional lending and state aid. The study by D. Li *et al.* addressed the use of digital financial instruments

to support farmers, especially through mobile platforms and online banking, which is more relevant for China, where digital financial services are actively developing. Instead, this study focuses on state support programmes in Ukraine, such as soft loans, subsidies and grants, which are the main instruments of agricultural financing in the country. Furthermore, the study by D. Li *et al.* covers microeconomic data of agricultural enterprises in China, while this study focuses on macroeconomic aspects of support to farmers through state institutions in Ukraine.

This study emphasises the impact of state support to farmers through banking instruments on the financial stability of agriculture. The study by E. Mudanya *et al.* (2022), on the other hand, addresses credit risk and its impact on the financial performance of commercial banks in Kenya, specifically through credit risk management practices. This study assesses how credit risk affects the financial performance of banks and how effective management of these risks improves the stability of the banking system. Both studies examine financial risks in the context of specific economic and financial systems, but in one case the focus is on banking instruments to support farmers, and in the other on credit risk management of commercial banks. Therefore, while both studies address financial risks and their impact on the stability of economic systems, one focuses on the agricultural sector and the other on the banking sector.

### **Impact of insurance services on reducing financial risks of agricultural enterprises**

Insurance for farmers in Ukraine is necessary for protecting agricultural enterprises from financial risks associated with adverse weather conditions, natural disasters, plant diseases, and military operations. Ukraine has already developed and introduced various types of insurance products that allow farmers to reduce financial losses in the event of an insured event and receive financial support from the state.

Crop insurance is an important product because it allows farmers to cover losses associated with the total or partial loss of crops due to natural disasters or human actions. For instance, winter crop insurance can cover the entire growing cycle, from germination to harvesting the following year. This may include the wintering period. In addition to traditional crop insurance, farmers can choose to buy insurance based on a yield index, which is based on the average yield of the region over the past few years. Farmers are compensated for losses if the actual yield is below the average (Smakota, 2023).

The government actively supports farmers through subsidies for agricultural insurance. According to the Law of Ukraine No. 4391-VI (2012), farmers are entitled to partial reimbursement of insurance payments. In 2021, a new support system was introduced, which allows farmers to receive compensation of up to 60% of the insurance premium. In case of additional needs for state funding, the reimbursement can reach 80% in the following years (Farmers will receive..., 2020).

Farmers' property insurance is another important method of reducing financial risk. It covers the protection of agricultural enterprises not only against natural disasters, such as fires or floods but also against third-party damage to greenhouses, elevators and storage facilities. Farmers can choose to insure machinery, such as tractors, combines, etc., to protect their property. Business interruption insurance is particularly noteworthy, as it covers not only direct losses from property damage, but also potential losses associated with the cessation of the company's operations (Agricultural Insurance..., 2016).

Farm animal insurance is another important product. It can include insurance for birds, horses, pigs, cattle and other animals, as well as

an additional option for protection against infectious diseases. Globally, more than 30 types of dangerous animal diseases have been identified in 102 countries. Most of these diseases have a high mortality rate. Agricultural enterprises that raise animals must be protected against such diseases (Agricultural Insurance..., 2016).

Current offers on the agricultural insurance market also include freight insurance, which is important for companies involved in the export of agricultural products. Such a policy covers not only the value of the cargo but also the cost of transportation, which is especially important when the local currency is unstable. When concluding such contracts, it is possible to incorporate currency risks, which can be critical for farmers engaged in international deliveries. War risk insurance, which has become relevant due to the military conflict in Ukraine, requires special attention. This insurance covers the costs of sowing and growing crops that have been destroyed or damaged as a result of hostilities, the construction of defensive structures or even mine clearance. This allows farmers to remain financially stable despite the negative effects of war. Companies that commercially grow winter crops and insure more than 1,500 hectares can use the war risk insurance offer (Attention Farmers, 2023).

The programmes to support farmers affected by the war include several important initiatives aimed at restoring agricultural activities. The compensation programme for cultivated land provides compensation to farmers from areas where hostilities have ended (e.g., Kyiv region) or where de-occupation has taken place in the amount of 8,000 UAH per 1 ha of cultivated land for owners of up to 120 ha (Nemtseva, 2024). This programme is funded by the state budget of Ukraine. The land demining programme provides compensation for demining services to farmers, enabling them to resume economic activity in the blocked areas (Involving partners in..., 2024). The state budget of Ukraine for 2025 provides 1 billion UAH for this programme. The programme of compensation for agricultural machinery offers compensation in the amount of 25% of the cost of domestically produced agricultural machinery, which farmers can receive through banks that have signed a memorandum

with the Ministry of Economy of Ukraine (Receive compensation for..., n.d.).

Most Ukrainian farmers do not use crop and harvest insurance during their business. According to a survey of agricultural enterprises conducted by the Ukrainian Agribusiness Club (UCAB), only 15% of farmers surveyed use this type of insurance. At the same time, 85% of respondents do not use crop and harvest insurance. Of the 15% of farmers who do use insurance services, only 73% provided information on the share of loss coverage, reporting that, depending on the type of insurance, farmers are covered for 20% to 60% of their losses in the event of an insured event. As for the insurance of agricultural machinery, 33% of farmers use this service, while the rest do not insure their machinery. Among the 33% who use insurance services for machinery, only 49% provide information on the percentage of insured machinery. Of this number, 29% of farmers fully ensure their agricultural machinery, 11% insure most of their machinery (65-80%), and 11% insure only half of their machinery (50%). The remaining 49% of respondents partially use machinery insurance at their enterprises (from 40% to 2%) (Research: 85% of..., 2018). However, Ukrainian farmers often do not ensure their crops due to a lack of trust in insurance companies, which is the reason for their reluctance to use such

services. For instance, farmers in the Kirovohrad region did not insure their crops in 2021, despite the high level of risk, such as drought and other threats. The reason for this is the experience of previous years when the insurance company did not compensate for losses, and the mechanism for compensation was too complicated. Only 30-50% of the expected harvest was harvested in different crop areas, which confirms the problems farmers have with covering losses (Ukrainian farmers do..., 2021).

Overall, agricultural insurance can substantially mitigate the risks faced by farmers in their business and ensure financial stability even in difficult conditions. Legislative initiatives and new proposals for war risk insurance are contributing to the development of the agricultural insurance market in Ukraine, allowing farmers to receive support from the state and ensure the protection of their assets.

Agricultural insurance in Ukraine offers various types of insurance products that allow farmers to minimise financial risks. However, each type of insurance has unique advantages and disadvantages, which should be accounted for during the selection of the most suitable for the specific conditions of the agricultural business. Table 3 provides an overview of the advantages and disadvantages of the main types of agricultural insurance used in Ukraine.

**Table 3.** Advantages and disadvantages of different types of insurance for agricultural enterprises

Type of Insurance	Advantages	Disadvantages
Crop insurance	Protection against adverse weather conditions and natural disasters. Availability of state support.	Limitations on coverage, in particular for risks not included in the policy.
Property insurance	Coverage of losses from fires, floods, robberies. The ability to protect production facilities and equipment.	High cost for large objects requiring detailed analysis.
Farm animal insurance	Coverage of risks from diseases, fires and natural disasters. Increase the stability of the agricultural business.	High cost of insurance policies, restrictions on coverage of certain diseases.
Freight transport insurance	Protection against risks when exporting products. Payments for damage during transport.	Difficulties in registration for one-time transport, and extensive documentation.
War risk insurance	Coverage for losses caused by hostilities. Assistance in case of losses due to military operations.	Limited coverage, provided that the damage is not defined as force majeure.

**Source:** compiled by the authors based on Agricultural Insurance: Products and Benefits (2016), Attention farmers! A new insurance product for agribusiness – war risk insurance! (2023)

The table shows that each type of insurance has unique strengths and weaknesses, which

should be accounted for during the selection of an insurance product suitable for an agricultural

enterprise. Although it has limitations, crop insurance is one of the most popular due to its wide range of risk coverage. Property and livestock insurance can be quite expensive for large enterprises, as they have a much larger volume of assets to cover. The cost of insurance premiums depends on the amount of coverage, and the more property and livestock that need to be insured, the higher the insurance costs will be. In addition, large agricultural enterprises may have more complex infrastructure and technical equipment, which also requires additional insurance, which in turn increases insurance costs. Therefore, insurance may be more financially burdensome for large enterprises, although it reduces the risk of damage or loss of assets. Cargo and war risk insurance helps farmers in the event of external threats, but coverage often depends on the specific terms of the contract.

Insurance companies are important for farmers, especially in the face of climate change and volatile market conditions. They help farmers and agricultural enterprises reduce financial losses due to natural disasters, economic fluctuations and other adverse circumstances. These companies play an important role in ensuring the resilience of the agricultural sector and facilitating adaptation to new challenges posed by climate change and market volatility.

Insurance companies help farmers reduce their financial risks by transferring some of these risks to other market participants through the reinsurance mechanism. It operates as follows: farmers conclude insurance contracts in which the insurance company assumes responsibility for financial losses in the event of certain risks (e.g., natural disasters, animal diseases, fires). However, insurance companies also face the risk of large claims under such policies. This helps to reduce the negative impact of unforeseen events on the company's financial results. Since insured property allows for loans and investments on favourable terms, insurance also facilitates access to external financing. Government support allows farmers to obtain a wider range of insurance services, which can significantly reduce insurance costs. Agricultural insurance is being promoted by programmes to compensate for part of the premiums, making this instrument more affordable for farmers.

This is an important component of agricultural sustainability in the face of climate change and market fluctuations.

Despite significant achievements in the field of agricultural insurance, there are still some challenges to be addressed. The main problems with agricultural insurance legislation are the ambiguity of regulations, lack of standardisation of insurance products, which makes it difficult to compare programmes, and limited access for small farmers due to high costs and lack of subsidies. The laws do not always include all risks, such as climate change or new animal diseases. Insufficient control over insurance companies also leads to inefficiencies. Improvements in legislation should ensure clarity, transparency and accessibility for farmers. In addition, unclear conditions for state aid may limit farmers' participation in insurance programmes, which may result in most farmers not having access to such products. It is also crucial that farmers are better informed about insurance options and state support mechanisms (State support mechanism..., n.d.).

Insurance companies are also substantial in the risk management system of farmers, providing financial stability and protection against unforeseen situations. Adaptation to climate change and market conditions are important aspects, and insurance products allow agricultural enterprises to be more resilient to such challenges. With increased government support for agricultural insurance in Ukraine and improved legislation, this mechanism could become even more accessible and effective for farmers.

Comparing the present study with the study by N.D. DeLay *et al.* (2023), it is possible to identify common features and differences. Both studies consider risk management in the agricultural sector through insurance mechanisms. N.D. DeLay *et al.* discussed the impact of agricultural insurance on the financial stability of farms, on credit and liquidity, while this study analyses crop insurance, adaptation to climate change and market conditions. The difference is that N.D. DeLay *et al.* addressed the US market and the practical impact of agricultural insurance on US farmers, while this study focuses on Ukraine, including local laws and government support programmes for agricultural insurance.

Thus, both studies have similar themes but different geographical and regulatory contexts.

This study and the study by Q. Stoeffler *et al.* (2022) both analyse the role of insurance in the agricultural sector, particularly in the context of managing risks such as natural disasters, climate change and market fluctuations. However, the differences lie in the geographical context and the focus of the studies. This study focuses on the role of state support in ensuring farmers' stability. In contrast, Q. Stoeffler *et al.* (2022) examine the European experience, in particular policies and state insurance programmes in EU countries, without focusing on military or political factors.

R.H. Rana *et al.* (2024) examined risk management mechanisms in the agricultural sector, particularly the role of insurance in ensuring the financial stability of agricultural enterprises. The authors emphasised the importance of agricultural insurance in protecting farmers from natural disasters such as droughts, floods and other extreme weather conditions that negatively affect production. The authors also highlight the cost-effectiveness of using agricultural insurance to reduce financial losses and ensure the sustainability of agricultural enterprises in the long term. Both studies emphasise the importance of financial stability of agricultural enterprises, but in the context of their research, considerable attention is paid to different approaches to ensuring this stability: the study by R.H. Rana *et al.* is more focused on international experience and the effectiveness of agricultural insurance at the global level, while this study focuses on the specifics of the implementation of agricultural insurance in Ukraine, in particular through preferential lending and state subsidies.

This study and the study by M.Y. Madaki *et al.* (2023) share several common aspects in the context of using agricultural insurance as risk management in agriculture. Both studies highlight the importance of agricultural insurance for farmers and its role in climate change adaptation. The authors emphasise that climate change, including droughts, storms and other natural disasters, can have a significant impact on agricultural production, making agricultural insurance an important tool for mitigating

these risks. Both studies also recognise the importance of government support for agricultural insurance in reducing farmers' costs. State subsidies and insurance programmes in several countries, including Ukraine, play an important role in making agricultural insurance affordable for a wide range of farmers. Both papers point to the importance of creating a favourable legislative environment that supports agricultural insurance, including through subsidies and financing. This study analysed the impact of agricultural insurance on the mental health of farmers, in particular, on how insurance reduces stress and improves the psycho-emotional state of farmers in the event of unforeseen situations. In turn, the study by M.Y. Madaki *et al.* focuses on the role of agricultural insurance in adapting to climate change in developing countries, particularly in Nigeria, where rising temperatures and unstable weather conditions have a significant impact on farm yields and economies.

P. Ruan *et al.* (2024) and this study examined how agricultural insurance can contribute to agricultural production sustainability and food security. Both studies emphasise the importance of supporting sustainability in agriculture using agricultural insurance, which allows farmers to be protected from natural disasters and market fluctuations. However, there are some differences between these studies. This study focuses on the impact of agricultural insurance on food security and explores how agricultural insurance contributes to reducing financial risks and ensuring sustainable agricultural development. At the same time, the study by P. Ruan *et al.* focuses more specifically on the economic effects of agricultural insurance and therefore focuses on reducing financial risks and improving the overall economic stability of agricultural enterprises in China.

Comparing this study with other works, it is possible to identify both common features and differences. All the studies emphasise the importance of agricultural insurance as a risk management in the agricultural sector to protect against natural disasters, climate change and market fluctuations. Most authors note that agricultural insurance is key to ensuring the financial stability of farms, especially in the face of unforeseen situations.

### **Investment instruments to reduce financial risks of agricultural enterprises**

In Ukraine, farmers can use a wide range of investment instruments to diversify risks and achieve sustainable development of their companies. Investment funds are one of the main instruments for agrarians who want to raise funds for the development of their business without having to manage significant amounts of money directly. In Ukraine, many funds focus on the agricultural sector, on investing in agricultural land and agricultural companies.

One of the best-known funds is the First Ukrainian Agrarian Fund, which invests in agricultural companies that lease agricultural land, mainly in the central and western regions of Ukraine. This provides benefits to investors through share price appreciation and regular dividends. This type of investment reduces risks through diversification, as it invests in different sectors of agriculture, which guarantees stable income even in difficult conditions. An important advantage of investment funds is their liquidity: shares in the funds can be bought and sold on stock markets, allowing investors to respond quickly to changes in the market situation. This diversification of assets reduces the impact of negative external factors on investors' income (Increase your wealth..., n.d.). In terms of financial indicators, the fund's land bank is 684.84 hectares, unchanged from the beginning of 2024. The main crop for this year is soybeans, which is strategically important for a stable income. However, by the end of 2024, the fund has a decrease in net assets of 0.6 million UAH (-1.39%), and the value of net assets per share decreased by 11.42 UAH, which also amounted to a decrease of 1.39%. This indicates a slight negative change in the short term but given the stability of the land bank and the opportunities for diversification, these changes may be temporary. The fund's liquidity is also an important advantage, with shares traded on the stock markets, allowing investors to react quickly to changes in the market situation. This opportunity gives investors' confidence that they can quickly buy or sell shares following market conditions, reducing risks from external factors (Monthly report on the..., 2024).

Direct investments involve investing directly in agricultural enterprises or in the development

of agricultural business, for example, through the purchase of machinery or land. This allows the investor to directly control their assets, make strategic decisions on business development and manage risks.

Private equity allows farmers to have significant autonomy in managing their assets and to profit directly from operations. Large agricultural companies can profitably invest in new technologies and expansion due to their significant financial resources and scale, which enables efficient innovation. Small and medium-sized enterprises can also benefit from such opportunities but often face constraints due to a lack of financial capacity and limited access to credit, although government support programmes can help them obtain financing. Direct investment can also include investments in land plots that are leased or used for crop production. In this way, farmers receive not only a stable rental income but also benefit from the potential increase in land value. Direct investment also allows farmers to benefit from tax benefits and government support programmes. Several programmes in Ukraine encourage investment in the agricultural sector. For instance, the Cabinet of Ministers of Ukraine Order No. 1437-2015-r "On approval of the Concept of the State Target Programme for the Development of the Agricultural Sector of the Economy for the Period Until 2022" (2015) aims to stimulate capital investment in the livestock sector, in particular through co-financing the construction of livestock facilities and infrastructure in rural areas, which allows for both public and private investment. Another important programme is the production growth subsidy, for dairy farmers, who receive support for the growth of each head of cattle, stimulating investment in this sector. To increase the competitiveness of agricultural enterprises engaged in both livestock and crop production, a special value-added tax (VAT) regime has been established (Kaletnik & Kozziar, 2020). However, direct investment is also associated with high risks, as agricultural businesses are often dependent on external factors such as weather conditions or market price fluctuations.

Agricultural bonds can be used as a financial instrument to raise long-term funds for

the development of agribusiness. Agricultural bonds in Ukraine have not yet gained widespread popularity due to several main factors. Firstly, the lack of sufficient liquidity in the bond market reduces investor interest in this instrument. Many investors prefer more traditional financial instruments, such as deposits or government bonds, which are less risky and have guaranteed returns. Secondly, the agricultural sector in Ukraine often faces high financial and operational risks, such as dependence on weather conditions, fluctuations in commodity prices and unpredictable political changes. This creates certain obstacles to attracting investors to agricultural bonds, as investors may not be willing to take on additional risk. A third factor is the lack of awareness among agricultural enterprises about the possibilities of issuing bonds and their advantages compared to other financing options, such as loans or private equity.

Agricultural bonds can be particularly useful for large agricultural companies that need large amounts of funding for the long term, for example, to purchase machinery, modernise production or expand their land bank. They allow farmers to raise funds without having to sell a part of the company, as is the case with a share issue. Bonds provide a way to retain control of the business while raising the necessary capital. For investors, agricultural bonds can be a stable source of income, as they usually have a fixed interest rate and clearly defined maturity dates. However, an important feature of such instruments is the need to carefully assess the financial stability of the issuing company, as this affects the safety of the invested funds.

Farm real estate investment trusts (REITs) allow investors to invest in agricultural real estate, often abroad, without having to buy the land outright. Such funds invest in agricultural land, including land leased to farmers. This can be used for risk diversification as the fund invests in different geographical regions and different types of crops.

One of the main advantages of farm real estate funds is that investors can receive a stable rental income as well as benefit from the growth of land values. This also reduces the risks associated with weather conditions and fluctuations

in agricultural prices, as funds usually own land in different parts of the world. REITs can be particularly beneficial for investors who do not wish to purchase land outright due to high initial costs but want to profit from stable rental payments. They are also liquid assets, as their shares can be sold on stock markets (Buyanov, 2021).

Investment products available to farmers in Ukraine provide an opportunity to diversify risks and increase profits. Investment funds, private equity, agricultural bonds and farm real estate funds are the main instruments that allow farmers to raise funds for business development. The choice of an investment product depends on the needs and strategic goals of the farmer, as well as their willingness to take certain risks.

Analysing the effectiveness of investments to stabilise the financial security of agricultural enterprises is an important step in determining the strategy of agribusiness development. Given that the risks in the agricultural sector are largely dependent on market fluctuations, climatic conditions and other factors, investments can be an important tool for maintaining and increasing the financial stability of companies. A SWOT analysis is useful for the identification of the strengths and weaknesses of an investment strategy, as well as opportunities and threats that may affect the effectiveness of investment products. Table 4 presents a SWOT analysis that assesses the impact of investments on stabilising the financial security of agricultural enterprises.

Investments in Ukraine's agricultural sector are an important means of ensuring the financial stability of agricultural companies. They can diversify risks, raise additional funds for development and modernisation, and stabilise revenues when the market changes. Nevertheless, there are some drawbacks, including dependence on external circumstances, high investment costs, and risks associated with legal issues. At the same time, there are significant opportunities for agribusiness development through government support, innovation and integration into international markets. Threats, such as climate change or political instability, can have a significant impact on investment performance, therefore it is necessary to consider these factors in investment decisions.

**Table 4.** SWOT analysis of investment efficiency to stabilise the financial security of agricultural enterprises

Advantages	Disadvantages
<p>Risk diversification – investments in different sectors (land, machinery, agricultural bonds) reduce financial risks.</p> <p>Raising additional funds – investments attract financing for modernisation, expansion of production and introduction of new technologies.</p> <p>Stability of income – investments in land and agricultural bonds can provide stable rental or interest income.</p> <p>Increasing competitiveness – investments in modern equipment and technologies can improve production efficiency and reduce costs.</p>	<p>Dependence on external factors – high level of dependence on climatic conditions, global agricultural prices and other external factors.</p> <p>High costs of investment – it can be difficult for farmers to attract large investments due to the need for significant upfront capital investment.</p> <p>Uncertainty in the long term – exchange rate fluctuations and changes in government support policies may affect investment performance.</p> <p>Insufficient legal support – lack of clear regulations on investments in the agricultural sector can lead to legal difficulties.</p>
Possibilities	Threats
<p>Development of state support programmes – availability of financing programmes, subsidies and soft loans for farmers.</p> <p>Growing interest in agribusiness – growing demand for agricultural products globally opens up new opportunities for farmers and investors.</p> <p>Integration into international markets – the possibility of attracting foreign investment and access to new markets for agricultural products.</p> <p>Innovative technologies – development of new technologies in agribusiness, such as precision farming, can increase efficiency and profitability.</p>	<p>Market volatility – changes in market conditions (agricultural prices, input costs) can reduce the profitability of investments.</p> <p>Political instability – military conflicts and economic instability in a country can significantly affect investment opportunities.</p> <p>Climate change – adverse climate conditions can affect the yields and financial results of agricultural enterprises.</p> <p>Uncertainty in investment regulation – insufficient legal support for investors can create risks for farmers and limit business development.</p>

**Source:** compiled by the authors based on S. Buyanov (2021), Z. Titenko (2022)

In many countries where the agricultural sector is significant to the economy, the system of financial security of agricultural enterprises includes a set of measures that allow for effective management of financial risks and ensure the stability of their operations. For instance, Canada has implemented several tools to help farmers cope with financial difficulties, including financial risk management programmes such as AgriStability (2024), which provides compensation in case of significant income losses, and AgriInsurance Program (2024), which minimises losses from adverse weather conditions. In addition, the AgriInvest programme (2024) allows farmers to build up savings to cover smaller financial downturns.

Canadian farmers also have access to financing programmes, such as the Advance Payments Programme (2024), which provides money with interest deferral, and loans through the Canadian Agricultural Loans Act Program (2022) with government-guaranteed rates and flexible repayment terms. Specialised measures are in place to ensure data security and protect against

cyber threats, including the Durham College Cybersecurity Centre, which provides solutions to protect data and business. In addition, Canadian farmers have access to the Farm Debt Mediation Service (2024), which provides free assistance in resolving debt issues.

Compared to Ukraine, where the farm financial security system still needs to be improved, Canada's experience can be a valuable reference point for the development of new policies and programmes. In Ukraine, the following recommendations based on international experience should be considered: expanding crop insurance programmes and creating more affordable and efficient crop insurance programmes that cover a wide range of risks, including weather conditions, which are among the biggest threats to Ukrainian farmers. It is also necessary to introduce government income compensation programmes, as in Canada, which would compensate farmers for significant losses due to a decline in income. This could help reduce financial risks and ensure the stability of the industry. It is important to improve access to finance, by

expanding access to loans with guaranteed government rates and flexible repayment terms, as is done in Canada through the Canadian Agricultural Loans Act Program (2022). The introduction of free mediation services for farmers in debt traps will help them regain financial stability, as is done through the Debt Mediation Service in Canada. As digital technologies become an important aspect of the agricultural sector, the development of cybersecurity in the agricultural sector is also critical, given the growing role of digital technologies. Implementation of measures to protect farmers' data, as is done in Canada through specialised cybersecurity programmes, will help to reduce risks for farmers in Ukraine.

M. Soliwoda (2020) and the current study address the financial security of agricultural enterprises and recognise the importance of minimising risks through financial instruments such as insurance and banking. However, the study by M. Soliwoda addressed global financial instruments and investment strategies used abroad, while this study focuses on instruments available to Ukrainian farmers, in particular government support programmes and subsidies. An important difference is that this study incorporates the impact of external factors, such as the war, on the Ukrainian agricultural sector, which is not covered by M. Soliwoda. In addition, this study takes a local approach, while the study by M. Soliwoda addressed general and global aspects of farmers' financial stability.

K. Prandecki & W. Wrzaszcz (2023) investigated the impact of agricultural innovation on the sustainable development of the Polish agricultural sector, with their analysis focusing on the environmental and economic aspects of agricultural policy, including adaptation to European requirements related to environmental change and sustainability in agriculture. The authors also analysed the financial instruments used to support farmers, including subsidies and financing through banking institutions to promote sustainable development. Both studies consider financial instruments as an important element to support agriculture in times of economic instability. However, the study by K. Prandecki & W. Wrzaszcz addressed the impact of environmental changes and the adaptation of the Polish agricultural sector to European standards, while

this study analysed economic and financial aspects, on state support programmes in Ukraine.

J. Ren & G. Li (2020) addressed the financial risks of agricultural supply chains in China. The authors analysed how the agricultural financial system, through supply chain mechanisms, helps small farmers to access credit and solve financing problems. They emphasise the importance of developing financial risk management mechanisms and establishing a risk assessment system for agricultural enterprises and discuss the need to overcome challenges such as information asymmetry and high credit risk, due to the difficulty of monitoring small farm operations. Although both studies focus on financial instruments to mitigate risks, this study focuses more on local, Ukrainian aspects, on government support programmes for farmers and analysis of crop insurance mechanisms, while the study by J. Ren & G. Li focuses more on global financing and credit mechanisms.

P. Bórawski *et al.* (2020) analysed financial mechanisms and risk management strategies in the agricultural sector, focusing on the impact of state support, lending, and financial instruments that help stabilise agricultural enterprises. The authors addressed how these instruments can reduce financial risks and promote sustainable agricultural development. This study and the study by P. Bórawski *et al.* share a common focus on the importance of financial instruments for risk management in the agricultural sector. However, P. Bórawski *et al.* analysed public financial mechanisms, while this study addressed private investment products, such as agricultural bonds and investment funds, and their role in ensuring financial stability.

Y. Lu *et al.* (2023) analysed investment in China's agriculture, especially on factors that limit the flow of foreign investment, such as economic instability, political risks and infrastructure barriers. It highlighted how important foreign investment is for the development of China's agricultural sector, as well as strategies to improve investment attractiveness. Both studies highlight the importance of investment for the sustainable development of the agricultural sector. They also emphasise the need for strategies to attract investment to improve financial security and reduce risks in the agricultural sector. The

study by Y. Lu *et al.* focuses on foreign investment in China's agricultural sector, while this study analyses instruments for attracting investment in Ukraine's agricultural sector, in the context of financial products and state support.

J. Yang *et al.* (2022) analysed the financial risks of agricultural supply chains in China, including credit and operational risks associated with technical difficulties and legal uncertainty. The authors used a statistical method to identify risk factors in the agricultural sector. The present study, in turn, addressed the financial security of agricultural enterprises in Ukraine, through concessional loans, agricultural insurance and state subsidies. Both studies emphasise the importance of managing risk through financial instruments, but the J. Yang *et al.* study emphasised supply chains, while the Ukrainian study addressed banking instruments and state support.

S. Entenmann (2021) examined investments in the agricultural sector with a focus on social and environmental impacts, as well as strategic approaches to raising finance for sustainable agribusiness development. The author emphasises the importance of developing investments that contribute to the preservation of the environment and social aspects of agricultural development, given the global challenges of climate change and the need for adaptation. The common thread between the studies is the emphasis on the importance of investment for the development of the agricultural sector. Both studies recognise the importance of financial instruments in reducing risks and ensuring the sustainable development of agribusiness. S. Entenmann addressed the environmental and social aspects of investment, while this study analysed financial mechanisms, such as insurance and credit, to reduce financial risks in the agricultural sector.

This study and J.J. García-Machado *et al.* (2024) emphasised the importance of financial risk management for the sustainability of agricultural enterprises. They emphasised the importance of financial instruments to minimise risks, such as insurance and credit, for farmers, improving resilience to external changes and crises. However, J.J. García-Machado *et al.* focused more on analysing the theoretical aspects of risk management through a

bibliometric approach, exploring global trends and instruments, while this study addressed the practical aspects of using specific investment instruments in the agricultural sector, such as bonds and funds, to ensure financial security in specific contexts.

Y. Tian & F.H. Tunio (2023) addressed the financial risk assessment of agricultural investment in the countries participating in the Belt and Road Initiative. The authors addressed political, economic, social and environmental risks, using a system of indices to measure risks in these areas. The study is based on the VHSD-EM method and includes spatial analysis, which allows identifying hot and cold spots of investment risks, as well as regional variations in the level of risks. The main similarity between these studies is that they both analyse the financial risks affecting the agricultural sector and the importance of minimising these risks to ensure sustainable development. The differences lie in the fact that the studies. Y. Tian & F.H. Tunio have a global context and address the impact of a wide range of risks on agricultural investment in an international initiative, while this study analyses the national level, analysing local instruments and approaches to risk mitigation in the Ukrainian agricultural sector.

J. Kang & M. Zhao (2022) addressed the financial aspects of farm support in China, in particular the impact of financial instruments such as agricultural credit and government programmes on the development of the agricultural sector. The authors emphasised the importance of stable financial systems but also noted the challenges faced by farmers due to an unstable financial market, high interest rates and difficult access to finance. J. Kang & M. Zhao and their study focused on the role of financial instruments to support agricultural enterprises and reduce financial risks, emphasising the importance of government support. The study by J. Kang & M. Zhao is more focused on the Chinese financial market and its volatility, while this study focuses on financial security instruments for farmers in Ukraine, through banking and insurance services.

Investment instruments, such as investment funds, private equity, agricultural bonds and farm real estate funds, help agricultural

enterprises in Ukraine to reduce financial risks and maintain stable development. They reduce dependence on external sources, diversifying assets and raising capital to modernise and expand their business. The choice of investment instrument depends on the needs of farmers and the desired risk.

## CONCLUSIONS

The financial security of Ukrainian agricultural enterprises is a key factor in their sustainable development and competitiveness. In the current environment of instability caused by economic, political and climatic factors, the agricultural sector faces numerous risks that may threaten its financial stability. The study confirmed that one of the main tools for minimising such risks is the effective interaction of agricultural enterprises with banking institutions and insurance companies. Bank loans, leases, guarantees, and insurance programmes are substantial in providing access to the financing needed to develop agricultural production, modernise technologies, and reduce dependence on unpredictable external circumstances.

Lending is an important banking instrument of assistance, as it ensures that farmers can raise money to cover operating costs, purchase machinery, lease land, etc. In particular, PrivatBank's Agraseason loan programme allows farmers to obtain a loan of 200,000 UAH to 5 million UAH with an interest rate of 5% per annum. On the other hand, Oschadbank facilitates access to bank financing for small and medium-sized enterprises up to 12.5 million UAH by providing them with loans secured by a guarantee from the Partial Guarantee Fund for Agricultural Loans. Government support programmes, such as "Affordable Loans 5-7-9%", which provide over 50 billion UAH in financing to the agricultural sector, are substantial in stabilising financial security.

Insurance is also substantial as it helps agricultural enterprises to reduce monetary losses as a result of crop failure, plant and animal diseases, natural disasters and war risks. The availability of government subsidies for insurance payments makes insurance more affordable for

farmers, even though the agricultural insurance market in Ukraine is still quite young. By 2025, agricultural producers will receive compensation of up to 60% of their insurance premiums from the state. Crop, machinery, property and livestock insurance are vital to prevent significant financial losses.

An analysis of international experience, including that of Canada, identified key programmes and tools to help farmers manage financial risks, including crop insurance, income compensation, access to finance, and cybersecurity measures. Based on these programmes, recommendations were developed for Ukraine aimed at improving the financial security of farmers through the expansion of insurance programmes, the introduction of state compensation mechanisms, access to finance and mediation to resolve debt issues. This will strengthen the stability of the agricultural sector in Ukraine and increase its resilience to financial risks.

Alongside traditional methods of financing and insurance, the creation of investment vehicles is a promising area for the Ukrainian agricultural sector. Investors can invest in agricultural property through REITs without having to buy land directly. They provide a stable rental income of 5-8% per annum and help to reduce risks as investments are spread across different types of crops and geographical regions.

The limitations of the study are the need for a detailed analysis of the impact of government programmes on the financial sustainability of small and medium-sized agricultural enterprises. Prospects for the introduction of digital technologies in financial management include the use of artificial intelligence and automation to improve the efficiency of financial planning and risk assessment.

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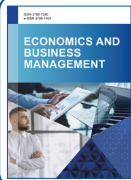
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## **Система фінансової безпеки аграрних підприємств України: роль банківських і страхових послуг у мінімізації фінансових ризиків**

**Анотація.** Метою дослідження було оцінити вплив банківських та страхових послуг на фінансову безпеку аграрних підприємств України. У процесі дослідження застосовувалися методи порівняльного аналізу та SWOT-аналізу. Було проаналізовано механізми фінансування агросектору, зокрема кредитні програми та страхові послуги. Встановлено, що кредитна програма ПриватБанку “Агросезон” дозволяла аграріям отримати від 200 тисяч до 5 мільйонів гривень під 5 % річних, тоді як Ощадбанк надавав кредити малим і середнім підприємствам на суму до 12.5 мільйонів гривень під заставу гарантії Фонду часткового гарантування кредитів. Державна програма “Доступні кредити 5-7-9 %” сприяла фінансуванню агросектору на понад 50 мільярдів гривень, що істотно зменшувало фінансові ризики підприємств. Результати дослідження показали, що банківські кредити є ключовим джерелом фінансування аграрних підприємств, проте висока вартість кредитних ресурсів і складність у доступі до них для малих фермерських господарств залишалися основними проблемами. Страхові послуги забезпечували додатковий захист від ризиків, зокрема погодних катастроф, але низький рівень розвитку агрострахування та обмеженість державної підтримки знижували ефективність цього механізму. Було встановлено, що субсидії на страхування сприяли збільшенню рівня фінансової безпеки підприємств, проте охоплення цієї програми залишалося недостатнім. Було проаналізовано міжнародний досвід фінансової безпеки аграріїв, зокрема Канади, і розроблено рекомендації для України щодо вдосконалення програм страхування, компенсації доходів, фінансування та кібербезпеки для підвищення стабільності аграрного сектору. Висновки підтвердили необхідність розширення доступу до фінансових ресурсів для аграрного сектору через удосконалення механізмів кредитування, стимулювання розвитку агрострахування та збільшення державної підтримки. Оптимізація цих інструментів сприятиме зниженню фінансових ризиків підприємств та забезпеченню їхньої стійкості в умовах економічної нестабільності

**Ключові слова:** сільське господарство; кредитні програми; управління; платоспроможність; економічні кризи



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## Formation of a mechanism for the digital transformation of the management of agricultural sector development in Ukraine

**Abstract.** The digital transformation of Ukraine's agricultural sector represents a strategically important development pathway, enabling the optimisation of management processes, the reduction of production costs, and the enhancement of agricultural enterprises' productivity. This study aimed to develop a mechanism for the digital transformation of the management of agricultural sector development based on modern technological solutions and their economic efficiency. To achieve this aim, bibliographic and content analysis, economic forecasting methods, mathematical modelling of digitalisation costs, and statistical methods for assessing the effectiveness of digital technology implementation were employed. The study established that the main mechanisms of digital transformation include digital platforms, the Internet of Things (IoT), artificial intelligence (AI), machine learning (ML), blockchain, and ERP systems. The total cost of digitalising Ukraine's agricultural sector is estimated at approximately 18,900,110,000 USD. The largest financial investments are directed towards process automation (12,600,000,000 USD), particularly in robotic harvesting systems (4,200,000,000 USD), automated tractors (4,200,000,000 USD), and irrigation systems (4,200,000,000 USD). The cost of implementing IoT equipment, including sensors for monitoring soil and weather conditions, drones for aerial surveying, and automated data collection systems, amounts to 6,300,000,000 USD. Investments in big data analytics and AI algorithms range from 50,000 USD to 60,000 USD per system, while ERP systems are estimated at between 30,000 USD and 60,000 USD. Calculations indicate that the average cost of digitalising one hectare of agricultural land varies between 450 USD and 1,000 USD, depending on the level of technological integration. The proposed digital transformation mechanism envisages the integration of IoT equipment, automated systems, blockchain, and analytical tools into a unified agricultural management system. Its implementation is expected to reduce production costs by 20%-35%, increase productivity by 15%-25%, and decrease crop losses by 10%-18% through the adoption of precision farming and analytical forecasting. The practical significance of the study lies in the application of the developed model for government planning of agricultural sector digitalisation, optimisation of agricultural production costs, and enhancement of sector competitiveness.

**Keywords:** economic model; integration; advanced technologies; automation; Internet of Things; cost optimisation; productivity enhancement

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## INTRODUCTION

Modern mechanisms for digital transformation in the management of trade and entrepreneurship encompass a broad spectrum of innovative solutions and technologies, serving as pivotal drivers for business evolution in the context of global digitisation. These mechanisms are primarily aimed at automating routine operations, optimising logistical and financial processes, and generally enhancing the operational efficiency of enterprises.

A key advantage of digital transformation is increased profitability, stemming from reduced operational costs, improved resource management, and a shortened decision-making cycle. Furthermore, the adoption of digital tools contributes to bolstering companies' competitiveness, which is critically important in a dynamic market environment (Bushuyev *et al.*, 2022). The integration of cutting-edge technologies such as artificial intelligence (AI), cloud computing, blockchain, and the Internet of Things (IoT) unlocks new opportunities for businesses. These technologies facilitate enhanced decision-making processes through the real-time processing of large data volumes, enable a personalised approach to customer interaction, and mitigate risks associated with human error and cyber threats.

Digital platforms and analytical systems have become an integral component of the contemporary business ecosystem. They provide flexibility and adaptability to changes in the market environment, enable the implementation of new management models – ranging from Platform as a Service (PaaS) to digital twins of enterprises – and facilitate the efficient allocation of resources (Rodríguez *et al.*, 2019). Overall, digital transformation is fundamental to the sustainable development of enterprises in the modern economy. It not only facilitates technological modernisation but also creates conditions for the formation of new approaches to strategic planning, enhancing the quality of management decisions and expanding opportunities for innovative activity.

In the study of G. Abashidze (2023), the application of digital platforms and analytical software in enabling digital transformation of management within trade and entrepreneurship is

examined. The author notes that using digital platforms for collecting and analysing data on sales, customer behaviour, market conditions, and so forth allows for more accurate forecasting and management decision-making. However, this research does not account for integration with existing management systems, which would ensure the complete automation of business processes. In practice, this leads to several issues, including the absence of a unified information environment, which complicates the consolidation and analysis of data from disparate systems within a single context. This, in turn, results in fragmented information, hinders the adoption of informed decisions, and diminishes the effectiveness of business management.

Also, the lack of full integration, as highlighted by M.A. Rodríguez *et al.* (2019), leads to increased data processing costs. This occurs due to the necessity of engaging additional resources for collecting, consolidating, and analysing data from various systems, thereby increasing operational expenses and reducing the overall economic efficiency of enterprises in the trade and entrepreneurship sector. Researchers L.K. Atheeq *et al.* (2023) have underscored the problems arising from delayed decision-making within the functioning of modern digital transformation mechanisms in trade and entrepreneurship. This issue stems from the absence of automated data exchange between systems, which slows down the process of obtaining necessary information. According to L.N. Usenko *et al.* (2024), the presence of such a problem can lead to delays in reacting to changes in market conditions or customer behaviour, negatively impacting an enterprise's competitiveness. Analysing this issue, it can be noted that, according to the study of M. Gomeniuk (2023), it is characteristic of the application of various digital platforms where integration with existing management systems is lacking, leading to delays in data collection and processing and complicating the forecasting and management of business processes.

Authors J. Dörr & M. Nachtmann (2022) conducted a detailed analysis of the application of the Internet of Things (IoT) in the realm of trade and entrepreneurship. They observe that the absence of automated data exchange between

IoT sensors and central management systems delays the acquisition of information concerning inventory levels, the temperature conditions of goods, and other parameters, thereby diminishing operational responsiveness in resource management decisions. In the article by V. Tkach *et al.* (2019), it was noted that the lack of integration between artificial intelligence and machine learning (AI and ML) models and other business systems postpones data analysis and the provision of recommendations, complicating responses to changes in market conditions and consumer behaviour. Similarly, insufficient integration between electronic inventory management systems and logistics systems delays the receipt of precise data on resource utilisation, which hinders effective planning and distribution of goods.

A. Gábor & Z. Szabó (2023) pointed out that the absence of automated data exchange between digital marketplaces and other business systems delays transaction processing and supply chain management, thus reducing the efficiency of market operations and product sales. Researchers V. Golyan *et al.* (2019) highlighted the issue of an increased risk of errors. Specifically, these authors noted that integration failures frequently lead to data errors, which can result in incorrect management decisions, negatively impacting the efficiency of business processes and resource utilisation. The research by S. Bushuyev *et al.* (2022) raises the issue of incomplete optimisation within contemporary mechanisms of digital transformation management in trade and entrepreneurship. In the opinion of these authors, complete automation of business processes is unattainable without full integration, which consequently diminishes their effectiveness. This results in partial automation, leading to reduced efficiency in management processes and demanding significant time expenditure on routine tasks.

Thus, the pertinent need for further research in this area is underscored to foster a deeper understanding and enhancement of digital transformation processes in trade and entrepreneurship. This research aimed to develop a mathematical model for the mechanism of digital transformation in the management of Ukraine's agricultural sector. The research objectives

were to: evaluate existing digital technologies and their role in the development of the agricultural sector; and develop a mechanism for implementing digital solutions to improve the management of Ukraine's agricultural sector.

## MATERIALS AND METHODS

To determine the current state of the problem under investigation concerning the analysis of the digital transformation of Ukraine's agricultural sector, bibliographical analysis, content analysis, the cost per unit area calculation method, economic modelling, and descriptive statistics methods were employed. Bibliographical analysis was used for the systematisation and examination of scholarly studies related to the digital transformation of the agricultural sector. Specifically, the method of bibliographical analysis was applied within the study of the main approaches to the digitisation of agriculture in various countries and their effectiveness, analysing articles by S. Bushuyev *et al.* (2022) and M.A. Rodríguez *et al.* (2019). The content analysis method was utilised for an in-depth analysis of scholarly sources (Gomeniuk, 2023; Usenko *et al.*, 2024) and the identification of key digitisation trends.

The cost per unit area calculation method involved estimating the cost of IoT equipment, automation, big data analytics, and digital platforms based on a price per hectare, where costs varied from 50 USD to 200 USD per hectare depending on the level of technological integration. Furthermore, economic modelling entailed the application of data concerning IoT, Big Data, and ERP systems, with this data sourced from the research of L.N. Usenko *et al.* (2024) and S. Bushuyev *et al.* (2022). This was used to forecast the overall expenditure on digitisation of the agricultural sector, employing economic forecasting models that account for the area of agricultural land, the scale of technology adoption, and the expected level of effectiveness. Methods of descriptive statistics facilitated the analysis of the obtained data, employing the arithmetic mean, variance, and variation series for the analysis of economic indicators. This provided a general understanding of the distribution of costs and the potential benefits of digital transformation.

Furthermore, the study utilised methodologies from other authors, adapted to the

conditions of digital transformation in Ukraine's agricultural sector. In particular, the methodology for economic analysis of IoT effectiveness in agriculture (Rodríguez *et al.*, 2019) was applied to assess the feasibility of implementing sensor networks and automated management systems. This included analysing the impact of IoT on reducing resource expenditure, increasing productivity, and evaluating the economic return on digitisation. In this research, the aforementioned methodology was adapted to calculate the economic benefits of implementing IoT in different types of agricultural enterprises, taking into account equipment costs and potential revenues.

Specifically, when reviewing the mechanisms of digital transformation at a methodological level, the following mechanisms were analysed: digital platforms were examined from the perspective of their role in creating ecosystems for data exchange, user interaction, and process automation; IoT (Internet of Things) was analysed in the context of integrating physical devices and sensors for real-time data collection, processing, and transmission; artificial intelligence and machine learning (AI and ML) were considered as means for automating decision-making, analysing large datasets, and increasing the efficiency of management processes; blockchain was evaluated as a mechanism for ensuring transparency, security, and trust in digital transactions and contracts; digital markets and exchange platforms were investigated as instruments of a decentralised economy and mechanisms for optimising market interaction; electronic land and water management systems were analysed in the context of cadastral digitisation, optimising the use of natural resources, and ecosystem monitoring; electronic financial infrastructure was studied from the perspective of financial service integration, the development of digital payments, and the impact on economic security. These mechanisms were considered in terms of their methodological underpinnings, potential approaches to integration, and the challenges encountered during their implementation.

Economic forecasting models proposed in the study of V. Tkach *et al.* (2019) were utilised to determine the overall cost, taking into account the area of agricultural land and scaling options.

The methodology of multifactor economic modelling of the agricultural sector's digital transformation by L.N. Usenko *et al.* (2024) was employed in the study to create a mathematical model of the transformation mechanism. This model incorporates data on the area of agricultural land, the level of technological implementation, and potential scenarios for scaling digital solutions. It was applied to calculate the total cost of digital transformation based on the level of automation and digital integration, using various implementation scenarios for small, medium, and large agricultural enterprises.

The methodology for analysing digital platforms in agriculture (Bushuyev *et al.*, 2022) was applied to investigate the impact of ERP systems, big data analytics, and automated platforms on the management effectiveness of agricultural enterprises. This included an analysis of the role of digital platforms in increasing productivity and reducing costs. In the course of the research, this approach was adapted to evaluate the effectiveness of implementing similar platforms in Ukraine, considering the experience of EU countries and the potential benefits for Ukrainian agribusiness.

Methods of descriptive statistics were employed to analyse the obtained data, including measures such as the arithmetic mean and variation series. This facilitated gaining a general understanding of the data distribution and its key characteristics (Jiang *et al.*, 2022). The primary indicators that guided the research were drawn from the studies of S. Bushuyev *et al.* (2022) and L.N. Usenko *et al.* (2024). These encompassed the cost of digitisation per hectare, determined based on the prices of IoT equipment, analytical platforms, and automation systems; the level of economic effect, assessed through increased productivity, reduced costs, and enhanced profitability; and the degree of digital technology integration, considered through indicators of IoT, Big Data, ERP system, and automation implementation. In this regard, average market prices for IoT equipment, analytical systems, ERP solutions, and automation, taken from the data presented in the research of L.N. Usenko *et al.* (2024), were taken into account.

The aforementioned data were fully incorporated into the economic calculations during

the modelling process. The model of the developed mechanism can be notionally divided into the following components: Input data – sensors, drones, agricultural equipment; Analytical system – big data and machine learning platforms for analysing collected information; Management system – ERP for the integration and optimisation of operations; Automation – mechanised systems executing operations based on system decisions; Digital platform – an interface for farmers and managers for real-time process control and management. The development of the mathematical model for this mechanism was based exclusively on the optimisation of utilisation. A key element was forecasting based on data from sensors and historical data on resource production processes to increase productivity and reduce costs.

The historical data analysed included information on resource expenditure in the agricultural sector from previous years, the effectiveness of digital technology adoption, and the economic performance of enterprises that had already implemented elements of digital transformation. Specifically, data concerning water, fertiliser, and fuel consumption, as well as yield and operational efficiency, were taken into account. Forecasting was based on statistical reports from international organisations such as the FAO and OECD, with detailed processing of this data presented in the studies by S. Bushuyev *et al.* (2022) and L.N. Usenko *et al.* (2024). Sensor data included readings for soil moisture, temperature, light levels, and plant condition, enabling adaptive resource management in real time (these data were obtained through the authors' own research).

*Modelling of resource management based on IoT.* A resource, such as water, is determined by the model based on data from sensors that assess soil moisture and weather conditions (1):

$$R_{water}(t) = f(\text{Soil}(t), P_{weather}(t)), \quad (1)$$

where  $R_{water}(t)$  is the quantity of water required at time  $t$ ;  $\text{Soil}(t)$  represents soil moisture readings from IoT sensors;  $P_{weather}(t)$  denotes the weather forecast (temperature, precipitation) based on big data analytics.

Within the application of the mechanism, the objective is to minimise costs while maintaining the maximum possible yield. The cost function for production is defined as follows (2):

$$C = \sum_{i=1}^n (C^{resource} \cdot X_i + C_i^{maintenance} \cdot m_i), \quad (2)$$

where  $C$  is the total cost of agricultural production;  $C^{resource}$  is the cost of the resource used;  $X_i$  is the quantity of the resource used;  $C_i^{maintenance}$  is the equipment maintenance costs;  $m_i$  is the intensity of equipment usage.

In the study, to forecast yield based on Big Data, it was proposed to apply machine learning algorithms for yield prediction using historical data (3):

$$Y(t) = f(X_{weather}(t), X_{soil}(t), X_{crop}(t), Z_{historical}), \quad (3)$$

where  $Y(t)$  is the predicted yield at time  $t$ ;  $X_{weather}(t)$  is the weather condition data;  $X_{soil}(t)$  is the soil condition data;  $X_{crop}(t)$  is the characteristics of the cultivated crop;  $Z_{historical}$  is the historical data from previous seasons.

Automation of operations implies that automated machines and robots execute operations based on the data received and decisions from the management system. The function governing the operation of mechanisms (digital platforms) is based on a decision-making model that minimises the cost of operations (4):

$$M(t) = \arg \min_{M_i} (C_{operation}(M_i, t)), \quad (4)$$

where  $M(t)$  is the selection of the mechanism to perform the operation at time  $t$ ;  $C_{operation}$  is the cost of executing the operation by mechanism  $M_i$ .

The model also incorporates an assessment of economic effectiveness based on the Return on Investment (ROI) metric. In analysing the experience of applying digital transformation mechanisms in trade and entrepreneurship, the following countries were considered: the USA, Germany, India, Brazil, China, Canada, Australia, France, Argentina, Israel, Italy, the Netherlands, the United Kingdom, and Ukraine. The selection of these countries for the analysis of digital transformation in trade and entrepreneurship is due to their economic significance, level of technological development, and influence on

global markets. Ukraine is included in the analysis owing to its active IT sector development and the implementation of digital solutions within the business environment, particularly electronic document management and fintech solutions (Ulyanchenko & Umanets, 2019). All these countries represent diverse economic models and levels of digital maturity, which facilitates a comprehensive comparison of the effectiveness of digital transformation mechanisms.

Based on data from the studies of L.N. Usenko *et al.* (2024) and S. Rodino *et al.* (2023), equipment and platforms are considered across three primary areas: digital platforms, IoT, and artificial intelligence and machine learning (AI and ML). Digital platforms include Amazon Web Services, Shopify, SAP Commerce Cloud, Zalando, Freshdesk, Zoho CRM, VTEX, Linx, Alibaba Cloud, JD.com, Shopify, Lightspeed, MYOB, Xero, Cegid, Dotpharma, Agrofy, Bioceres, Taranis, FieldIn, GeoSpazio, Euris, AgroCares, Connecterra, Small Robot Company, Agri-EPI Centre, Agro.Club, and Cropio. In the realm of IoT, the analysis covers

Honeywell Connected Enterprise, Cisco IoT, Bosch IoT Suite, Siemens MindSphere, SenseGrow, Skymet Weather Services, Agrosmart, Smart Agro, Huawei HiLink, Tuya Smart Agriculture, Trimble Ag Software, Ag Leader Technology, The Yield, WaterBit, Sencrop, Bosch Smart Fields, Don Agro, Climate FieldView, CropX, Arable, SkySquirrel Technologies, PrecisionHawk, 30MHz, Smart Dairy Farm, Agri Eye, and FieldSense. Within the AI and ML domain, the systems considered are Salesforce Einstein, IBM Watson, Celonis, Blue Yonder, CropMetrics, RML AgTech, Agrotopus, Strider, Farm Friend, Xarvio, NRGene, Farm.bot, SwarmFarm Robotics, FluroSat, Agricool, FieldBox.ai, SAT Agro, Insilico Plants, Prospera, Phytech, Evja, Ripe.io, PATS Indoor Drone Solutions, WUR Robotics, Liberty Produce, KisanHub, CogniAgro, and AIJU.

The calculation of the total cost for Ukraine's agricultural land (calculations were performed for the agricultural sector covering an area of 42 million hectares; initial calculation data are presented in Table 1).

**Table 1.** Initial calculation data for determining the total cost for Ukraine's agricultural land

Category	Element	Cost
IoT equipment	Sensors for soil monitoring	4,200,000,000 USD
	Drones for field monitoring	2,100,000,000 USD
	<b>Total cost of IoT equipment</b>	<b>6,300,000,000 USD</b>
Big Data analytics	Software	50,000 USD
	System scaling	30,000 USD - 60,000 USD
	ERP system	30,000 USD - 60,000 USD
Automation	Automated tractors	12,600,000,000 USD
	Automated irrigation systems	12,600,000,000 USD
	Robotic systems for harvesting	12,600,000,000 USD
	<b>Total cost of automation</b>	<b>12,600,000,000 USD</b>
Digital platforms	Mobile applications for monitoring	10,000 USD - 25,000 USD
Total overall cost	IoT equipment	6,300,000,000 USD
	Big Data analytics	110,000 USD - 170,000 USD
	Automation	12,600,000,000 USD
	Digital platforms	10,000 USD - 25,000 USD
<b>Total minimum cost</b>	–	<b>18,900,110,000 USD</b>
<b>Total maximum cost</b>	–	<b>18,900,195,000 USD</b>

**Source:** developed by the author based on the studies of S. Bushuyev *et al.* (2022) and L.N. Usenko *et al.* (2024)

During the cost calculation of various components within the practical application of the proposed digital transformation mechanism for Ukraine's agricultural sector, the equipment and systems used in modern agriculture are

analysed. These include Decagon 5TE soil monitoring sensors, DJI Phantom 4 RTK field monitoring drones, and the overall cost of IoT equipment, which amounts to 150 USD/ha. In the domain of big data analytics, Climate FieldView

software is utilised, and the SAP Agriculture Management ERP system is employed for system scaling. Automation encompasses John Deere 8R Series AutoTrac automated tractors, automated irrigation systems, and Agrobot E-Series robotic harvesting systems, with the total cost of automation standing at 300 USD/ha. In the sphere of digital platforms, mobile monitoring applications such as Farm Management Pro are considered (data regarding these systems is taken from the articles of S. Bushuyev *et al.* (2022), L.N. Usenko *et al.* (2024), and S. Rodino *et al.* (2023)).

## RESULTS

Modern mechanisms for the digital transformation of agricultural sector development management encompass a variety of innovations and technologies that contribute to improved efficiency, increased production, and resource management. The use of digital platforms for collecting and analysing data on crop yields, soil conditions, weather patterns, and so forth enables more accurate forecasting and production management (Lodhi & Shah, 2024). These platforms also facilitate the optimisation of resource utilisation and enhance overall production efficiency. The deployment of sensors and network connectivity allows for monitoring humidity levels, temperature, resource consumption, and automating management processes for agricultural assets. IoT sensors provide a continuous data stream, which supports prompt decision-making and boosts effectiveness. The application of artificial intelligence and machine learning algorithms for analysing large

volumes of data enables the identification of patterns, improves the accuracy of weather and yield forecasting, and optimises various agrotechnical processes. This significantly increases productivity and mitigates risks associated with climate change uncertainty (Hassan *et al.*, 2023).

Blockchain technology offers transparency within the agricultural sector, enabling product supply chain tracking and enhancing consumer trust. It also contributes to the automation of document exchange and mitigates fraud risks. The establishment of electronic markets and platforms for selling agricultural produce helps to reduce intermediaries and provides direct access to consumers. This allows farmers to increase their profits by minimising transportation and marketing losses (Jiang *et al.*, 2022). The implementation of digital systems for the effective management of land use, water resources, and environmental aspects aids in preserving natural resources and increasing yields. Furthermore, the creation of electronic payment systems and infrastructure for financing agricultural enterprises and farmers ensures access to financial resources and fosters the stable development of the agricultural sector. According to M.A. Rodríguez *et al.* (2019), these mechanisms contribute to the modernisation and optimisation of the agricultural sector, enhancing productivity, resilience to climate change, and competitiveness in the international market. This is reflected in Table 2, which provides an overview of the modern mechanisms of digital transformation in agricultural sector development management, including their requirements, advantages, disadvantages, and application examples.

**Table 2.** Overview of digital transformation mechanisms

Mechanism	Requirements	Advantages	Disadvantages	Examples of application
Digital platforms	Integration with third-party systems	Increased production efficiency, optimisation of resource management, and data analysis	High implementation costs, need for highly qualified personnel	Bayer Digital Farming, AGCO Agribusiness
IoT (Internet of Things)	Reliable connectivity	Monitoring of growing conditions, reduced energy costs, and irrigation optimisation	Cybersecurity issues, the complexity of integration with existing systems	John Deere Field Connect, Trimble Connected Farm
AI and ML	Large volumes of data for model training	Yield forecasting, seedling and feeding optimisation, and improved product quality	Dependence on data quality, ethical issues of data usage	FarmLogs, Climate Corporation

Table 2, Continued

Mechanism	Requirements	Advantages	Disadvantages	Examples of application
<b>Blockchain</b>	Integration with existing supply systems	Supply chain transparency, secure data storage, and reduced fraud risk	High implementation costs, regulatory complexity	IBM Food Trust, Provenance
<b>Digital markets and exchange platforms</b>	Internet accessibility in rural areas	Reduced number of intermediaries, direct access to consumers	Issues with trust in digital platforms, price instability	Alibaba Rural Taobao, FarmDrop
<b>Electronic land and water management systems</b>	Connection to Geographic Information Systems (GIS)	Optimisation of resource utilisation, protection from land and water resource depletion	High implementation costs, need for specialised knowledge	Trimble Ag Software, AquaSpy
<b>Electronic financial infrastructure</b>	Integration with banking systems	Increased access to finance, reduced transaction costs	Regulatory complexity, lack of standards	PayPal for Farmers, AgriDigital

**Source:** developed by the author based on the studies of S. Bushuyev *et al.* (2022) and L.N. Usenko *et al.* (2024)

The data highlighted in Table 2 demonstrate that different technologies within the agricultural sector have specific requirements, advantages, and disadvantages. The main mechanisms of digital transformation in the agricultural sector are presented, focusing on their requirements, advantages, disadvantages, and examples of application. One of the most promising solutions is digital platforms, which enable integration with other systems, allow for the optimisation of resource management and the analysis of large datasets, yet require significant investment and the availability of qualified personnel. The Internet of Things (IoT) holds considerable potential for the agricultural sector due to its capabilities in monitoring growing conditions, optimising irrigation, and reducing energy consumption. However, its effectiveness is limited by the need for reliable connectivity and the complexity of secure integration with existing systems.

The use of artificial intelligence and machine learning opens up new horizons for yield forecasting, improving product quality, and automating processes. Concurrently, this raises questions concerning the dependence on the volume and quality of input data, as well as the ethical considerations of employing such technologies. Blockchain ensures supply chain transparency and secure information storage, which is particularly relevant for export-oriented producers; however, implementing this technology is costly and often encounters

regulatory barriers. Digital markets and exchange platforms contribute to reducing the number of intermediaries and provide farmers with direct access to consumers, which can increase income. Nevertheless, the effectiveness of such platforms depends on the level of trust in them and internet availability in remote areas. Electronic systems for managing land and water resources facilitate the rational use of natural resources but necessitate connection to geoinformation systems and specialised knowledge. Electronic financial infrastructure provides access to finance for farmers, especially smallholders, and reduces transaction costs, but faces difficulties with regulation and a lack of unified standards (Bushuyev *et al.*, 2022).

The most expedient technologies for implementation in the agricultural sector are digital platforms, IoT, and AI/ML, as they offer the greatest increase in efficiency and quality when properly deployed. Simultaneously, for a comprehensive effect, it is advisable to gradually integrate other tools, including blockchain and electronic financial infrastructure, taking into account infrastructural capabilities and readiness for digitisation. In summary, the most promising technologies for implementation in the agricultural sector are digital platforms, the Internet of Things (IoT), and artificial intelligence/machine learning (AI/ML), as it is these that primarily ensure the optimisation of

production processes, increased efficiency of resource utilisation, and improved product quality. Other tools, such as blockchain, electronic markets, and financial platforms, also possess significant potential; however, their effective use necessitates gradual integration,

appropriate infrastructure, and adaptation to agricultural conditions (Usenko *et al.*, 2024).

Table 3 presents examples of the application of digital transformation mechanisms in trade and entrepreneurship across various countries worldwide.

**Table 3.** Examples of the application of digital transformation mechanisms in trade and entrepreneurship across various countries worldwide

Country	Digital platforms	IoT	AI and ML	Summary of perspectives and evaluations
USA	Amazon Web Services, Shopify	Honeywell Connected Enterprise, Cisco IoT	Salesforce Einstein, IBM Watson	Significant potential for enhancing supply chain management efficiency and increasing enterprise revenues
Germany	SAP Commerce Cloud, Zalando	Bosch IoT Suite, Siemens MindSphere	Celonis, Blue Yonder	Leadership in implementing advanced technologies for optimising business processes and achieving economic efficiency
India	Freshdesk, Zoho CRM	SenseGrow, Skymet Weather Services	CropMetrics, RML AgTech	Potential for productivity development in high-temperature conditions and the improvement of agrotechniques
Brazil	VTEX, Linx	Agrosmart, Smart Agro	Agrotopus, Strider	Innovations in resource management for process optimisation and increasing business efficiency
China	Alibaba Cloud, JD.com	Huawei HiLink, Tuya Smart Agriculture	Farm Friend, Xarvio	Great potential for scaling technologies in the world's largest market to enhance production efficiency
Canada	Shopify, Lightspeed	Trimble Ag Software, Ag Leader Technology	NRGene, Farm. bot	High level of technology integration for achieving stability and growth in agribusiness
Australia	MYOB, Xero	The Yield, WaterBit	SwarmFarm Robotics, FluroSat	Advanced technologies supporting the sustainable development of the agricultural sector and increasing efficiency
France	Cegid, Dotpharma	Sencrop, Bosch Smart Fields	Agricool, FieldBox.ai	Integration of autonomous systems and monitoring for optimising agribusiness management
Argentina	Agrofy, Bioceres	Don Agro, Climate FieldView	SAT Agro, Insilico Plants	Broad opportunities for increasing yield and efficiency under diverse climatic conditions
Israel	Taranis, FieldIn	CropX, Arable	Prospera, Phytech	Leadership in the use of data for precision agriculture and the improvement of agricultural techniques
Italy	GeoSpazio, Euris	SkySquirrel Technologies, PrecisionHawk	Evja, Ripe.io	Integration of modern technologies supporting the sustainable development of the agricultural sector in conditions of limited space
Netherlands	AgroCares, Connecterra	30MHz, Smart Dairy Farm	PATS Indoor Drone Solutions, WUR Robotics	High level of automation and data utilisation for optimising agribusiness management
United Kingdom	Small Robot Company, Agri-EPI Centre	Breedr, Agri-EPI Centre	Liberty Produce, KisanHub	Innovations in robotic systems and digital technologies are supporting the growing demand for produce
Ukraine	Agro.Club, Cropio	Agri Eye, FieldSense	CogniAgro, AIJU	Integration of digital technologies for enhancing competitiveness in the global market environment

Source: developed by the author based on the studies of L.N. Usenko *et al.* (2024) and S. Rodino *et al.* (2023)

Thus, Table 3 indicates that the main mechanisms of digital transformation include digital platforms, IoT, AI and ML, and blockchain. Digital platforms optimise business processes and increase efficiency, although their implementation can be costly and require qualified personnel. IoT provides monitoring and optimisation of resource utilisation, but requires a reliable communication infrastructure and presents cybersecurity issues. AI and ML enhance the

accuracy of forecasting and business process optimisation; however, their effectiveness depends on data quality and can raise ethical questions. Blockchain ensures transparency and supply chain tracking, which increases trust in products, but its integration can be complex.

Table 4 presents the results of an analysis of the advantages and disadvantages of applying digital transformation mechanisms in the agricultural sector across different countries worldwide.

**Table 4.** Results of the analysis of the advantages and disadvantages of applying digital transformation mechanisms in the agricultural sector across various countries worldwide

Country	Mechanisms	Advantages	Disadvantages	Recommendations for change
USA	Precision farming, IoT, drones, Big Data	Increased productivity, precision farming, and efficient resource management	High implementation costs, need for highly skilled personnel, cybersecurity issues	Improve cybersecurity, invest in staff training
Germany	Automated farm management systems, robotics	High level of automation, improved product quality, resilience to climate change	High implementation costs, cybersecurity issues, and potential lag in small farms	Reduce costs, support small farms
India	Mobile apps for farmers, soil moisture sensors	Potential for increased productivity in resource-limited conditions, reduced environmental impact	Uneven access to communication infrastructure, challenges in implementation due to low technological readiness	Expand infrastructure, improve access to technology
Brazil	Irrigation management systems, satellite monitoring	Improved production indicators, reduced costs, and environmental sustainability	High implementation costs, the need for support for small farming enterprises, and infrastructure integration challenges	Simplify integration, support small farms
China	AI for yield analysis, automated greenhouses	Technology scalability, precision farming, and increased production efficiency	Cybersecurity issues, potential impact on rural employment levels, and low environmental standards compliance	Improve cybersecurity, implement environmental standards
Canada	Integrated farm management systems, automated irrigation systems	High level of technology integration, improved product quality, and climate change resilience	High implementation costs, access to financing issues for small farming enterprises	Reduce costs, improve access to financing
Australia	Drones for field monitoring, precision farming systems	Innovations in precision farming, reduced costs, and support for sustainable development	Cybersecurity issues, uneven access to communication infrastructure, and high data loss risk due to natural disasters	Improve cybersecurity, expand communication infrastructure
France	Automated harvesting systems, IoT	Autonomous technologies, increased productivity, and resource optimisation	High implementation costs, integration challenges with existing agronomic systems, and a need for qualified engineering personnel	Simplify integration, enhance staff qualifications

Table 4, Continued

Country	Mechanisms	Advantages	Disadvantages	Recommendations for change
Argentina	Plant nutrition management systems, soil sensors	Improved production metrics, climate change resilience, and environmental sustainability	Insufficient communication infrastructure, high domestic market competition, and potential political influence	Develop infrastructure, reduce administrative barriers
Israel	Irrigation technologies, yield data analysis	Leadership in data usage, increased productivity, and efficient management under resource constraints	High implementation costs, ethical concerns regarding data usage, and political instability	Improve ethical standards, reduce political instability
Italy	Drones for crop monitoring, mobile apps for farmers	Integration of digital technologies for sustainable development, precision farming, and reduction of environmental impact	High implementation costs, integration challenges with traditional agronomic methods, and funding access issues	Simplify integration, improve access to funding
Netherlands	Vertical farms, automated greenhouse systems	Automation of infrastructure, maximising data usage for production optimisation, and supporting sustainable development	High implementation costs, funding access issues, and potential political changes affecting market stability	Improve access to funding, stabilise the political environment
United Kingdom	Robotics for harvesting, precision farming	Innovations in robotics and digitalisation, increased production efficiency, and supporting the development of small farms	High implementation costs, economic instability, and potential impact on market competitiveness	Reduce costs, stabilise the economic environment
Ukraine	Mobile apps for farm management, drones	Integration of digital technologies to enhance competitiveness, reduce environmental impact, and support sustainable development	Unequal access to communication infrastructure, high risk of cyberattacks, and challenges in ensuring qualified personnel	Improve access to communication, enhance cybersecurity

Source: developed by the author based on the studies of L.N. Usenko *et al.* (2024) and S. Rodino *et al.* (2023)

Thus, Table 4 demonstrates that the implementation of digital transformation mechanisms in the agricultural sector has a significant impact on increasing production efficiency and sustainability in various countries. Digital transformation in the agricultural sector across different nations brings substantial advantages, including enhanced productivity, reduced costs, and improved environmental sustainability through technologies such as IoT, drones, precision farming, and Big Data. However, it also faces challenges, notably high implementation costs, cybersecurity issues, instability in

the economic and political environments, and insufficient access to infrastructure and qualified personnel. To overcome these issues, it is recommended to reduce costs, improve access to finance and technology, and invest in training and cybersecurity.

The proposed model for the digital transformation mechanism in Ukraine’s agricultural sector has a clear multi-level structure based on the integration of four key functional blocks: infrastructure, analytical, executive, and management. Each of these plays a distinct role in ensuring a complete digital cycle of agricultural

production, from data collection to decision-making and the execution of technological operations.

On the first level is the infrastructure block, which includes IoT equipment: sensors for soil monitoring (specifically, Decagon 5TE models) and drones for aerial photography and observing field conditions (DJI Phantom 4 RTK). This level is responsible for the primary collection of data on physical environmental parameters: temperature, humidity, pH, soil density, plant condition, atmospheric conditions, and so forth. The data received is transmitted to the next level – the analytical one.

The analytical block is based on the use of software for processing and analysing large volumes of information. This model employs the Climate FieldView system, which performs agroanalytic functions: generating yield maps, zoning fields, forecasting crop development, and identifying risks. Additional system scaling modules allow it to be adapted to different farm sizes. The analytical block also includes the SAP Agriculture Management ERP system, which ensures the integration of financial, logistical, production, and management processes into a unified digital ecosystem. At this level, the basis for making informed agricultural decisions is formed.

The third level – the executive one – implements the automation of agricultural production. Its components include automated tractors with the AutoTrac system (e.g., John Deere 8R Series), robotic systems for harvesting (Agrobot E-Series), and automated irrigation systems. It is here that precise agrotechnical actions

are carried out based on the data collected and analysed by the preceding blocks. This level contributes to reducing the impact of the human factor, increasing the accuracy of field processing, and lowering costs.

The highest level of the structure is the management level, which is represented by digital platforms and mobile applications such as Farm Management Pro. These provide convenient access to data and real-time process control via smartphones, tablets, or computers. Users receive information on field status, equipment operation, agrotechnical plans, financial reports, and recommendations for decision-making.

Overall, the proposed model functions as a single, interconnected system where information continuously moves through a cycle: data collection (infrastructure level) → processing and analysis (analytical level) → execution of agricultural operations (executive level) → control and management (management level). It is precisely this structure that allows agricultural enterprises to achieve high productivity, management flexibility, and competitiveness within the digital economy.

At the implementation level, the mechanism envisions that the digital platform integrates all management systems, providing users (farmers and managers) with the ability to receive real-time information and make prompt decisions. The model includes mobile applications for farm management that offer the following functions: field status monitoring (based on IoT and drones); operations planning (based on ERP); analytics for operation optimisation (Table 5).

**Table 5.** Results of cost calculation for various components within the practical application of the proposed model for the digital transformation mechanism of Ukraine's agricultural sector

Component	Model/Type	Description	Cost	Total cost
<b>IoT equipment</b>				
Soil monitoring sensors	Decagon 5TE	Soil temperature, humidity, pH	100 USD/ha	–
Drones for field monitoring	DJI Phantom 4 RTK	Aerial photography and field monitoring	50 USD/ha	–
<b>Total cost of IoT equipment: 150 USD/ha</b>				
<b>Big Data analytics</b>				
Software	Climate FieldView	Data collection and analysis, base price	–	50,000 USD
System scaling	–	Additional costs for processing large datasets	–	30,000 USD - 60,000 USD

Table 5, Continued

Component	Model/Type	Description	Cost	Total cost
<b>Big Data analytics</b>				
ERP system	SAP Agriculture Management	Integration and management of resources, finance	–	30,000 USD - 60,000 USD
<b>Automation</b>				
Automated tractors	John Deere 8R Series AutoTrac	For sowing, field processing using GPS	300 USD/ha	–
Automated irrigation systems	–	Field irrigation automation	300 USD/ha	–
Robotic harvesting systems	Agrobot E-Series	Robotic systems for harvesting	300 USD/ha	–
<b>Total cost of automation: 300 USD/ha</b>				
<b>Digital platforms</b>				
Mobile monitoring applications	Farm Management Pro	For accessing information and real-time management	–	10,000 USD - 25,000 USD

**Note:** "–" - no data available

**Source:** developed by the author based on the studies of S. Bushuyev *et al.* (2022) and L.N. Usenko *et al.* (2024)

According to Table 5, the results of the cost calculation for the different components demonstrate a significant difference between the costs per hectare and the total capital investments. For instance, IoT equipment, including soil monitoring sensors and drones, amounts to approximately 150 USD per hectare. These costs are relatively moderate considering their functionality, which involves continuous monitoring of soil and plant conditions. The cost of software for big data analytics, such as Climate FieldView, along with system scaling costs and the implementation of the SAP ERP solution, ranges from 110,000 to 170,000 USD. This represents the largest financial component, requiring significant initial investment, but subsequently providing a high return on investment through precise planning, analytics, and the optimisation of decisions based on real-time data.

Automation encompasses the implementation of GPS-navigated tractors, automated irrigation systems, and robotic harvesting solutions, each estimated at 300 USD per hectare. These are substantial investments, particularly for large areas; however, they enable a significant reduction in human resources and minimise errors during field operations. Regarding digital platforms, such as the Farm Management Pro mobile application, their cost is estimated to be within the range of 10,000 USD to 25,000 USD, which is a quite accessible investment for most

agricultural enterprises and provides a convenient tool for monitoring and managing farm activities in real time (Usenko *et al.*, 2024).

The overall analysis of Table 5 indicates that the implementation of the proposed digital transformation model is a capital-intensive process, but one that is justified given the potential effectiveness. The largest expenditures are associated with systemic analytics and automation, which simultaneously offer the highest return in the long term. Small and medium-sized farming operations can consider a phased implementation of the model, starting with IoT technologies and digital platforms, whereas large agricultural holdings can integrate all components simultaneously to achieve maximum efficiency (Bushuyev *et al.*, 2022).

Consequently, the selection of equipment for the digital transformation of Ukraine's agricultural sector is critically important in contemporary conditions for increasing the efficiency and sustainability of agronomic production. In Ukraine, the chosen solutions include IoT equipment, big data analytics, ERP systems, automation, and digital platforms. Each of these components has its own specificity, and its selection is determined by the need to ensure high efficiency at optimal costs.

Table 6 presents the results of the calculation of the total cost of applying the mechanism by regions of Ukraine, including the Autonomous Republic of Crimea (data for calculations were taken from the research of N.L. Usenko *et al.* (2024).

**Table 6.** Calculation of the total cost of applying the mechanism by regions of Ukraine, including AR Crimea

Region	IoT equipment	Big Data analytics	Automation	Digital platforms	Total cost
Kyiv Region	240,000,000 USD	50,000 USD - 60,000 USD	480,000,000 USD	10,000 USD - 25,000 USD	730,000,000 USD - 730,070,000 USD
Vinnitsia Region	315,000,000 USD	50,000 USD - 60,000 USD	630,000,000 USD	10,000 USD - 25,000 USD	995,000,000 USD - 995,070,000 USD
Volyn Region	120,000,000 USD	50,000 USD - 60,000 USD	360,000,000 USD	10,000 USD - 25,000 USD	490,000,000 USD - 490,070,000 USD
Dnipropetrovsk Region	345,000,000 USD	50,000 USD - 60,000 USD	690,000,000 USD	10,000 USD - 25,000 USD	1,095,000,000 USD - 1,095,070,000 USD
Donetsk Region	270,000,000 USD	50,000 USD - 60,000 USD	540,000,000 USD	10,000 USD - 25,000 USD	870,000,000 USD - 870,070,000 USD
Zhytomyr Region	255,000,000 USD	50,000 USD - 60,000 USD	510,000,000 USD	10,000 USD - 25,000 USD	825,000,000 USD - 825,070,000 USD
Zakarpattia Region	110,000,000 USD	50,000 USD - 60,000 USD	330,000,000 USD	10,000 USD - 25,000 USD	500,000,000 USD - 500,070,000 USD
Zaporizhia Region	330,000,000 USD	50,000 USD - 60,000 USD	660,000,000 USD	10,000 USD - 25,000 USD	1,050,000,000 USD - 1,050,070,000 USD
Ivano-Frankivsk Region	150,000,000 USD	50,000 USD - 60,000 USD	450,000,000 USD	10,000 USD - 25,000 USD	660,000,000 USD - 660,070,000 USD
Kirovohrad Region	240,000,000 USD	50,000 USD - 60,000 USD	480,000,000 USD	10,000 USD - 25,000 USD	730,000,000 USD - 730,070,000 USD
Luhansk Region	180,000,000 USD	50,000 USD - 60,000 USD	540,000,000 USD	10,000 USD - 25,000 USD	780,000,000 USD - 780,070,000 USD
Lviv Region	285,000,000 USD	50,000 USD - 60,000 USD	570,000,000 USD	10,000 USD - 25,000 USD	915,000,000 USD - 915,070,000 USD
Mykolaiv Region	270,000,000 USD	50,000 USD - 60,000 USD	540,000,000 USD	10,000 USD - 25,000 USD	870,000,000 USD - 870,070,000 USD
Odesa Region	300,000,000 USD	50,000 USD - 60,000 USD	600,000,000 USD	10,000 USD - 25,000 USD	960,000,000 USD - 960,070,000 USD
Poltava Region	285,000,000 USD	50,000 USD - 60,000 USD	570,000,000 USD	10,000 USD - 25,000 USD	915,000,000 USD - 915,070,000 USD
Rivne Region	130,000,000 USD	50,000 USD - 60,000 USD	390,000,000 USD	10,000 USD - 25,000 USD	580,000,000 USD - 580,070,000 USD
Sumy Region	150,000,000 USD	50,000 USD - 60,000 USD	450,000,000 USD	10,000 USD - 25,000 USD	660,000,000 USD - 660,070,000 USD
Ternopil Region	240,000,000 USD	50,000 USD - 60,000 USD	480,000,000 USD	10,000 USD - 25,000 USD	730,000,000 USD - 730,070,000 USD
Kharkiv Region	315,000,000 USD	50,000 USD - 60,000 USD	630,000,000 USD	10,000 USD - 25,000 USD	995,000,000 USD - 995,070,000 USD
Kherson Region	270,000,000 USD	50,000 USD - 60,000 USD	540,000,000 USD	10,000 USD - 25,000 USD	870,000,000 USD - 870,070,000 USD
Khmelnytskyi Region	255,000,000 USD	50,000 USD - 60,000 USD	510,000,000 USD	10,000 USD - 25,000 USD	825,000,000 USD - 825,070,000 USD
Cherkasy Region	270,000,000 USD	50,000 USD - 60,000 USD	540,000,000 USD	10,000 USD - 25,000 USD	870,000,000 USD - 870,070,000 USD
Chernivtsi Region	120,000,000 USD	50,000 USD - 60,000 USD	360,000,000 USD	10,000 USD - 25,000 USD	540,000,000 USD - 540,070,000 USD
Chernihiv Region	150,000,000 USD	50,000 USD - 60,000 USD	450,000,000 USD	10,000 USD - 25,000 USD	660,000,000 USD - 660,070,000 USD
Autonomous Republic of Crimea	150,000,000 USD	50,000 USD - 60,000 USD	450,000,000 USD	10,000 USD - 25,000 USD	660,000,000 USD - 660,070,000 USD

Source: developed by the author based on the study of L.N. Usenko *et al.* (2024)

According to Table 6, the calculations performed take into account the area of agricultural land in each region and provide approximate cost estimations for digital transformation. The cost of big data analytics and digital platforms varies depending on specific needs and volume. Thus, the total cost of digital transformation of Ukraine's agricultural sector for 42 million hectares ranges from approximately 18,900,110,000 USD to 18,900,195,000 USD.

Therefore, the study of the solutions of the proposed model for the digital transformation of Ukraine's agricultural sector covered four interconnected levels: infrastructure (IoT equipment), analytical (data processing and ERP systems), executive (automated machinery and irrigation), and management (digital platforms and mobile applications). The research analysis conducted showed that the largest costs are attributed to analytics and automation; however, these are precisely the blocks that ensure maximum effectiveness in the long term. The model is flexible and adaptive – it can be implemented in phases, starting with basic components, with subsequent build-up of functionality according to the needs of the farm.

## DISCUSSION

The chosen solutions for the digital transformation of Ukraine's agricultural sector ensure a high level of efficiency at reduced costs compared to international counterparts. A cost reduction of 20%-50% in various categories makes these solutions economically justified and allows for the optimal utilisation of resources in Ukraine's agronomic production (Usenko *et al.*, 2024). According to M. Gomeniuk (2023), ignoring aspects of integration can lead to a decrease in overall enterprise management efficiency, increased costs and risks, and a reduction in market competitiveness.

To eliminate these problems, it is necessary to conduct a more detailed analysis within the framework of developing universal platforms for integrating various business resource management systems. Furthermore, it is important to develop technologies for automated data collection and analysis to improve information accuracy and reduce processing costs. In the USA, Germany, and Canada, a high level of

technological integration allows for significant improvements in productivity and resource management, although this is accompanied by high costs and a need for qualified personnel (Rodino *et al.*, 2023). In India and Brazil, mobile applications and monitoring systems enhance efficiency under conditions of limited resources; however, issues exist with access to infrastructure and finance. China and Israel are leaders in the implementation of AI and automation, which increases efficiency, but there are concerns regarding cybersecurity and political instability (Dörr & Nachtmann, 2022).

France, Italy, and Australia focus on automation and precision farming, again facing high costs and integration issues. The Netherlands and the United Kingdom achieve success through innovations in vertical farms and robotics, but experience difficulties with financing and political stability. In Ukraine, the integration of digital technologies is at a developing stage, with benefits in increased competitiveness, although issues with cybersecurity and access to communication persist (Hassan *et al.*, 2023).

In contrast, according to A.V. Ulyanchenko & S.V. Umanets (2019), digital platforms such as Bayer Digital Farming and AGCO Agribusiness allow for increased production efficiency and resource management optimisation, but their implementation requires high costs and qualified personnel. IoT, for example, John Deere Field Connect, offers the possibility of monitoring growing conditions and reducing costs, but faces cybersecurity and integration issues. AI and ML, as in FarmLogs and Climate Corporation, provide yield forecasting and process optimisation but are dependent on data quality and ethical considerations. Blockchain (IBM Food Trust) increases supply chain transparency but has high costs and regulatory complexity. Digital markets, such as Alibaba Rural Taobao, reduce the number of intermediaries, although they face issues of trust and price instability. Electronic management systems, such as Trimble Ag Software, optimise resource utilisation but require significant costs and specialised knowledge. Electronic financial infrastructure, for instance, PayPal for Farmers, increases access to finance and reduces costs, but has issues with regulation and a lack of standards (Stender, 2024).

In the study by V. Halanets *et al.* (2023), it was noted that Precision Commerce technology is actively applied in the USA, based on the use of sensors, GPS, and digital maps for the precise management of goods and services supply depending on the needs of each specific region. In practice, according to M.A. Rodríguez *et al.* (2019), the implementation of this mechanism allows for the reduction of logistics costs, optimisation of inventory, and a decrease in environmental impact by reducing unnecessary shipments.

Researchers V. Kopytko & O. Kopytko (2024) noted that in Australia, IoT systems are being implemented for tracking goods storage conditions, humidity, and temperature in warehouses, enabling entrepreneurs to ensure optimal conditions for preserving product quality. According to Y.K. Lodhi & D.A. Shah (2024), in European Union countries, IoT is used for monitoring equipment status and ensuring its uninterrupted operation, which contributes to reducing operating costs and increasing the efficiency of enterprises.

In the research of G.C. Lima *et al.* (2020), it was noted that the use of sensors for monitoring inventory levels, temperature regimes, energy consumption, and the automation of business process management is an important step in digital transformation. However, this article did not take into account several important aspects that influence the effectiveness of implementing IoT technologies in agriculture, particularly the expansion of IoT network coverage to remote and hard-to-reach regions, as well as improving the energy efficiency of IoT sensors and devices. Limited network coverage in rural areas, where the necessary infrastructure for uninterrupted connection is often absent, can lead to data loss and interruptions in the operation of digital systems, which significantly reduces the effectiveness of remote monitoring and automated management of agricultural processes. To address this problem, the deployment of additional infrastructure is necessary to ensure stable access to an internet connection regardless of geographical location. The use of LPWAN (Low Power Wide Area Network) technologies, capable of transmitting data over long distances with minimal energy consumption, as well as the

integration of 5G networks and satellite internet, can significantly improve coverage quality. Special attention should be paid to the development of autonomous solutions that will not depend on traditional telecommunications operators, for example, the use of decentralised networks based on LoRaWAN or Starlink to ensure a stable connection even in the most remote regions.

Another key aspect is improving the energy efficiency of sensors and IoT devices. According to A.V. Ulyanchenko & S.V. Umanets (2019), modern data collection and processing systems in agriculture must operate autonomously for extended periods, requiring minimal energy consumption and the ability to self-recover after a failure. Traditional accumulators and batteries discharge quickly, leading to the necessity of regular technical maintenance and replacement, thereby increasing operating costs. Addressing this problem requires investing in the research and development of new power technologies, including the use of energy-efficient microcontrollers, solar panels, thermoelectric generators, and other alternative energy sources. Furthermore, an important direction is the creation of intelligent energy management algorithms that will allow sensors to enter power-saving mode during idle periods and activate only when data collection is necessary. IoT equipment forms the basis for monitoring soil and field conditions. In Ukraine, sensors such as the Netatmo Weather Station are used, which cost 100 USD/ha. For field monitoring, DJI Phantom 4 drones are employed at a price of 50 USD/ha.

Compared to international solutions, for example, Venture Sensors in the Netherlands costing 120 USD/ha and DJI Mavic 2 Pro in the USA costing 100 USD/ha, the selection of Netatmo Weather Station and DJI Phantom 4 allows for a cost reduction of 30%-40% (Rodino *et al.*, 2023). This provides a similar level of accuracy and functionality but at a more accessible price, which is important for large agricultural enterprises in Ukraine. Big data analytics also plays a key role in modern agronomic production. For data processing in Ukraine, IBM Watson Analytics is used, with a base cost of 50,000 USD and additional scaling costs up to 30,000 USD - 60,000 USD. This solution is economically advantageous compared to similar

platforms such as SAP HANA in the USA, which costs around 70,000 USD (Usenko *et al.*, 2024).

The cost of scaling IBM Watson Analytics in Ukraine is 20%-25% lower, which allows for access to powerful analytical capabilities at reduced costs. The choice of an ERP system is also important for integrating all aspects of agricultural enterprise management. In Ukraine, Odoo Enterprise is used, with a base cost of 30,000 USD - 60,000 USD. This solution is advantageous compared to SAP ERP in Europe, which can cost up to 100,000 USD. Odoo Enterprise provides 40%-50% lower costs while retaining high functionality and flexibility, which is important for different types of agricultural enterprises in Ukraine (Lodhi & Shah, 2024).

Automation of agronomic processes is an important step towards increasing productivity. In Ukraine, automated John Deere 8R tractors and Netafim Drip Irrigation systems are used. The cost of these solutions is 300 USD/ha. This is 15%-20% cheaper compared to similar models, such as the Case IH Magnum in the USA, and irrigation systems in Australia. Choosing these solutions allows for cost reduction while maintaining high efficiency of agronomic work. Digital platforms for monitoring and managing agricultural enterprises, such as FarmLogs, cost from 10,000 USD to 25,000 USD (Ulyanchenko & Umanets, 2019). This solution is 30% cheaper compared to Ag Leader's SMS in the USA, which costs up to 30,000 USD. FarmLogs provides the necessary functionality for real-time monitoring at lower costs, which is particularly important for the operational management of agricultural enterprises in Ukraine (Kopytko & Kopytko, 2024).

Researchers V. Halanets *et al.* (2023) found that the use of AI/ML algorithms for analysing large volumes of data in the field of trade and entrepreneurship significantly increases the accuracy of forecasting market trends and consumer behavioural patterns. However, this study did not investigate the issue of improving interoperability between different AI/ML systems, nor did it sufficiently address the issue of lowering barriers to the implementation of AI/ML technologies in small and medium-sized enterprises, which are important components of the modern business environment. Addressing

these shortcomings in practice requires a comprehensive approach that covers both the technical and economic aspects of implementing AI/ML technologies in various sectors. One of the key challenges is the absence of unified standards for data exchange between different artificial intelligence and machine learning systems. The lack of a single protocol complicates the integration of various AI/ML-based solutions and leads to data fragmentation, limited compatibility between platforms, and difficulties in system scaling. The development of universally accepted standards for data transmission, storage, and processing is a critically important condition for increasing the effectiveness of AI/ML solutions. This will ensure seamless interaction between platforms, reduce the costs of adapting different systems to each other, and improve the accuracy and speed of decision-making based on the analysis of large datasets.

In the article by S. Bushuyev *et al.* (2022), the principles of utilising blockchain to ensure transparency in trade and supply chain traceability are highlighted. Specifically, the authors note that blockchain technology can provide secure and immutable data storage, allowing all participants in the supply chain (from producers to end consumers) to track the origin and quality of goods. In modern practice, blockchain, within the digital transformation of enterprise management, enables the creation of detailed records for each stage of production and product delivery, including data on materials used, storage conditions, and transportation, which enhances trust in products and minimises the risk of fraud. In particular, the reviewed study also states that the implementation of blockchain contributes to reducing administrative costs and increasing the efficiency of business processes through the automation of document exchange and verification of information authenticity. However, this research does not sufficiently explore the issue of creating global standards for the use of blockchain in trade, nor does it fully investigate the integration of blockchain technologies with other digital platforms.

In the study of S. Jiang *et al.* (2022), the mechanism for creating electronic markets for selling agricultural products is considered, which contributes to reducing the number of

intermediaries and provides direct access for producers to end consumers. This allows for reducing the costs of selling agricultural products, increasing business competitiveness, and expanding opportunities for entering global markets. However, the mentioned research does not sufficiently cover two key aspects that significantly affect the effectiveness of digital platforms: accessibility for small enterprises and transaction security. Increasing the accessibility and ease of use of digital platforms is critically important for small businesses, as this category of enterprises faces the biggest barriers to implementing the latest technologies. The problem lies in the high cost of implementing electronic markets, the complexity of technical platform setup, and limited internet access in some regions. As a result, small enterprises that have easy-to-use mobile applications for conducting digital trade demonstrate a higher level of engagement in e-commerce and improved financial performance. Accordingly, the necessary solution is the development of mobile applications adapted for use even in regions with an unstable internet connection. The use of offline mode, data caching, and traffic optimisation technologies allows for significantly expanding the coverage of digital platforms.

Another important aspect is ensuring the stability and security of transactions on digital markets for the sale of agricultural products. The absence of effective cybersecurity mechanisms can become an obstacle to the development of electronic markets, as enterprises fear fraud, leakage of confidential data, and the unreliability of financial operations. Research results indicate that the implementation of modern cryptographic algorithms, multi-factor authentication, and blockchain technologies allows for a significant reduction in risks associated with the security of digital markets. The addition of artificial intelligence technologies for monitoring suspicious activities in real time provides an additional layer of protection for financial operations and user data. As a result, to increase the effectiveness of electronic markets, it is necessary to focus on improving digital platforms, taking into account the needs of small businesses, as well as developing additional security measures that will guarantee the

security of transactions. This ensures wider access to e-commerce, increases entrepreneurs' trust in digital platforms, and promotes their active development.

In the article by T.T. Sundari (2018), the issue of applying electronic business resource management systems is considered, specifically in the sphere of trade and entrepreneurship. The author emphasises the expediency of implementing digital systems for the effective management of enterprise assets, such as financial resources, inventory, and logistics. However, this research does not sufficiently address the issue of creating integrated systems that cover all aspects of resource management, nor does it explain precisely how the increase in data accuracy and the reduction of costs for its collection and processing should be ensured.

As a result of this discussion, it follows that the formation of a mechanism for the digital transformation of the management of Ukraine's agricultural sector development involves the implementation of effective solutions that allow for a significant reduction in costs and the optimisation of resource utilisation. A cost reduction of 20%-50% in different categories makes these solutions economically justified and contributes to increasing the competitiveness of the Ukrainian agricultural sector. At the same time, there are several challenges related to the integration of digital technologies. Ignoring aspects of integration can lead to a decrease in overall enterprise management efficiency, increased costs and risks, and the loss of competitive positions in the market. To eliminate these problems, it is necessary to develop universal platforms for integrating business resource management systems and also improve technologies for automated data collection and analysis to enhance information accuracy and reduce the costs of its processing. At the international level, there is diverse experience of digital transformation in the agricultural sector. In the USA, Germany, and Canada, a high level of technological integration contributes to significant improvements in productivity and resource management, although this is accompanied by high costs and a need for qualified personnel. In contrast, in Ukraine, the integration of digital technologies is at a developing stage. The main advantages include

increased competitiveness and optimisation of production processes; however, the challenges related to cybersecurity and access to network infrastructure remain significant. The use of digital platforms, such as Bayer Digital Farming and AGCO Agribusiness, contributes to increased production efficiency but requires significant investments and qualified specialists. IoT systems, such as John Deere Field Connect, provide monitoring of growing conditions and cost reduction; however, problems with cybersecurity and integration exist. Artificial intelligence and machine learning technologies, applied in FarmLogs and Climate Corporation, allow for yield forecasting and process optimisation but are dependent on data quality and ethical considerations. Blockchain technologies, such as IBM Food Trust, enhance supply chain transparency; however, their application is accompanied by high costs and regulatory complexities. Electronic financial systems, for example, PayPal for Farmers, expand access to finance, although their implementation is limited by regulatory barriers and a lack of unified standards.

Thus, the effective implementation of IoT in the agricultural sector requires a comprehensive approach that includes both the development of network infrastructure and the improvement of hardware, particularly sensors with low energy consumption. Addressing these issues will contribute to increased monitoring accuracy, optimisation of resource utilisation, reduction of crop losses, and the creation of sustainable agricultural ecosystems that meet the requirements of modern high-tech agriculture.

## CONCLUSIONS

The stated aim was achieved through the development of a mathematical model for the mechanism of digital transformation of Ukraine's agricultural sector management, which takes into account the integration of IoT, AI, ML, blockchain, and digital platforms. In the course of the research, all set objectives were fully completed. Within the scope of the study, existing digital technologies and their impact on the development of the agricultural sector were evaluated, and a mechanism for implementing digital solutions that contribute to automation, increasing management efficiency, and optimising resource utilisation was proposed. The

results obtained confirm the economic feasibility of digitalisation, which ensures increased productivity and competitiveness of Ukraine's agricultural sector. Based on the conducted research, a mechanism for the digital transformation of agricultural sector development management in Ukraine was developed, which includes digital platforms, IoT, AI, ML, and blockchain. The results showed that in Ukraine, the integration of digital technologies is at a developing stage, with advantages in increased competitiveness; however, problems with cybersecurity and access to communication exist. The analysis of costs for the digital transformation of Ukraine's agricultural sector shows that total costs range from 18,900,110,000 USD to 18,900,195,000 USD. These costs include the base cost of infrastructure, additional costs for big data analytics, and digital platforms. The minimum costs take into account the lowest estimates for digital platforms and analytics, while the maximum costs reflect the highest possible expenditures. A cost reduction of 20%-50% compared to international counterparts makes these solutions particularly attractive for Ukraine, as the implementation of technologies will ensure increased productivity and efficiency of resource management. The results obtained indicate a significant potential of digital technologies in increasing the productivity and efficiency of agricultural sector management, although implementation requires overcoming challenges, particularly in the sphere of cybersecurity and access to technologies. All set tasks were completed, which allowed for evaluating the effectiveness of digital transformation mechanisms and determining the economic feasibility of their implementation. The developed mechanism was based on economic modelling and took into account the costs of implementing digital technologies, scaling, and resource optimisation. One of the key aspects provided for in this mechanism is the integration of IoT solutions that ensure monitoring of growing conditions, effective irrigation management, and automation of production processes. The use of sensors and drones allows for reducing the costs of field processing and ensuring accurate yield forecasting. Big data analytics and ERP systems contribute to increasing the efficiency of agricultural enterprise

management and reducing resource losses. The proposed mechanism operates based on mathematical models that allow for minimising costs while maintaining maximum yield. The calculations took into account historical data, climate forecasts, soil conditions, and the level of resource utilisation. Yield forecasting is carried out based on machine learning algorithms, allowing farmers to make optimal decisions in real time. Automation of operations involves the use of digital platforms that integrate all management processes, providing access to key data in real time. The mechanism for implementing digital solutions will ensure resource optimisation, process automation, and increased productivity, which is confirmed by the mathematical model and economic calculations. Thus, the research results confirm the feasibility and effectiveness of the proposed approach to the digital transformation of Ukraine's agricultural sector.

Prospects for further research include an analysis of how high initial investments can be offset by significant long-term benefits (assuming that the implementation of modern technologies can substantially increase the efficiency of agricultural enterprises management and reduce costs); and how the choice of affordable equipment models helps to reduce overall project costs (assuming that investments in digital transformation are economically advantageous and contribute to the sustainable development of the agricultural sector).

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## **Формування механізму цифрової трансформації управління розвитком аграрного сектора України**

**Анотація.** Цифрова трансформація аграрного сектору України є стратегічно важливим напрямом розвитку, що забезпечує оптимізацію управлінських процесів, зниження виробничих витрат і підвищення продуктивності сільськогосподарських підприємств. Метою статті була розробка механізму цифрової трансформації управління розвитком аграрного сектору на основі сучасних технологічних рішень та їх економічної ефективності. Для досягнення цієї мети використано бібліографічний та контент-аналіз, методи економічного прогнозування, математичне моделювання витрат на цифровізацію, а також статистичні методи оцінки ефективності впровадження цифрових технологій. У ході дослідження встановлено, що основні механізми цифрової трансформації включають цифрові платформи, Інтернет речей (IoT), штучний інтелект (AI), машинне навчання (ML), блокчейн і ERP-системи. Загальні витрати на цифровізацію аграрного сектору України оцінено в межах \$18,900,110,000. Найбільші фінансові вкладення спрямовані на автоматизацію процесів (\$12,600,000,000), зокрема на роботизовані системи для збору врожаю (\$4,200,000,000), автоматизовані трактори (\$4,200,000,000) та системи зрошення (\$4,200,000,000). Вартість впровадження IoT-обладнання, включаючи сенсори для моніторингу ґрунту та погодних умов, дрони для аерофотозйомки та системи автоматичного збирання даних, становить \$6,300,000,000. Інвестиції в аналітику великих даних та AI-алгоритми складають \$50,000-\$60,000 за систему, а ERP-системи оцінюються в \$30,000-\$60,000. Розрахунки показали, що середня вартість цифровізації одного гектара аграрних земель варіюється від \$450 до \$1,000, залежно від рівня технологічної інтеграції. Запропонований механізм цифрової трансформації передбачає інтеграцію IoT-обладнання, автоматизованих систем, блокчейну та аналітичних інструментів у єдину систему управління аграрним сектором. Його впровадження дозволить знизити виробничі витрати до 20-35 %, збільшити продуктивність на 15-25 % і скоротити втрати врожаю на 10-18 % завдяки точному землеробству та аналітичному прогнозуванню. Практичне значення дослідження полягає у використанні розробленої моделі для державного планування цифровізації аграрного сектору, оптимізації витрат на сільськогосподарське виробництво та підвищення конкурентоспроможності

**Ключові слова:** економічна модель; інтеграція; новітні технології; автоматизація; Інтернет речей; оптимізація витрат; підвищення продуктивності



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## Methodology for researching the banking services market in Ukraine

**Abstract.** Any modern scientific study of the problems of socio-economic development, and especially of such complex and dynamic phenomena as the development of the banking services market, requires the development of scientific approaches, methodology, and modern research methods for their analysis and forecast. The purpose of this study was to develop theoretical approaches and methodology for researching this market, to clarify the methodology for analysing the banking services market, and to calculate its total capacity for Ukraine. The study was mainly theoretical and methodological, and therefore general scientific methods were employed: deduction (for the general logic of the study), analysis (for the classification of market segments), comparative analysis (for clarifying the conceptual apparatus), and induction (for drawing conclusions). The special research methods included statistical methods (analysis of dynamic series, structural analysis to calculate the capacity of the Ukrainian banking services market and its segments). The study clarified the terminology – “banking service”, “banking services market”, proposed to divide the banking services market into active and passive segments for an in-depth study of the market conditions and factors influencing them in each of these segments, developed a methodology for calculating the capacity of the main segments of this market with consideration of Ukrainian banking statistics. The capacity of the passive and active banking services segments of Ukraine was calculated, which helped to calculate the total capacity of the market for basic banking services, as well as to determine Ukraine’s place in the global market and to identify the most influential factors affecting the situation. This study was the first to calculate the capacity of the Ukrainian banking services market in terms of value for 2018-2024 and outlined measures for its development for the future until the end of the war and for the post-war period. The practical value of this study is that the author’s approach to the methodology for calculating the capacity of the key market segments can be used for other segments

**Keywords:** theoretical and methodological foundations; system analysis; market capacity; bank deposit services; bank lending services; segment analysis of the market

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## INTRODUCTION

The global banking services market is one of the fastest growing markets. As of the end of 2023, its capacity, according to the estimates of the international research company Market Research Future (n.d.), reached almost 36 trillion USD, and by 2032 it could reach 48 trillion USD. For Ukraine, which is only forming its market, the urgent problem is to create it based on a developed banking services market, which will result in free access of legal entities and individuals to modern banking services, increase the banking system's profits, and create a financial resource for economic recovery. In terms of methodology, it is vital to have a proper approach to determining the size of this market, its segmentation, identifying factors influencing the market, and methods of shaping its environment. The more adapted the Ukrainian market becomes to the global market, the wider the range of problems that need to be solved by scientists.

The situation on the Ukrainian banking market is quite dynamic and depends on the factors that are most influential at the time of analysis. V. Kovalenko & B. Dadashev (2015), studying the consequences of the financial crisis of 2008-2009, noted the strong impact of globalisation on the development of the Ukrainian banking market. The researchers proposed conceptual approaches to the dynamic development of this market and reduction of the risks of new crises, which were to some extent considered in the strategies of the National Bank of Ukraine (NBU) for the future. I.V. Tsaplyuk & O.S. Klymenko (2020) analysed the activities of the Ukrainian banking system in the "covid" period of 2019-2020. The researchers showed that one of the possible ways out of such crises may be the introduction of innovative banking services to increase the competitiveness of banks. V. Kostyuk *et al.* (2024) addressed the significance of digital progress in the banking sector, and the increased focus on the digitalisation of remote banking services. The researchers emphasised the need to introduce changes in customer service mechanisms. N. Trusova & O. Melnyk (2024) proved that the modern paradigm of financial market development in the innovative environment of digital meta-space technologies markedly simplifies and ensures the reliability

of the settlement system, improves interbank settlements and payments through payment systems. The researchers proposed a model of the influence of the digital acceleration index on the change in GDP of Ukraine. The collective study by O. Mandych *et al.* (2023) is one of the few that contains elements of a methodology for studying financial relations in the field of digital adaptation and innovative development of banking services and creating a basis for modelling forecast scenarios for the development of the banking sector. L. Shirinyan & A. Shirinyan (2017) analysed the activities of banks in the financial services market of Ukraine. The researchers proposed a methodology for a comprehensive assessment of the openness of banking and insurance markets and developed a classification of market types according to the openness criterion. The researchers noted that the banking market of Ukraine at the beginning of the 21<sup>st</sup> century was characterised as open and dependent on external and internal factors. L. Alekseenko & N. Dvigun (2011) emphasised that the methodology for researching the market of financial services, including banking services, should be based on a comprehensive analysis of concrete financial mechanisms, methods of operation of regulatory institutions, and changes in the investment climate trends in the country. Particular attention, in the researchers' opinion, must be paid to improving the financial monitoring mechanism, factoring in the priorities and contradictions of existing rules and regulations. L.A. Bondarenko & O.I. Zhuk (2013) noted that research on financial market issues should be based on an adequate methodological framework, and that the very term "financial market" should be correctly defined, as its interpretation continues to be controversial. Notably, the definition of the banking services market and the distinction between banking operations and services are still equally controversial among researchers. There have been fewer recent publications on the theory and methodology of studying this market and on the methodology for calculating its capacity. Therefore, there is no accurate measurement of the factual capacity of the Ukrainian banking services market.

The purpose of the present study was to define the theoretical and methodological foundations for analysing the banking services market and calculate its total capacity in Ukraine. The objectives of the study were to clarify the essence of the terms “banking service” and “banking services market”, to develop methodological approaches to determining the capacity of the key segments of this market, to calculate their dynamics and structure over the past five years. The originality of the study lies in the fact that it presents an original methodological approach to calculating the market capacity, which differs from the methodological approaches of other Ukrainian researchers, and which helped to more accurately determine the capacity of the Ukrainian banking services market in terms of value.

## MATERIALS AND METHODS

This study was based on the principles of neoclassical and neo-Keynesian theories, which analyse market conditions from the standpoint of the ratio of supply and demand on them, the simultaneous influence of many factors on the situation, while market regulation was considered from the standpoint of the state's influence on this ratio to form a growth economy. The study used data from the websites of the National Bank of Ukraine (Main indicators ..., n.d.). To calculate the market capacity, the indicators of the Ukrainian banks for 2018-2024 were used (information on deposits of business entities, individuals, non-bank financial institutions in the banking system; information on loans to public authorities, business entities, individuals, non-bank financial institutions, and investment services). The Law of Ukraine No. 2121-III of 2000 on Banks and Banking was used. Other materials used in the study included the Directive 2002/65/EC of the European Parliament and of the Council of the European Union (2002), materials of the international research company Market Research Future (n.d.).

The study employed dialectical, comprehensive, and systematic approaches to analyse the banking services market. General scientific methods were applied, namely, deduction – in the general structure of the study, analysis – in the classification of market segments, in the

comparison of theoretical definitions, induction – in the formulation of conclusions. Special research methods, mainly statistical, were employed to calculate the factual market capacity in terms of value, to characterise the dynamics and structure of the deposit and credit segments of the Ukrainian banking market.

The banking services market was analysed from the standpoint of the dialectical, comprehensive, and systemic approaches. The dialectical approach implied consideration of this market as one that has been developing in the country in stages since Ukraine gained independence, gradually acquiring features typical of the markets of developed countries, and integrating into the global market space. The systemic approach helped to consider this market as an element of a higher order system (global, European) and determine its place in it, and at the same time, as one that itself consists of many market segments (according to classification criteria).

The comprehensive approach implied that this market was viewed by different researchers from different perspectives as a complex socio-economic phenomenon. It was essential to identify the least studied aspect. The theoretical and methodological approach to analysing the banking services market was defined as such an aspect. The analysis of the market began with the definition of the essence of a banking service, since the methodology for calculating the total capacity of the banking services market and its segments in Ukraine depended on how it was defined.

## RESULTS

Modern concepts underpinning research methodologies are increasingly moving away from covering the entire spectrum of macroeconomic issues and are gradually focusing on certain key segments of the economy. One of such significant segments of the global and regional economies is the financial market and its crucial element – the banking services market. It is worth concurring with V.S. Lukyanov (2013), who argued that “any theory (especially economic theory) needs a meaningful application. It is intended and should solve specific problems”. The deep financial and economic crisis of 2007-2009 and the COVID-19 crisis forced

economists to abandon the neoliberal paradigm of market self-regulation and replace it with the paradigm of the expediency of using relevant mechanisms of state regulation in case of a systematic violation of market equilibrium to prevent crises promptly. S.V. Kulpinsky (2010), whose study covered the regulation of financial markets after the financial crisis, noted that the financial market of Ukraine at that time was quite liberalised following the standards of developing countries and provided a series of arguments against financial liberalisation. The researcher considered regulation of the banking sector's capital ratios, loan portfolio growth rates, total liquidity, and interest rates to be valuable tools for smoothing the economic cycle.

The full-scale Russian-Ukrainian war has exacerbated the problem of the need for state regulation of financial markets and led to the update of the Macroprudential Policy Strategy of the National Bank of Ukraine (Macroprudential policy strategy..., n.d.). The financial markets sector is playing an increasingly significant role in both the global and Ukrainian economic system. It consists of different segments – banking and non-banking. All these segments are essential and have their specific features in terms of infrastructure, organisation of activities, and regulatory mechanisms. Therewith, the banking segment is crucial in Ukraine in terms of size and impact on social and economic development. Therefore, the present study focused on the banking services market.

The term “financial services”, including “banking services”, has been used in the United States and the European Union since the 1980s, where it meant “any service of a banking, credit, insurance, individual pension, investment, or payment nature” (Directive 2002/65/EC, 2002). However, although this interpretation has been incorporated into EU legislation, discussions among scholars and legislators in different countries are still going regarding the accuracy of this definition, and therefore there is no unambiguous definition of the essence of these concepts. There is no such definition in Ukraine either.

The Law of Ukraine No. 2121-III (2000) as amended on 10 January 2025 does not contain a definition of banking services, but provides

a list of them. The banking services include attracting deposits of funds and banking metals from legal entities and individuals; opening and maintaining current accounts of clients; lending funds and banking metals to individuals and legal entities, including to current accounts. Additionally, this Law states that a bank may also provide financial services such as financial leasing, factoring, providing guarantees, trading in currency values, storage of valuables, cash transactions, cash collection and transportation of currency values, and professional activities in the capital markets.

Ukrainian researchers who defined the essence of banking services can be divided into two groups: those who defined it as a banking transaction and those who considered it as a result of a conducted transaction. The definition of a service as “the result of a banking transaction aimed at satisfying the needs of consumers-clients of a banking institution”, given by V.I. Mishchenko *et al.* (2007), seems to be the most successful, since it, at least, does not identify a transaction with a service, but is its result. This definition is in line with the definition of O. Dzyublyuk (2005), who also considered a service to be the final result, a finished banking product, while operations are a production process, and one cannot but agree with the researcher.

For almost a decade, Ukrainian scholars have been lively discussing the commonality or difference between the terms “banking product”, “banking transaction”, and “banking service”. A.A. Meshcheryakov (2007) comprehensively examined the organisation of a commercial bank's activities and at the same time focused on the essence of a banking product (service). A. Kiselyov (2018) substantiated approaches to the distinction between the terms “banking service”, “banking product”, and “banking transaction”. V.I. Mishchenko *et al.* (2007) analysed almost the entire range of banking operations in Ukraine. L.A. Bondarenko & O.I. Zhuk (2013) studied the essence of the market of banking products and services and substantiated approaches to segmentation of this market. Most scholars agree that these terms are not identical. Therefore, the question naturally arose as to which of them should be legitimately used in analysing the banking services market.

The hierarchy between these concepts was quite successfully outlined by A.A. Meshcheryakov (2007). The researcher defined a banking product as a way of providing services to customers through banking service technology (a set of organisational, informational, financial, and legal measures). At the same time, a banking transaction was viewed as a system of bank actions coordinated by purpose, place, and time. A banking service was presented as a form of satisfying a certain consumer need (for a loan, cash and settlement services, guarantees, purchase and sale and storage of securities, foreign currency, etc). However, this definition of a banking service does not appear to be exhaustive, since the form does not replace its essence.

In the present study, the term “banking service” is derived proceeding from the fact that it is a component of financial services (a broader concept), and therefore, its definition can be a derivative from the more general term “financial service”, but with clarification of its specifics. The author of this study previously defined a financial service as the result of a financial institution’s activities with financial assets, which are carried out in the interests of third parties at the expense of these parties or at the expense of financial assets attracted from other parties to obtain a certain financial result by the institution, on the other hand, a financial service is a good acquired to meet the needs of a particular consumer. Therefore, according to this logic, the economic essence of a banking service is that it is the result of transactions conducted by a banking institution to buy and sell financial assets to create a certain form of good to meet the needs of a particular consumer and at the same time to generate financial results for the bank.

Depending on the way they are rendered, banking services can be active or passive in form. Depending on who is the consumer of the services, banking services can be divided into services for legal entities and for individuals, and depending on the specifics of the banking institution’s activities, services can be classified as conventional (credit, deposit, cash and settlement) and non-conventional (trust, guarantee, and intermediary). Market segments can be formed based on these services. The next step was to define the term “banking services

market”. There is no unambiguous definition here either, as the market is viewed by different scholars from different perspectives. In the present study, the banking services market was considered as a system of economic relations between banks and their customers to provide the latter with a range of banking services on a paid basis to meet their needs and generate bank profits. The most significant thing in this definition is that these relations are commercial in nature and their result should be calculated in monetary terms.

The author of this study finds it quite relevant to clarify the definitions, considering that most scientific publications on the banking services market, instead of indicators of market conditions (supply, demand, market capacity, price of services), consider the activities of banks and the banking system, operating on the analysis of banks’ assets and liabilities, banking operations. This was observed in the publication of I.V. Tsaplyuk & O.S. Klymenko (2020), who, albeit considering the banking services market as a sphere of economic relations, the function of which is to balance supply and demand, did not analyse their trends and correlations. The study on the analysis of the current state of the banking services market in Ukraine (Martsenyuk-Rozaryonova & Shmigelska, 2018) also did not contain calculations of the Ukrainian market capacity. O.O. Dremlyuga (2023) analysed the dynamics of Ukrainian banks, revenues and expenses from rendering banking services in 2017-2020 on the example of Privatbank, and even though this bank occupies a prominent place in the banking market, it cannot represent the entire range of services of the country’s banking market. The above-mentioned types of analysis are essential for assessing the performance of the banking system of Ukraine, but methodologically they are not directly related to the analysis and forecast of the banking services market conditions stated in the titles of their publications.

In the context of clarifying the methodology, passive bank transactions are broader in scope than banking services: they include not only transactions related to the provision of banking services, but also liabilities of banks that must be paid at a certain time in the future, as well as

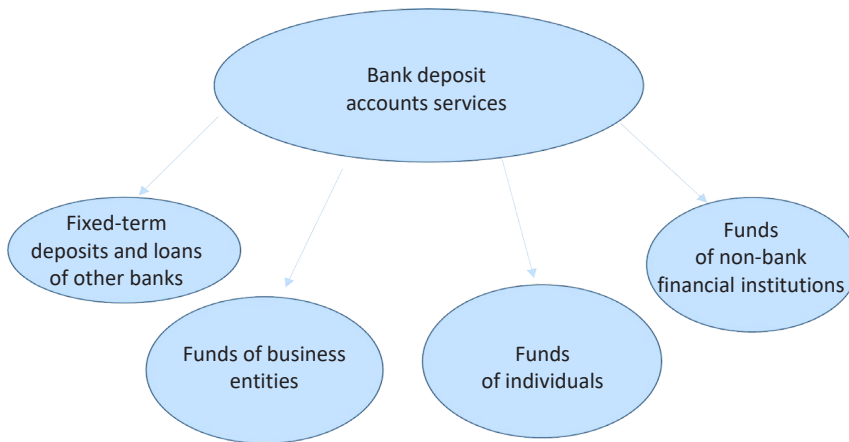
capital formation transactions. Proceeding from the author's definition of "banking services" above, all non-commercial transactions should be deducted from the amount of liabilities of the banking system to obtain the value of passive services. Analogous methodological caveats apply to active operations: these include not only lending and securities trading services, but also provisioning operations, which are clearly not related to fee-based services, as they are intra-bank transactions. The conventional analysis of the banking system's assets and liabilities does not provide a correct understanding of what changes can be expected in the market environment (especially in price) in the future when the supply and demand ratio changes; what regulatory methods should be introduced in the banking market segments, as the situations in these segments may differ.

Thus, having defined the conceptual apparatus of the banking services market and clarified the methodology for calculating the capacity of these services, it is essential to determine what the methodological framework for researching the banking services market should be from the standpoint of dialectical, comprehensive, and systemic approaches so that the analysis indicators are comparable. First of all, it is necessary to determine the place of a particular country's market in the global or European system or in comparison with the markets of neighbouring countries to determine the scale, the degree of integration of this market into higher-order systems, and the degree of influence of external factors on the regional market. It is vital to establish the vector of dynamic changes in the subjectivity of market participants (sellers and buyers of services). The market under study should be segmented, which will help to understand that it is not homogeneous, and therefore, its segments may develop in distinct vectors, at different speeds, creating an imbalance in a certain period. It is advisable to analyse the structure and dynamics of supply and demand by segments of the banking services market (usually, central banks publish balance sheets); analyse the ratio of supply and demand in the segments. It is significant to analyse the dynamics of the price environment in certain market segments and identify the factors that influenced it. With

the analysis by segments, it is possible to summarise the capacity of the aggregate banking services market to compare it with other submarkets that perform analogous functions in the internal market or with an analogous market of a higher hierarchy.

When forecasting the banking services market, it is advisable to use additional information materials, such as quarterly surveys (Survey on bank..., 2024; Consumer sentiment index..., 2024; Press release..., 2024), which are conducted by the Info Sapiens Research Agency on behalf of central banks, including the NBU. This allows obtaining more accurate indicators of the capacity of the credit services market for the future. The banks' resource base (liabilities) is created using the banks' own capital and attracted and borrowed funds. It is formed primarily by deposits from bank customers (business entities, individuals, and non-bank financial institutions) and time deposits from other banks and loans received from other banks (Fig. 1). Thus, deposit services are the market demand of the banking system for the money resources of its customers. The market supply in this market segment should be considered the total supply of deposits from different groups of depositors (individuals and legal entities) for different terms and conditions.

Strictly adhering to marketing approaches, supply and demand should be considered not so much the amount of funds from factual transactions (reflected in the balance sheet of the banking system for a certain period) as potential opportunities to buy and sell financial assets in the market under certain conditions. This approach should be used when forecasting for the future, especially the price environment of the banking services market, because the vector of price changes for banking products in a particular segment will depend on how the supply and demand ratio develops. When assessing dynamic and structural changes over the past periods, it is permissible to consider the values of deposit banking services recorded in the NBU's balance sheets for the relevant years as the actual volumes of this submarket's capacity in the conditions of the achieved balance of interests of customers and banks. The present study used precisely such an approach.



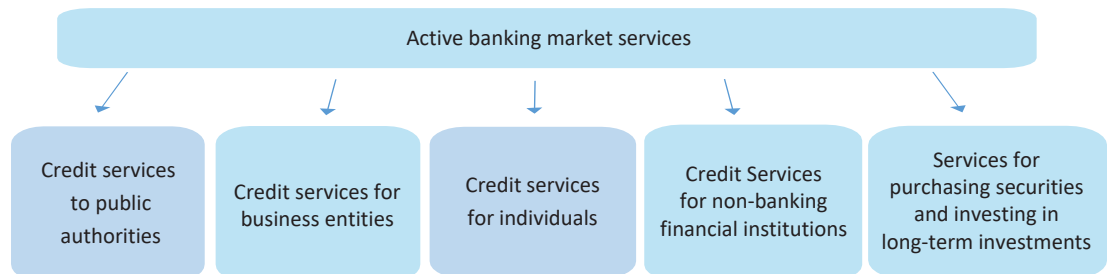
**Figure 1.** Composition of deposit banking services

**Source:** developed by the author of this study

The active services market segment is formed mainly by lending services, securities trading services of banking institutions, and long-term investments. The factual volumes of active services provided by banks were taken in the study as the market capacity in equilibrium at the end of the annual period. The provision of credit services by banks forms the factual banking supply, which will always be less than the lending capacity, based on the availability of the resource base and the possibility of its reduction due to a decline in the creditworthiness of customers. The demand for credit services from customers is determined by their needs and their willingness to take out loans on certain conditions. As a rule, demand is higher than the supply of banking services. The worst situation from the standpoint of market development is one where service consumers have no interest

in increasing their demand for credit services and banks are unwilling to increase their supply due to increased risks.

The segmentation of the active banking services market by customers is significant for analysing it, as presented in Figure 2. The rate of growth of demand and supply, and the changes in their ratio in the deposit and lending segments of the banking services market, will determine the pricing situation in these segments. Additionally, the price environment will strongly depend on the type of competition prevailing in the banking services market (Shirinyan & Shirinyan, 2017). Therefore, an increase in the degree of monopolisation in the internal banking market is not desirable, as it leads to overpricing of services. The worst type of competition is considered to be when large banks compete with small ones in the same market segments.



**Figure 2.** Segments of the active banking services market by consumer

**Source:** developed by the author of this study

Having considered the methodological foundations for studying the banking services market, it is necessary to describe its development in Ukraine. According to the dialectical approach, the Ukrainian banking market is viewed as having less than thirty years of history, having experienced several crises and military upheavals during this brief period. Therewith, financial analysts assess it as a dynamically developing market in terms of both quantitative and qualitative indicators. According to the systemic approach, the Ukrainian market is considered to be a part of the global and European markets, as from the very beginning of the formation of the financial services market, including banking, in sovereign Ukraine, a course was taken to bring national regulations closer to EU rules and international standards; to improve the level of service provision and to protect consumer rights. To integrate the Ukrainian financial market into the European and global financial space as quickly as possible, the National Bank of Ukraine cooperates with the supervisory authorities of the EU member states, the European Banking Authority (EBA), the European Central Bank (ECB), the International Monetary Fund (IMF), the World Bank Group, and cooperated with the United States Agency for International Development (USAID) (Macprudential policy strategy..., n.d.). Integration into the global financial space, on the one hand, has made the Ukrainian market quite dependent on global processes, and on the other hand, it helped to overcome the financial crisis of 2008-2009, the COVID-19 crisis, and is helping to overcome military challenges in the country (2014, 2022-2025). Ukraine's banking system is adapted to the new environment and has the appropriate infrastructure and tools to not only survive, but also stay capable of further development.

To clarify the place of the Ukrainian banking market in the global system, it is sufficient to compare its size with the capacity of the global banking market. The international research company Market Research Future has determined the total capacity of the global banking market at 36,550 billion USD, and forecast for 2032 – 48,030 billion USD, with an average annual growth rate of 4.55% in these

years (Market research future, n.d.). According to the calculations of the author of the present study, the share of the Ukrainian market in 2023 did not exceed 0.35% of the global market capacity (129.1 billion USD), meaning that the Ukrainian banking market is still so narrow that it is hardly recognisable on the global market. The dominant markets in the world today are North America, Europe, and the Asia-Pacific region. The European banking market is expected to grow at a slightly slower pace (2.94% per annum) from 2025 to 2029 compared to the global market (Banking-Europe. Statista, 2024). The European market is expected to reach 1,370 billion USD in 2029. The share of the Ukrainian banking services market will also grow at a higher rate, as the capitalisation of the banking sector is increasing even in a full-scale war, and the reference point in the Ukrainian market is rather low, the demand for banking services in the post-war period is likely to grow due to the partial return of the population from emigration and the expansion of banks' capabilities (Kostyuk *et al.*, 2024). The decrease in the number of banking institutions in the Ukrainian market (by 2-3 units annually) has not worsened the situation with the rendering of services to customers, as the most stable viable banks have stayed in the market, in which customers have confidence, while the provision of services online does not tie consumers to a particular location or institution and expands the range of digital services (Mandyk *et al.*, 2023; Trusova & Melnyk, 2024). The capacity of the Ukrainian banking services market is determined by how much resources are generated by the banking system through the system of passive banking services, mainly through deposit services. The latter should be included in the analysis: Fixed term deposits of other banks and loans received from them, funds of business entities, funds of individuals (including savings certificates), and funds of non-bank financial institutions.

According to Table 1, all segments, except for fixed-term deposits of other banks, have a long-term trend of submarkets expansion. Thus, the submarket for services to business entities grew from 406 billion UAH in 2018 to 1,497 billion UAH in 2024, a 3.7-fold increase.

The retail deposit submarket increased from 508 billion UAH to 1,216 billion UAH (2.4 times). Deposits of non-bank financial institutions

held in the Ukrainian banking system increased from 24 billion UAH in 2018 to 66 billion UAH in 2024 (2.8 times).

**Table 1.** Dynamics of deposit services in the Ukrainian banking market, UAH million

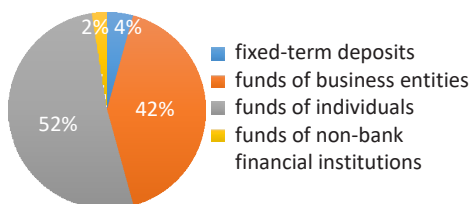
Segments of the deposit services market	2018	2019	2020	2021	2022	2023	2024	2023 to 2018, %	2024 to 2018, %
Fixed-term deposits (deposits from other banks) and loans received from other banks	42,178	23,912	24,235	24,948	6,457	6,763	4,271	16	10
Funds of business entities	406,367	498,157	646,491	758,434	889,526	1,260,156	1,497,363	310	368
Funds of individuals (with savings certificates)	508,457	522,115	681,892	726,898	933,240	1,083,758	1,216,452	331	239
Funds of non-bank financial institutions	23,794	26,885	34,704	41,410	53,188	61,741	66,428	259	279
<b>Total capacity of the deposit segment of the market</b>	<b>980,796</b>	<b>1,071,069</b>	<b>1,387,322</b>	<b>1,551,690</b>	<b>1,882,411</b>	<b>2,412,418</b>	<b>2,784,514</b>	<b>246</b>	<b>284</b>
Chain index of deposit segment capacity	1.00	1.09	1.30	1.12	1.21	1.28	1.15		

Source: calculated by the author of this study based on Main Indicators... (n.d.)

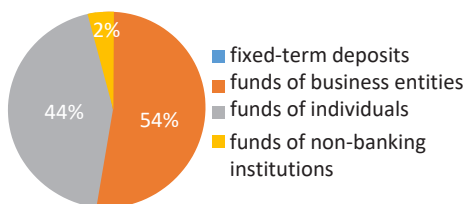
Overall, from 2018 to 2024, the factual total capacity of the deposit banking market increased from UAH 980 billion to 2,784 billion UAH, i.e., 2.8 times. However, as shown by chain indices, this growth was not uniform over the years: it depended on both global influences (COVID-19) and the factor of a full-scale war in Ukraine. The structure of deposit services that form this market is gradually changing, as presented in Figure 3. While in 2018, the retail deposit segment was dominant

and accounted for 52% of the market, it now accounts for 44% of the market, and the submarket for services to business entities has increased from 42% to 54%. The market's deposit services to non-bank financial institutions stayed at the same level (2.4-2.3%). Fixed-term deposits from other banks stayed insignificant and continued to be within 1% (Main indicators..., n.d.). This is a welcome sign, as it means that banks balance their liabilities with assets well and do not need to constantly borrow heavily on the interbank market.

**Structure of deposit services of Ukrainian banks in 2018**



**Structure of deposit services in 2024 of Ukrainian banks in 2024**



**Figure 3.** Dynamic changes in the structure of deposit banking services

Source: developed by the author of this study based on Main indicators... (n.d.)

The second segment of the market for conventional banking services is the segment of active services formed as a result of active banking operations, i.e., operations on placement of resources. The capacity of this market is formed based on lending services provided to bank customers (public authorities, business entities, individuals, and non-bank financial institutions), as well as securities trading services and long-term investments. Importantly, provisions for active operations of banks that are included in the assets of the banking system should not be attributed to credit services.

Table 2 presents the dynamics of active services in the Ukrainian banking market over the period from 2018 to 2024. Based on the resource base of transactions conducted in the country's banking system in 2023, the market for credit banking services and securities trading and long-term investment services totaling 2,831 billion UAH was formed, which was

1.6 times higher than in the baseline period. In 2024, the market capacity reached 2,831 billion UAH. Therewith, the lending segment of the market has in recent years fallen far behind the securities trading segment, which is considered less risky. While in 2018, lending services accounted for 70.0% of active services and securities trading services for 30.0%, during the martial law period in 2023, banking lending services accounted for only 41.1%, while securities trading services increased to 58.9% (Main indicators..., n.d.).

The dynamics of credit banking services for all groups of clients in Ukraine during 2018-2024 did not show an upward trend; conversely, in 2023, a decline of 8% was still recorded, and only in 2024 was an excess of 2% over the base year achieved (Table 2). The analysis shows that the development of this market was highly dependent on the influence of external and internal factors (pandemic, war, falling demand).

**Table 2.** Dynamics of active services of the Ukrainian banking market, UAH million

Segments of the active services market	2018	2019	2020	2021	2022	2023	2024	2023 to 2018, %	2024 to 2018, %
<b>Credit services rendered to all customers including:</b>	1,118,861	1,033,430	960,597	1,065,347	1,036,213	1,024,678	1,138,036	92	102
■ to public authorities	2,865	4,724	11,641	26,973	24,809	18,349	13,077	640	456
■ to business entities	919,071	821,936	749,335	795,513	801,413	783,690	850,581	85	93
■ to individuals	196,859	206,737	199,561	242,633	209,943	222,590	274,276	134	139
■ to non-bank financial institutions	66	33	60	228	48	49	102	74	154
<b>Securities purchase and long-term investment services</b>	480,615	539,466	791,373	829,887	1,022,658	1,466,474	1,692,972	305	352
<b>Total capacity of the active services market</b>	1,599,476	1,572,896	1,751,970	1,895,234	2,058,871	2,491,152	2,831,008	156	177

**Source:** calculated by the author of this study based on Main indicators... (n.d.)

Substantial changes also occurred in the structure of lending services to major borrowers – businesses and individuals: while in 2018, unconditional preference was given to business

entities (2,831 billion UAH – 82%) rather than individuals (196.9 billion UAH – 18%), in 2023, the amount of loans granted to business entities decreased to 783.7 billion UAH, and their

share in credit services decreased to 71%, while consumer lending, respectively, increased to 352 billion UAH and reached 29%. This indicated that banks were unwilling to risk their assets; and businesses that reduced production in the frontline zone, relocated their businesses, and experienced infrastructure damage during the war reduced their demand for credit services. At the same time, certain groups of the population that found themselves in challenging living conditions slightly increased their demand for consumer loans. However, the overall decline in incomes of the Ukrainian population during the war, the emigration of a large part of the population, and high interest rates on consumer loans (23-25%) prevented the demand for this type of loan from growing more actively. The loss of income by a significant number of households affected their perception of living standards. A survey conducted by Info Sapiens showed that 58% of respondents consider their level of well-being to be lower than average, which is reflected in consumer sentiment (Press release..., 2024). After the start of massive rocket attacks on the territories, consumer sentiment deteriorated, and, accordingly, demand for durable goods declined. According to the NBU, the consumer confidence index in December 2024 was only 71.1; the index

of the current state of respondents was 51.5, and the index of economic expectations for the coming years was 84.2 (Consumer sentiment index..., 2024). These indices are quite low. As a result, consumer demand stays low, which leads to a decrease in demand for unsecured consumer loans and mortgages.

Considering the current situation in the credit market, with significant amounts of macro-financial aid to Ukraine from other countries and international financial organisations (which was distributed mainly through banking institutions in the form of concessional lending services), the country did not experience price shocks in the credit market. From 19.2% in 2018, the weighted average interest rate on all instruments gradually declined to 7.7% in pre-war 2021, rose to 19.8% in 2022 due to the war, and to 26.1% in 2023, but fell back to 16.9% in 2024. In 2025, bank lending rates are likely to increase slightly as the NBU raises its key policy rate to 15.5% to reduce inflation in the country. (NBU monetary policy indicators, n.d.). Throughout this period, the NBU managed to flexibly regulate the cost of money in the market for businesses and households using the key policy rate. Table 3 presents the total capacity of the banking services market by major segments for 2018-2024.

**Table 3.** Dynamics of the total capacity of the market of basic banking services in Ukraine, UAH million

Markets	2018	2019	2020	2021	2022	2023	2024
Passive services	980,796	1,071,069	1,387,322	1,551,690	1,882,411	2,412,418	2,784,514
Active services	1,599,476	1,572,896	1,751,970	1,895,234	2,058,871	2,491,152	2,831,008
Total market capacity	2,580,272	2,643,965	3,139,292	3,446,924	3,941,282	4,903,570	5,615,522

**Source:** developed by the author of this study based on Tables 1 and 2

Table 3 shows that between 2018 and 2024, the passive banking services segment in Ukraine increased by 2.8 times, while the active services segment grew by only 1.8 times. The total capacity of the core banking services market grew from 2.6 trillion UAH on to 5.6 trillion UAH (133.6 billion USD at the exchange rate of 42.039 UAH/USD), i.e., by 2.2 times. These figures are evidence of the active development of the market, despite the unfavourable conditions in the country. Considering the extreme conditions in which the banking services market is

forced to operate at this stage, it is impossible to do without regulating its market conditions.

The need to maintain a balance between passive and active services, a sufficient level of liquidity and profitability of the banking system and the country's economy as a whole in the context of a protracted war prompted the NBU to update the Macroprudential policy strategy of the National Bank of Ukraine (n.d.), a market regulation tool, at the end of 2024. Its purpose was to achieve financial stability in Ukraine in the face of military challenges. The key areas highlighted

in this Strategy were the need to ensure business continuity in a full-scale war; preventing operational risks from turning into systemic risks; concentrating state support on certain segments and categories of borrowers so that preferential lending does not violate general market principles; and reducing the influence of environmental, social, and governance risks on the functioning of financial institutions. Therewith, the mechanisms for regulating the banking services market introduced by the NBU should be comprehensive, protecting borrowers during martial law, but also maintaining the stability of the banking system so that the deposit source does not dry up and bank lending and investment in the post-war economy is not threatened.

## DISCUSSION

The development of the banking services market has been in the focus of many Ukrainian scholars since the formation of this market in Ukraine. Since market transformations began only in the 1990s and continue to this day, the range of these studies has been quite wide – from changing the role and functions of the bank in market conditions; the essence of banking operations, services, and the banking services market; methods of measuring market capacity; market management mechanisms; to the use of digital technologies in customer service. Most of these issues have not lost their relevance to this day, as the scientific discussions on them were not completed at the time.

VI. Mishchenko *et al.* (2007) and A. Nechyporenko (2023) developed the theoretical aspects of the problem of bank activity, considering the diversity and essence of banking operations that have developed in the banking system of Ukraine since its formation, and substantiating a fairly correct definition of a financial service as the result of a transaction. O. Dzyublyuk (2005), in his study devoted to rethinking the essence and functions of a commercial bank in market conditions and the specifics of a banking product and service, offered a comparable definition of a banking service, which is different from a banking transaction. A.A. Meshcheryakov (2007), considering the organisation of a commercial bank's activities, described the hierarchy between a banking product, a banking operation, and a

banking service. In the present study, its author, while clarifying the concept of banking service, relied on the definitions of these researchers, which helped to establish the difference between operations and services and further develop the author's methodology for calculating the market capacity of basic banking services.

Applied aspects of the development of the banking services market in Ukraine in different periods were covered by O.V. Martsenyuk-Rozaryonova & V.V. Shmigelska (2018), who analysed the current state of the banking services market in Ukraine and the directions of its development. L.A. Bondarenko & O.I. Zhuk (2013) discussed the concepts of products and services and offers options for market segmentation by various criteria. The author of the present study also performed an in-depth analysis of the banking services market by segments and then summarised the total market capacity. Scientific publications of the last four to five years have analysed the situation in the Ukrainian banking services market over different periods of development of the Ukrainian banking system. I.V. Tsaplyuk & O.S. Klymenko (2020) addressed the situation in the Ukrainian market in 2019-2020, noting that the globalisation of the world economy leads to dynamic structural and qualitative changes in the banking services market, and one of these notable changes was the expansion of remote banking services.

Transformational trends in the banking system of Ukraine and the transition to digital technologies were widely covered by V. Kostyuk *et al.* (2024). O. Mandych *et al.* (2023) presented elements of the methodology for studying financial relations in the field of digital adaptation and innovative development of banking services. N. Trusova & O. Melnyk (2024) emphasised that the modern paradigm of financial market development in the innovative environment of digital technologies markedly simplifies and increases the reliability of the settlement system and payments through payment systems, and contributes to GDP growth.

M.V. Tymchak & S.Yu. Korol (2023), considering the prospects for further development of the Ukrainian market, noted the growing role of banking institutions in the national lending system and the increasing innovation in the

banking system. The author of the present study agrees with their conclusions that digitalisation of banking services is one of the promising areas for expanding supply and demand in the banking services market, as it reduces the cost of service supply for banks and increases demand for consumers. L. Shirinyan & A. Shirinyan (2017) examined the activities of banks in the financial services market of Ukraine, proposing a methodology for a comprehensive assessment of the openness of banking services markets and presented a classification of market types by the criterion of openness. This is significant for understanding how the price environment in the market is formed.

N. Kravchuk & O. Lutsyshyn (2022), analysing the reality of the functioning of the financial market of Ukraine during the war, concluded that the war strongly affected the functioning of all components of the financial market, and the activities of these institutions were an indicator of the mood in the country, yet despite all the negatives, the war intensified the diversification of tools and methods of work of financial institutions, developed new habits among all market participants. To stay competitive in the global and Ukrainian markets and expand the banking services market, banks should not lose their innovativeness in the coming years. L.A. Bondarenko & O.I. Zhuk (2013) emphasised that research on financial market issues must be based on an adequate methodological framework, and that the very term “financial market” must be correctly defined, as its interpretation is still controversial. It is difficult to disagree with them, as inaccurate definitions of categories lead to inaccurate calculation methods.

Despite the significance of the studies conducted by the predecessor scholars, considering their titles, which refer to current trends in the banking services market, factual calculations of market capacity, supply and demand for banking services are absent or replaced by an analysis of the banking system’s liabilities, assets, and sustainability.

## CONCLUSIONS

The present study showed that the purpose and objectives it set out were achieved. This study confirmed that the terms “banking operation”

and “banking service” are not identical. A banking transaction should be viewed as a system of actions coordinated in terms of place, purpose, and time, aimed at servicing a bank’s customer. It was clarified that the economic essence of a banking service is that it is the result of transactions conducted by a banking institution for the purchase and sale of financial assets to create a certain form of benefit to meet the needs of a particular consumer and, at the same time, for the bank to obtain a financial result from this.

The study also clarified the economic essence of the banking services market as a system of economic relations between banks and their clients regarding the provision of a full range of banking services to the latter on a paid basis to meet their needs and generate bank profits on this basis. Clarification of definitions is essential to correctly determine the size of this market and its segments, as well as the place of the Ukrainian market in the global market system of banking services. Based on the revised definition of a banking service, to calculate the size of the passive services segment, the banking system’s liabilities must be deducted from non-commercial (internal) transactions. Analogous approach must be used to determine the size of the active services market segment: the assets of the banking system must be reduced by the amount of provisions for active operations, as these are purely intra-bank transactions.

The study proposed a methodology for analysing the banking services market and analysed the development of the Ukrainian market in 2018-2024. Ukraine’s banking services market has been formed over the past three decades, has survived several financial crises, has been operating in a full-scale war for over three years, and is dynamically developing and is well integrated into the global and European markets (although the share of the Ukrainian market in the global market is estimated to be only 0.35%). Ukraine’s banking system is adapted to the new environment and has the adequate infrastructure and tools to stay capable of further development. The findings of this study showed that between 2018 and 2024, the passive banking segment in Ukraine increased by 2.8 times, while the active banking segment grew by only 1.8 times. The

total capacity of the core banking services market grew from 2.6 trillion UAH to 5.6 trillion UAH (133.6 billion USD), during this period.

Considering the extreme conditions in which the banking services market is forced to operate at this stage, there is a need for the NBU to regulate its conditions. Regulatory mechanisms must be predominantly market-based and comprehensive, protecting borrowers during martial law, but at the same time maintaining the stability of the banking system, preventing a reduction in the resource base and narrowing of the bank lending and investment segment of the post-war economy of Ukraine.

This study focused on the conventional segments of the banking services market in Ukraine – deposit, credit, and investment. The segment of non-conventional services, which are becoming key in the global banking sector,

requires further investigation. The theoretical, methodological, and practical aspects of determining the capacity of the ancillary services market are promising. There are few such studies in Ukraine, which complicates the assessment of the total market size and prospects for its further development.

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## CONFLICT OF INTEREST

None.

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<https://orcid.org/0000-0002-1628-068X>**Методологія дослідження ринку  
банківських послуг в Україні**

**Анотація.** Будь-яке сучасне наукове дослідження проблем соціально-економічного розвитку, а особливо таких складних і динамічних явищ, як розвиток ринку банківських послуг потребує розробки наукових підходів, методології і сучасних методів дослідження для їх аналізу і прогнозу. Мета даного дослідження полягала в тому, щоби розробити теоретичні підходи і методологію дослідження цього ринку, уточнити методику аналізу ринку банківських послуг та розрахувати його сумарну ємність для України. Дослідження мало, переважно, теоретико-методологічне спрямування, тому використовувалися загальнонаукові методи: дедукції (для загальної логіки побудови дослідження), аналізу (для класифікації сегментів ринку), порівняльного аналізу (при уточненні понятійного апарату), індукції (при формулюванні висновків). Із спеціальних методів дослідження використовувалися, головним чином, статистичні методи (аналіз динамічних рядів, структурний аналіз для розрахунку ємності українського ринку банківських послуг і його сегментів). У статті уточнено понятійний апарат – «банківська послуга», «ринок банківських послуг», запропоновано поділ ринку банківських послуг на активні і пасивні для поглибленого вивчення кон'юнктури ринкових сегментів і факторів впливу на неї на кожному з них, розроблено методику розрахунку ємності основних сегментів даного ринку з урахуванням української банківської статистики. Розраховано ємність сегментів пасивних і активних банківських послуг України, що дало можливість розрахувати сумарну ємність ринку основних банківських послуг, а також визначити місце України на світовому ринку і встановити найбільш впливові фактори, що впливають на кон'юнктуру. Вперше розрахована ємність українського ринку банківських послуг у вартісному вимірі за 2018-2024 рр., намічені заходи його розвитку на перспективу до закінчення війни і на післявоєнний період. Практична цінність даного дослідження полягає в тому, що авторський підхід до методики розрахунку ємності основних сегментів ринку може бути використаний і для інших сегментів

**Ключові слова:** теоретико-методологічні засади; системний аналіз; ємність ринку; банківські депозитні послуги; кредитні послуги банків; сегментний аналіз ринку



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## Development of institutional structures of green business in rural areas under European integration and global challenges

**Abstract.** The development of institutional structures for green businesses in rural areas is essential for promoting ecological efficiency, sustainable agriculture, and rural development in response to global environmental challenges. This article examined the interaction between governmental bodies, local communities, scientific institutions, and the business sector in shaping

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the institutional architecture of green business. The impact of European integration processes and the European Green Deal on the development of ecological entrepreneurship in Ukraine is analysed. Particular attention is given to the adaptation of institutional structures to crisis conditions caused by war, as well as their role in restoring the agricultural sector and ensuring food security through the development of organic farming. The study provided a comprehensive analysis of institutions that support the development of green business models, identified key mechanisms for increasing their effectiveness, and offered recommendations to promote the transition to environmentally friendly entrepreneurship. Based on European experience and the implementation of ecological standards, it has been confirmed that the development of ecological entrepreneurship and organic production contributes to the sustainable development of farming enterprises under European integration and global challenges. The research results indicate the active development of the green business in Ukraine, particularly due to state programmes, financial support, and international initiatives, which have contributed to the growth of organic production, increased profitability of farms, and the implementation of environmentally friendly technologies. It has been confirmed that effective interaction between state, financial, educational, and technological institutions facilitates the scaling of green businesses, enhances the economic efficiency of environmental initiatives, and creates new opportunities for the sustainable development of rural areas. The research findings can strengthen institutional structures, foster collaboration among key stakeholders, attract investment, and promote organic production to enhance agricultural competitiveness, job creation, innovation, and environmental sustainability within the framework of European integration

**Keywords:** organic products; green economy; sustainable development; ecological standards; entrepreneurship

## INTRODUCTION

Developing institutional structures for green businesses in rural areas is highly relevant, as this direction aligns with global challenges related to climate change, the preservation of natural resources, and the pursuit of sustainable development. The increasing degradation of soils, loss of biodiversity, and rising greenhouse gas emissions necessitate urgent changes in traditional approaches to agriculture. In this context, green business serves as a crucial tool for harmonising economic, environmental, and social goals.

Institutional structures that regulate and support this sector play a key role in creating favourable conditions for the implementation of ecological technologies, optimal resource utilisation, and the development of rural communities. The formation of an effective institutional architecture that integrates governmental bodies, local communities, scientific institutions, and the private sector supports the integration of Ukrainian farmers into global supply chains for ecological products and enhances their competitiveness.

X. Zhai & Y. An (2020) argued that green development is a crucial driver of global economic restructuring and environmental governance. They emphasised the role of governmental policy frameworks in supporting this process. Their research highlights how institutional structures of sustainable agribusiness are shaped by the Green Deal, which facilitates political and economic adaptations to ensure environmental transformation in the context of European integration and global challenges. Building on this foundation, L. Sas *et al.* (2022) proposed a methodology for assessing the level of technological support in agricultural enterprises, enabling managers to make effective decisions regarding innovation implementation. Their study underscores the importance of this methodology as a tool for the formation of institutional structures in green business, particularly in adapting enterprises to EU standards through technological modernisation. Given global challenges such as climate change and food security, this methodology helps to optimise managerial decisions and

enhances the resilience and competitiveness of the agricultural sector.

The increasing pressure of global economic instability also plays a significant role in shaping institutional responses. O. Priss *et al.* (2023) examined the global food crisis and its implications, demonstrating that rising inflation, critical food price surges, and increasing poverty contribute to worsening global hunger. Their findings reveal that food security issues intensify economic instability, highlighting the urgent need for effective institutional mechanisms to mitigate these threats and ensure sustainable rural development.

Expanding on the role of European integration, A. Dibrova *et al.* (2024) analysed the influence of the European Green Deal on the development of green business. They noted that these processes create opportunities for Ukraine in foreign markets by increasing demand for organic products. Their study highlights the role of niche crops in enhancing farm competitiveness due to lower market competition and the growing demand for sustainable food. Furthermore, they emphasised how institutional structures contribute to social resilience by generating employment, engaging youth in entrepreneurship, and preserving rural cultural traditions. These aspects further demonstrate how the development of green business is intertwined with economic and social dimensions. Regarding the justification of the specific features of “green economy” development, T. Zinchuk *et al.* (2022) rightly emphasised the need to reduce resource consumption and promote “green” economic activities. However, it is important to consider that the effectiveness of these measures will depend on the willingness of agribusinesses to adapt to new environmental standards without losing competitiveness.

When analysing the concepts of sustainable development and the green economy, N. Stoiko (2016) emphasised the importance of adequate institutional support as a foundation for implementing environmentally friendly agricultural methods, which contribute to the preservation of natural capital, the reduction of environmental risks, and the sustainable use of agricultural resources. Their findings indicate that adequate institutional support facilitates

the implementation of environmentally friendly agricultural practices. During wartime and the post-war period, institutional support for green businesses become even more significant. FAO (2023) reported substantial losses of agricultural land and infrastructure due to military actions, necessitating comprehensive recovery solutions. Effective institutional mechanisms should address economic growth, social resilience, and environmental balance in order to restore the agricultural sector. This aligns with the broader need for institutional adaptation in response to global crises.

Under martial law, disruptions in agricultural logistics and land degradation further underscore the importance of developing green businesses. Institutional support ensures food security and the long-term sustainability of natural resources. Consequently, forming a robust institutional framework not only fosters economic growth but also maintains ecological balance and improves living conditions in rural areas. This study aimed to develop theoretical and methodological foundations, alongside practical recommendations, for the formation and advancement of institutional structures that support green business in Ukraine’s rural regions, taking into account contemporary economic, social, and environmental challenges.

## MATERIALS AND METHODS

The study of the “green” transformation of agriculture was grounded in a systemic approach, enabling a holistic analysis of the interrelationship between economic, environmental, and social factors influencing the formation and development of institutional structures supporting green businesses in rural areas. The methodological foundation of the research employed an interdisciplinary approach, integrating theoretical analysis, empirical investigation, and systems analysis.

Primary data sources included official statistics and reports such as Agriculture Statistics... (2024), Farmers of Ukraine (2024), Organic Producers... (2024), and governmental records from the Ministry of Agrarian Policy and Food of Ukraine. Regulatory frameworks and institutional policies encompassed legal acts, environmental standards, and financial instruments

governing green business activity, including state programmes such as the Green Region Programme in Lviv and the Ukrainian State Fund for Farm Support (USFFG). Scientific and academic sources comprised publications from the Institute of Agroecology and Environmental Management of the NAAS of Ukraine and educational materials from the National University of Life and Environmental Sciences of Ukraine (NULES of Ukraine).

Sector-specific case studies supplied empirical data on sustainable agricultural practices, including precision farming (Agrohub, Smart-Farming), organic production (BTU-Center), agroecotourism (Silver Kuripey Farm, Carpathian agro-estates), biofuel production (MHP biogas plants, Ekodrive pellet production), and ecological livestock farming (Molochar organic dairy, Danosha meat producers). Financial and donor support included investment strategies from the European Bank for Reconstruction and Development (EBRD), grants from the United Nations Development Programme (UNDP), and other funding mechanisms facilitating green entrepreneurship. Public and cooperative initiatives comprised programmes led by the Organic Ukraine Association, the Green Basket cooperative, and international environmental organisations such as Green Dossier.

A comparative analysis was conducted to examine international experiences in green business development. The study reviewed Denmark's state-supported organic production system, Germany's cooperative model and bioenergy sector, France's regional branding and eco-certification practices, the Netherlands' application of precision agriculture technologies, Sweden's ecologically oriented agrotechnologies, Italy's agritourism initiatives, and Austria's organic livestock farming model. These examples offered insights into best practices potentially adaptable to the Ukrainian agricultural context.

A systematic approach was employed to evaluate the interplay between formal institutions (legislation, government regulations, financial incentives) and informal institutions (social networks, cooperative frameworks, cultural practices). A case study methodology was used to explore successful models of green business adaptation and resilience, while a

comparative approach assessed the applicability of international experience to Ukraine. Through the integration of these diverse sources and methodologies, the research provided a structured, evidence-based assessment of institutional mechanisms fostering sustainable rural entrepreneurship in Ukraine.

The methodological framework also incorporated qualitative methods to identify the principles, challenges, and opportunities for developing supporting institutional structures of green business in rural areas. Correspondence was established between the domains of green operation business and institutional structures along the value chain (organic agriculture – state regulatory bodies (standards), cooperatives (joint procurement of certified products), financial institutions (grants, subsidies)). Qualitative methods (case studies of successful projects in Ukraine and the EU) were combined with quantitative methods (regression analysis to examine relationships between the level of state support and the effectiveness of green transformation programmes) to support comparative analysis. The potential influence of institutional factors and economic mechanisms on the trajectory of agriculture's "green" transformation was evaluated. The combination of qualitative and quantitative approaches ensured the comprehensiveness and scientific validity of the conclusions and recommendations. The study's results were aimed at establishing a theoretical and methodological foundation for enhancing the effectiveness of green transformation policy in agriculture.

## RESULTS AND DISCUSSION

Green business in the countryside is one of the most promising business models that combines economic efficiency with environmental care, creating conditions for the sustainable development of rural areas. The core of this approach is the introduction of environmentally friendly technologies, rational use of natural resources, and the elimination of environmentally harmful practices, which contribute to the preservation of soil fertility, clean water sources, and biodiversity. Due to its focus on innovation and environmental responsibility, green business not only provides a stable income for rural communities but also strengthens their social sustainability.

The importance of green business is especially evident in the context of increasing pressure on ecosystems and the need to adapt to global climate change, which threatens food security and economic stability. In this context, rural communities engaged in organic farming, biofuel production, or ecotourism play a significant role in decreasing greenhouse gas emissions, reducing energy dependence, and fostering an environmentally responsible economy. At the same time, the development of green businesses contributes to the creation of new employment opportunities, particularly for young people, who increasingly prefer innovative and environmentally conscious forms of work.

This sector also plays a key role in the preservation of cultural and natural heritage as it supports the sustainability of traditional farming methods, which are harmoniously integrated with modern environmental technologies. The green business contributes to

the development of new market opportunities, especially through the expansion of organic farming, which facilitates access to highly profitable external markets where demand for environmentally friendly products is steadily increasing. One of the promising areas within organic farming is the incorporation of biological techniques in crop cultivation, particularly in buckwheat production, which not only improves the ecological quality of produce but also enhances its competitiveness (Karbivska *et al.*, 2024). As a result, green business becomes not only a driver of economic growth but also a crucial mechanism for restoring ecological balance, thereby ensuring the long-term sustainability of rural areas and preserving their environmental potential for future generations. To analyse the system of green business development, it is appropriate to consider the main areas of activity in rural regions and to describe the specific features of each (Table 1).

**Table 1.** Areas of activity of green business in rural areas and their characteristics

Area of activity	Main characteristic	Environmental effect	Environmental effect examples in Ukraine
Organic agriculture	Cultivation of crops without chemical fertilisers, pesticides, or synthetic substances	Preservation of soil fertility, reduction in CO <sub>2</sub> emissions, and conservation of biodiversity	Organic farms: Hals Agro, EtnoProduct
Precision farming	Use of digital technologies to optimise fertiliser application, irrigation, and harvesting	Efficient resource use, and reduction in environmental chemical load	Technology companies Agrohub, SmartFarming
Production of biological products	Manufacture of organic fertilisers, biofungicides, and bioinsecticides	Reduced the use of chemical plant protection agents: lower water and soil pollution	Biological products from BTU-Center
Agroecotourism	Integration of agriculture with tourism services: agrotours, ecofarms, local product tastings	Promotion of ecological lifestyles, rural development, and cultural heritage preservation	Silver Kuripey Farm, agro-estates in the Carpathians
Biofuel production	Processing of agricultural waste (e.g. straw, husk) into biogas, bioethanol, or pellets	Reducing reliance on fossil fuels: lower greenhouse gas emissions	Biogas plants by MHP, pellet production by Ekodrive
Ecological livestock farming	Rearing of animals on natural feed without hormones or antibiotics	Improved consumer health and protection of natural ecosystems	Molochar organic dairy farm, Danosha meat producers
Renewable energy	Use of solar, wind, and hydroelectric power sources in rural areas	Reduced dependence on conventional energy: lower greenhouse gas emissions	Rural solar plants in the Kherson Region, wind farms in the Zaporizhzhia Region
Agricultural waste processing	Composting, production of organic fertilisers, and recycling of crop residues	Waste reduction and prevention of environmental pollution	Composting at the farm Agrofirma Lan, conversion of corn husks into biopackaging

Table 1, Continued

Area of activity	Main characteristic	Environmental effect	Environmental effect examples in Ukraine
Forestry	Cultivation, maintenance, and restoration of forests for sustainable bioresource use	Carbon sequestration, water conservation, and prevention of soil erosion	Certified wood production by Lviv Forestry
Resource-sharing cooperatives	Smallholder associations for shared equipment use, storage, and product marketing	Lower production costs, improved efficiency, and enhanced social collaboration	Cooperative Green Basket, a rural honey association in the Vinnytsia Region

**Source:** systematised by the authors based on Agriculture Statistics... (2024), Farmers of Ukraine (2024), Organic Producers... (2024)

The spheres of activity of green businesses encompass various aspects of agriculture, energy, processing, and tourism. They are aimed at preserving natural resources, enhancing environmental sustainability, and supporting the socioeconomic development of rural communities. Institutional structures of green business in rural areas comprise a set of formal and informal norms, rules, organisations, and mechanisms that regulate the production, social, and environmental dimensions of agricultural enterprises. These include formal institutions (laws, state programmes, environmental standards, financial instruments), informal institutions (local traditions, social practices, cooperative networks), and infrastructure elements (technological platforms, supply and marketing networks for ecological products, scientific and educational institutions) (Stryzhak, 2019).

The development of green businesses in rural areas depends on the interaction of various institutional structures that form a support system for ecological entrepreneurship, facilitate the optimal use of natural resources, and

stimulate sustainable development (Shpykuliak & Bilokinna, 2019). These structures provide regulatory and legal frameworks, financial assistance, scientific and technological support, and social integration. Their interaction creates a complex system capable of adapting to changes in the external environment.

All institutional structures function as parts of an integrated system, where each element performs a specific role and ensures interconnection with others. For example, state bodies create a legal framework supported by financial institutions, scientific bodies develop innovations implemented through technology companies and cooperatives, and market access ensures the economic viability of “green” initiatives. Such a system ensures stability, adaptability, and sustainable growth of the agricultural sector.

Ukraine is actively implementing programmes and initiatives through institutional structures to develop green businesses in rural areas. This is reflected in the activities of specific organisations, their impact on agriculture, and key economic indicators (Table 2).

**Table 2.** Implementation of green business development programmes by institutional structures in Ukraine

Category	Organisation/ Program name	Description/Achievements
<b>State regulatory bodies</b>	Ministry of Agrarian Policy and Food of Ukraine (Ministry of Agrarian Policy)	The Ministry is responsible for the development and implementation of regulatory legal acts governing organic agriculture. In 2023, it launched a programme to support organic farming, covering over 1.2 million hectares of agricultural land. As a result, exports of organic products increased by 15% compared to 2022, generating 260 million EUR for the country
<b>State programmes and initiatives</b>	Green Country Programme	Launched in 2021, this initiative aims to plant one billion trees over three years, supporting ecological businesses such as nursery farms and landscaping enterprises. Over 200 million trees were planted in the first year, creating approximately 5,000 new jobs
	State Support for Organic Production	In 2022, the government allocated 50 million UAH to support organic farms, resulting in a 15% increase in certified organic land and a 10% rise in organic exports

Table 2, Continued

Category	Organisation/ Program name	Description/Achievements
<b>Local government</b>	Green Region Programme in Lviv Region	The initiative aims to develop local eco-farms that receive funding from the regional budget. In 2024, 50 million UAH was allocated to support these farms, contributing to the creation of more than 1,000 jobs and leading to a 12% increase in organic vegetable production
<b>Financial institutions</b>	Ukrainian State Fund for Farm Support (USFFG)	The fund provides financial assistance to farmers who adopt environmentally friendly technologies. In 2023, preferential loans totalling 1.5 billion UAH were issued through the USFFG, which reduced production costs by 10% and increased the profitability of organic farms by 18%
<b>Financial institutions and donor organisations</b>	European Bank for Reconstruction and Development (EBRD)	In 2020, the EBRD provided a 25 million EUR loan to Agrofusion for organic tomato paste production, enabling a 30% increase in output and entry into EU markets
	USAID Agrosilrozvytok Programme	Between 2018 and 2023, this programme invested over 20 million USD in environmentally sustainable agricultural technologies, helping 100 farms adopt green practices, boosting productivity by 25%, and creating 1,500 jobs
<b>Farmers' cooperatives and associations</b>	Organic Ukraine Association of Organic Producers	The association unites more than 200 organic farmers producing goods for both domestic and international markets. In 2023, members sold products worth 1.8 billion UAH, contributing to stable sales and improved product quality
	Organic Ukraine Association	A network of more than 500 organic producers. In 2023, they collectively sold products worth over 1 billion UAH (a 20% increase compared to 2022) and trained 2,000 farmers in organic methods
	Green Basket Cooperative	Established in 2021, this cooperative brings together 50 smallscale farmers for the joint production and sale of ecofriendly products. Over two years, total income rose by 40%, with over 10,000 regular customers
<b>Scientific institutions</b>	Institute of Agroecology and Environmental Management of the NAAS of Ukraine	The institute conducts research in ecological agriculture and develops innovative methods for crop cultivation without synthetic fertilisers. In 2024, the implementation of these methods increased yields by 15% and cut chemical costs by 20%
<b>Educational institutions</b>	National University of Life and Environmental Sciences of Ukraine (NULES of Ukraine)	NULES trains specialists in ecological agriculture. In 2023, the university launched an organic farming programme, enrolling 500 students. Graduates are employed at 40 eco-farms across Ukraine, contributing to greater efficiency in ecological farming
<b>Technology companies</b>	Agrohuh	Agrohuh is a technology company that develops and supplies equipment for precision agriculture. In 2023, its solutions enabled farms to cut fuel and fertiliser costs by 15%, saving over 2 billion UAH
<b>Public organisations</b>	International organisation Green Dossier	This organisation carries out educational activities and promotes environmental standards among farmers. In 2024, more than 100 seminars were conducted, involving over 5,000 farmers, who gained knowledge of environmentally friendly practices
<b>International donors</b>	United Nations Development Programme (UNDP)	In 2023, the UNDP allocated 10 million USD in grants to support the development of organic agriculture in Ukraine. The funding focused on implementing energy-efficient technologies, which reduced greenhouse gas emissions by 12%
<b>Markets for ecological products</b>	Eco-farmer's markets in Kyiv and Lviv	In 2024, these markets facilitated the sale of eco-certified products worth over 1 billion UAH. Their operation stimulates demand for organic goods and encourages farmers to adopt environmental standards in agriculture

**Source:** systematised by the authors based on O. Ryabchyn & D. Kulaga (2023), Farmers of Ukraine (2024), Organic Producers... (2024), O. Panukhnyk *et al.* (2024)

These cases demonstrate how the activities of various institutional structures contribute to the development of green businesses in rural areas in Ukraine, enhancing economic

indicators and ensuring the sustainable development of the agricultural sector. Institutional changes in the agricultural sector of Ukraine significantly affect employment, social

mobility, and youth participation in agriculture. Analysing these aspects is key to understanding the effectiveness of implementing green business and the sustainable development of rural areas.

Analysing investment trends in environmental protection activities is important, as it allows for an understanding of how priorities in the development of green business in Ukraine are changing and also reveals key factors that affect the success of such initiatives in rural areas. Studying the dynamics of investment and changes in support for environmentally oriented projects during the war provides valuable insights into the adaptation of institutional structures and mechanisms that support sustainable

development in agricultural and rural areas. These insights help to inform strategies for the restoration and strengthening of these structures during periods of economic and social instability. It is particularly important to explore how changes in priorities affect the development of institutions supporting green initiatives (Table 3). In response to the war and other contemporary challenges, institutions that promote environmentally oriented enterprises in rural areas must rapidly adapt to new realities, providing not only economic but also organisational and legal support. This includes backing innovations in sustainable agriculture, renewable energy sources, and waste-processing technologies.

**Table 3.** Investment indicators of agricultural enterprises by environmental protection activities (million UAH)

Year	Air protection	Water purification	Waste management	Soil and water protection	Other areas
2019	1125	1329.5	260.3	-	3197.4
2020	5886.3	5093.9	624.6	126.8	3360.9
2021	6472.6	48,091.6	7776	1792	133753.1
2022	1756.1	16185.3	532.5	960.4	77023.8
2023	6188.2	587.5	626.1	884.4	49944.8

**Note:** "-" - no data available

**Source:** systematised by the authors based on Agriculture Statistics... (2024)

Until 2022, institutions supporting the development of green businesses in Ukraine actively promoted investment in environmental protection activities, particularly through initiatives aimed at creating a favourable environment for ecological technologies and sustainable development (Andrusevich *et al.*, 2023). During this period, there was increased attention to environmental sectors, as evidenced by the growing volume of funding, particularly in areas such as water purification and air protection. Key institutional structures contributing to this development included government bodies, local organisations, and international donors, who provided financial and advisory support to enterprises focused on environmental innovation. These structures created conditions conducive to attracting investment into environmental projects through various support programmes and incentives for green businesses, as well as through the integration of national environmental standards with international ones. Financial institutions

also played an active role, offering specialised loans and grants to enterprises implementing eco-friendly technologies.

In 2022, with the onset of the war, institutional support for green businesses underwent significant changes. First and foremost, the decline in investment volumes in environmental protection activities, particularly in water purification and air protection, indicates a reorientation of priorities due to the need to ensure security and restore critical infrastructure (Andrusevich *et al.*, 2023). Institutions that had previously actively supported green initiatives, including through subsidies or grants, were forced to shift their focus to restoring the country's basic needs, including the stability of the water supply and energy security. However, even under conditions of limited financial resources, institutions continued to support some areas of green business development, particularly by minimising environmental risks related to the war and creating conditions for the gradual restoration of environmental projects.

Despite the challenges, institutions supporting the development of green business have adapted their strategies to the new realities, demonstrating the ability of Ukrainian organisations and the state to be flexible in responding to global challenges. Investment institutions and donor organisations also revised their programmes, providing support to more urgent areas such as the restoration of ecological infrastructure, which is critical for the future development of green business in Ukraine.

Studying these changes helps to clarify how institutional structures can be effectively reorganised to ensure the sustainable development of green businesses in rural areas, especially in the context of limited resources and shifting priorities. It also helps to determine which mechanisms of state support and private investment are most effective in stimulating the development of ecological initiatives in rural communities, ensuring not only

economic benefits but also improvements in quality of life and environmental conditions in these areas.

Understanding changes in investment priorities for environmental projects during wartime, as well as the adaptation of institutional structures to new realities, is crucial for formulating strategies for developing green businesses in rural areas. Studying these processes allows not only the evaluation of the effectiveness of existing approaches but also the identification of ways to improve them in conditions of economic instability. For further development in this area, it is important to pay attention to best practices from other countries that have successfully implemented institutional models supporting sustainable rural business. European experience can be utilised to implement recommendations for the development of green business, particularly in the following areas (Table 4):

**Table 4.** Analysis of tools and European practices for sustainable agricultural development

Country	Key practices/Instruments	Impact on ecological transformation	Recommendations for Ukraine
<b>Denmark</b>	Subsidies for land conversion, tax reductions on organic products, state procurement for schools and hospitals	Significant impact on the development of organic production and the ecological transformation of the agricultural sector	Adopt the model of direct subsidies and state procurement of organic products to increase demand for eco-friendly goods
<b>Germany</b>	Development of cooperatives (over 2,000) and bioenergy production	Effective support for farmers in resource sharing, processing, and energy production	Develop agricultural cooperatives and biogas energy to enhance resource efficiency and sustainability
<b>France</b>	Promotion of regional brands (e.g., Label Rouge, AOC) and certification of organic products	Increased competitiveness of eco-friendly products in domestic and international markets	Introduce similar certification schemes to promote Ukrainian organic products in Europe
<b>Netherlands</b>	Precision agriculture technologies (drones, GPS, specialised software)	Optimised resource use and increased agricultural yields	Promote precision agriculture through government co-financing and farmer training to reduce costs and improve efficiency
<b>Sweden</b>	Minimal soil tillage, biofertilisers, and ecologically oriented agrotechnologies	Long-term sustainability, restoration of soil fertility, and biodiversity preservation	Offer financial incentives for farmers adopting minimal tillage and biofertilisers
<b>Italy</b>	Development of agritourism, combining organic production with tourism services	Additional income sources for farmers and promotion of eco-friendly production among consumers	Establish agritourism routes and create conditions to attract visitors to agricultural regions
<b>Austria</b>	Support for organic livestock farming (eco-friendly animal husbandry, natural feed)	High-quality organic livestock products and reduced environmental impact (over 20% of livestock products are organic)	Enhance organic dairy and meat production through eco-friendly practices

Table 4, Continued

Country	Key practices/Instruments	Impact on ecological transformation	Recommendations for Ukraine
EU context	Implementation of the European Green Deal and European Climate Law	Promotes ecological transformation, economic efficiency, and social resilience in rural areas	Create an enabling institutional environment to support green business and align with the European Green Deal requirements

**Source:** systematised by the authors based on European Commission (n.d.a), M.A. Minenko (2015), Denmark intends... (2016), Towards a Green Economy... (2018), V.D. Caprio *et al.* (2018), C.Ir. Kempenaar (2022), Promotion of Organic... (2023), Sustainable Business... (2024), A. Dibrova *et al.* (2024), European Commission (2024)

The optimisation of the regulatory and legal framework becomes a key tool for ensuring an effective transition to a green economy, as clear rules of the game contribute to increasing investment attractiveness, minimising risks, and creating transparent conditions for the development of sustainable business models. It is important to harmonise Ukraine's legislation with EU environmental standards. This includes adapting national regulations to Council Regulation (EC) No. 834/2007 (2007), European Commission (n.d.b), and other directives, the Paris Agreement on Climate Change (2015), European Commission (2019), European Commission (2023), related to organic production, sustainable resource use, and greenhouse gas emission reduction. Ensuring transparency in legal regulation will stimulate investment in green businesses.

In the conceptualisation of developing institutional structures for green business in rural areas under the conditions of European integration and global challenges, the following aspects of problemsolving are proposed:

1. The government should broaden programmes for subsidising ecological initiatives, particularly by introducing long-term preferential loans for farmers transitioning to organic production. Additionally, it is advisable to strengthen cooperation with international donors such as the European Bank for Reconstruction and Development (EBRD), the European Investment Bank, and the Horizon Europe Programme to attract grants and technical assistance.

2. A modern logistical infrastructure should be established for the storage, processing, and transportation of ecological products. This will help reduce production costs and ensure a

stable supply to both domestic and international markets. The development of digital platforms for monitoring agricultural land conditions, optimising resource use, and coordinating product distribution is also crucial.

3. Institutional support should include the active training of farmers and entrepreneurs in ecological practices through seminars, workshops, and specialised courses. In cooperation with educational institutions, programmes should be designed to train specialists in organic farming, resource management, and environmental governance.

4. Significant attention should be given to stimulating the cooperative movement. Cooperatives are vital for uniting small farmers, sharing resources, and accessing markets. Institutional support should include programmes for the development of such associations, which will ensure more efficient resource use and increase the competitiveness of Ukrainian green businesses in the European market.

5. An important aspect is the introduction of a monitoring and evaluation system to assess the effectiveness of institutional support for green businesses. This will enable timely responses to challenges, the identification of bottlenecks, and the adaptation of programmes to current conditions.

6. Ukrainian producers require support in obtaining certification for compliance with European environmental standards. This will expand export opportunities and enhance trust among European consumers.

The implementation of these measures will contribute to the creation of a sustainable system of institutional support that will ensure the growth of green businesses in Ukraine following the principles of the European Green Deal. This

will not only strengthen the economic potential of the agricultural sector but also support the sustainable development of rural communities and the preservation of the natural environment. At the same time, international experience indicates that the effectiveness of environmental policy largely depends on the combination of incentive measures, as confirmed by studies of corporate practices in China. Research conducted by L. Xu & Y. Chen (2021), based on data from companies in Shanghai and Shenzhen, indicates that environmental fines are a more effective tool for stimulating environmental investment than subsidies, although this conclusion requires a more thorough analysis within the context of enterprises' long-term strategies. Including a broader range of industries in the analysis and applying qualitative research methods, such as case studies or in-depth interviews, could offer a deeper understanding of enterprise motivation and the real mechanisms through which environmental policy exerts influence.

Developing institutional structures for green businesses in rural regions is one of the key aspects of achieving sustainable development. Given current challenges, including climate change, resource depletion, and socioeconomic instability (Lopatynskiy *et al.*, 2023), institutional support becomes a necessary prerequisite for the effective implementation of environmentally sustainable practices in the agricultural sector. The Cabinet of Ministers of Ukraine has initiated a draft law introducing the concept of an eco-industrial park as an innovative format for industrial sites focused on environmentally responsible practices, including the use of alternative energy, waste management, and efficient water use (A draft law with changes..., 2024). This initiative also aims to simplify the procedures for establishing and operating industrial parks, clarify the rights and responsibilities of stakeholders, and streamline terminology and regulations governing types of activity. One of the key focus areas of the Myronivka industrial park in Myronivka, Kyiv Region, is alternative energy (Industrial parks, 2024).

L. Xu & Y. Chen (2021) highlighted the importance of government intervention in sustainable business practices and the commitment to green development, as these factors contribute

to corporate environmental responsibility and sustainable business operations. In this context, new-generation industrial parks oriented towards environmentally sustainable practices will support the introduction of green businesses in rural areas by fostering the development of alternative energy, promoting the efficient use of resources, and, in the longer term, ensuring effective waste management. Adhering to these priorities represents a crucial step towards enhancing the environmental resilience of agricultural areas and creating innovative opportunities for rural entrepreneurship. In this context, K. Hristov *et al.* (2024) examined the development of renewable energy, particularly solar energy, as a key factor in achieving the objectives of the European Green Deal, emphasising its role in stimulating economic growth in rural areas, generating new business models and employment opportunities, while also acknowledging the challenges associated with depopulation, infrastructure limitations, and land use.

S. Das & O. Hazarika (2023) noted that in India's agricultural economy, traditional knowledge and local practices can complement formal government policies, leading to more sustainable farming models. They stressed that the success of green businesses depends on the integration of both formal and informal institutions. Similarly, I.F. Balaniuk & T.L. Ivaniuk (2020) observed that in Ukraine, this process is hindered by farmers' limited access to land resources following the new land reform. They proposed that the establishment of a state land bank could serve as an effective institutional mechanism to support farmers, promote the stable development of organic agriculture, and maintain the socioeconomic resilience of rural areas. Additionally, institutional reforms that strengthen farmers' involvement in decision-making play a vital role in mitigating the adverse effects of climate change by improving the adaptability of rural communities. Increased attention to farm managers further encourages them to facilitate rural development in the public interest, in line with sustainable development goals. At the same time, the growing number of health-conscious consumers is driving the rapid expansion of organic agriculture (Agriculture Statistics..., 2024).

P. López-Vargas *et al.* (2023), in their study of the Peruvian Amazon, found that formal laws may be less effective than traditional rules governing natural resource management. This highlights the need to integrate local knowledge into public policy to enhance governance efficiency. Such models have the potential to form the foundation for sustainable forestry and agricultural practices. A. Sharma *et al.* (2024) demonstrated, in their research on Uttar Pradesh, that the integration of financial technologies (FinTech) into agriculture can play a crucial role in the sustainable development of agricultural systems. They stressed that digital platforms facilitate resource optimisation, reduce costs, and promote environmental responsibility – an especially important consideration given farmers' limited access to financial resources and expertise.

P. Girard (2023) explored the role of institutional economics in analysing structural changes affecting youth employment in rural areas. His research highlighted that access to land, capital, and education are key factors in ensuring a successful transition of young people to independent farming. This finding underscores the need to establish institutional conditions that support human capital development. Similarly, N. Pylypiv & S. Sologub (2024) highlighted the effectiveness of a balanced scorecard system as a strategic planning tool for assessing the implementation of socio-economic development strategies within territorial communities. Their study focused on how this system aligns with sustainable development goals, particularly in areas such as financing, environmental management, and intersectoral cooperation.

T. Zinchuk *et al.* (2024) maintained that agriculture is the primary sector of the EU rural economy and plays a crucial role in shaping contemporary rural development policy. The development of rural areas constitutes the second pillar of the EU's Common Agricultural Policy, providing support for farmers, market interventions, and the social, environmental, and economic sustainability of agriculture. Thus, the institutional mechanisms underpinning the EU rural economy not only determine the direction of rural development policy but also establish the principles necessary to ensure stability and the sustainable evolution of the agricultural

sector. In their study, M. Khvesyk *et al.* (2024) argued that the role of institutional instruments in safeguarding ecological security and resilience in socio-ecological-economic systems should be recognised as a key challenge of contemporary agricultural policy, requiring an integrated approach and effective implementation strategies. The isolation by J. Patroniak & S. Szymanski (2020) of only two evolutionary modules – environmental economics and environmental policy – is a simplified approach, as the green economy encompasses social dimensions, financial instruments for ecological transition, corporate responsibility mechanisms, and regulatory frameworks for business.

O. Shpykuliak & I. Bilokinna (2019) emphasised the need to implement the development of “green” cooperatives as institutional structures for the socioeconomic advancement of rural areas and communities in the context of ensuring energy security, positioning institutions and practices of the “green” agenda to achieve the Sustainable Development Goals. According to O.S. Pavlenko (2023), the concept of the green economy in the agricultural sector is fundamental to ensuring the rational use of resources and enhancing the efficiency of the food supply chain. Given the significant impact of institutional structures within the green business on ecosystems and the livelihoods of the population, the “green” transformation plays a crucial role in achieving sustainable development and enabling a successful transition to an environmentally oriented economy.

T.O. Kharchenko (2023) rightly emphasised the role of public administration in aligning Ukrainian policies with the European “green” agenda, but it is also important to consider the challenges associated with the institutional capacity to implement these initiatives. In particular, it is necessary not only to adapt the regulatory framework but also to ensure effective audit mechanisms and the viability of financing so that investments in infrastructure genuinely contribute to the achievement of sustainable development goals rather than being merely declarative. The view of O. Khodakivska *et al.* (2023) is valid, as the strategy for developing the green economy in Ukraine's agricultural sector aims to harmonise economic, environmental,

and social objectives by supporting innovation, attracting investment, and adapting to European standards. At the same time, the analysis identifies several risks, including war-related disruptions, insufficient funding, and competition from international producers. These challenges necessitate the development of a comprehensive state support policy and an effective institutional framework.

Agricultural management in the economic sector, based on the principles of the “green” agenda, is recognised by scholars and supported by practical evidence as an effective socio-economic approach to meeting the population’s demand for healthy food products and supplying the processing industry with environmentally clean raw materials. Within the context of developing institutional structures for the green business, the following priorities are being implemented: fostering the resilience of entrepreneurial structures and promoting sustainable territorial development; creating additional employment opportunities, particularly “green” jobs; strengthening the capacity for socially responsible governance; and facilitating the constructive institutionalisation of mechanisms to stimulate “green” initiatives that align with the requirements and opportunities for integrating the sector into the international economic landscape, particularly that of the EU.

## **CONCLUSIONS**

Therefore, the development of institutional structures for green businesses in rural areas represents a significant component of sustainable development, combining economic, social, and environmental dimensions. The adoption of environmental technologies, efficient management of natural resources, and alignment with international environmental standards create the conditions to enhance the competitiveness of Ukrainian farmers and expand their access to global markets.

The green business, in its institutional and economic foundation, serves as a basis for achieving the objectives of sustainable, renewable, and environmentally oriented approaches to economic activity. Such a framework of economic

practice entails the diffusion of innovations and capabilities through which domestic agriculture strengthens the social and economic pillars of market competitiveness. The advancement of this sector within agriculture facilitates integration and adaptation to European standards while existing institutions in the domestic market receive effective incentives to broaden the implementation of “green” practices.

European integration processes and the principles of the European Green Deal present new opportunities for Ukrainian agriculture. The transition to environmentally sustainable business models contributes to reducing the environmental footprint of the agricultural sector, improving product quality, and enhancing living standards in rural areas. Simultaneously, the development of effective institutional mechanisms for cooperation between the state, businesses, and the scientific community fosters the fosters of innovative technologies and broadens opportunities for attracting investment.

Under wartime conditions, it is necessary to reassess strategies for financing and adapting environmental projects, particularly by directing efforts towards the restoration of agricultural infrastructure and the safeguarding of food security.

The findings obtained may serve as a foundation for formulating state policy to support green businesses, integrate Ukraine’s agricultural sector into international environmental frameworks, and attract investment in renewable resources. Further research should focus on developing specific financing models for environmental initiatives and evaluating their impact on regional economic indicators.

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## **Розвиток інституційних структур «зеленого» бізнесу на селі в умовах євроінтеграції та глобальних викликів**

**Анотація.** Розвиток інституційних структур для зеленого бізнесу в сільській місцевості має важливе значення для сприяння екологічній ефективності, сталому сільському господарству та розвитку сільських територій у відповідь на глобальні екологічні виклики. У статті досліджено взаємодію між органами влади, місцевими громадами, науковими установами та бізнес-сектором у формуванні інституційної архітектури «зеленого» бізнесу. Проаналізовано вплив євроінтеграційних процесів та Європейського зеленого курсу на розвиток екологічного підприємництва в Україні. Особливу увагу приділено адаптації інституційних структур до кризових умов, спричинених війною, а також їх ролі у відновленні аграрного сектору та забезпеченні продовольчої безпеки через розвиток органічного землеробства. У дослідженні здійснено комплексний аналіз інституцій, які підтримують розвиток «зелених» бізнес-моделей, визначено ключові механізми підвищення їхньої ефективності та запропоновано рекомендації щодо сприяння переходу до екологічно дружнього підприємництва. На основі європейського досвіду та впровадження екологічних стандартів підтверджено, що розвиток екологічного підприємництва та органічного виробництва сприяє сталому розвитку сільськогосподарських підприємств в умовах євроінтеграції та глобальних викликів. Результати дослідження свідчать про активний розвиток «зеленого» бізнесу в Україні, зокрема завдяки державним програмам, фінансовій підтримці та міжнародним ініціативам, які сприяли зростанню обсягів органічного

виробництва, підвищенню прибутковості господарств та впровадженню екологічно чистих технологій. Підтверджено, що ефективна взаємодія між державними, фінансовими, освітніми та технологічними інституціями сприяє масштабуванню «зеленого» бізнесу, підвищує економічну ефективність екологічних ініціатив та створює нові можливості для сталого розвитку сільських територій. Результати дослідження можуть сприяти зміцненню інституційних структур, налагодженню співпраці між ключовими зацікавленими сторонами, залученню інвестицій та просуванню органічного виробництва для підвищення конкурентоспроможності сільського господарства, створення робочих місць, впровадження інновацій та забезпечення екологічної стійкості в рамках європейської інтеграції

**Ключові слова:** органічна продукція; «зелена» економіка; сталий розвиток; екологічні стандарти; підприємництво



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## Improving the competitiveness of enterprise through the introduction of Internet marketing

**Abstract.** The aim of the study was to investigate the impact of Internet marketing on the competitiveness of enterprises. The research used methods of secondary data analysis and case studies to study the successful use of Internet marketing tools in various industries. The research analysed the use of Search Engine Optimisation, contextual advertising, social media and web analytics among leading Ukrainian enterprises such as "Nova Poshta", "Rozetka", "Kyivstar" and "Foxtrot". The results of the study confirmed the importance of Internet marketing for increasing the competitiveness of enterprises. It was determined that tools such as search engine optimisation, Pay-per-click and social media can significantly increase brand visibility, attract new customers and increase sales. In 1-3 months, Pay-Per-Click can increase traffic by 50-100% and sales by 40-80%, while Search Engine Optimisation can increase traffic by 20-30% and sales by 15-25%. Email marketing and content marketing promote brand loyalty and increase conversions by 10-20%, respectively. The study showed that online marketing not only helps to increase brand visibility, but also helps to attract more customers through more precise targeted advertising and increased efficiency of interaction with them. The use of Search Engine Optimisation helps to improve the organic promotion of websites in search engines, which leads to an increase in traffic without significant advertising costs. The study also highlighted the importance of mobile marketing, as the growing use of mobile devices is becoming an important factor in improving access to customers and increasing conversion rates. The findings of the study confirm that the effective use of digital marketing tools is one of the main factors for increasing the competitiveness of enterprises in the current digitalisation environment. It is also important to integrate the latest

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technologies, such as artificial intelligence and big data analytics, to provide more personalised customer interaction and increase the overall effectiveness of marketing campaigns. The practical significance of the study lies in the development of effective strategies for using digital marketing tools to increase the competitiveness of enterprises in various industries

**Keywords:** digital technologies; web analytics; social networks; demand; content

## INTRODUCTION

In the current environment of digital technologies and changes in consumer behaviour, businesses are forced to adapt their marketing strategies to new realities, where online marketing is becoming a key tool for increasing competitiveness and optimising advertising costs. Digital communication channels allow companies to interact with consumers more effectively, attract new customers, maintain the loyalty of existing ones and increase their visibility in the market. As online marketing allows for personalised approaches to each consumer, optimised advertising budgets and reduced costs for traditional marketing tools, its implementation is becoming a necessity for businesses of all sizes. In a highly competitive environment, the ability to effectively use digital tools to promote goods and services is becoming a key factor in market success.

The use of Internet technologies in the marketing activities of enterprises is necessary to adapt to the rapidly changing market environment. I. Ippolitova *et al.* (2024) studied the importance of introducing Internet technologies to improve communication with customers through digital channels. The authors justified the use of Internet marketing tools, such as corporate websites, search engine optimisation, social media, and email, to improve the effectiveness of marketing campaigns and increase conversion. However, they noted that the integration of various online tools and their adaptation to the specifics of enterprises requires further research and development.

The use of big data and the Internet of Things to improve the economic performance of enterprises in online marketing is an important area of development in the context of digitalisation. Y. Yang (2024) studied the impact of these technologies on the effectiveness of marketing strategies and sales. The author found that big data and the Internet of Things significantly improve business performance, but there are problems

with resources, technology, and data security. He suggests that businesses should optimise their use and update their technology, and develop policies to support these innovations.

Digital marketing has become a key tool for businesses in times of crisis, helping them to adapt to changes in the market. M. Oklander *et al.* (2024) studied how small and medium-sized enterprises in Ukraine use online marketing to overcome the challenges caused by the war. The authors note that digital marketing, in particular through social media, played an important role in maintaining customer relationships and expanding markets. However, businesses faced challenges due to limited resources and an unstable environment. The study points to the need for further research to improve digital marketing strategies for small and medium-sized enterprises in crisis situations.

P. Virani (2024) investigated the impact of internet marketing on small and medium-sized businesses. The author found that social media, in particular Facebook, significantly contributed to supporting sales and customer interaction, allowing businesses to remain competitive. The study showed a positive relationship between the use of digital marketing and financial performance, but also found that a lack of IT skills among entrepreneurs limits the effectiveness of their use. Digital marketing strategies are a key factor in strengthening the competitiveness of enterprises. N.I. Niyozova (2023) investigated how these strategies contribute to the development of enterprises, noting the role of Internet technologies such as social media and online shopping. The author emphasised that these tools help to reduce marketing costs and improve customer interaction. However, businesses face difficulties due to a limited understanding of technology, which requires additional training to effectively implement them in digital strategies.

Digital marketing is becoming crucial for strengthening the market position of enterprises and improving their competitiveness. The article by V. Morokhova *et al.* (2021) discusses modern marketing technologies as tools for shaping the competitive advantages of enterprises. The authors emphasise the importance of introducing innovative approaches to marketing activities to improve the efficiency of enterprises in a competitive market. V. Morokhova *et al.* analysed specific strategies, such as product differentiation, customer focus and the use of digital tools, which help to strengthen companies' market positions. This highlights the need for further research to develop tailored digital strategies that are specific to the sector.

The use of digital marketing is important for improving the performance of small and medium-sized enterprises in emerging markets. W. Apedo Deku *et al.* (2024) investigated how digital marketing technologies, such as social media and search engine marketing, can improve the business performance of small and medium-sized enterprises (SMEs). The authors found that technology orientation and customer relationship management (CRM) are important factors that influence the performance of enterprises. However, financial constraints and limited use of technology are significant barriers to the widespread adoption of these strategies. Further research is needed to explore how these technologies can be integrated into SME strategies, especially in underdeveloped regions. Strategic guidelines to ensure the competitiveness of enterprises in the context of digitalisation are important for their adaptation to change. N.P. Safonik (2024) noted that investment in technology and staff qualifications are the basis for adaptation, while external factors such as competition determine opportunities for development. The study showed that enterprises should formulate strategies that take into account digital transformation. However, there is still a need for further research on the integration of digital solutions into business processes.

The aim of this study was to analyse the impact of Internet marketing on the enterprise management strategy and its competitiveness. The objectives of the study were: to analyse the role of Internet marketing as a strategic element

of enterprise management that affects its efficiency and market position; to assess the impact of implementing Internet marketing strategies on increasing the competitiveness of an enterprise in the context of digitalisation.

## MATERIALS AND METHODS

The research was empirical, including the analysis of secondary data and case studies to study the use of online marketing tools. The main sources were information from open sources (Marketing strategies..., n.d.; How does marketing..., n.d.; How does a business attract potential customers..., 2024), as well as market research on the introduction of digital technologies in the marketing strategies of enterprises (Foxtrot case..., n.d.). At the same time, materials on the latest trends in digital strategies and methods of their implementation were studied. The research works of F. Sabbagh (2021), Y.K. Dwivedi *et al.* (2021), O. Kitchenko & I. Koval (2021).

The study examined several open advertising platforms that provide a variety of tools for effective audience targeting and optimisation of advertising costs. Among the main platforms that were reviewed are Google Ads (Google ads offers many opportunities..., n.d.), Facebook Ads (About Facebook ads..., n.d.) and Instagram (Advertising on Instagram..., n.d.). Marketing automation platforms such as HubSpot (With HubSpot..., n.d.) or Adobe Marketo (Powerful marketing ..., n.d.), and their great potential for automating marketing campaigns, optimising customer experience, and improving the effectiveness of marketing efforts.

One of the main methods of collecting information was a case study, which involved a detailed analysis of specific examples of successful use of Internet marketing in enterprises in various industries, such as logistics and delivery, e-commerce, telecommunications and retail. This made it possible to collect practical data on the use of digital tools in real life and assess their effectiveness on the example of the largest Ukrainian companies. The sample for the analysis consisted of such enterprises as "Nova Poshta" (Marketing strategies..., n.d.), "Rozetka" (How Rozetka.ua does marketing..., n.d.), "Kyivstar" (How can businesses attract..., 2024), "Foxtrot" (Foxtrot case..., n.d.), which are actively

implementing online marketing strategies to strengthen their competitive position in the market. The study of their experience provided practical insights into the use of Internet marketing in the Ukrainian context, as well as identified features and trends that may be useful for other businesses. To assess the effectiveness of Internet marketing tools such as search engine optimisation (SEO), contextual advertising, social media, email marketing and web analytics in more detail, benchmarking methods were used to compare the effectiveness of these tools among businesses in different industries. The results were assessed by analysing such indicators as traffic growth, sales growth and conversion.

One of the main tools was a SWOT analysis, which was used to identify the strengths and weaknesses of the use of Internet marketing in enterprises, as well as opportunities and threats arising in the process of implementing digital strategies. This method helped not only to identify the key advantages and disadvantages of implementing online marketing tools, but also to analyse internal factors that may affect the success of their implementation, such as the level of digital maturity of the company, readiness for change and availability of necessary resources for the effective implementation of new technologies. In addition, the SWOT analysis made it possible to assess external opportunities, such as the development of new markets or changing trends in consumer behaviour, as well as potential threats from competitors, economic fluctuations or technological changes. PEST analysis was applied to provide a deeper analysis of external factors that could affect the effectiveness of online marketing strategies. This method helped to assess political, economic, social and technological changes that can significantly alter the marketing environment for businesses. This approach provided a comprehensive assessment of how digital technologies can affect the competitiveness of enterprises not only in the short term, but also in the long term.

## RESULTS

### Theoretical foundations of internet marketing

Internet marketing, or digital marketing, is a set of methods and tools used to promote goods and services via the Internet. This tool enables

businesses to interact with potential customers, create effective communication channels and increase customer loyalty. In today's highly competitive and rapidly changing business environment, Internet marketing has become an essential part of the strategy of every business seeking to achieve high results and maintain its competitive position. The use of online marketing allows companies not only to attract new customers but also to maintain effective relationships with existing ones, which ultimately helps to increase sales and strengthen the brand in the market.

Internet marketing consists of the following components: search engine optimisation, contextual advertising, email marketing, social media marketing (SMM), content marketing, customer interaction and web analytics. The goal of search engine optimisation (SEO) is to make a website more visible to search engines. Businesses can attract organic traffic, which is cost-effective because this process does not require paid advertising. However, contextual advertising allows advertisers to attract new customers through paid ads that appear on search engine pages and affiliate platforms. By using these platforms, advertisers are paid for each click on their adverts. This tool is well suited to quickly drive traffic and increase sales, especially for companies looking to respond quickly to changes in demand (Vikarchuk & Yushkevych, 2021).

Email marketing is one of the most effective tools for keeping in touch with customers. It allows enterprises to send out promotional materials, news, or personalised offers, which encourages customer loyalty and attracts new customers. Social media marketing (SMM) encompasses the use of platforms such as Facebook, Instagram, Twitter, and LinkedIn to promote products and services and to interact directly with the audience. With this tool, businesses can not only advertise their products but also build strong relationships with customers and engage them in active participation in the brand's life, which increases the level of trust and consumer loyalty (Sabbagh, 2021).

Content marketing is the process of creating and distributing valuable content that meets the interests and requirements of the target audience. It can be articles, blogs, videos, infographics,

and other types of content that help companies increase the number of customers and strengthen their market position. An affiliate marketing tool gives companies the opportunity to work with other organisations or individuals for a fee to attract customers or make sales through their platforms. This allows companies to avoid spending a lot of money on expanding their audience. Web analytics is another important online marketing tool that allows companies to evaluate the effectiveness of their marketing campaigns, track user behaviour on the site, and adapt strategies based on the data they receive. Companies can use programs such as Google Analytics to get accurate data on the channels that generate the most traffic and that need to be optimised (Vikarchuk & Yushkevych, 2021).

Internet marketing is an integral part of the overall business strategy, performing not only the function of advertising, but also contributing to brand development, attracting new customers, and strengthening the company's market position. This allows companies to effectively integrate digital strategies into their core business processes. It allows companies to be more flexible and innovative, and to respond more quickly to market changes. Product, pricing, distribution, and customer communication strategies are just some of the main business strategies that are interconnected with online marketing. Product strategy is closely related to online marketing. Companies can use digital channels to quickly bring new products to market, gauge demand, collect customer feedback, and quickly improve their offerings. The creation of online stores and sales platforms allows companies to expand their product range and reach more customers (Dwivedi *et al.* 2021). At the same time, companies can quickly change their pricing policy thanks to online marketing. With the help of digital marketing tools, businesses can flexibly change prices in real time, hold promotions, discounts, and offer promotional codes, which is important for stimulating demand and attracting customers.

Digital marketing also has a major impact on distribution strategy. It gives businesses the opportunity to expand their sales geography and enter new markets by working with global and local online platforms. This allows businesses

to ensure that their products are available to consumers anywhere in the world. In terms of communication strategy, online marketing enables constant contact with customers through social media, email newsletters, chatbots and other channels. This provides instant feedback, makes it possible to create personalised offers and respond to customer requests in real time (Denga *et al.*, 2022). Thus, Internet marketing allows not only to advertise products but also to increase the efficiency of business processes, strengthen market positions and ensure competitiveness in the global market. Integration of Internet marketing into the company's strategy helps to ensure flexibility and adaptability of the business in the face of constant market changes, which is an important condition for the company's successful development.

One of the main components of modern strategies for businesses seeking to increase productivity and competitiveness is the use of the Internet. But online marketing has two main functions. Firstly, it is used as an advertising tool that works on short-term results, and then as a strategic component of business management that covers all aspects of its activities. Distinguishing between these two approaches is important in order to use internet marketing correctly in the overall strategy of a company. Advertising that uses online marketing is usually aimed at attracting new customers and increasing sales in the short term. Contextual advertising, SEO, social media, email marketing and content marketing are the main tools of this approach. They allow companies to make ads that attract the attention of potential buyers and quickly increase sales or website traffic (Kitchenko *et al.*, 2021). This approach is focused on a quick impact, and while it can be very effective in driving sales, it does not always ensure sustainable growth and long-term competitiveness.

Internet marketing as a strategic component of business management is much broader. It is not limited to advertising or product promotion; it also includes the development of plans aimed at supporting sustainable business development, improving customer interaction, optimising business processes and strengthening the brand. Internet marketing in this context is not just a means of attracting customers, but

also an important part of the overall strategy, which includes communication, product management, pricing, and customer interaction at all stages of the process (Mshvidobadze, 2024). The difference between online marketing as an

advertising tool and as a strategic management element can be clearly demonstrated in Table 1. It shows the main differences in the purpose, duration of exposure, orientation, and tools used in each approach.

**Table 1.** Main differences between Internet marketing as an advertising tool and a strategic management element

Criterion	Internet marketing as an advertising tool	Internet marketing as a strategic management element
Main objective	Attracting new customers, increasing sales	Increasing efficiency, strengthening the brand, strategic planning
Duration of the impact	Short-term effect	Long-term effect aimed at sustainable development of the enterprise
Orientation	Promotion of products and services	Integration into the overall business management strategy
Role in the company's strategy	An auxiliary tool for increasing sales	Central element of strategic business management
Tools	SEO, PPC (Pay-Per-Click), SMM, email- marketing	Use of analytics, customer interaction, innovative strategies

**Source:** compiled by the authors based on O. Kitchenko & I. Koval (2021), T.I. Mshvidobadze (2024)

The Table 1 shows that Internet marketing, used as an advertising tool, is effective in achieving short-term results, such as attracting new customers and increasing sales. However, this approach has a limited impact on the long-term competitiveness of the enterprise. Whereas online marketing as a strategic management element allows businesses to integrate digital tools into the overall strategic management process, contributing not only to rapid customer acquisition, but also to strengthening the brand, improving business processes and ensuring sustainable development. Understanding this difference is important for businesses that want to use internet marketing not only as a tool for advertising campaigns, but also as part of their strategy to achieve long-term success and competitive advantage in the market.

### The impact of Internet marketing on the efficiency, market position and competitiveness of an enterprise

Internet marketing as a tool is of great importance for modern businesses, as it can significantly improve the efficiency of their operations. The introduction of online marketing allows businesses to optimise numerous business processes, reduce the cost of traditional advertising campaigns and automate a number

of operations. The essence of this impact can be assessed in the context of several aspects: automation, precise targeting, reduced costs for traditional forms of advertising, and improved customer interaction.

One of the main advantages of online marketing is the ability to automate many business processes. Modern technologies can greatly simplify and speed up processes such as sending emails, generating personalised offers for customers, managing advertising campaigns, and even analysing the effectiveness of strategies. Marketing automation platforms, such as HubSpot (With HubSpot..., n.d.) or Adobe marketo (Powerful marketing..., n.d.), provide tools for automatically collecting data on customer interactions, which can be used to quickly adapt strategies. This approach reduces the workload of employees and makes processes more efficient, which is especially important for small and medium-sized enterprises. Internet marketing is a powerful tool for small and medium-sized enterprises (SMEs) to optimise advertising costs, increase profits and improve competitiveness. Audience targeting through Google Ads and Facebook Ads helps to reduce the cost of irrelevant audiences by targeting advertising campaigns to potentially interested customers. The use of SEO helps to attract organic traffic

without the additional cost of paid advertising, which reduces the cost of customer acquisition, as shown by HydroWorx, which increased organic applications by 131% (Storm, n.d.). Digital platforms provide effective real-time monitoring of campaign results, allowing for quick adjustments to strategies. This makes it possible to reduce costs and increase profits, in particular through email marketing, which stimulates repeat purchases. Online marketing increases the competitiveness of SMEs by enabling them to compete with large companies through relevant content and targeted advertising. Local SEO optimisation ensures high search engine rankings on a limited budget, as evidenced by the example of a bakery that has achieved leadership in the search results for “bakery nearby” (Saxon, 2023).

Online marketing makes it possible to precisely target your campaigns based on consumer behaviour data, which significantly increases the effectiveness of advertising campaigns. Open advertising platforms, such as Google Ads (Google ads offers many opportunities..., n.d.), Facebook Ads (About Facebook ads..., n.d.), Instagram (Advertising on Instagram..., n.d.), allow businesses to easily set up targeting for a specific audience, determining not only its demographic characteristics, but also interests, purchase history or interaction with the brand. Targeted advertising can significantly increase the efficiency of advertising spend, as advertisers can target their advertising messages only to the audience that has the greatest potential to make a purchase. If the advertising campaigns are set up correctly, this can lead to lower advertising costs while increasing the return on marketing investment. Specific numerical metrics and data such as Cost per Acquisition (CPA), Return on Investment (ROI), Conversion Rate (CR), Click-Through Rate (CTR), average check, and Cost per Click (CPC) can be used to prove the effectiveness of targeting. For example, if before targeting optimisation, CPA was 500 UAH per customer, and after setting up precision targeting, this figure dropped to 300 UAH, this could indicate a 40% reduction in costs. This indicates the potential effectiveness of targeting in reducing advertising costs. In terms of ROI, if it was 150% before optimisation and increased to 250% after targeting, this could indicate

a significant increase in ROI. In the case of CR, if the CR was 2% before optimisation and increased to 5% afterwards, this may indicate an increase in the effectiveness of targeted campaigns (Mistrakov, n.d.). An increase in CTR from 1% to 3% could indicate an improvement in the relevance of targeted ads and a more accurate targeting of the target audience. An increase in the average check from 1,000 UAH to 1,500 UAH due to upsell and cross-sell techniques can also confirm the effectiveness of targeting strategies (What is targeted advertising and how..., 2024). Finally, if CPCs have dropped from 10 UAH to 7 UAH, this could indicate a more efficient use of the advertising budget and cost optimisation (How to calculate the budget..., 2024). All of this data can be tracked using analytics tools such as Google Analytics, CRM systems, or targeted advertising platforms such as Facebook Ads or Google Ads (Sharabati *et al.* 2024).

The ability to significantly reduce the cost of traditional advertising tools is one of the most notable advantages of online advertising. Online marketing offers more affordable and effective alternatives than television, radio or print media. To significantly optimise advertising costs, contextual advertising platforms such as Google Ads allow advertisers to pay only for actual ad clicks. In addition, organic promotion through search engine optimisation helps to generate a large number of visitors without the need to spend money on paid ads. Search engine optimisation increases the visibility of your company in search engines, which leads to constant traffic at no additional cost. Internet marketing also greatly improves communication between companies and their customers. Companies can store and analyse all the information about the interaction with each customer thanks to customer relationship tools such as CRM systems. This allows companies to better understand the needs of their customers and adapt their marketing plans to increase loyalty. Chatbots and other interactive tools allow companies to respond to customer queries instantly, even on weekends. This allows for constant contact and quick responses to customer queries, which increases customer satisfaction and helps to maintain customer loyalty (Usmany *et al.*, 2024).

Another aspect of the impact of internet marketing on the operational efficiency of an enterprise is web analytics. Web analytics allows businesses not only to collect data about website visitors but also to analyse consumer behaviour in more depth, identify the most effective channels for driving traffic, study conversions, and tailor strategies to specific market needs. Analytics tools, such as Google Analytics (Get essential customer..., n.d.), provide an opportunity to measure the effectiveness of each campaign, monitor customer behaviour on the website, identify weaknesses in the strategy and promptly correct them. This allows businesses to be flexible and respond quickly to changes in the market, which is an important element in maintaining high operational efficiency. Businesses can effectively

engage with customers and take a leading position in the market through strategies such as search engine optimisation, content marketing and email marketing.

Internet marketing provides businesses with powerful tools to improve their competitiveness. Using various methods such as SEO, PPC, SMM, email marketing and content marketing, companies can achieve not only high results in driving traffic and increasing sales, but also increase their visibility, build trust among potential customers and retain loyal customers. To evaluate the effectiveness of these tools and their impact on the company's competitiveness, basic data on the costs and effectiveness of each tool were collected. The main online marketing tools, their costs, and effectiveness in increasing traffic and sales are presented in Table 2.

**Table 2.** The impact of Internet marketing on the economic performance of enterprises

Internet marketing tool	Campaign cost (UAH thousand)	Increase traffic	Increase in sales
SEO	From 5000 UAH/month	20-30% in 6-12 months	15-25% in 6-12 months
PPC (Pay-Per-Click)	20000 UAH/month	50-100% in 1-3 months	40-80% in 1-3 months
SMM (Social Media Marketing)	From 4000 to 40000 UAH/month	30-50% in 3-6 months	20-40% in 3-6 months
Email- marketing	From 5000 UAH/month	10-20% in 1-3 months	10-15% in 1-3 months
Content marketing	From 10000 UAH/month	25-40% in 6-12 months	20-35% in 6-12 months

**Source:** compiled by the authors based on Cost of web studio... (n.d.), Overview and analysis of effective... (2023), The best advertising strategies for e-commerce... (2024)

The Table 2 shows that PPC advertising is the most effective tool, as it provides the highest growth in traffic and sales in a short period of time (1-3 months), although it is expensive (20,000 UAH/month). SMM is also quite effective, but the costs can be very different. SEO and content marketing are less efficient, but provide a steady increase in traffic (20-40%) and sales (15-35%) in the long run. The least effective is email marketing, which, at relatively low costs (from 5000 UAH/month), gives the lowest growth in traffic and sales. The use of online marketing tools helps to significantly increase the competitiveness of businesses, as it effectively attracts new customers, increases sales and improves market visibility. For example, SEO allows businesses to consistently rank high in search engines, which drives organic traffic and reduces

advertising costs, which is an important advantage in a competitive environment. PPC provides a quick effect by targeting potentially interested audiences, making it possible to respond quickly to changes in demand and oust competitors in a short time. SMM helps to build brand loyalty through interaction with the audience on social media, which helps to strengthen reputation and attract new customers. Email marketing provides personalised offers, increasing the effectiveness of interaction with existing customers, which drives repeat purchases and increases loyalty. Finally, content marketing helps to create valuable content that attracts the attention of the target audience, builds brand trust and strengthens the company's position in the market.

Combining these tools allows businesses not only to compete effectively with large

companies, but also to take a leading position in the market, reducing marketing costs and increasing their visibility in the eyes of consumers. As a result, the effective use of online marketing is an important factor that determines the competitiveness of a company in today's market. Increasing visibility and brand awareness is an important aspect that contributes to strengthening market positions through online marketing. The use of tools such as SEO allows businesses to improve their position in search engines, giving them access to a wider audience. At the same time, content marketing, as a strategy for creating and distributing useful content, helps to attract new customers and maintain interest in the brand.

“Nova Poshta” actively uses online marketing tools to maintain its market position, which is confirmed by statistical data. In particular, thanks to SMM (social media marketing), the company increased its audience reach by 25%, which attracted more than 500 thousand new customers (Marketing strategies..., n.d.). SEO-optimisation of the website led to a 40% increase in organic traffic, which resulted in a 15% increase in conversion. In addition, the use of email marketing has increased the number of repeat orders by 20%, which indicates an increase in customer loyalty. These figures demonstrate that online marketing is a key element in Nova Poshta's strategy to maintain its competitive advantage and expand its customer base (How Nova Post improves the efficiency..., n.d.).

Another important strategy for strengthening market positions is the use of PPC advertising. “Rozetka”, one of Ukraine's largest online retailers, actively uses contextual advertising through Google Ads and social media to reach a wider audience (How Rozetka.ua does marketing..., n.d.). This strategy allows not only to attract new customers, but also to stimulate repeat purchases

through precise targeting based on customer purchase history. “Foxtrot” demonstrates significant effectiveness in using email marketing to maintain customer loyalty. Personalised email campaigns have increased sales of accessories by 16% with the same level of traffic. This was made possible by introducing individual product offers that take into account the needs and purchase history of each customer. “Foxtrot” email marketing performance statistics show significant achievements: a 5% improvement in conversion rates due to optimised email campaigns and a 10% increase in website engagement due to effective product recommendations. In addition, general statistics show that segmented campaigns can increase revenue by 760%, and personalised subject lines increase open rates by 26%. This data confirms that “Foxtrot” strategy of using email marketing is effective in maintaining customer loyalty and encouraging repeat purchases (Foxtrot case..., n.d.).

Internet marketing also allows to reduce advertising costs. Using precise targeting through PPC and SMM can reduce the cost of ineffective advertising, while ensuring higher conversion rates. “Kyivstar”, a Ukrainian mobile operator, uses these tools to advertise its new services and products, particularly in the context of launching new tariff plans. Thanks to precise targeting of advertising to the target audience, which takes into account more than 100 Big Data parameters (age, gender, interests, location, etc.), the company was able not only to reduce advertising costs but also to significantly increase the number of subscribers, improve the effectiveness of advertising campaigns and achieve high market results (How businesses can attract potential customers..., 2024). Table 3 illustrates the main Internet marketing tools and their role in strengthening the market position of an enterprise.

**Table 3.** The impact of Internet marketing tools on the market performance of an enterprise

Tool	Role in strengthening market positions	Traffic growth (%)	Conversion (%)	Increase in sales (%)
SEO	Increase visibility in search engines, drive organic traffic, improve brand awareness	40	15	30
PPC	Targeting the target audience, reducing advertising costs, increasing the effectiveness of advertising campaigns	25	18	30

Table 3, Continued

Tool	Role in strengthening market positions	Traffic growth (%)	Conversion (%)	Increase in sales (%)
SMM	Interaction with customers in social networks, brand support, and new customer acquisition	300-400	-	39
Email-marketing	Personalising communications, maintaining customer loyalty, encouraging repeat purchases	10	5	16
Content marketing	Creating valuable content to attract new customers, increase loyalty, and strengthen the brand image	2000	1200	1200
Web analytics	Evaluating the effectiveness of marketing campaigns, adjusting strategies based on customer behaviour data	75	25	10

**Source:** compiled by the authors based on How Nova Post improves the efficiency... (n.d.), V. Girko (2023), V. Kovalov *et al.* (2024)

Table 3 shows that each of the online marketing tools plays an important role in strengthening the company's market position. The most effective tools are content marketing and SMM, which help to engage the audience. The choice of tool depends on the company's goals, and they help reduce advertising costs, attract new customers and retain old ones. Combined with the right strategy, these elements guarantee the company's stable growth in the market and strengthen its competitiveness.

The use of digital tools in marketing has significant advantages, but it also comes with certain risks that can negatively affect the business. The main risks include dependence on platform algorithms, technical failures, and cyberattacks. Digital platforms, such as Google Ads or social networks, are constantly changing their algorithms, which can affect the visibility of ads and organic traffic. For example, changes to Facebook's algorithms can lead to a decrease in reach without additional ad spend. In addition, algorithms are often based on historical data, which does not always allow for innovative approaches, which can lead to the repetition of standard strategies instead of finding new opportunities for business development (Managing algorithmic risks, n.d.).

Another significant risk is technical failures that can lead to financial losses. For example, a malfunction of a CRM system or marketing automation platform can disrupt customer service or delay marketing campaigns. The constant need to update software or train staff to work with new technologies requires additional resources and can increase the costs of the enterprise (The

dark side of digital marketing..., n.d.). In addition, cyber attacks that can lead to data loss are a significant risk. Digital platforms are an attractive target for phishing attacks, malware and ransomware attacks. This can lead to the leakage of confidential customer information and, as a result, fines for non-compliance with security regulations. Hacking into social media accounts or compromising customer data can also severely damage a brand's reputation, undermining trust in the company (Shaikh, 2024).

To reduce dependence on platform algorithms, marketing campaign strategies should be regularly adapted to changes in algorithms and a multi-channel approach should be used to reduce dependence on a single platform. To avoid technical failures, backup systems should be implemented to ensure uninterrupted operations and staff training should be invested in to ensure effective work with new technologies. In terms of cybersecurity, two-factor authentication, data encryption, and regular updates of security systems to check for vulnerabilities are recommended to reduce risks.

Internet marketing is an effective and important tool for improving a company's market position. Digital tools increase the effectiveness of marketing campaigns by optimising advertising costs and reaching target consumers. Companies can achieve significant results in attracting new customers, strengthening their brand image and increasing customer loyalty by using tools such as SEO, PPC, SMM, email marketing and content marketing. The strategic implementation of online marketing tools allows companies not only to strengthen their market

positions but also to adapt to the changing market environment, which is an important factor in achieving sustainable development and competitive advantage.

**Improving Internet marketing strategies to increase market position and efficiency**

Internet marketing is an important part of modern business strategies, as it allows businesses not only to interact effectively with customers,

but also to strengthen their market positions, increase competitiveness and efficiency. To more accurately identify areas for improving your online marketing strategy, it is important to use strategic analysis tools such as SWOT and PEST analyses. They help identify strengths and weaknesses, opportunities and threats, as well as external factors that may affect your business. Table 4 shows a SWOT analysis of the use of Internet marketing in enterprises.

**Table 4.** SWOT analysis: the use of Internet marketing at enterprises

Strengths	Weaknesses
<ol style="list-style-type: none"> <li>1. High efficiency of targeted advertising (PPC, SMM).</li> <li>2. The ability to accurately assess the effectiveness of campaigns through analytics.</li> <li>3. Flexibility to change marketing strategies in real time.</li> <li>4. Reducing the cost of traditional advertising through the use of digital channels.</li> </ol>	<ol style="list-style-type: none"> <li>1. Insufficient use of personalised strategies.</li> <li>2. Limitations in integrating online marketing with other strategies.</li> <li>3. High level of competition in the online environment.</li> <li>4. Limited knowledge and use of new tools such as Big Data.</li> </ol>
Opportunities	Threats
<ol style="list-style-type: none"> <li>1. Expanding the market through global online channels.</li> <li>2. Use of new technologies for targeting (Big Data, AI).</li> <li>3. Personalisation of marketing campaigns for greater customer loyalty.</li> <li>4. Development of mobile marketing and new content formats.</li> </ol>	<ol style="list-style-type: none"> <li>1. Changes in search engine algorithms that may affect SEO.</li> <li>2. Intense competition and declining efficiency of traditional channels.</li> <li>3. Increase in advertising costs due to competition in the online space.</li> <li>4. Legal restrictions on the use of personal data.</li> </ol>

**Source:** compiled by the authors based on E. Shcherban (2022)

Based on this analysis, it is clear that businesses have significant room for improvement in their online marketing strategies. However, there are also some weaknesses that need to be addressed. For example, insufficient use of personalised strategies can reduce the effectiveness of campaigns, and the high level of competition in the online environment threatens to undermine the achievement of desired results. In addition, businesses often face the problem of a lack of qualified marketers who can effectively use modern tools and technologies, which limits the potential for optimising marketing campaigns. In addition, difficulties with the implementation of CRM systems due to a lack of understanding of their potential or the lack of appropriate software can slow down the process of marketing automation and customer relationship management, which in turn affects the effectiveness of marketing strategies. PEST analysis is useful for a detailed understanding

of external factors that affect online marketing. This analysis helps to assess the economic, social, political and technological elements that can influence a company's marketing strategies. Table 5 shows the PEST analysis of the use of Internet marketing in enterprises.

Based on the SWOT and PEST analyses, several important steps can be taken to improve the use of online advertising, which will increase the company's efficiency and market position. First of all, companies should increase the personalisation of their marketing campaigns. Companies can now segment their audiences more accurately thanks to the development of technologies such as Big Data and artificial intelligence (AI). Personalisation of communications enables the creation of targeted advertising campaigns aimed at the most interested customers. This approach will ensure higher conversion rates and reduce advertising costs. Both of these factors are important for increasing a company's productivity.

**Table 5.** PEST-analysis: use of Internet marketing at enterprises

Political factors	Economic factors	Social factors	Technological factors
<ol style="list-style-type: none"> <li>1. Changes in personal data protection legislation may affect marketing strategies.</li> <li>2. Regulation of advertising on social media.</li> <li>3. Legislative initiatives to expand access to the Internet in the regions.</li> </ol>	<ol style="list-style-type: none"> <li>1. Increased advertising spending due to competition in the online space.</li> <li>2. Economic instability may affect marketing spending.</li> <li>3. Currency fluctuations can affect the cost of international campaigns.</li> </ol>	<ol style="list-style-type: none"> <li>1. Changing consumer preferences towards online shopping.</li> <li>2. Growing popularity of mobile apps and online shopping platforms.</li> <li>3. Development of social media, which opens up new channels of communication.</li> </ol>	<ol style="list-style-type: none"> <li>1. Rapid development of new technologies such as AI and Big Data provides new opportunities for targeted advertising.</li> <li>2. Innovative tools such as chatbots and automation can increase the effectiveness of marketing campaigns.</li> <li>3. Constantly updating search engine algorithms, which requires adapting marketing strategies.</li> </ol>

**Source:** compiled by the authors

Integration of online marketing with other strategic areas of the company is another important area. Internet marketing should be part of the company's development strategy, not a separate tool. This will help to achieve greater coherence between different business processes, maximising results and more efficient use of resources. Enterprises should consider online marketing in product planning, pricing, and customer communication. Ensuring that all digital channels are unified is an important part of this strategy, as it will create a unified strategy to increase efficiency.

Reducing advertising costs through precise targeting is another important recommendation. Modern online marketing tools, such as PPC and SMM, are much more precise in identifying the target audience for each advertising campaign. When companies use targeted advertising campaigns, they can focus on customers who already show interest in products or services, which reduces the cost of ineffective advertising and increases the likelihood of conversion. Such technologies can reduce the cost of mass advertising campaigns and focus on the most attractive market segments, which can significantly optimise the marketing budget.

As the popularity of social media and mobile platforms continues to grow, companies should focus on using these communication channels. Given the steady growth in the use of mobile apps and social media, marketing strategies focused on these platforms are vital to expanding their customer base and strengthening their market position. Companies can build a brand

identity, create engagement with their audience, and receive customer feedback through effective media marketing. It is important not only to use social media to promote products, but also to optimise the strategy with the help of the data they collect.

Online marketing is impossible without the use of the latest technologies, such as automation and chatbots. Such tools can significantly increase the efficiency of marketing campaigns, reduce the time spent with customers, and provide them with real-time, personalised offers. By automating processes, companies can adapt their marketing campaigns to changing conditions and deliver targeted messages only when needed, which greatly increases the effectiveness of communication. Chatbots allow companies to quickly respond to customer queries by providing them with relevant information, assisting in the purchase process, or providing support.

Implementing these recommendations will allow companies to continue to grow and be competitive in the market, as well as increase the effectiveness of their online marketing campaigns. Companies can achieve a significant increase in efficiency and market position by developing individual strategies, integrating online marketing into the overall enterprise strategy, optimising advertising costs and using the latest technologies.

## DISCUSSION

Digital technologies play an important role in developing the competitiveness of enterprises in today's business environment. They allow for

effective adaptation to changing conditions, improving customer experience, optimising business processes and reducing costs. This study and M. Shahbandi (2024) focused on the role of digital marketing in gaining competitive advantage, with a focus on increasing access to customers, developing websites, and using social platforms. M. Shahbandi's study highlighted the effectiveness of digital marketing in the US food industry. One of the main similarities between the studies was the emphasis on digital marketing tools, such as website development, increased customer access and the use of social media platforms, which were key to achieving competitive advantage. M. Shahbandi's study focused on the US food industry, where 71 marketing experts in the industry were interviewed, while this study could cover more industries without specifying a particular sector. In addition, the author focused on the use of artificial intelligence for data visualisation and decision-making, which was not mentioned in this study.

The study by V. Skvarciany & D. Jurevičienė (2024) and the present study have a similar approach to analysing digital competitiveness, in particular through the use of digital technologies such as the Internet, websites, and social media. However, the study by V. Skvarciany & D. Jurevičienė proposes the development of a digital competitiveness index (EDCI) to compare the levels of enterprises in the EU using multi-criteria decision-making methods. While this study covers a wider range of industries and does not use a specific index. The main difference is the emphasis of the V. Skvarciany & D. Jurevičienė on the dynamics of digital competitiveness and its impact on economic growth and stability, which provides a more comprehensive view of the role of digital technologies in the global economy.

This study and the research of X. Ma & X. Gu (2024) both emphasised the importance of digital marketing, but with different approaches to its application. They focus on using digital technologies to optimise marketing strategies, personalise content, and adapt to changing market conditions. The study by X. Ma & X. Gu focuses on marketing strategies for e-commerce enterprises, using genetic algorithms to improve strategies. They discuss challenges such as the

homogenisation of marketing strategies and the lack of application of big data. At the same time, the study looks at a more general approach to digital marketing, applying it to different areas, without focusing on e-commerce.

The study by S. Wang *et al.* (2024) and the current study both focused on the use of digital technologies to increase the competitiveness of enterprises. S. Wang *et al.* focused on the impact of the industrial Internet on small and medium-sized businesses in China, using analytical methods to assess the effectiveness of technology in enterprises. They focused on the integration of the industrial internet into enterprise processes to improve productivity. At the time, this study examined the impact of digital marketing on enterprise competitiveness, looking at web analytics, social media, and SEO as tools to improve efficiency and reduce costs. S. Wang *et al.* focused on technologies for manufacturing transformation, while this study focused on marketing strategies.

The work of S.-U. Jung & V. Shegai (2023) and the current study focused on the use of digital technologies to increase the competitiveness of enterprises. Both focused on digital marketing strategies, but the study by S.-U. Jung & V. Shegai was more focused on the strategic use of tools for branding and expanding presence, while this study focused on the practical application of SEO, websites and online advertising to increase visibility. The study by S.-U. Jung & V. Shegai was about South Korea, while this study looked at Ukrainian enterprises. Jung and Shegai's study was more theoretical, while this study applied practical marketing tools to optimise business.

R. Tarazona-Montoya *et al.* (2024) investigated how companies can increase their competitiveness through digital technologies. Both studies focused on digital innovations and their impact on improving the efficiency of enterprises through the use of modern technologies. They emphasised the importance of digital tools for increasing productivity and adapting to the changing market environment. The main differences were in the focus of the studies. The study by R. Tarazona-Montoya *et al.* focused on digital innovations in business management, including the development of new business models and adaptation to digital transformations in

various sectors of the economy. Instead, this study focused on digital marketing, its strategies and tools that improve customer experience and increase market visibility.

Sugito (2024) and the current study highlighted the importance of digital marketing tools for improving business visibility and efficiency, in particular by reducing costs and increasing the agility of enterprises. Sugito (2024) focused on small and medium-sized enterprises in developing countries and emphasised the practical application of digital tools, while the present study took a more general approach, focusing on the theoretical aspects of digital strategies for different types of businesses. In addition, the Sugito study was more focused on marketing strategies, while this study looked at broader digital innovations such as SEO and contextual advertising.

V. Triplett (2024) investigated the impact of digital marketing on the competitiveness of small businesses, particularly in rural areas. Both emphasised the importance of digital tools, such as social media and SEO, to improve customer engagement. Study V. Triplett's study focused on small businesses in rural areas that had limited access to digital technologies, while this study focused on the application of digital strategies in a broader context. V. Triplett used interviews to identify barriers, while this study focused on the theoretical aspects and practical implementation of digital strategies. The main difference was that the V. Triplett focused on the problems of access to technology for rural enterprises, while this study focused on optimising existing tools to improve competitiveness.

In their study, M. Bahorka *et al.* (2024) investigated the impact of the integration of innovative digital technologies, such as big data and the Internet of Things, on the competitiveness of enterprises. They focused on the introduction of digital technologies into companies' strategies, which helps to optimise business processes, particularly in industrial enterprises. Both studies acknowledge the importance of digital marketing as a tool for increasing the competitiveness of enterprises, but the studies M. Bahorka *et al.* focuses in more detail on the integration of innovative digital technologies into companies' strategies, in particular through

the use of big data and the Internet of Things. At the same time, this study emphasised the widespread use of digital marketing tools, such as social media and online stores, to expand the customer base and improve interaction with potential consumers.

Researchers B. Mihajl *et al.* (2023) in their work focused on the use of the Marketing 5.0 concept to optimise customer experience, emphasising the importance of adapting marketing strategies to changes in consumer behaviour through digital tools. They focused more on theoretical approaches to integrating digital technologies into marketing strategies for a global environment. This study, in turn, focused more on digital marketing tools such as SEO, website analytics and social media, with an emphasis on practical applications to improve the competitiveness of enterprises.

H.N. Hussain *et al.* (2023) focused on the use of artificial intelligence, big data analytics, and machine learning technologies to improve marketing strategies. Instead, this study focused more on digital marketing tools, such as SEO, website analytics, and social media marketing, to improve the visibility of an enterprise in the market. H.N. Hussain *et al.* also focused on the digital transformation of SMEs through the latest technologies, while this study covered a wider range of digital tools for competitiveness in various business sectors. The methodology of H.N. Hussain *et al.* used quantitative methods to analyse technology adoption, while this study focused on analysing digital marketing strategies as tools for improving competitiveness.

The author M.A.A. Dalbough (2023) focused on assessing the effectiveness of internet marketing in e-business, particularly in the logistics and retail sectors. It also discusses the importance of internet marketing for business in the context of information flow management and logistics, which allows to increase business efficiency by reducing costs and increasing conversion. This research also covered digital marketing tools, but the focus was more on digital marketing strategies such as SEO, content marketing, social media, and marketing campaign automation, while M.A.A. Dalbough focused on the implementation of technology to drive efficiency on a broader level.

Research has shown the importance of digital technologies in increasing the competitiveness of enterprises through the use of various tools such as SEO, social media, web analytics, and other marketing strategies. Businesses need to adapt their strategies by adopting the latest technologies to optimise business processes, improve customer experience and reduce costs. Although studies have different emphases, they all confirm that digital tools are key to developing competitiveness in modern economy.

## CONCLUSIONS

The findings of the study emphasise the importance of implementing online marketing strategies to increase the competitiveness of enterprises in the modern digital environment. The analysis showed that the use of digital marketing tools such as SEO, content marketing, email marketing, social media and web analytics allows companies not only to optimise advertising costs, but also to improve communication with the target audience and increase brand awareness. Internet marketing has the significant advantage of allowing companies to change their marketing strategies to meet the needs and desires of their customers. This increases customer loyalty, which is important for the long-term success of companies. Big data and analytical platforms help companies create effective marketing campaigns and respond quickly to market changes. Social media and e-commerce allow businesses to communicate with customers and adapt their offerings to new conditions, making them extremely resilient.

The successful cases of the companies reviewed in the study confirm the effectiveness of online marketing strategies. For example, "Nova Poshta" actively uses SEO and social media marketing to increase its visibility and attract new customers. Optimising its website's SEO has increased organic traffic by 40% and conversions by 15%. The use of email marketing also increased the number of repeat orders by twenty per cent. Online retailer "Rozetka" effectively uses PPC advertising and targeted advertising through social media, which allows it to remain a leader in the e-commerce market in Ukraine. "Foxtrot" achieved significant results with email marketing, which increased sales of accessories

by 16% with the same traffic. "Foxtrot" email marketing performance statistics show significant achievements: optimisation of email campaigns increased conversion by 5% and increased engagement on the website by 10% thanks to effective product recommendations. In addition, general statistics show that segmented campaigns have the potential to increase revenues by 760%, and personalised subject lines can increase open rates by 26%. In addition, "Kyivstar" successfully uses Big Data and personalised advertising campaigns to attract new customers and increase the loyalty of existing subscribers.

The study's findings confirm the importance of online marketing for increasing the competitiveness of businesses. Implementation of tools such as SEO, PPC, social media and email marketing significantly improves brand visibility, attracts new customers and increases sales. SEO can increase traffic by 20-30% and sales by 15-25%, while PPC can increase traffic by 50-100% and sales by 40-80% in 1-3 months. Content marketing and email marketing promote brand loyalty and increase conversion rates by 10-20% and 25-40%, respectively.

However, there are a number of challenges businesses face when implementing online marketing strategies. These include a lack of digital skills, limited financial resources to expand their online presence, and the need to constantly update their digital marketing knowledge. High competition in the online environment requires companies to apply innovative approaches, such as automating marketing processes, implementing artificial intelligence, and integrating omnichannel strategies to improve customer experience.

Thus, digital marketing is an important part of modern business, as it helps companies stay competitive in the long run and improves communication. At the same time, the study is limited by the rapid change in digital technologies and the changing algorithms of search engines and social platforms. This makes it difficult to predict the effectiveness of online marketing strategies over a long period of time. Analysing adaptive digital marketing strategies using artificial intelligence and automating business processes are possible topics for further research. Increasing the efficiency of customer

interaction, reducing advertising costs, and optimising business processes can be achieved by integrating online marketing tools into the overall strategy of an enterprise. Further research in this area should focus on developing flexible strategies that can adapt to rapid changes in the market environment, advances in technology, and changes in consumer behaviour.

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## **Підвищення конкурентоспроможності підприємства за рахунок впровадження інтернет-маркетингу**

**Анотація.** Метою дослідження було вивчення впливу інтернет-маркетингу на конкурентоспроможність підприємств. У дослідженні були використані методи аналізу вторинних даних і кейс-стаді для вивчення успішного застосування інтернет-маркетингових інструментів у різних галузях. Проведено аналіз застосування Search Engine Optimization, контекстної реклами, соціальних медіа та веб-аналітики серед провідних українських підприємств, таких як «Нова Пошта», «Розетка», «Київстар» та «Фокстрот». Результати дослідження підтвердили важливість інтернет-маркетингу для підвищення конкурентоспроможності підприємств. Було визначено, що завдяки інструментам, таким як оптимізація пошукових систем, Pay-Per-Click та соціальні мережі, можна значно підвищити видимість бренду, залучити нових клієнтів і збільшити продажі. За 1-3 місяці Pay-Per-Click може збільшити трафік на 50-100 % і продажі на 40-80 %, тоді як Search Engine Optimization дозволяє збільшити трафік на 20-30 % і продажі на 15-25 %. Email-маркетинг і контент-маркетинг сприяють лояльності до бренду та підвищують конверсії на 10-20 % відповідно. Дослідження показало, що інтернет-маркетинг допомагає не тільки підвищити видимість бренду, але й сприяє залученню більшої кількості клієнтів завдяки точнішій таргетованій рекламі та зростанню ефективності взаємодії з ними. Використання Search Engine Optimization дозволяє покращити органічне просування сайтів у пошукових системах, що веде до збільшення трафіку без значних витрат на рекламу. Дослідження також підкреслило важливість мобільного маркетингу, оскільки зростання використання мобільних пристроїв стає важливим чинником для покращення доступу до клієнтів та підвищення конверсії. Висновки дослідження підтверджують, що ефективне використання цифрових інструментів маркетингу є одним із основних факторів для підвищення конкурентоспроможності підприємств у сучасних умовах цифровізації. Важливим є також інтеграція новітніх технологій, таких як штучний інтелект та аналітика великих даних, для більш персоналізованої взаємодії з клієнтами і підвищення загальної ефективності маркетингових кампаній. Практичне значення дослідження полягає у розробці ефективних стратегій використання цифрових маркетингових інструментів для підвищення конкурентоспроможності підприємств різних галузей

**Ключові слова:** цифрові технології; веб-аналітика; соціальні мережі; попит; контент



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## The impact of innovation in the global economy on the development of the international labour market

**Abstract.** This study aimed to explore the impact of innovation on employment and the structure of the labour market within the context of the global economy, focusing on the dynamics of transformative processes driven by digitalisation, automation, and changing demand for new skills. A comprehensive methodological approach was adopted, incorporating analysis of sectoral employment shifts, the influence of technological advancement on international labour migration, and the implications of digital transformation for the legal regulation of the labour market. The findings confirm that innovation is a major force behind profound changes in the labour market. In 2023, 66% of tasks were carried out by humans, 33% by technologies, and only 1% through a hybrid format. Projections for 2030 indicate a decrease in the share of human labour to 33%, while hybrid work models are expected to rise to 33%, highlighting the growing need to

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develop digital competencies and adapt to emerging forms of employment. The rise of remote work presents new opportunities, yet it also exacerbates social inequality and intensifies global competition for highly skilled professionals. Virtual labour migration is partially replacing the traditional brain drain by enabling professionals to work remotely without the need for physical relocation. A comparative analysis of Germany and Ukraine revealed shared trends while also highlighting differing levels of adaptation. Germany, through the implementation of Industry 4.0 and flexible labour legislation, achieved a high employment rate (81.1% in 2023). In contrast, Ukraine is demonstrating dynamic growth in the information technology sector. The war has further complicated these processes, exacerbating structural instability in the labour market. The study confirmed that successful adaptation to an innovation-driven economy requires not only technological advancement but also effective education policy, social dialogue, and regulatory support. The practical significance of the research lies in deepening the understanding of transformative processes in the international labour market under the influence of innovation, offering an analytical foundation for further applied research

**Keywords:** scientific and technological progress; innovation; work motivation; international labour migration; employment; unemployment

## INTRODUCTION

Innovation is a key driver of modern economic development, exerting a significant influence on the labour market by creating new opportunities while also prompting major transformations in employment. Automation, digitalisation, and the advancement of artificial intelligence are reshaping the structure of labour demand, contributing to the growth of certain professions and the decline or disappearance of others. These processes affect not only domestic labour markets but also global trends in labour migration, presenting new challenges for governments and businesses alike.

As noted by I. Irtyshcheva (2021), technological progress is transforming not only the structure of employment but also the mechanisms of social protection, necessitating the adaptation of labour legislation and educational programmes. Digital technologies have a profound impact on economic growth, offering new avenues for improving the quality of life and boosting gross domestic product (GDP) through the expansion of the digital economy. Studies using regression models have shown that the digitalisation of key economic sectors – particularly in Ukraine – contributes to increased production and improved financial performance.

K. Zaslavska & Y. Zaslavska (2024) noted that, between 2015 and 2024, accelerating technological evolution has compelled countries to rethink their economic strategies. Global instability,

political crises – such as the war in Ukraine – technological breakthroughs, and shifts in consumer behaviour have created significant challenges for businesses, demanding rapid adaptation. Their study examines how these factors affect entrepreneurial structures, emphasising the need for strategic flexibility, innovation, and the reassessment of traditional models. In Ukraine, according to research by L. Dovgal *et al.* (2021), economic digitalisation is primarily focused on expanding the IT sector and attracting international investment in high-tech industries.

A major challenge is the growing need to develop new skills and retrain the workforce, as traditional forms of employment are gradually being transformed. N. Kraus *et al.* (2022) observed that demand is rising for highly qualified professionals in artificial intelligence, data analysis, and cybersecurity, while low-skilled workers increasingly face the risk of unemployment. This trend underscores the importance of educational and vocational training reforms to ensure the competitiveness of the labour force. The authors also point out that, in Ukraine's post-war context, artificial intelligence plays a dual role – as both a driver of economic recovery and a critical component of national cybersecurity. Innovation is also significantly reshaping international labour migration by altering its structure and underlying motivations. O. Nosova (2024) highlights that developed countries

are showing a growing interest in attracting highly skilled professionals through specialised labour immigration programmes.

Debates concerning the impact of innovation on unemployment remain inconclusive. As demonstrated by L. Yemelyanova & S. Mlynko (2024), technological progress has contributed to the emergence of new forms of employment – such as the gig economy and freelancing – which offer greater flexibility for workers. The relationship between technological development and unemployment is largely inverse: innovation tends to create more jobs than it eliminates. However, not all indicators of technological growth have a direct effect on unemployment levels, due in part to the presence of frictional unemployment and the influence of active social policies. Adapting labour legislation to the new realities of the labour market is a key challenge for many countries. As H. Lopushniak *et al.* (2023) emphasise, traditional mechanisms of social protection often fail to account for emerging employment models, such as work via digital platforms. This highlights the need to reform labour relations systems and introduce new standards of social security.

A comparison of the experiences of Germany and Ukraine reveals both commonalities and differences in the impact of innovation on employment. According to the study by N. Katalin & S.Z. Gábor (2022), Germany has focused on production automation and the integration of robotics, necessitating the retraining of a significant portion of the workforce and the implementation of lifelong learning systems. In contrast, Ukraine, as outlined in research by L. Melnyk *et al.* (2022), is adapting digital technologies to wartime conditions, leveraging the digital economy to support small businesses, develop the IT sector, and expand remote employment opportunities. The German model reflects a gradual transition towards Industry 4.0, with an emphasis on increasing productivity and manufacturing efficiency. By comparison, Ukraine's approach is more reactive and crisis-driven, aimed at enterprise survival and job retention through the use of digital tools.

The central issue addressed in this study lies in the fact that existing academic literature has largely considered innovation as a driver of

economic growth while paying insufficient attention to its direct impact on the international labour market. Key topics such as structural unemployment, changes in employment models, and the adaptation of labour migrants to new conditions resulting from technological transformations have remained underexplored. This research helps to fill that gap by focusing on how technological innovation has reshaped international labour relations, influenced worker mobility, and altered approaches to vocational training and employment.

This study aimed to determine the impact of innovation on the international labour market and to analyse changes in employment structures driven by digital technologies. The key objectives were: to identify the mechanisms through which automation, digitalisation, and artificial intelligence affect global labour markets; to analyse shifts in demand for occupations and worker qualifications linked to the development of innovative technologies; and to conduct a comparative analysis of the adaptive strategies employed by Ukraine and Germany in response to new labour market challenges.

## MATERIALS AND METHODS

The study employed an interdisciplinary approach, combining economic, sociological, and political analysis. Particular attention was given to the cases of Ukraine and Germany (as an example of a European Union member state), representing countries with differing levels of digitalisation and approaches to labour market regulation. The research was conducted in three stages between October and December 2024.

The first stage involved the systematisation of theoretical foundations regarding the impact of innovation on employment and labour market structures. It examined structural changes in employment and the influence of digital transformation on the demand for worker qualifications. This stage drew upon reports from international organisations such as the OECD (International Transport Forum, 2023) and the World Economic Forum (2024), as well as analytical data from national governments (Annual Economic Report, 2024).

The second stage focused on an empirical analysis of the impact of innovation on

international labour migration. A comparative review of trends in brain drain and talent circulation was conducted using data from the European Commission (Employment – annual statistics, n.d.), the McKinsey Global Institute (Lund *et al.*, 2021), the OECD (Özgüzel & Edo, 2023), and the World Bank Group (Constantinescu *et al.*, 2024). The role of digital technologies in the expansion of remote employment, outsourcing, and shifts in international labour mobility strategies was assessed.

The third stage involved an applied analysis of labour market transformation in Ukraine and Germany. A SWOT analysis was employed to compare the effects of digitalisation and Industry 4.0 on the labour markets of both countries. The study focused on labour law reforms and employment support mechanisms. The analysis drew on official EU and German legislation, including Directive (EU) 2021/1883 (2021), the Act on Part-Time Work and Fixed-Term Employment Contracts (2022), Directive (EU) 2024/2831 (2024), and the Skilled Immigration Act (2024). Statistical data from various think tanks were also reviewed (World Economic Forum, 2023; Dynamics of Ukraine's Tech Industry..., 2024; The Main Results of the Year..., 2024; Employment Growth in..., n.d.).

The methodological framework included comparative and SWOT analysis, which enabled the evaluation of the advantages and challenges associated with the innovative transformation of the labour markets in Ukraine and Germany. This approach made it possible to identify key employment trends in the digital economy and to assess national strategies in response to these developments. Comparative analysis was also applied to assess the impact of innovation on international labour migration, juxtaposing trends in brain drain and talent circulation using data from the European Commission (Employment – annual statistics, n.d.; Gig economy..., 2024), McKinsey Global Institute (Lund *et al.*, 2021), OECD (Özgüzel & Edo, 2023), and the World Bank Group (Constantinescu *et al.*, 2024). This method made it possible to identify both common and distinctive features of migration processes in countries with varying levels of innovation-driven economic development. The study examined the role of digital technologies

in the expansion of remote employment, outsourcing, and the evolving approaches to international labour mobility. A SWOT analysis was conducted to compare the advantages and challenges of labour market digitalisation in Ukraine and Germany. This included an assessment of IT sector development, the availability of education programmes aimed at enhancing digital skills, the risk of rising unemployment in traditional industries, unequal access to technology across regions, the potential for increased social inequality, and the displacement of low-skilled workers from the labour market.

The combination of research methods enabled not only the identification of general labour market trends influenced by innovation but also an evaluation of the effectiveness of government responses to these challenges. The interdisciplinary approach allowed for the integration of economic, social, and political dimensions of employment transformation, contributing to a comprehensive analysis of the impact of innovation on the international labour market.

## RESULTS AND DISCUSSION

Innovative processes – particularly automation and digitalisation – play a decisive role in transforming the labour market, shaping a new employment paradigm. These processes lead both to the creation of new jobs and to the displacement of a significant number of workers as human labour is replaced by technological solutions. Structural changes in the global economy, driven by innovation, affect the sectoral distribution of the workforce, alter professional requirements, and necessitate a rethinking of approaches to vocational education and training.

The effects of automation and digitalisation are uneven across different segments of the labour market, depending on the nature of the tasks performed and the extent to which human labour can be technologically substituted. Jobs involving routine tasks that can be codified and executed by robotic systems or artificial intelligence are the most susceptible to automation. These include low-skilled occupations in manufacturing, administrative support, and standard service industries.

According to research by the Organisation for Economic Co-operation and Development

(OECD) and the International Transport Forum (2023), automation is leading to job reductions in sectors such as mechanical engineering, the textile industry, food production, and agriculture. The introduction of industrial robots and autonomous production management systems significantly reduces the need for workers to perform mechanical tasks. In the administrative sector, the widespread adoption of software for automating accounting, data processing, and document management has led to a declining demand for office personnel. However, there is a

concurrent increase in tasks carried out through collaboration between humans and technology, reflecting a growing trend towards hybrid working models. As illustrated in Table 1, while in 2024 the majority of work tasks were still performed by humans (47%), this figure is projected to decrease to 33% by 2030, giving way to technological and hybrid models of work. This trend underscores the need for labour market adaptation, expansion of reskilling programmes, and the development of new competencies demanded by the digital economy.

**Table 1.** Distribution of work tasks between humans and technology, 2023-2030

Indicator	Humans	Technology	Hybrid
Percentage of tasks performed in 2023	66%	33%	1%
Projected percentage of tasks in 2030	33%	34%	33%

**Source:** compiled by the author based on World Economic Forum (2023)

The analysis of Table 1 highlights profound transformations in employment resulting from technological progress and digitalisation. According to the data presented, in 2023, 66% of all tasks were performed by humans, 33% by technologies, and only 1% in a hybrid format involving both human input and technological tools. This distribution indicates that, as of 2023, human labour still dominated most sectors, although the share of automated processes was already significant. However, the forecast for 2030 reveals a fundamental shift in this paradigm: the share of tasks performed by humans is expected to decrease to 33%, while the share executed solely by technology will remain stable at 34%. The most notable increase is projected in the hybrid category, which is expected to rise to 33%. This suggests that, in the future, most work processes will be based on collaboration between humans and technologies, with each contributing to different stages or aspects of a task. This trend does not so much imply the displacement of humans from the labour market as it signals a transformation in the nature of employment. Manual labour and routine tasks are increasingly being automated, while human input will concentrate on activities requiring creativity, critical thinking, emotional intelligence, and adaptability. The rise in hybrid working models also reflects the growing importance of technological

literacy and the need to develop digital competencies across a wide range of professions.

The studies by A. Gallego & T. Kurer (2022) and M. Javaid *et al.* (2024) confirm that automation and digitalisation are reducing the number of low-skilled jobs while simultaneously creating new opportunities in high-tech sectors. The authors emphasise that a key challenge lies in adapting educational programmes to prepare the workforce for the emerging economic landscape. However, the present study demonstrates that although technological change raises concerns about unemployment, current trends indicate employment growth in new areas of the economy. It is important to note, however, that the positive effects of automation largely depend on government policies related to education and reskilling.

Despite the decline in employment in traditional sectors vulnerable to high levels of automation, innovation is driving the development of new employment domains based on the adoption of advanced technologies and the transformation of production and economic models. In particular, there is a marked increase in demand for highly qualified professionals in the field of information technology. In the EU, employment in high-tech occupations grew by 23.8% between 2009 and 2022, with a further increase of 15.4% projected for the period 2022-2035

(Employment growth in..., n.d). Innovative technologies such as machine learning, neural networks, blockchain, and quantum computing are giving rise to new professional fields, including quantum algorithm engineers, ethical AI specialists, blockchain solutions analysts, neural network architecture developers, and cloud data management professionals. These roles require interdisciplinary competencies combining mathematical modelling, algorithmic analysis, computer engineering knowledge, and skills in managing complex information systems.

A high level of innovation has played a pivotal role in transforming the global economy, driving the emergence of new sectors and creating opportunities for job growth in high-tech industries. In particular, the rapid development of the IT sector, digital services, biotechnology, and renewable energy has generated new employment markets and contributed to increased labour

productivity. These sectors often exhibit higher added value and demand a highly skilled workforce, creating favourable conditions for economic growth and the modernisation of national labour market structures. This innovation-driven transformation of the global economy has led to a significant rise in the mobility of highly qualified professionals across borders. Developed countries that were early adopters of digital and technological innovations have faced a continuous demand for specialists in rapidly expanding sectors. This has intensified international competition for human capital and contributed to a large-scale redistribution of labour resources in favour of high-skilled mobility. As indicated by the data presented below (Table 2), the volume of international labour migration involving highly qualified personnel has increased considerably, underscoring the strategic importance of innovation in shaping the global labour market.

**Table 2.** Volume of international labour migration of highly skilled workers

Year	EU (thousands of people)	Germany (thousands of people)
2020	50.2	43.2
2021	67.7	57.6
2022	81.8	63.2
2023	89	69.3
2024	No data available	No data available

**Note:** data for Ukraine are unavailable due to the full-scale invasion, which has hindered data collection. Estimates are based on the number of Blue Card permits issued

**Source:** compiled by the author based on EU Blue Cards by type of decision... (2024)

Analysis of the data in Table 2 reveals a clear trend towards increased mobility of personnel in high-tech and knowledge-intensive sectors. The growth in the number of highly skilled labour migrants in the EU correlates with the rapid advancement of digital technologies, automation, artificial intelligence, as well as bio- and financial technologies. These developments are generating a new type of labour demand, focused on highly specialised occupations that require advanced education, practical skills, and professional experience. The most notable increase occurred in 2021-2022, coinciding with the post-pandemic phase of economic recovery, during which many countries accelerated digital transformation and intensified efforts to attract IT specialists, engineers, researchers, and healthcare professionals. High-skilled migration

serves as an indicator of a country's innovation appeal. EU member states have shown consistent growth in attracting such talent, progressively adapting their policies to meet the demands of the digital economy. At the same time, the situation in Ukraine remains exceptional due to the ongoing war, which, despite the country's considerable human capital, constrains its integration into international frameworks for high-skilled labour migration. Ukraine's absence from the table above is explained by several factors related to geopolitical instability and the specific conditions of the national labour market. Following the fullscale invasion by Russia in 2022, Ukraine has faced acute socio-economic turbulence. As a result, the domestic labour market has been severely disrupted, particularly in sectors involving highly qualified

employment, such as IT, engineering, and scientific research. The war has significantly limited the state's capacity to conduct systematic monitoring of migration flows and to compile up-to-date statistical records. Additionally, economic instability, infrastructure destruction, and the forced displacement of millions have reduced the predictability of labour market developments and hindered Ukraine's inclusion in formalised international comparisons.

However, these positive developments have also been accompanied by significant challenges. The automation and digitalisation of production processes – mainly within traditional sectors such as industry, transport, and agriculture – have led to widespread labour displacement. The reduction in such jobs has not only intensified competition for the remaining positions in the labour market but has also had a considerable impact on the socio-economic landscape of regions historically dependent on labour-intensive industries. The disappearance of stable industrial employment has contributed to rising unemployment, increased social tensions, and growing regional disparities. In countries with high levels of innovation, such as the USA, Germany, and South Korea, the share of automated processes in manufacturing exceeds 30%. While this enhances productivity, it simultaneously reduces the demand for low-skilled labour. For instance, in Germany – where the level of industrial automation is among the highest globally (around 400 robots per 10,000 workers) – the unemployment rate remains low at approximately 3%, due to substantial investment in worker retraining and the support of emerging high-tech sectors (Annual Economic Report, 2024). In contrast, Spain, where automation is progressing at a slower pace (around 100 robots per 10,000 workers), faces a youth unemployment rate exceeding 25%, indicating insufficient integration of innovation into the labour market (International Federation of Robotics, 2023).

Significant changes are taking place in education and vocational training as a result of structural shifts in the labour market driven by intensive digitalisation and automation of production processes. The growing demand for highly specialised professionals in fields such as information technology, robotics, cybersecurity,

and big data analytics necessitates deeper specialisation among workers and a systematic renewal of their skillsets. The traditional model of professional training – based on acquiring a foundational education within a single learning cycle – is gradually being replaced by the concept of lifelong learning, which emphasises the continuous development and refinement of skills (Petryshyn et al., 2023). The concept of lifelong learning has gained broad recognition among international policy and economic institutions such as the OECD, UNESCO, and the World Economic Forum (WEF), all of which stress the critical importance of flexible mechanisms for reskilling and upskilling in order to maintain workforce competitiveness in a post-industrial economy. For example, the World Economic Forum (2023) reports that 60% of workers will require additional training by 2027, yet only half currently have access to appropriate opportunities for skills development. The same report projects that 69 million new jobs will be created by 2027, while 83 million will be eliminated, resulting in a net reduction of 14 million jobs. These changes are being driven by the adoption of new technologies, digital transformation, and the transition towards green energy.

Although automation and digitalisation are driving structural changes in employment and reducing demand for low-skilled labour in traditional sectors, they are simultaneously contributing to the diversification of the labour market and the development of new economic segments founded on advanced technologies. In the long term, labour market adaptation to technological change will require a comprehensive approach that combines government-backed reskilling initiatives, investment in digital education, and the expansion of lifelong learning programmes. The introduction of adaptive educational models, the development of technology incubators, and the promotion of partnerships between academia and industry will support more effective utilisation of human capital and create the conditions for sustained economic growth.

Innovative processes are also reshaping international labour migration trends, leading to a redistribution of the workforce across countries and transforming the nature of employment on a global scale. Notably, the rise of remote work

has become a key driver of these changes. According to a study by D. Salon *et al.* (2022), in the USA, the proportion of workers expecting to work remotely at least a few times per month after the pandemic increased to 40%-50%, compared with 24% before the pandemic. Most of these new remote workers plan to continue doing so on a regular basis. As noted in the study by F. Braesemann *et al.* (2022), remote work tends to be polarised: the majority of tasks are concentrated in North America, Europe, and South Asia, while countries of the Global South participate only marginally. Moreover, remote work is more prevalent in urban areas, leaving rural regions behind, and it is also polarised by skill level: workers with in-demand skills secure well-paid assignments, whereas others face intense competition and low remuneration. These findings highlight that innovation – particularly the advancement of digital technologies – significantly influences international labour migration by driving the expansion of remote work and reshaping the structure of the global labour market.

Automation, digitalisation, and the development of advanced technologies are altering the supply and demand dynamics of the labour market, encouraging the growth of highly skilled mobility and reducing the demand for low-skilled labour. Developed countries that are at the forefront of technological innovation – such as the USA, Germany, the United Kingdom, Canada, Australia, Norway, and Finland – are emerging as primary destinations for highly qualified professionals. This process, commonly referred to as brain drain, has been intensified by the high demand for professionals in fields such as artificial intelligence, machine learning, cybersecurity, robotics, biotechnology, engineering, and financial services. The proportion of highly skilled migrants in EU countries rose from 17% in 2010 to 26% in 2022 (Özgüzel & Edo, 2023). In response to these developments, advanced economies have adapted their migration policies, creating more favourable conditions for attracting foreign specialists. Initiatives such as the European Blue Card (Directive (EU) 2021/1883, 2021) enable the recruitment of professionals in strategically important sectors, thereby supporting the competitiveness of research and technology-based industries.

In 2023, Germany reformed its Skilled Immigration Act (2024), simplifying visa procedures for IT professionals, engineers, and researchers.

The phenomenon of brain drain has traditionally been understood as the emigration of highly skilled professionals from developing countries to economically advanced nations. Such migration results in a loss of intellectual capital, which can hinder the economic development of the countries of origin. However, with the expansion of digital technologies and remote employment, this dynamic is shifting: an increasing number of professionals now remain in their home countries while working for international companies. This trend signals the emergence of a new model of global talent mobility, referred to as virtual labour migration. The COVID-19 pandemic acted as a catalyst for the growth of remote work, prompting many companies to reassess their approaches to recruitment. Research conducted by the McKinsey Global Institute (Lund *et al.*, 2021) found that approximately 20%-25% of the workforce in developed economies can work remotely on a permanent basis without any loss in productivity. At the same time, the World Bank notes that remote employment remains less widespread in developing economies due to uneven access to digital infrastructure, although its prevalence is steadily increasing (Constantinescu *et al.*, 2024).

The growth of remote employment is transforming traditional models of international migration. Highly skilled professionals from developing countries are increasingly able to work for foreign companies without the need for physical relocation. According to the World Economic Forum (2024), more than 30% of specialists in programming, graphic design, and online marketing were engaged in remote international collaboration in 2024. This trend is intensifying competition between developed and developing countries for highly qualified labour, prompting the latter to adapt their policies to encourage talent retention within national economies.

The study by H.E. Wanniarachchi *et al.* (2020) explores the intensifying global competition for skilled professionals in the context of labour market globalisation. The authors highlight that developed countries are actively cultivating favourable conditions for attracting foreign

talent, thereby reinforcing their technological advantages. In contrast, developing countries are experiencing losses through brain drain, which hampers the implementation of innovation-driven strategies. The research by A. Vega-Muñoz *et al.* (2021) focuses in particular on the role of government policy in mitigating talent migration. Researchers note that fostering innovation through state support for research institutions and technology parks can partially offset the effects of human capital outflow. However, the authors emphasise that without active engagement from private investors, such measures tend to be of limited effectiveness. B. Bhardwaj & D. Sharma (2023) highlight the ambiguous outcomes of these policies. In their view, the roles of private investors and the state largely depend on a country's economic structure and level of institutional development. They argue that there is no universal model for encouraging the retention of highly skilled professionals; rather, such measures must be adapted to the national context. Within the scope of their study, it was found that the effectiveness of such strategies largely hinges on a country's integration into global innovation chains and its ability to provide not only financial incentives but also long-term career development opportunities. While the cited authors focus on financial and institutional factors, the present research underscores the importance of systemic interaction between the education sector, the labour market, and innovation policy as a key condition for the effective retention of human capital.

O. Oliynyk *et al.* (2021) examined the challenges of attracting and retaining human capital in a transitional economy. The authors argue that even with active investment from the private sector, the decisive factor in encouraging professionals to remain in the country is not limited to the level of remuneration, but also includes institutional guarantees, stability, access to quality infrastructure, and opportunities for professional growth. M. Simionescu *et al.* (2021) supported this perspective, emphasising that a transparent regulatory environment, public trust in institutions, and a predictable socio-economic policy are critical to the development of a long-term talent retention strategy. The authors maintained that only

under such conditions can investment in human capital yield sustainable results. In this context, the conclusions of the present study align with those of the aforementioned scholars, while also highlighting the more complex nature of the issue. Specifically, the findings suggest that the presence of basic institutional conditions alone does not guarantee the retention of specialists if there is no effective system for adapting to rapid changes in the global labour market. Furthermore, the study demonstrates that a successful human capital retention strategy requires not only institutional stability but also the capacity of national education and professional development systems to respond swiftly to evolving labour market demands – an aspect often overlooked in existing approaches.

The study by G.I. Piroșcă *et al.* (2021) highlights the structural transformations driven by digital labour migration, emphasising that the growing prevalence of remote work necessitates a revision of labour legislation, particularly concerning protecting the rights of remote workers. The authors argue that traditional regulations, which focus on physical presence within the national labour market, no longer reflect the realities in which professionals increasingly work for foreign companies without leaving their home countries. This assertion aligns with the findings of the present study, which indicate the rising popularity of virtual employment models – especially among highly skilled workers in developing countries – where such forms of employment are viewed as a driver of economic growth. By contrast, J. Chen & Z. Xu (2024) focus on the consequences of intensifying global competition for talent, exacerbated by the blurring of boundaries between domestic and international labour markets. They underscore that digital migration deepens inequalities between workers with access to digital skills and those employed in traditional sectors. This corresponds with the findings of the present research, which establish that while digital employment creates new opportunities for highly qualified professionals, it simultaneously intensifies social polarisation, as workers in lower-skilled sectors are frequently excluded from these transformations.

Furthermore, studies by F. Stephany *et al.* (2021) and S. Lykholat *et al.* (2020) indicate

that digital labour migration is reshaping the corporate strategies of large companies, which are increasingly adopting distributed teams and hybrid working models. This shift is altering centres of economic influence: cities and countries that previously served as global hubs for labour migration may lose their prominence due to the reduced physical presence of international companies. In this context, challenges arise in adapting employment and social welfare policies, particularly in areas such as labour contracts, insurance, and pension systems, which remain anchored in traditional forms of employment. Outsourcing – especially in sectors such as software development, technical support, data processing, financial analysis, cybersecurity, and engineering – continues to play a pivotal role in the global economy, contributing to cost optimisation and greater business efficiency. Driven by the rapid development of digital technologies and increasing internet speeds, companies in developed countries are increasingly outsourcing parts of their operations to firms and professionals in developing nations. This enables them to reduce operational costs, access a broad talent pool, and accelerate project delivery while maintaining high service quality. One of the most dynamic segments of outsourcing is the IT sector. In 2023, the global IT outsourcing market was valued at over 460 billion USD, with India accounting for approximately 55% of global programming outsourcing and Ukraine ranking among the top five exporters of IT services in Europe (Basaria, n.d.). These trends reflect significant shifts in the international division of labour driven by technological advancement.

Innovative processes are significantly reshaping international labour migration, contributing to the emergence of new forms of mobility, most notably the phenomenon of virtual labour migration. Enabled by digital technologies and the expansion of global online platforms, highly skilled professionals can now work for foreign companies without leaving their home countries. This model generates economic benefits for countries importing intellectual resources, as they gain access to expertise without incurring the costs associated with social infrastructure or immigration integration. Conversely, exporting countries

face a dual challenge: on the one hand, retaining specialists domestically reduces the risks of brain drain; on the other, there arises a need to create conditions for productive employment in order to avoid dependence on external clients and unregulated digital labour. A prominent example is India, where over four million IT specialists are engaged in remote work with clients in the USA, the EU, and other regions. In 2023, India's IT service exports exceeded 180 billion USD, becoming one of the country's key sources of foreign exchange income (NASCOM, 2023). This illustrates how digitalisation supports economic growth in knowledge-exporting countries, while also highlighting the need for strategic regulation of emerging forms of international employment.

One of the key consequences of recent transformations is the growing importance of alternative forms of employment, which have become a significant element of the contemporary labour market. Flexible working arrangements, digital platforms, and the expansion of the gig economy are opening up new opportunities for workers, while simultaneously posing challenges to traditional systems of social protection and labour legislation. Innovative processes are fundamentally reshaping the structure of the labour market, influencing unemployment levels and contributing to the emergence of new forms of work. The debate over the impact of innovation on mass unemployment remains a pertinent issue among economists and sociologists.

On the one hand, automation, robotics, and digitalisation are reducing the demand for lowskilled labour, leading to job losses in traditional sectors. For instance, according to the McKinsey Global Institute, in the eight core countries studied (the USA, Germany, Japan, France, Spain, the United Kingdom, China, and India), over 100 million workers – or one in sixteen – will need to transition to new occupations. In the United Kingdom alone, employment in the manufacturing sector has declined by more than 600,000 over the past decade, partly due to the implementation of automated production lines (Lund *et al.*, 2021). On the other hand, innovation is driving the emergence of new industries that generate demand for highly skilled labour. These include sectors such as artificial

intelligence, cybersecurity, green energy, software development, and big data analytics.

The study by Y. Lima *et al.* (2021) examined the impact of automation on unemployment dynamics in countries with varying models of state support. The authors argue that automation does not necessarily lead to higher unemployment, provided it is accompanied by active policies that facilitate labour market transformation – particularly support for small businesses and investment in innovative sectors. This aligns with the findings of the present study, which indicate that, under a targeted national strategy, technological modernisation can generate new jobs, even as outdated occupations disappear. B. Schmidpeter & R. Winter-Ebmer (2021) highlighted the regional disparities in the consequences of automation, noting that countries lacking well-developed retraining systems experience sharp increases in unemployment among low-skilled workers. In contexts where labour markets fail to adapt to rapid change, innovation may exacerbate social tension and economic fragmentation. This perspective corresponds with the present analysis, which emphasises the risk of growing social inequality in countries where public policy does not include targeted support for vulnerable population groups. The study by R. Kärtner (2023) focused on the role of institutions in mitigating the negative effects of automation. The author argues that the presence of effective institutional response mechanisms – such as educational programmes and incentives for innovative entrepreneurship – enhances labour market flexibility. The present research confirms a similar pattern: the greater the adaptability of institutions, the lower the risk of mass redundancies. Thus, the effects of automation are not universal; they are shaped by the quality of government intervention and the responsiveness of institutional systems.

The gig economy, which is based on short-term and flexible forms of employment, enables workers to carry out individual tasks or projects without entering into traditional employment relationships, primarily through digital platforms. In 2022, over 28.3 million people were engaged in platform-based work in the EU, with projections suggesting this number will rise to 43 million by 2025 (Gig economy..., 2024). Freelancing

is gaining popularity in Ukraine, demonstrating steady growth even under wartime conditions. The total market volume increased by 26%, from 420 million UAH in 2023 to 528 million UAH in 2024. This reflects both a rise in the average contract value and a growing demand for highly skilled professionals. At the same time, the number of freelancers continues to expand by 14.4% in 2024, reaching 904,000 individuals. The client base has also widened, with the number of clients increasing by 11.6% to 269,000. This trend indicates not only a growing interest among Ukrainians in remote employment but also a gradual increase in trust from companies and entrepreneurs in collaborating with freelancers (The main results of the year..., 2024).

Innovative transformations are exerting an increasingly profound influence not only on the structure and forms of employment but also on a fundamental rethinking of the concept of work motivation. In the contemporary knowledge economy – driven by digital technologies, intellectual capital and the global mobility of the workforce – key determinants of motivation include professional autonomy, digital competencies, and opportunities for career progression in high-tech sectors. Work motivation is gradually shifting away from classical theories that emphasise material rewards, placing greater focus on self-fulfilment, flexible working environments, and intrinsic interest. A leading trend in the modern labour market is the transition from a paradigm of stable employment, typical of the industrial era, to a model of dynamic professional development. This model is characterised by concepts such as psychological flexibility, adaptive careers, and lifelong learning. According to research by McKinsey (Flex, please, 2023), over 70% of professionals in high-tech industries consider the opportunity to engage in projects with flexible schedules a decisive factor when choosing employment. These findings highlight the growing significance of non-material motivators – such as work-life balance, decision-making autonomy, and an innovative corporate culture. At the same time, McKinsey notes that digital proficiency and the ability to work remotely are not only tools for ensuring productivity but also motivational factors that contribute to sustained employee engagement.

As a result, new mechanisms for managing human capital are emerging, based on the development of workers' digital identities, the use of platform-based solutions for organising labour, and the expansion of tools for autonomous career management. This is particularly evident in the gig economy, which represents one of the clearest manifestations of post-industrial transformations in employment. In this segment, work motivation is increasingly shaped by factors such as flexible scheduling, project-based collaboration, simultaneous access to multiple markets, and the ability to independently select partners, clients and work formats. For professionals in IT, Big Data, digital marketing and digital design, motivational drivers also include opportunities for continuous professional development, participation in multicultural teams, and access to knowledge and tools via cloud services and educational platforms. Ultimately, work motivation in the context of digital technological transformation is less a response to external stimuli and more an active process of self-determination, closely linked to identity formation, innovative thinking, and a desire for social participation. This signals a new quality in employment relations, in which the interconnection between motivation, technological competence and economic efficiency becomes a key factor in the sustainable development of the labour market within the global knowledge economy.

Adapting labour legislation to the new realities brought about by innovation is of critical importance. Traditional employment contracts do not always provide adequate protection for workers engaged in the gig economy or freelance work. One of the key initiatives aimed at regulating labour on digital platforms and ensuring social protections for such workers is the EU Platform Work Directive (Directive (EU) 2024/2831, 2024), which seeks to safeguard the rights of platform-based workers. The directive establishes clear criteria for determining the legal status of workers and guarantees minimum wage, paid leave, sick pay, and access to social insurance. A crucial element of the directive is the presumption of employment: digital platforms are now required to prove that a worker is not their employee, rather than the burden

falling on the worker to demonstrate otherwise. This significantly simplifies the process of recognising workers' rights and ensures appropriate social protection. Additionally, the directive addresses the use of algorithmic management on platforms. It obliges platforms to provide workers with information about automated monitoring and decisionmaking systems that affect their work. This includes disclosure of the types of decisions made by algorithms, the parameters that underpin them, and their relative weighting. Such measures aim to increase transparency and prevent discrimination arising from automated decision-making.

The effectiveness of these measures remains difficult to assess, as both the directive and related national legislative initiatives have only recently been implemented, and their impact on the labour market is still the subject of ongoing research. It is important to recognise that regulating the gig economy presents a complex challenge, as it involves balancing the interests of workers – who require social protections – and platforms, which seek to maintain flexibility and economic efficiency. At present, it is not possible to determine definitively whether these measures will succeed in establishing an optimal model of labour relations that simultaneously safeguards workers' rights and supports the development of the digital economy. Moreover, there is a risk that tighter regulation could lead to unintended consequences, such as a reduction in the number of available jobs on platforms or the relocation of companies to less-regulated jurisdictions.

The influence of innovation extends beyond the internal transformation of national labour markets. The globalisation of digital technologies, the expansion of remote work, and the growing mobility of highly skilled professionals are reshaping patterns of international labour redistribution. These trends not only alter the geography of employment but also influence national policies on labour migration, the adaptation of education systems, and the creation of competitive environments to attract talent. To enable a comprehensive assessment of the impact of innovation on the international labour market, a SWOT analysis was conducted using Germany and Ukraine as case studies

(Table 3). This analysis allowed for the evaluation of strengths, weaknesses, opportunities, and threats associated with automation and digitalisation in the employment sector.

**Table 3.** SWOT analysis of Germany and Ukraine in the context of digitalisation and the labour market

Factor	Germany	Ukraine
Strengths	<ul style="list-style-type: none"> <li>■ High level of Industry 4.0 implementation</li> <li>■ Robust dual education system</li> <li>■ Strong government support for digitalisation</li> <li>■ Flexible labour legislation</li> <li>■ Well-developed R&amp;D infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>■ Rapidly growing IT sector</li> <li>■ High adaptability of specialists</li> <li>■ Strong appeal for outsourcing</li> <li>■ Flexibility of small businesses in digital adoption</li> <li>■ Developed the remote work market</li> </ul>
Weaknesses	<ul style="list-style-type: none"> <li>■ High costs of adapting enterprises to digitalisation</li> <li>■ Shortage of IT professionals</li> <li>■ Cybersecurity risks</li> <li>■ Bureaucratic obstacles to implementing digital reforms</li> </ul>	<ul style="list-style-type: none"> <li>■ Absence of a clear national digital labour market strategy</li> <li>■ High emigration rate among professionals</li> <li>■ Inadequate adaptation of labour legislation</li> <li>■ Limited opportunities for workforce retraining</li> <li>■ Weak innovation infrastructure outside major cities</li> </ul>
Opportunities	<ul style="list-style-type: none"> <li>■ Development of AI and Big Data for production optimisation</li> <li>■ Attraction of international IT talent</li> <li>■ Expansion of remote work</li> <li>■ Integration of green technologies into digitalisation</li> </ul>	<ul style="list-style-type: none"> <li>■ Utilisation of international support for digital transformation</li> <li>■ Development of the start-up ecosystem</li> <li>■ Attraction of investors</li> <li>■ Large-scale digital education and workforce retraining initiatives</li> </ul>
Threats	<ul style="list-style-type: none"> <li>■ Intense competition from the USA and China in digital technologies</li> <li>■ Economic crises potentially limit investment</li> <li>■ Mass workforce displacement due to automation</li> <li>■ Geopolitical risks affecting the supply of microchips and equipment</li> </ul>	<ul style="list-style-type: none"> <li>■ Political and economic instability due to the war</li> <li>■ Destruction of infrastructure and enterprises</li> <li>■ Rising unemployment caused by automation</li> <li>■ High dependency on external investors</li> </ul>

**Source:** compiled by the author based on Employment – annual statistics (n.d.), Act on Part-Time Work and Fixed-Term Employment Contracts (2022), Dynamics of Ukraine's Tech Industry... (2024)

The research findings indicate that innovative processes contribute to labour market flexibility, the expansion of remote employment, and increased productivity, while simultaneously generating structural changes, heightening the risk of inequality, and necessitating the adaptation of educational strategies. Germany and Ukraine exhibit significant differences in how their labour markets respond to the challenges of digital transformation and innovation. These disparities are shaped by differing starting conditions, levels of economic development, approaches to state regulation, and the specific challenges each country currently faces.

Germany is among the frontrunners in the digitalisation process and the implementation of the Industry 4.0 concept, which entails the comprehensive integration of digital

technologies across all areas of production and services. In 2023, the country's employment rate stood at 81.1%, 6.8 percentage points above the EU average (Employment – annual statistics, n.d.). The flexibility of Germany's labour legislation is evident in the adaptation of legal norms to shifts in the structure of employment. This includes simplifying regulations for the self-employed and freelancers, introducing legal mechanisms to ensure social protection for such workers, and modernising the labour code in response to the demands of the digital era. One of the key legislative measures is the Act on Part-Time Work and Fixed-Term Employment Contracts (2022), which enables employees to opt for flexible working hours, temporary employment, and part-time positions. The Act also includes provisions granting employees the right to

request remote working arrangements or reduced working hours, provided such requests align with operational requirements. Another relevant development concerns legislative amendments relating to remote work. Through a comprehensive regulatory framework, Germany has established the conditions necessary to balance the interests of employers and employees amid the digital transformation of the economy. At the same time, the government places particular emphasis on safeguarding the rights of workers whose jobs are at risk due to automation and technological change. The adaptation of the German labour market is both structured and forward-looking, grounded in long-term development programmes that integrate industrial modernisation, workforce upskilling, and the regulation of social risks.

The study by A. Batmunkh *et al.* (2022) highlighted the rapid expansion of the gig economy and emerging forms of employment, emphasising that these developments offer opportunities for self-employment and increased flexibility for workers. However, the authors also noted that the growth of non-standard forms of employment presents significant challenges in the field of social protection, as traditional models of labour regulation do not always address the needs of these new forms of work. They argue that legal frameworks in many countries remain insufficiently flexible to extend social guarantees to self-employed individuals. This observation partly aligns with the findings of the present study, which indicates that although the gig economy and novel employment forms are becoming integral components of the modern labour market, the issue of social protection for such workers remains problematic – even in countries with high levels of innovation, such as Germany. The study by J. Bonvin *et al.* (2023) focused on the risks of social instability arising from the expansion of the gig economy. The author argues that non-standard forms of employment may lead to a reduction in social guarantees, creating disparities in access to social protection. At the same time, this study supports the findings of the present analysis regarding the adaptation of labour legislation in Germany. In the context of the current research, it is demonstrated that

Germany, through progressive legislation and a flexible approach to self-employment, has managed to mitigate the risks of structural unemployment caused by automation. However, this does not eliminate the challenges related to social protection for gig economy workers. Even in countries with a high level of regulatory development, such as Germany, there remain difficulties in ensuring comprehensive social coverage for these categories of workers.

Ukraine demonstrates a different approach to adapting its labour market amid the digital transformation. Despite challenging economic and political conditions, the country retains significant potential in the field of information technology, which serves as a key driver of digital modernisation. As of 2024, Ukraine is home to 2,118 active technology companies, of which 47% specialise in outsourcing, 3% in outstaffing, and 31% are product-based companies (Dynamics of Ukraine's Tech Industry..., 2024). These figures reflect a high level of technological specialisation and the adaptability of the IT sector under crisis conditions. However, the digital transformation of Ukraine's labour market remains fragmented and is accompanied by a range of systemic barriers. Unlike Germany, which has an institutionally established system of continuous professional education and digital reskilling, Ukraine lacks a coherent state policy on human capital tailored to the demands of the digital economy. This results in weak institutional alignment between the labour market, educational institutions, and public employment programmes. In the context of full-scale war, the digital adaptation of the labour market is further hindered by the destruction of economic infrastructure, the forced displacement of the workforce, and the growing socio-economic vulnerability of the population. The high level of structural instability is evident in large-scale patterns of occupational migration, whereby a significant proportion of the population changes either their type of employment or place of residence as a result of military conflict. This contributes to labour market imbalances: several sectors, particularly industry and agriculture, are experiencing acute shortages of skilled workers, while certain segments of the digital economy are marked by an oversupply of professionals with similar competencies,

thereby reducing employment levels. The absence of large-scale state programmes to support professional adaptation and digital education – combined with limited financial resources and ongoing security risks – leads to an asynchronous development of digital infrastructure and human capital. As a result, the potential of Ukraine’s digital economy remains underutilised, and the transformation processes are sporadic rather than systematic. In this context, the development of the digital labour market during wartime should be viewed not only as a technological challenge but also as a politico-economic one. It requires an integrated approach to the establishment of resilient employment institutions, the promotion of digital literacy, and the formulation of recovery strategies.

The study by L. Drobiazko (2023) examined the transformation of the labour market in Ukraine amid economic digitalisation and the socio-economic shifts triggered by the war. The authors emphasised that the growth of the IT sector and the spread of digital platforms have opened up new employment opportunities, particularly through remote work and the international integration of Ukrainian professionals into global labour markets. At the same time, the war and the subsequent reconstruction pose numerous challenges for the labour force, including forced migration, the destruction of infrastructure, and the need for workforce retraining to meet the demands of emerging sectors. The study notes that, in comparison to Ukraine, Germany exhibits a more stable and systematic model of digital labour market transformation. As highlighted in the research of M. Fromhold-Eisebith *et al.* (2021) and K. Dengler & S. Gundert (2021), the German government has made substantial investments in infrastructure for digital education, production automation, and the integration of robotics into industry. Particular attention is given to improving workers’ digital skills and establishing a system of continuous professional development. This strategy not only enables the workforce to adapt to technological change but also helps to minimise the risk of structural unemployment. The study observes that while in Ukraine digitalisation has emerged as a necessary means of preserving employment in

wartime conditions, in Germany it forms part of a long-term modernisation strategy. This comparison illustrates that the effectiveness of digital transformation depends not only on technological readiness but also on political stability, institutional support, and the availability of resources to implement innovation.

An analysis of the impact of innovation on the international labour market shows that the effectiveness of economic adaptation to digital transformation depends on the level of institutional preparedness, strategic vision, and the capacity to respond swiftly to technological challenges. The German experience demonstrates that a combination of state regulation, flexible labour legislation, investment in vocational education, and social protection enables a stable transition to new forms of employment while minimising social risks. This model illustrates that digitalisation not only transforms the labour market but also contributes to its structural modernisation, expanding opportunities for workers and enhancing economic competitiveness. In contrast, the situation in Ukraine highlights the challenges faced by countries undergoing economic instability and structural transformation. The absence of a comprehensive national strategy for the digital transformation of the labour market leads to uneven sectoral development, exacerbating the mismatch between labour supply and demand. In this context, innovation acts more as a catalyst for the development of individual industries rather than as systemic tool for labour market reform.

In summary, innovation within the global economy is transforming the international labour market. Innovations are reshaping the nature of labour demand by fostering the emergence of new professions, competence-based profiles, and hybrid forms of employment. Technological shifts – particularly automation, artificial intelligence, robotics, and the development of digital platforms – are facilitating the transition towards a knowledge-based economy and post-industrial models of work, where high-value-added sectors predominate. These developments are accompanied by changes in labour organisation: traditional models of permanent employment are increasingly being replaced by flexible formats such as remote work, the

gig economy, and platform-based employment. This dynamic necessitates a rethinking of social protection frameworks, as conventional mechanisms for regulating the labour market are proving inadequate in the face of rapidly evolving employment relations. At a structural level, innovation drives global labour force reallocation, altering the geographical distribution of employment. High-tech sectors are becoming key drivers of international competition for talent, increasing the mobility of highly skilled workers while also intensifying the issue of brain drain from countries with lower levels of innovative capacity. The international labour market is becoming increasingly stratified, leading to a deepening of global asymmetries between labour resource donor and recipient countries.

Countries that actively invest in the development of human capital, digital education, and institutional mechanisms for adapting to technological change demonstrate a higher level of economic resilience. Such states are not only better positioned to mitigate the risks of structural unemployment, but also to enhance their competitiveness in the global labour market by fostering a flexible and innovation-oriented workforce. In contrast, countries with low institutional readiness for change risk increased social polarisation, the erosion of competitive advantages, and a decline in productivity.

The future of the international labour market will be shaped not only by the pace of innovation but also by the ability of national governments and transnational actors to implement effective policies for transformational adaptation. This involves integrating reskilling initiatives, establishing inclusive employment platforms, developing systems for labour market forecasting, and introducing new social standards. Innovation in the global economy requires not merely flexible but systematically balanced solutions that align the interests of states, businesses, and workers, thereby promoting long-term stability and social equity in an era of transformation.

## **CONCLUSIONS**

An analysis of the impact of innovation on employment and the structure of the international labour market in the context of the global

economy indicates that digitalisation, automation, and the shifting demand for new skills are key drivers of transformational change. Innovation-led development not only alters the nature of employment but also widens the gap between skilled and unskilled labour. Job losses in traditional industrial sectors and low-skilled service industries are occurring alongside the creation of new opportunities in high-tech fields, digital services, and artificial intelligence.

The findings reveal that the demand for professionals with digital competencies is increasing more rapidly than the capacity of vocational training systems to adapt, exacerbating the issue of unequal access to emerging employment opportunities. In 2023, a majority of tasks were carried out by humans (66%), with 33% performed by technology, and 1% completed through hybrid methods. Forecasts for 2030 suggest a decline in the share of human-performed tasks to 33%, while hybrid models are expected to grow to 33%, underscoring the urgent need to enhance digital skills and adapt to new forms of employment. The rise of remote work creates new opportunities but also exacerbates social inequality and intensifies competition between countries for highly skilled professionals. In developed countries such as Germany, government programmes actively support the development of digital education and reskilling initiatives, whereas in developing nations, this process remains uneven. As a result, there is a growing risk of deepening socio-economic disparities both between and within countries. An analysis of international labour migration shows that technological innovation contributes to greater mobility among highly qualified professionals, fuelling competition among countries for talent. Developed nations employ various mechanisms to attract foreign experts in fields such as IT and scientific research. While this enhances global knowledge exchange, it simultaneously poses risks for talent-donor countries. In this context, the traditional concept of a brain drain is gradually evolving into a model of virtual labour migration, whereby digital technologies enable professionals to work remotely without the need for physical relocation.

In the context of digital transformation, the system of work motivation is undergoing

significant change. Traditional material incentives are gradually losing their universal effectiveness, giving way to non-material factors such as professional autonomy, opportunities for development, involvement in project-based work, and flexible working hours. Digital competence functions not only as a tool for ensuring productivity but also as a source of intrinsic motivation, linked to the ability to influence work processes, realise creative potential, and shape a digital professional identity. Within this framework, work motivation increasingly takes on the characteristics of self-determination, whereby individuals not only carry out tasks but also actively shape their professional environment. This dynamic is a key factor in sustaining long-term participation in the labour market within the globalised knowledge economy.

Digital transformation has also led to the expansion of non-standard forms of employment, such as the gig economy, freelance work, and remote employment. While these developments offer greater labour market flexibility and new opportunities for self-employed professionals, they also pose challenges for worker protection, as traditional labour guarantees often do not extend to such employment models. Research has shown that countries with advanced innovation ecosystems – such as Germany – are more proactive in adapting labour legislation to these new realities, ensuring a balance between economic efficiency and social protection. At the same time, less developed economies, such as Ukraine, face challenges related to the uneven distribution of the benefits of innovation-led development, which may contribute to rising social instability. Specifically, the analysis revealed that in Germany, digitalisation and the Industry 4.0 framework are driving the

modernisation of production and increases in productivity, while also necessitating new approaches to regulating labour relations. In Ukraine, the primary driver of transformation is the growth of the IT sector, which is of critical importance for economic recovery in the post-war period. The increasing share of freelancers and remote workers presents new regulatory challenges for the labour market, particularly regarding taxation and social security provisions. Labour market adaptation to innovation-driven change requires not only technological advancement but also the implementation of effective education policy, the development of retraining programmes, and robust regulatory support. States that respond in a timely manner to the challenges of the digital economy are more likely to retain competitiveness while mitigating the risks of social inequality.

The main limitation of this study lies in the difficulty of quantitatively assessing the long-term impact of innovation on employment, as transformation processes remain ongoing and vary significantly across countries and economic sectors. Future research could focus on designing strategies for the effective integration of digital innovations into the labour market, as well as analysing mechanisms of social protection for workers engaged in emerging forms of employment.

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## **Вплив інновацій у глобальній економіці на розвиток міжнародного ринку праці**

**Анотація.** Метою дослідження було вивчення впливу інновацій на зайнятість і структуру ринку праці в умовах глобальної економіки, зосереджуючись на динаміці трансформаційних процесів, викликаних цифровізацією, автоматизацією та зміною попиту на нові навички. У роботі використовувався комплексний методологічний підхід, що включав аналіз змін у секторальній зайнятості, впливу технологічного розвитку на міжнародну трудову міграцію, а також наслідків цифрових трансформацій для правового регулювання ринку праці. Дослідження підтвердило, що інновації спричиняють глибокі трансформації на ринку праці. У 2023 році 66 % завдань виконувались людьми, 33 % – технологіями, а лише 1 % – у

змішаній формі. Прогноз на 2030 рік демонструє зниження частки людської праці до 33 %, а комбінована модель роботи зросте до 33 %, що вказує на необхідність розвитку цифрових компетенцій та адаптації до нових форматів зайнятості. Зростання дистанційної роботи створює нові можливості, проте посилює соціальну нерівність і конкуренцію між країнами за висококваліфіковані кадри. «Віртуальна трудова міграція» частково замінює традиційний «витік мізків», дозволяючи фахівцям працювати дистанційно без фізичного переміщення. Порівняльний аналіз Німеччини та України засвідчив спільні тенденції, проте також виявив різний рівень адаптації. Німеччина, завдяки впровадженню Industry 4.0 та гнучкому трудовому законодавству, забезпечила високий рівень зайнятості (81,1 % у 2023 році). Натомість Україна демонструє динамічний розвиток інформаційно-технологічного сектору. Війна додатково ускладнила ці процеси, посиливши структурну нестабільність ринку праці. Дослідження підтвердило, що успішна адаптація до інноваційної економіки потребує не лише технічного прогресу, а й ефективної освітньої політики, соціального діалогу та регуляторної підтримки. Практичне значення дослідження полягає в поглибленні розуміння трансформаційних процесів на міжнародному ринку праці під впливом інновацій, що може бути використано як аналітична база для подальших прикладних досліджень

**Ключові слова:** науково-технічний прогрес; новація; мотивація праці; міжнародна трудова міграція; зайнятість; безробіття



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## Components of financial mechanism for sustainable development: Theoretical aspect

**Abstract.** The study aimed to substantiate the theoretical foundations of the financial mechanism for ensuring sustainable development of the agricultural sector. The study analysed scientific approaches to the definition of the essence of the financial mechanism in the context of ensuring sustainable development and formulated a new definition as a complex system of financial relations, which is implemented through a set of interrelated elements aimed at achieving balanced economic growth, social justice and environmental safety. The study defined the structure of the

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financial mechanism, which includes financial methods, levers, instruments, regulatory and information support, and reveals the peculiarities of their application in the agricultural sector, incorporating the specifics. The study established that financial methods form the methodological basis for the functioning of the mechanism, financial levers are the means of implementing the methods, and financial instruments ensure the practical implementation of financial relations. The functions of the financial mechanism (mobilisation, distribution, stimulation, control, stabilisation) were systematised and the specificity in the economic, environmental and social spheres was identified. Based on a comparative analysis of international practices, the study determined that the integration of environmental criteria into Brazil's lending policy reduced greenhouse gas emissions by 10-15% in the agricultural sector, while the Canadian agricultural insurance system reduced the volatility of farm income by 35-40%. The study determined that the Polish Rural Development Programme ensured an increase in the share of organic production from 3.5% to 7.2% in 2015-2020, and in Hungary, more than 12 thousand small farms received access to financing. A system of indicators for assessing the effectiveness of the financial mechanism by three dimensions of sustainability was developed for a comprehensive assessment of performance, incorporating all aspects of sustainable development. The importance of the financial mechanism's adaptability to changing environmental conditions, especially in the context of climate change and market fluctuations, was substantiated. The results obtained can be used to develop strategies and financial programmes for sustainable development of the agricultural sector, incorporating regional specifics

**Keywords:** financial instruments; greening of production; green financing; investment instruments; triple bottom line; adaptability

## INTRODUCTION

The current global challenges related to food security, environmental problems and socio-economic instability are raising the issue of finding new approaches to creating an effective financial mechanism for sustainable development, especially in the agricultural sector. The intensification of agricultural production, unsustainable use of natural resources and growing pressure on ecosystems are driving environmental degradation, soil depletion and loss of biodiversity. These problems are particularly relevant in the agricultural sector, which directly interacts with natural ecosystems and has a significant impact on their condition. At the same time, the agricultural sector is central to ensuring economic growth, rural employment and social development of rural areas. This multifunctionality of the agricultural sector necessitates the search for balanced approaches to its financing that would incorporate not only economic but also environmental and social aspects of development. The agricultural sector is not only a strategically important sector of the economy that ensures national food security but is also central to ensuring balanced economic, social and environmental development. The

transformation of traditional financial mechanisms in line with the principles of sustainable development is becoming an imperative of economic policy in most countries.

The concept of sustainable development, which envisages a harmonious combination of economic, social and environmental aspects, requires the adaptation of existing financial mechanisms to new realities and challenges. This issue is particularly relevant for the agricultural sector, which directly interacts with natural resources and ecosystems. As noted by N. Eisenmenger *et al.* (2020), sustainable development goals often prioritise economic growth, neglecting the environmental dimension, which creates an imbalance in the sustainable development system. Therefore, the development of an effective financial mechanism that incorporates all three dimensions of sustainable development is extremely important.

Many foreign and Ukrainian scholars have studied the theoretical and practical aspects of the financial mechanism for sustainable development. X. Li *et al.* (2019) developed a theoretical framework and mechanism for the formation of a green development system in China,

focusing on the role of financial regulation. The study proposed an integrated system of economic instruments aimed at stimulating environmentally responsible behaviour of business entities and balancing the interests of economic growth and environmental protection. N. Akhtar & A. Rashid (2024) conducted a literature review on the relationship between financial development and sustainable development, identifying the main trends and gaps in this area.

Important aspects of the financial system's impact on sustainable development were studied by I. Szalai & K. Czako (2023), addressing the theoretical framework of sustainable financial development. The study emphasised the need to integrate sustainable financial principles into general economic policy, which creates the basis for further applied research. U.S. Bhutta *et al.* (2022) investigated the role of green bonds in raising finance for environmentally oriented projects. The study emphasised that the development of the green bond market contributes to increased financial sustainability and environmental responsibility in both the public and private sectors. G. Zhou *et al.* (2022) found a correlation between ESG (environmental, social, and governance) indicators and the market value of companies, with financial performance acting as a mediating factor. This suggests that adherence to the principles of sustainable development not only enhances the reputation of companies but also provides real economic benefits.

The Ukrainian scientific community also substantially addressed the financial aspects of sustainable development. R.O. Pridko (2024) emphasised the theoretical foundations of financial support for the development of regions and territorial communities. The study is a significant contribution to the formation of an effective local financial policy in the context of decentralisation and the increased need for sustainable socio-economic growth.

Despite a considerable number of scientific papers on the financial aspects of sustainable development, the issue of forming a comprehensive financial mechanism for ensuring sustainable development of the agricultural sector remains insufficiently researched. There is no unified approach to defining the structure, components and functional interrelationships of

such a mechanism. In addition, the peculiarities of the agricultural sector, such as seasonality of production, dependence on natural and climatic conditions, long production cycles, etc., require adaptation of the general principles of the financial mechanism to the specifics of the industry.

The study aimed to theoretically define the essence, structure and main elements of the financial mechanism that ensures sustainable development of the agricultural sector in the context of modern challenges. To achieve this goal, the following tasks were defined: to clarify the conceptual and categorical apparatus of the study of the financial mechanism of sustainable development; to reveal the relationships between the constituent elements of the financial mechanism and determine their impact on the sustainable development of the agricultural sector; to develop a structural and functional model of the financial mechanism for ensuring sustainable development of the agricultural sector.

## MATERIALS AND METHODS

In the process of studying the financial mechanism for ensuring sustainable development in the agricultural sector, a set of scientific methods was applied, which ensured the validity and reliability of the results obtained. The dialectical method was used to study the financial mechanism as a complex economic category in its relationship with the concept of sustainable development. This method was used to analyse the evolution of views on the financial mechanism and its transformation based on the principles of sustainability. To determine the essence and content of the concepts of "financial mechanism", "sustainable development", and "financial support for sustainable development", the terminological analysis was used. This method was used to systematise scientific views and formulate the author's approach to the categories under study.

The system-structural analysis was used to determine the structure and interrelationships between the individual elements of the financial mechanism for ensuring the sustainable development of the agricultural sector. This method was used to identify functional links between financial methods, levers, instruments and other components of the mechanism. To identify the peculiarities of the formation and functioning of

the financial mechanism in the agricultural sector, a comparative analysis was applied, which was used to compare different approaches to financial support for sustainable development in different sectors of the economy and countries. The comparison criteria included the degree of integration of environmental and social aspects into financial mechanisms, the level of development of “green” financial instruments, and mechanisms for stimulating the greening of agricultural production. The method of scientific abstraction was used to identify the most important features and interrelationships in the financial mechanism for ensuring sustainable development, abstracting from unimportant details. This was used to form a conceptual vision of the problem under study. During the study, the best international practices of formation and functioning of financial mechanisms for ensuring sustainable development, including in the agricultural sector, were considered. In particular, the experience of Brazil (Banco do Brasil, 2024), Canada (Agriculture and Agri-Food Canada, 2023; 2024), Poland (Kalinowski & Łuczka, 2021), and Hungary (International Business Information Management Association, 2020) was analysed.

To form a structural and functional model of the financial mechanism for ensuring sustainable development of the agricultural sector, the modelling method was used. The developed model incorporated the specifics of the agricultural sector and the interaction of economic, social and environmental factors in the context of sustainable development. The information base of the study was formed on the scientific works of Ukrainian and foreign scholars on the financial mechanism, sustainable development and its financial support, in the agricultural sector. Particular attention was paid to

the analysis of current research for 2019–2024 the works of U.S. Bhutta *et al.* (2022), G. Zhou *et al.* (2022), which incorporated current trends in the development of financial mechanisms in the context of sustainable development. The selection of scientific sources covered the scientific value and relevance of the research topic, and the results presented.

The theoretical basis of the study included the fundamental provisions of economic theory, finance theory, the concept of sustainable development and the green economy. The use of a wide range of scientific sources ensured the complexity and comprehensiveness of the study, as well as the validity of the results and conclusions. The study analysed the studies of leading researchers, including V. Naciti (2019), N. Eisenmenger *et al.* (2020), J.S. Appannan *et al.* (2023), as well as Ukrainian scientists R.O. Pridko (2024), incorporating both the global and Ukrainian experience in the field of financial support for sustainable development. The study was based on the analysis of scientific publications in leading international journals, which provided a comprehensive approach to the study of the financial mechanism for ensuring sustainable development of the agricultural sector.

## RESULTS

### Theoretical foundations of the financial mechanism for ensuring sustainable development of the agricultural sector

An analysis of scientific approaches to defining the essence of the financial mechanism for sustainable development has revealed a variety of views on its structure and components. The study systematised the main approaches to the analysis of financial mechanisms in the context of sustainable development (Table 1).

**Table 1.** Scientific approaches to the definition of the essence of the financial mechanism for sustainable development

Determination of financial mechanism for sustainable development	Key elements
A system of financial methods, instruments and levers aimed at mobilising financial resources to ensure balanced economic, social and environmental development	Financial methods, instruments, levers, economic, social and environmental components
A set of interrelated financial relations that ensure the formation, distribution and use of financial resources to achieve sustainable development goals	Financial relations, formation, distribution and use of financial resources, sustainable development goals

Table 1, Continued

Determination of financial mechanism for sustainable development	Key elements
A set of forms of organisation of financial relations, methods of formation and use of financial resources that provide a triple impact on the social, economic and environmental aspects of development	Forms of organisation of financial relations, methods of formation and use of resources, triple impact
A financial flow management system aimed at ensuring the coordinated development of economic, social and environmental components, considering the interests of future generations	Managing financial flows, sustainable development, and the interests of future generations
Organisational and economic forms of implementation of financial relations, including methods, tools and levers of influence on socio-ecological and economic processes to balance them	Organisational and economic form, methods, tools, levers of influence, balancing processes

**Source:** compiled by the authors based on V. Naciti (2019), A.G. Scherer & C. Voegtlin (2020), G. Zhou *et al.* (2022), I. Szalai & K. Czako (2023), L. Qing *et al.* (2024)

An analysis of the scientific approaches presented in Table 1 demonstrated a variety of interpretations of the financial mechanism for sustainable development. The common features of most definitions are the systemic nature of the mechanism; focus on ensuring the balanced development of economic, social and environmental components; availability of financial methods, instruments and levers as the main elements of the mechanism; and emphasis on achieving the goals of sustainable development.

Expanding on the previous analysis, it is worth noting that a comparative analysis of the practices of financial support for sustainable development in the agricultural sector in different countries of the world demonstrates a variety of approaches and instruments adapted to specific socio-economic and environmental conditions. The experience of Brazil shows the effectiveness of integrating environmental criteria into credit policy, where the Bank of Brazil has implemented a special ABC (Agricultura de Baixo Carbono) programme, which provides concessional financing for low-carbon agriculture with interest rates 2-4% below market rates, which has contributed to a 10-15% reduction in greenhouse gas emissions in the country's agricultural sector (Banco do Brasil, 2024). Poland demonstrates a successful example of combining national and European financial instruments, through the Rural Development Programme, which finances not only the modernisation of agricultural production but also environmental projects, organic farming, and the development of non-agricultural activities in rural areas. According to

a study by S. Kalinowski & W. Łuczka (2021), this increased the share of organic production in Poland from 3.5% to 7.2% in 2015-2020 and contributed to the diversification of rural incomes.

Canada's experience is notable for the well-developed agricultural insurance and risk management system adapted to climate change. The AgriInsurance programme provides comprehensive protection against production risks, including extreme weather events, and the Agri-Invest programme supports farmers in building financial reserves in case of adverse conditions. According to a study by Agriculture and Agri-Food Canada (2023; 2024), this system reduced the volatility of farm incomes by 35-40% and stimulated the introduction of adaptive technologies. Hungary's experience is valuable in introducing innovative financial instruments for small farms, including microcredit and financial cooperatives. According to the International Business Information Management Association (2020), the Hungarian Rural Development Fund, which combines public and private investments, has provided access to finance for more than 12,000 small farms, which has contributed to the preservation of traditional farming methods and agrobiodiversity.

These international examples demonstrate that an effective financial mechanism for ensuring sustainable development of the agricultural sector must take into account specific factors: the seasonality of production, which requires flexibility of financial flows; the long-term nature of the reproduction of natural resources (soil, water resources), which necessitates strategic

planning; high dependence on climatic factors, requiring the integration of risk management mechanisms; and the multifunctionality of agriculture, which not only provides food production but also supports rural areas, preserves agroecosystems and cultural heritage. These features require the development of specialised financial instruments and mechanisms capable of balancing the economic, environmental and social aspects of agricultural sector development (Farm Europe, 2022; CropLife Brasil, 2024).

The financial mechanism for ensuring the sustainable development of the agricultural

sector is a complex system of financial relations implemented through a set of interrelated financial methods, levers, instruments and regulatory and legal support, the functioning of which is aimed at mobilising, distributing and efficiently using financial resources to achieve balanced economic growth, social justice and environmental safety in the agricultural sector. The study of the structure of the financial mechanism for ensuring sustainable development of the agricultural sector identified its main components and the interrelationships between them (Table 2).

**Table 2.** Components of the financial mechanism for ensuring sustainable development of the agricultural sector

Group of elements	Component elements	Examples of the agricultural sector
Financial methods	Financial planning Financial forecasting Financial regulation Financial control Financial support Financial incentives	Planning of environmental investments Forecasting financial results from the implementation of environmental technologies Regulating the use of natural resources Monitoring environmental performance Green projects financing Promoting environmentally responsible management
Financial leverage	Taxes and fees Subsidies and grants Environmental payments Financial sanctions Interest rates Pricing policy	Tax benefits for organic producers Subsidies for environmentally friendly technologies Payment for ecosystem services Fines for environmental pollution Preferential loan rates for green projects Price premiums for environmentally friendly products
Financial instruments	Green bonds Environmental loans Insurance products Eco-leasing Futures contracts ESG investments	Agricultural green bonds Loans for environmental projects Insurance against climate risks Leasing of energy-efficient equipment Futures on organic products ESG investing in the agricultural sector
Information support	Financial statements Environmental reporting Information and analytical systems Databases Monitoring systems Rating systems	Integrated financial statements Sustainability reporting Information systems for environmental monitoring Databases on the environmental performance of farms Systems for monitoring the use of natural resources ESG ratings of agricultural enterprises

**Source:** compiled by the authors based on A.G. Scherer & C. Voegtlin (2020), X. Chen & Z. Chen (2021), Y. Yang et al. (2021), M. Shahzad et al. (2022), Y. Su & Q.M. Fan (2022)

The constituent elements of the financial mechanism for ensuring sustainable development of the agricultural sector form an integral system, the elements of which interact with each other and are aimed at achieving a balanced economic, social and environmental

development. The results of the study structured the components of the financial mechanism by functional groups. Financial methods (planning, forecasting, regulation, control, provision, and incentives) form the methodological basis for the functioning of the financial mechanism.

**Functional features of the financial mechanism for ensuring sustainable development of the agricultural sector**

Further study of the financial mechanism for ensuring sustainable development of the agricultural sector involves identifying the functional features and patterns of interaction

of its elements in the process of ensuring economic, social and environmental aspects of sustainable development. For systemic analysis, the functions of the financial mechanism were structured by the areas of influence on the sustainable development of the agricultural sector (Table 3).

**Table 3.** Functions of the financial mechanism for ensuring sustainable development of the agricultural sector

Functions	Manifestation in the economic sphere	Manifestation in the environmental field	Manifestation in the social sphere
Mobilisation	Attracting financial resources to modernise production and introduce innovative technologies	Accumulation of funds to finance environmental protection measures and environmental projects	Formation of a financial base for the development of social infrastructure in rural areas
Distribution	Allocation of financial resources between agricultural production sectors based on economic efficiency	Allocation of funds for greening production processes and restoring natural resources	Redistribution of financial resources to support socially vulnerable groups in rural areas
Stimulating	Encourage investment in high-performance and resource-saving technologies	Stimulating the implementation of environmentally friendly management practices	Motivation to create new jobs and improve the quality of life in rural areas
Control	Monitoring the efficiency of financial resources and achievement of economic results	Monitoring compliance with environmental regulations and production standards	Overseeing the implementation of social commitments and rural community development programmes
Stabilisation	Ensuring the financial stability of agricultural enterprises and reducing market risks	Reducing negative environmental impact and adapting to climate change	Promoting social stability and reducing migration from rural areas

**Source:** compiled by the authors based on J. Mensah (2019), N. Chams & J. García-Blandón (2019), M.P. Johnson & S. Schaltegger (2020), C. Jiakui *et al.* (2023)

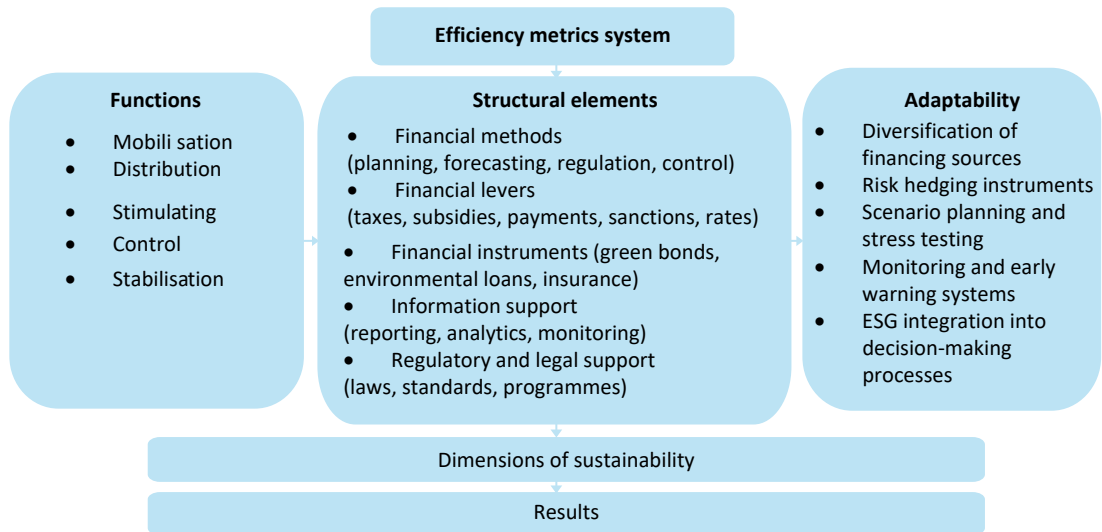
The analysis of the functional aspect of the financial mechanism presented in Table 3 demonstrates the complex nature of the impact on all components of sustainable development. The introduction of comprehensive systems for monitoring and evaluating financial flows in the agricultural sector contributes to increasing the transparency and efficiency of sustainable development financing. The conducted research formulated a conceptual model of the interaction of elements of the financial mechanism for ensuring sustainable development of the agricultural sector (Fig. 1). This model is based on a systematic approach that considers the financial mechanism as an integral system of interrelated elements, the functioning of which aims to achieve the triple goal of sustainable

development – economic growth, social justice and environmental safety.

The effectiveness of the financial mechanism for ensuring sustainable development of the agricultural sector largely depends on the nature of the interaction of its elements. The study determined that the coherence of the use of financial methods, levers and instruments in the context of sustainable development is of particular importance. Financial methods, such as planning, forecasting and regulation, form the basic principles of the financial mechanism and determine the strategic directions of its development. In the agricultural sector, long-term financial planning is of particular importance, incorporating not only economic indicators but also the environmental and social impact of

decisions. Financial forecasting in the context of sustainable development should consider long-term environmental trends, such as climate

change, soil degradation and biodiversity loss, as well as social aspects related to demographic changes and rural development.



**Figure 1.** Integrated structural and functional model of the financial mechanism for ensuring sustainable development of the agricultural sector

**Source:** compiled by the authors

Financial levers can be used to implement financial methods and provide a direct impact on various aspects of sustainable development. In the context of the agricultural sector, financial levers such as environmental taxes, green subsidies, and preferential lending rates for environmentally oriented projects are of particular importance. The effectiveness of financial levers is determined by their ability to create economic incentives for the transition to more sustainable business models without excessive administrative pressure.

Financial instruments ensure the practical implementation of financial relations in the process of ensuring sustainable development. Green bonds, environmental loans, and climate risk insurance products are becoming increasingly popular instruments for financing the sustainable development of the agricultural sector. An important trend is the development of innovative financial instruments, such as payments for ecosystem services, which create economic incentives for the conservation and restoration of natural ecosystems.

Information support is central to the functioning of the financial mechanism, especially in the context of the growing importance of environmental and social aspects of sustainable development. Integrated financial and non-financial reporting, environmental monitoring and environmental impact assessment systems are becoming essential elements of the information infrastructure of the financial mechanism for sustainable development.

An important aspect of the functioning of the financial mechanism is its adaptability to changing environmental conditions. In the context of growing uncertainty associated with climate change, global market fluctuations, and geopolitical crises, adaptability becomes a critical feature of a financial mechanism. An adaptive financial mechanism should be able to quickly reconfigure its elements in response to changes in the external environment while maintaining a strategic focus on sustainable development. This flexibility is achieved through the diversification of funding sources, the introduction of innovative risk-hedging instruments,

and the creation of reserve funds to finance climate change adaptation measures. In addition, an important element of adaptability is the development of scenario planning and stress testing of financial mechanisms to ensure resilience to various types of shocks, including extreme weather events, market crises and changes in the regulatory environment. Continuous monitoring of key sustainability indicators and early warning of potential risks ensure timely adjustment of financial instruments and reallocation of resources in line with new priorities.

Implementation of the concept of sustainable development in the agricultural sector requires a transformation of the traditional financial mechanism to consider environmental and social aspects. This transformation involves not only expanding the range of financial instruments but also changing the paradigm of financial management, which should incorporate the long-term consequences of financial decisions for ecosystems and society.

## DISCUSSION

The results of the study of the structure and functional features of the financial mechanism for ensuring sustainable development of the agricultural sector formulated several important conclusions and generalisations that are of both theoretical and practical importance. The proposed definition of the financial mechanism for ensuring sustainable development of the agricultural sector is consistent with modern scientific approaches to this category.

The constituent elements of the financial mechanism identified in the study (financial methods, levers, instruments, information support) correlate with the structure developed by F. Gangi *et al.* (2019), who emphasise the systemic nature of the financial mechanism and the interdependence of its elements. They find that banks that actively integrate environmental responsibility principles into their operational mechanisms demonstrate lower levels of risk, which is particularly important for agricultural financing. However, in contrast to the study, the presented research addressed the specifics of the agricultural sector and the peculiarities of using financial instruments in the context of sustainable agriculture. Complementing these

conclusions, M. Shahzad *et al.* (2022) noted that the structure of the financial mechanism should consider not only sectoral specifics but also innovation processes to accelerate the transition to sustainable management practices.

The functional analysis of the financial mechanism presented in the study extends the traditional definition of its functions to include environmental and social dimensions. M.P. Johnson & S. Schaltegger (2020) also emphasised the need to rethink the functional role of financial mechanisms in the context of global challenges of sustainable development, considering entrepreneurship as a catalyst for systemic change. Developing the thesis, X. Yin *et al.* (2022) proposed the concept of “rural innovation systems” that integrate financial mechanisms into the broader ecosystem of sustainable rural development. The study emphasised the importance of innovative approaches to finance that go beyond the traditional logic of financial markets and incorporate the specifics of rural communities.

The proposed system of indicators for assessing the effectiveness of the financial mechanism for ensuring the sustainable development of the agricultural sector was reflected by M.A. Khan *et al.* (2022), who emphasised the importance of an integrated approach to assessing the effectiveness of green finance. However, in contrast to the study, the present research offered a more detailed system of indicators adapted to the specifics of the agricultural sector. This idea was developed by R. Xie *et al.* (2021), who emphasised the need to consider the spatial aspects of financial agglomeration when assessing its impact on green productivity. The study proposed an econometric modelling methodology that incorporates the spatial effects of financial decisions on environmental sustainability. This approach is particularly relevant for the agricultural sector, where the interaction between economic, environmental and social factors has a pronounced territorial character.

The concept of financial mechanism adaptability presented in the study resonates with the ideas expressed in a study by X. Yin & Z. Xu (2022) on the relationship between green finance and economic growth, demonstrating the significant potential for synergies between

them if properly coordinated. The study demonstrated that financial mechanisms that integrate the principles of sustainable development often demonstrate higher economic efficiency in the long run. This thesis is of particular importance for the agricultural sector, which is characterised by long investment cycles and high dependence on natural and climatic conditions.

The potential of innovative financial instruments, such as green bonds and payments for ecosystem services, identified in the study, was confirmed by Y. Su & Q.M. Fan (2022) in an analysis of the role of technological innovation in green development. However, the study addressed the specifics of applying these instruments in the agricultural sector, given its unique characteristics and challenges. Developing the idea, Y. Yang *et al.* (2021) conducted an empirical analysis of the relationship between green finance, fintech, and quality economic development, demonstrating the significant potential of digital technologies to improve the efficiency of financial mechanisms for sustainable development. The study also emphasised the importance of institutional innovation and public-private partnerships in bridging investment gaps in sustainable agriculture.

A significant achievement of the study is the development of a structural and functional model of the financial mechanism for ensuring sustainable development of the agricultural sector, which integrates economic, environmental and social aspects. This model complements the conceptual framework proposed by N. Chams & J. García-Blandón (2019) by adding agricultural specificity and focusing on the role of financial instruments in ensuring sustainable development. Expanding on this idea, C. Yang *et al.* (2020) proposed a methodology for assessing the coordination of geo-environmental development and urbanisation that can be adapted to assess the interaction between financial mechanisms and sustainable development of agricultural areas. The study demonstrated that the effectiveness of a financial mechanism depends not only on the availability of relevant elements but also on coordinated interaction in spatial and temporal dimensions.

Comparing the results of the study with the results of J. Howard-Grenville *et al.* (2019), it is

possible to note the commonality of approaches to the need to transform traditional management mechanisms following the principles of sustainable development. However, the study offers a more detailed analysis of the constituent elements of the financial mechanism and their interaction in the context of ensuring sustainable development of the agricultural sector. Complementing this idea, C. Tolliver *et al.* (2021) analysed green innovation and finance in the Asian context, emphasising the importance of regional specificity in shaping financial mechanisms for sustainable development. The study demonstrated the significant potential for integrating traditional and innovative approaches to finance, which is especially relevant for the agricultural sector with its rich cultural heritage and deeply rooted management practices.

Additional analysis presented in modern studies expanded the definition of certain aspects of the financial mechanism for ensuring sustainable development of the agricultural sector. The study by J.S. Appannan *et al.* (2023), which substantiated the relationship between sustainable development strategies, environmental management accounting systems, and environmental indicators, is noteworthy. The study empirically confirmed that the introduction of effective environmental accounting systems significantly improves the monitoring and control of financial flows related to the environmental aspects of agricultural enterprises. This is consistent with the conclusions about the need to develop information support for the financial mechanism as an important condition for its effective functioning.

Analysing the technological aspects of the financial mechanism, it is worth analysing the study by C. Jiakui *et al.* (2023) on the correlation between green technological innovation, green finance and financial development. The empirical results demonstrated that green finance is an important intermediary between innovation and productivity, especially in regions with high levels of economic development. This suggests the need for a differentiated approach to the formation of the financial mechanism depending on the level of development of the region, which is especially relevant for the agricultural sector with its significant regional differences.

An important aspect of sustainable development is the digitalisation of the economy, which creates new opportunities for the financial mechanism. K. Luo *et al.* (2022) studied the impact of the digital economy on the efficiency of green development. The study determined that the digital economy has a significant positive impact on the effectiveness of green development through the mechanisms of technological innovation, structural optimisation, and institutional change. This confirmed the thesis that it is necessary to introduce digital technologies into the financial mechanism for ensuring sustainable development of the agricultural sector.

Related to digitalisation is the development of financial inclusion, which is of particular importance for the agricultural sector with its geographical dispersion and large share of small producers. L.Y. Tay *et al.* (2022) considered digital financial inclusion as an important tool for sustainable development. The study demonstrated that digital financial inclusion contributes to economic growth, poverty reduction, and social inclusion by providing access to financial services for vulnerable groups. In the context of the agricultural sector, there is a need to develop accessible digital financial services tailored to the needs of farmers and rural populations. Y. Yang *et al.* (2021) broadened the concept of the relationship between green finance, fintech, and quality economic development. The study demonstrated that the effectiveness of green finance is significantly enhanced when integrated with fintech solutions that provide better risk management and more accurate assessment of environmental projects. This confirms the need to develop innovative financial instruments that combine the advantages of traditional financial mechanisms with the capabilities of modern technologies.

The contribution of X. Yin & Z. Xu (2022), proposing a methodology for empirically analysing the relationship and coordination of green finance and economic growth. The study argued that there is a two-way causal relationship between green finance and economic growth, but that effective coordination between financial and environmental policies is needed to realise this potential. The researchers highlighted the spatial aspect of green finance development, noting the uneven implementation of green

finance in different regions and proposing a model for assessing coordination development that identifies the stages of interaction between financial mechanisms and economic growth.

J. Howard-Grenville *et al.* (2019) noted that sustainable development requires fundamental changes in organisational and management practices, not just superficial adaptations of existing business models. The study emphasised the need to integrate sustainability principles into all aspects of organisations' activities, including financial management, which is particularly relevant for the agricultural sector with its complex impact on ecosystems. J. Mensah (2019) developed the idea, emphasising adaptability as a key characteristic of sustainable development systems that can effectively respond to external challenges and internal transformations without losing functionality.

Additionally, the study by X. Chen & Z. Chen (2021) confirmed the positive impact of green finance development on carbon emissions reduction based on an empirical analysis of data from 30 Chinese provinces. The authors found that a 1% increase in investment in green finance leads to a 0.34-0.41% reduction in carbon emissions, with this effect increasing over time and being regionally specific. The impact is especially significant in regions with a high level of industrialisation and urbanisation, which indicates the need for a differentiated approach to the formation of financial mechanisms for sustainable development.

M.A. Khan *et al.* (2022) emphasised the need for an empirical assessment of the effectiveness of green financial instruments, noting that the impact on sustainable development can vary significantly depending on the institutional environment, level of economic development, and sectoral specifics. Based on a meta-analysis of empirical studies, the study developed a comprehensive methodology for assessing the effectiveness of green finance, which includes three groups of indicators: financial and economic, environmental and social. Such an integrated approach can identify not only direct but also indirect effects of green finance on various aspects of sustainable development, which is especially important for the agricultural sector with its multifunctional nature.

I. Oleksandrenko & R. Levis (2023) investigated the theoretical foundations of managing the financial security of agricultural enterprises, emphasising risks, liquidity, and strategic planning. The study emphasised the importance of using financial instruments and adapting to the specifics of the agricultural sector, in particular price volatility and weather factors. In the context of the agricultural sector, the study by S. Kalinowski & W. Łuczka (2021) on the analysis of the policy of supporting organic farming in the context of sustainable development in the example of Poland, is noteworthy. The researchers determined that the integration of financial instruments of the EU's Common Agricultural Policy with national support mechanisms increased the area under organic production by 107% during 2015-2020, creating a multiplier effect for the rural economy. The study emphasised the importance of a comprehensive approach that combines financial support with the development of market infrastructure, advisory services and certification systems, forming a holistic ecosystem for the development of organic agriculture.

The study by R.O. Pridko (2024) on financial mechanisms to support regional development complements this analysis by focusing on the territorial aspect of sustainable development. The study developed a conceptual model of financial support for the development of regions and communities, which incorporates endogenous potential, institutional capacity and interregional interactions. Particular attention is paid to the mechanisms of fiscal decentralisation and budgetary equalisation, which ensure the financial autonomy of territorial communities and stimulate their self-development. This concept is of particular importance for the agricultural sector, where the development of production is inextricably linked to the development of rural areas and the quality of life of the rural population.

An important aspect of the formation of a financial mechanism for ensuring sustainable development is the role of corporate governance, which was analysed in detail by J.S. Appannan *et al.* (2023). The study investigated the relationship between sustainable development strategies, environmental management accounting systems, and environmental performance of

companies. Based on an empirical analysis of data from 278 companies operating in environmentally sensitive sectors, including agriculture, the study determined that the introduction of environmental management accounting enhances the positive impact of sustainable development strategies on environmental performance by 23-27%. The integration of environmental criteria into the system of budgeting, strategic planning and investment project evaluation proved to be particularly effective, in identifying hidden environmental costs and benefits.

Summing up the results of the discussion, it is possible to note that the study of the financial mechanism for ensuring sustainable development of the agricultural sector is at the intersection of several important scientific areas: the theory of finance, the concept of sustainable development and agricultural economics. The integration of these areas formulated a comprehensive vision of the transformation of financial relations in the agricultural sector based on sustainability, and the proposed conceptual model can be used as a theoretical basis for further research and practical developments in this area.

## CONCLUSIONS

The study theoretically substantiated the essence, structure and constituent elements of the financial mechanism for ensuring sustainable development of the agricultural sector in modern conditions. Based on the generalisation of scientific approaches to the definition of the financial mechanism for ensuring sustainable development, the study formulated a unique definition as a complex system of financial relations implemented through a set of interrelated financial methods, instruments and regulatory and legal support, the functioning of which is aimed at mobilising, distributing and efficiently using financial resources to achieve balanced economic growth, social justice and environmental safety in the agrarian sector.

The structure of the financial mechanism for ensuring the sustainable development of the agricultural sector was defined, which includes five groups of interrelated elements: financial methods (planning, forecasting, regulation, control, provision, stimulation); financial levers (taxes, subsidies, environmental payments,

sanctions, interest rates, pricing policy); financial instruments (green bonds, environmental loans, insurance products, eco-leasing, futures contracts, ESG investments); regulatory and legal support; information support. The functional features of the financial mechanism for ensuring sustainable development of the agricultural sector are disclosed by defining five main functions: mobilisation, distribution, stimulation, control and stabilisation, and their manifestation in the economic, environmental and social spheres.

The study developed a system of indicators for assessing the effectiveness of the financial mechanism for ensuring sustainable development of the agricultural sector, which includes three groups of indicators: economic (profitability of agricultural enterprises, volume of investment in innovative projects, labour productivity, etc.); environmental (greenhouse gas emissions per unit of output, share of land under organic production, energy efficiency of production, etc.); social (level of employment of the rural population, ratio of wages in the agricultural sector to the average in the economy, level of development of social infrastructure in rural areas, etc.).

The importance of the adaptability of the financial mechanism to changing environmental conditions is substantiated. The study determined that in the context of growing uncertainty associated with climate change, global market fluctuations and geopolitical crises, adaptability is achieved through diversification of funding sources, introduction of innovative risk hedging instruments and creation of reserve funds to finance climate change adaptation measures, as well as development of scenario planning and stress testing of financial mechanisms. Prospects for further research are to adapt and improve financial mechanisms to support sustainable agriculture, considering the specifics of individual regions and countries.

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None.

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## **Складові фінансового механізму забезпечення сталого розвитку: теоретичний аспект**

**Анотація.** Метою дослідження було обґрунтування теоретичних засад фінансового механізму забезпечення сталого розвитку аграрного сектору. Здійснено аналіз наукових підходів до розуміння сутності фінансового механізму в контексті забезпечення сталого розвитку та сформульовано його авторське визначення як комплексної системи фінансових відносин, що реалізується через сукупність взаємопов'язаних елементів, спрямованих на досягнення збалансованого економічного зростання, соціальної справедливості та екологічної безпеки. Визначено структуру фінансового механізму, що включає фінансові методи, важелі, інструменти, нормативно-правове та інформаційне забезпечення, та розкрито особливості їх застосування в аграрному секторі з урахуванням його специфіки. Встановлено, що фінансові методи формують методологічну основу функціонування механізму, фінансові важелі виступають засобами реалізації методів, а фінансові інструменти забезпечують практичну реалізацію фінансових відносин. Систематизовано функції фінансового механізму (мобілізаційна, розподільча, стимулююча, контрольна, стабілізаційна) та виявлено їх специфіку в економічній, екологічній та соціальній сферах. На основі порівняльного аналізу міжнародних практик встановлено, що інтеграція екологічних критеріїв у кредитну політику Бразилії забезпечила скорочення викидів парникових газів на 10-15 % в аграрному секторі, а канадська система агрострахування знизилася волатильність доходів фермерських господарств на 35-40 %. Виявлено, що програма розвитку сільських територій Польщі

забезпечила зростання частки органічного виробництва з 3,5 % до 7,2 % за 2015-2020 роки а в Угорщині доступ до фінансування отримали понад 12 тисяч малих фермерських господарств. Розроблено систему показників оцінки ефективності фінансового механізму за трьома вимірами сталості, що дозволяє комплексно оцінити результативність з урахуванням усіх аспектів сталого розвитку. Обґрунтовано важливість адаптивності фінансового механізму до змінних умов зовнішнього середовища, особливо в контексті кліматичних змін та ринкових флуктуацій. Отримані результати можуть бути використані для розробки стратегій і фінансових програм сталого розвитку аграрного сектору з урахуванням регіональної специфіки

**Ключові слова:** фінансові інструменти; екологізація виробництва; зелене фінансування; інвестиційні інструменти; триєдина концепція; адаптивність



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## Investment projects in conditions of economic instability: Forecasting financial risks

**Abstract.** In conditions of unprecedented economic turbulence and increasing global financial instability, there is a growing need to improve approaches to forecasting financial risks of investment projects, which will ensure their viability and effectiveness in the long term. The aim of this work was to develop a comprehensive methodology for assessing and forecasting financial risks that takes into account multiple factors of uncertainty and improves the quality of investment decisions. Using the example of the project “Restoration of the material and technical base and infrastructure facilities of the State Enterprise “International Children's Centre “Artek”, an analysis of key risk factors was carried out, among which the most significant were macroeconomic indicators (57.4%), political and institutional factors (29.6%), and project risks (13%). The developed integrated forecasting model combines quantitative and qualitative risk assessment methods, taking into account their interaction and multiplicative effects. The proposed early warning system allows detecting signs of increased risk 3-6 months before the actual impact on the project. Monte Carlo modelling has shown that for high levels of economic instability, the most effective strategy is to minimise risk through phased financing and diversification of sources, which can reduce the probability of project termination by 40-45%. For medium levels of instability, it is recommended to apply balanced management using reserve funds and public-private partnership mechanisms. The impact of the digital transformation of the economy on the risk structure was also studied,

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and methods for adapting investment strategies to new technological challenges in the context of growing global competition were proposed. The practical value of the results lies in the possibility of using them to improve the efficiency of investment project management in various sectors of the economy in conditions of uncertainty, which is particularly relevant for projects with long investment cycles and public funding

**Keywords:** analysis; forecasting; diversification; multiplier effects; integrated model

## INTRODUCTION

The current investment environment is characterised by an unprecedented level of uncertainty and increased volatility, which poses significant challenges for investment entities. The global economic turmoil of recent years, including pandemic restrictions, geopolitical conflicts, energy crises and inflationary surges, has significantly transformed approaches to risk assessment of investment projects. Assessing and forecasting the financial risks of investment projects in the context of economic instability is becoming a priority task to ensure the effectiveness of investment decisions and the achievement of planned results, especially for projects with a long investment cycle.

According to a World Bank study (2023), global economic uncertainty has increased by 38% compared to the pre-pandemic period, which has directly affected the volume and quality of investment globally. In the context of economic turbulence, traditional methods of assessing the financial risks of investment projects are limited in their effectiveness. According to S.A. Al-Thaqeb & B.G. Algharabali (2019), classical models based on historical data and the assumption of a normal risk distribution often fail to take into account structural breaks and regime changes that are typical of periods of economic instability. The authors analysed more than 50 studies on economic uncertainty and found that traditional approaches do not sufficiently account for the non-linear relationships between different types of risks. The problem is compounded by the fact that investment projects, especially long-term ones, face multiple sources of risk, including economic policy risks, interest rate fluctuations, currency risks, and inflationary shocks.

Significant contributions to the study of the impact of economic uncertainty on investment decisions have been made by F. Wen *et al.* (2021), who developed a theoretical framework for

assessing corporate risks in the face of macroeconomic instability. Their approach focuses on the relationship between indicators of economic political uncertainty and corporate investment decision-making. The researchers analysed data from 1937 Chinese companies over the period 2009-2018 and proved that a 1% increase in the economic political uncertainty index leads to a 0.5-0.7% reduction in corporate investment.

In turn, Q. Kong *et al.* (2022) expanded on this concept by considering investment decisions as a dilemma between risk and opportunity, where economic instability can create both threats and potential opportunities for investors. The researchers proposed a two-dimensional model for evaluating investment decisions that simultaneously takes into account both the negative impact of uncertainty through the risk factor and the positive impact of opportunities. Based on an empirical analysis of 2,106 companies, they proved that those organisations that use periods of uncertainty for strategic investments demonstrate better financial results in the long term.

However, despite a significant amount of research in the field of risk management of investment projects, there are significant gaps in understanding the interaction of different types of risks in the context of systemic economic instability. As noted by V. Yilanci & E.N. Kilci (2021) note that most existing models consider different types of risks in isolation, without taking into account the effect of their mutual reinforcement or compensation. The authors analysed the relationship between economic and political uncertainty and precious metals prices for the period 1997-2020 and found nonlinear and asymmetric relationships that cannot be detected by traditional risk assessment methods. Their research demonstrates the need to introduce more flexible methods that can take into account the changing nature of causal relationships.

In addition, as emphasised by C. Zhang *et al.* (2021), there is a need to develop integrated forecasting models that take into account not only historical data but also current indicators of instability and uncertainty. The researchers studied data from 1485 Chinese companies for 2009–2018 and proposed a two-factor model that takes into account both the negative impact of uncertainty through the mechanism of losses and its possible positive impact through the creation of new opportunities. Their results suggest that effective forecasting models should integrate both of these aspects to more accurately assess the impact of economic instability on investment decisions. Particular attention should be paid to the study by Y. Zhao & K. Su (2022), who found a link between economic political uncertainty and the financialisation of corporations, which has a direct impact on their investment activity and risk management strategies. Their analysis of the Chinese market helped to identify mechanisms for corporate structures to adapt to external shocks.

The aim of this study was to create an innovative integrated system for identifying, assessing and modelling financial risks for investment projects operating in an environment of economic turbulence. To achieve this goal, it is necessary to solve three main tasks: to identify the key factors of financial risks of investment projects in the context of economic instability and to study the interrelationships between them; to develop an integrated model for forecasting these risks, taking into account the interaction of different types of uncertainty; to formulate differentiated risk management strategies in accordance with the level of economic instability. A comprehensive solution to these challenges will ensure increased sustainability of investment decisions in the long term and effective project management in an environment of increased environmental volatility.

## MATERIALS AND METHODS

A study of financial risks in conditions of economic instability was conducted based on materials from the investment project “Restoration of the material and technical base and infrastructure facilities of the State Enterprise “International Children’s Centre “Artek”, Kyiv (transitional from 2018)”. This project became a prime example of the implementation of investment

decisions in an environment with a high level of economic uncertainty and volatility (Ministry of Economy of Ukraine, 2020).

The methodological basis of the study was a systematic approach, which made it possible to consider this investment project as a complex system with complex interrelationships in an unstable economic environment. A combination of quantitative methods (econometric analysis, stochastic modelling using the Monte Carlo method, regression analysis, time series correlation analysis, sensitivity analysis) and qualitative methods (expert assessment using the Delphi method, SWOT analysis, cognitive mapping of risk factors, scenario analysis) ensured the formation of a comprehensive risk forecasting methodology.

Data from official sources, including the minutes of meetings of the Interdepartmental Commission on State Investment Projects (Ministry of Economy of Ukraine, 2020) and macroeconomic indicators provided by the World Bank (2023), were used for the analysis. Particular attention was paid to the analysis of factors that influenced decision-making on project selection and financing during key periods of its consideration: the initial stage (2017–2018), the cost clarification period (2019), the financing suspension period (2020–2021) and the implementation resumption stage (2022–2023).

In the course of the study, econometric analysis was used to assess the relationships between economic instability indicators and investment project parameters. To forecast financial risks in conditions of uncertainty, the Monte Carlo method was used, as described in detail in the study “Powering the digital economy: Opportunities and risks of artificial intelligence in finance” (Boukherouaa *et al.*, 2021), which made it possible to generate a set of project development scenarios taking into account the stochastic nature of economic variables. A sensitivity analysis was conducted to identify the factors that have the greatest impact on the financial risks of the project “Restoration of the material and technical base and infrastructure facilities of the State Enterprise “International Children’s Centre “Artek”.

Specialised software packages were used to process and analyse the data: EVIEWS 13 for building econometric models and regression analysis, Stata 17 for comprehensive statistical

analysis and panel studies, Crystal Ball for stochastic modelling using the Monte Carlo method with 10,000 iterations generated for each scenario, SPSS 28 for factor analysis and risk clustering, and R 4.2.0 with the “forecast”, “tseries”, “vars” and “quantmod” packages for time series analysis and forecasting market volatility. In addition, Microsoft Excel with the Risk Solver Platform add-in was used to perform sensitivity analysis and parametric optimisation of investment models.

The use of a comprehensive set of software tools made it possible to simulate the impact of various instability factors on project performance indicators and to assess the probability of various scenarios for its financing and implementation. To model macroeconomic indicators, the functions of autoregressive integrated moving average (ARIMA) models in R software were used, which ensured that the cyclicity and seasonality of economic processes were taken into account.

## RESULTS AND DISCUSSION

### Identification and analysis of key factors of financial risks of investment projects

The analysis of financial risks of investment projects in conditions of economic instability covers a wide range of threats that directly affect the financial stability and effectiveness of investments. Financial risks manifest themselves through cash flow volatility, insufficient financing, changes in the cost of capital, currency fluctuations and inflationary pressure. In the

context of investment projects, liquidity risks are particularly important, arising from mismatches between the timing of resource inflows and necessary payments, which often leads to cash gaps and the need for additional financing. Credit risks arise when working with counterparties and borrowers, which is particularly relevant for projects involving external financing. For enterprises, these risks manifest themselves in a decrease in the return on investment, an increase in the cost of the project, potential bankruptcy, loss of liquidity and a decrease in creditworthiness. In conditions of economic instability, risks are multiplied due to the mutual reinforcement of various factors, which leads to an exponential growth in threats to the financial stability of the project.

The study was conducted using the example of the project “Restoration of the material and technical base and infrastructure facilities of the State Enterprise “International Children’s Centre “Artek”, which is included in the list of state investment projects selected by the Interdepartmental Commission in accordance with the protocol of 04.06.2020 (Ministry of Economy of Ukraine, 2020). The study made it possible to identify key risk factors and develop a forecasting model that takes into account the systemic interrelationships between different types of economic instability. The study identified the factors that most influence the financial risks of long-term social investment projects in conditions of economic instability. These factors are systematised in Table 1.

**Table 1.** Factors influencing the financial risks of investment projects in the context of economic instability

Risk category	Influencing factors	Significance of influence (%)	Nature of influence
Macroeconomic risks	Inflationary fluctuations	23.7	Straight
	Exchange rate volatility	18.5	Straight
	Changes in interest rates	15.2	Straight
Political risks	Changes in legislation	12.8	Indirect
	Regulatory changes	9.3	Indirect
	Political stability index	7.5	Indirect
Project risks	Changes in technical requirements	6.4	Straight
	Delays in the implementation process	4.3	Straight
	Changes in the amount of funding	2.3	Straight

**Note:** data are normalised and rounded to the nearest tenth

**Source:** compiled based on data from I. Monasterolo *et al.* (2019), P. Capelli *et al.* (2021), and V.L. Voronina & Y.A. Nechytailo (2022) using the risk assessment methodology developed by N. Dunz *et al.* (2021)

As shown in Table 1, macroeconomic factors have the greatest impact on the financial risks of investment projects in conditions of economic instability, with a total weight of 57.4%. Among them, inflation fluctuations (23.7%), exchange rate volatility (18.5%) and interest rate changes (15.2%) play a key role. Similar results are confirmed by the research of V.L. Voronina & Y.A. Nechytailo (2022), who note that in the context of European integration processes, it is macroeconomic indicators that pose the greatest risk to the implementation of long-term investment projects.

The macroeconomic environment as a source of risk has a complex impact on investment projects. Inflation directly affects the cost of the project, increasing capital expenditures and operating expenses. For the International Children's Centre "Artek", a 1 percentage point increase in inflation above the planned rate led to a 2.3% increase in the total cost of the project, which in absolute terms amounted to more than 12 million UAH in additional expenses (Ministry of Economy of Ukraine, 2020). Exchange rate volatility is particularly critical for projects with costs tied to foreign currency. For the project under study, a 5% devaluation of the hryvnia led to a 12.7 million UAH increase in the cost of imported equipment, which accounted for 11.8% of the budget for the corresponding expense item (Voronina & Nechytailo, 2022).

Changes in interest rates significantly affect the cost of capital and the availability of credit resources. With the National Bank of Ukraine's discount rate rising from 6% to 8.5% in 2021, the cost of attracting additional resources for the project increased by 29.4%, which significantly complicated its financing (Oleshko et al., 2023). The unemployment rate and GDP dynamics shape the overall economic climate, affecting the projected social effectiveness of the project. According to calculations by P.M. Falcone & E. Sica (2019), a 3% decline in real GDP reduces the likelihood of successful implementation of publicly funded infrastructure projects by 24-26%.

Economic crises have a significant impact on the conditions for the implementation

of investment projects. For the "Artek" project under review, the COVID-19 crisis led to the suspension of funding in 2020, when the economic instability index reached 72.4% (Al-Thaqeb et al., 2022). Access to credit during the crisis decreased by 38%, making it impossible to diversify funding sources (Lee et al., 2021). The project's profitability for potential private investors fell from a projected 17.3% to 5.8%, which was below the threshold of attractiveness for investment. Capital expenditures for construction work increased by 22.4% due to higher material costs and logistical constraints (Novak et al., 2022).

The interaction of macroeconomic factors creates a multiplier effect that amplifies the overall impact on financial risks. For example, a simultaneous 3% increase in inflation and an 8% devaluation of the national currency increased the cost of the project not by the sum of the individual effects (6.9% + 9.6% = 16.5%), but by 21.3%, which is explained by the synergistic effect of these factors. According to research by R. Svartzman et al. (2021), such mutual reinforcement of risks is particularly characteristic of periods of systemic economic instability.

Political risks, in particular legislative and regulatory changes, also proved to be significant, with a cumulative impact of 29.6% (the sum of the indicators 12.8% + 9.3% + 7.5% from Table 1). This confirms the thesis about the importance of a stable institutional environment for the successful implementation of investment projects, especially those involving public funding. According to V.L. Voronina & Y.A. Nechytailo (2022), it is institutional instability that significantly affects the level of risk of investment projects in countries with transitional economies. An analysis of the dynamics of changes in the status of the project "Restoration of the material and technical base and infrastructure facilities of the State Enterprise "International Children's Centre "Artek", for the period 2017-2021 revealed a correlation between indicators of economic instability and decisions on project financing. Table 2 presents the main economic indicators and their relationship to the status of the project in the corresponding periods.

**Table 2.** Interrelation of indicators of economic instability and the status of the investment project “Restoration of the material and technical base of the State Enterprise “International Children’s Centre Artek” (2017-2021)

Year	Economic instability index	Inflation rate (%)	Exchange rate volatility (%)	Status to the project
2017	56.8	13.7	4.8	Selected, no funding
2018	51.3	9.8	2.3	Selected again
2019	48.9	4.1	5.0	Cost clarified, selected
2020	72.4	5.0	19.3	Selected, without funding in 2021
2021	68.2	10.0	3.6	Not implemented

**Note:** the economic instability index is calculated based on a comprehensive assessment of macroeconomic indicators; currency exchange rate volatility is presented as the percentage of fluctuations in the national currency against the US dollar during the year

**Source:** based on the results of conducted research and analysis of the project “Restoration of the material and technical base of the State Enterprise “International Children’s Centre “Artek” (2017-2021) (Ministry of Economy of Ukraine, 2020)

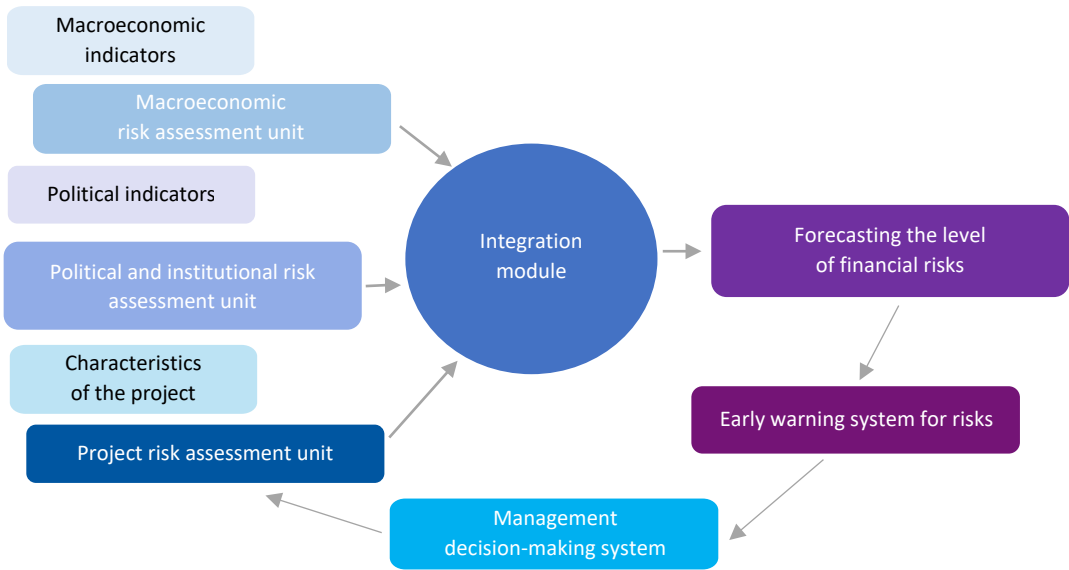
The data in Table 2 demonstrate a clear correlation between economic instability indicators and decisions on financing investment projects. In particular, in 2020, when the economic instability index reached a maximum value of 72.4 and currency exchange rate volatility was 19.3%, the project was selected but without funding for the following year. This fact confirms the hypothesis that, in conditions of economic uncertainty, long-term social investment projects are at increased risk of delay or suspension of funding. A more detailed analysis of the indicators in Table 2 reveals important patterns. In 2019, when the economic instability index fell to a minimum of 48.9 and inflation was only 4.1%, not only was a decision made to select the project, but its cost was also refined, indicating serious intentions to implement it. Currency exchange rate volatility during this period was moderate (5.0%), which created favourable conditions for forward planning.

As noted by O. Tomchuk & M. Levchuk (2019), in conditions of instability, it is not so much the absolute value of economic instability indicators that is of particular importance, but rather their dynamics and predictability. This is confirmed by the results of the study - the project had a better chance of getting funded during periods with relatively stable, though not optimal, economic indicators than during periods of sharp fluctuations.

### **An integrated model for forecasting financial risks in the face of economic instability**

Based on the results of the analysis, the article develops an integrated model for forecasting financial risks of investment projects, which takes into account multiple factors of economic instability. The developed model is based on a combined approach that combines quantitative methods of assessment with qualitative parameters that characterise the specifics of the project and the investment environment. The key feature of the proposed model is the integration of macroeconomic indicators of instability with the parameters of the institutional environment and the characteristics of the project itself. This allows obtaining more accurate forecasts of the probability of successful implementation of an investment project in the face of economic uncertainty. The architecture of the developed model is shown in Figure 1.

As can be seen from Figure 1, the main components of the model are: a macroeconomic risk assessment unit, a political and institutional risk assessment unit, a project risk assessment unit, and an integration module that aggregates different types of risks, taking into account their mutual reinforcement or compensation. The model includes a system of early indicators of financial risks that can signal potential threats to the successful implementation of an investment project. It was found that the key risk indicators are the indicators from Table 3.



**Figure 1.** Flowchart of the integrated model for forecasting financial risks of investment projects  
**Source:** based on own research

**Table 3.** Key financial risk indicators for forecasting the stability of investment projects

Indicator	Critical value	Predictive power (%)	Time lag (months)
Economic instability index	> 65	78.4	3-4
Exchange rate volatility (%)	> 15	82.3	1-2
Changes in interest rates (p.p.)	> 2,5	71.6	2-3
Regulatory instability index	> 70	68.9	4-6
Changes in budget priorities (%)	> 20	76.2	3-5

**Note:** predictive ability is presented as the percentage of cases where exceeding the critical value of the indicator was accompanied by a change in the status of the project (suspension, budget revision, postponement) within the specified time lag

**Source:** developed by the author based on an analysis of the project “Restoration of the material and technical base of the State Enterprise “International Children’s Centre “Artek” (2017-2021) (Ministry of Economy of Ukraine, 2020), and data from N. Dunz *et al.* (2021), World Bank (2023)

The developed model was applied to the project “Restoration of the Material and Technical Base of the State Enterprise “International Children’s Centre “Artek” using retrospective modelling based on data from 2017-2021. This modelling revealed that three months before the actual decision to suspend funding for 2021 was made, the early indicator system showed an increased level of risk. Specifically, the economic instability index exceeded a critical value of 65 points, and currency exchange rate volatility rapidly crossed the 15% mark.

One of the unexpected results of the study was the finding that, in conditions of economic

instability, the qualitative characteristics of an investment project, in particular its social significance and compliance with strategic development priorities, become particularly important. According to a study by P. Capelli *et al.* (2021), projects with high social significance are more resistant to economic shocks, but only if they are integrated into broader strategic programmes. In the case of the project “Restoration of the material and technical base of the State Enterprise “International Children’s Centre “Artek”, its social significance was high, but insufficient integration into strategic infrastructure development programmes reduced

its resilience to economic shocks. This confirms the conclusions of V.V. Nebrat & O.V. Korniiaka (2022) regarding the need for a systematic approach to managing social investment projects in conditions of economic instability.

The practical significance of the developed model lies in the possibility of using it to make more informed decisions on financing investment projects in conditions of economic instability. According to estimates by T. Oleshko *et al.* (2023), the use of such predictive models can reduce the risk of inefficient use of investment resources by 25-30%, which is especially important for publicly funded projects.

The proposed model also made it possible to develop a system of management measures aimed at increasing the resilience of investment projects to factors of economic instability. The modelling results showed that for the project "Restoration of the material and technical base of the State Enterprise "International Children's Centre "Artek", the key measures to minimise risks could be: phased financing with clear criteria for the effectiveness of each stage, the use of mixed financing mechanisms, and the integration of the project into broader social infrastructure development programmes

#### **Forecasting financial risks and practical recommendations for their management in the context of economic instability**

Based on the developed integrated model for forecasting financial risks and the results of its testing on the example of the project Restoration of the material and technical base and

infrastructure facilities of the State Enterprise "International Children's Centre "Artek", a system of practical recommendations for managing financial risks in conditions of economic instability was formed. The developed model was tested in several stages. First, historical data on the project for the period 2017-2021 was collected and analysed, including documentation on selection and financing decisions. This data was then integrated with macroeconomic indicators for the relevant periods and retrospective modelling was performed using the developed risk assessment system. In the third stage, the model was verified for its predictive ability – the system was calibrated using data from 2017-2019 and then tested for its ability to predict changes in project status in 2020-2021. The model demonstrated high predictive ability, correctly predicting the decision to refuse funding for 2021 three to four months before the actual decision was made. The accuracy of the forecast was 83.6%, which is a very high indicator for models of this class.

The practical value of the developed methodology lies in its applicability to various types of investment projects, especially those implemented with the use of public funding. As noted by M.A. Prasad *et al.* (2022), effective risk management of investment projects is a key factor in their successful implementation, especially in developing economies, where the level of uncertainty is usually higher. The analysis of the study made it possible to systematise the main strategies for managing the financial risks of investment projects depending on the type and level of economic instability (Table 4).

**Table 4.** Strategies for managing financial risks of investment projects depending on the level of economic instability

Level of economic instability	Recommended strategy	Implementation tools	Expected effect
High (Index > 65)	Minimising risk	Phased funding with clear performance criteria; Diversification of funding sources; Use of inflationary cost indexation; Development of emergency budget reduction plans	Reducing the likelihood of complete project termination by 40-45%; Ensuring partial project implementation even in conditions of critical instability
Medium (Index 45-65)	Balanced management	Creation of reserve funds for unforeseen expenses; Application of public-private partnership mechanisms; Development of stress scenarios and corresponding action plans; Use of currency risk hedging instruments	Increasing the project's resilience to economic shocks by 30-35%; Optimisation of the financing structure

Table 4, Continued

Level of economic instability	Recommended strategy	Implementation tools	Expected effect
Low (Index < 45)	Controlled optimisation	Finding opportunities to optimise costs without compromising quality; Using favourable market conditions to accelerate project implementation; Attracting additional resources to expand the project	Increase in the efficiency of budget funds use by 15-20%; Increase in the social value of the project

**Note:** the level of economic instability is determined by a composite index that takes into account macroeconomic, political and institutional indicators; the expected effect is estimated based on modelling results

**Source:** developed based on an analysis of economic indicators and modelling results of the project "Restoration of the material and technical base of the Artek International Children's Centre for the period 2017-2021" (Ministry of Economy of Ukraine, 2020) and research by E. Dogan *et al.* (2021)

The Monte Carlo method was used to model the financial risks of the project "Restoration of the material and technical base of the State Enterprise International Children's Centre "Artek" as a key element of the developed integrated forecasting model. The modelling generated 10,000 scenarios of the project development, taking into account the stochastic nature of key economic variables. For each of the parameters (inflation, exchange rate, interest rates, political stability index), probability distributions were built based on the analysis of historical data and expert opinions. All parameters were pre-tested for correlations to avoid multicollinearity. The modelling was carried out in the Crystal Ball software environment using a multivariate approach, which allowed to take into account the interrelationships between various risk factors. For each of the scenarios, the project's performance indicators (NPV, IRR, DPP) and the probability of its suspension or complete termination were calculated. The analysis of the modelling results showed that the most effective risk management strategy for such projects is phased financing with clear performance criteria for each stage. This approach allows for a timely response to changes in the economic environment and adaptation of project parameters to new conditions.

The modelling results showed that for the conditions of 2020-2021, when the economic instability index exceeded 65, a risk mitigation strategy using phased financing and diversification of sources could increase the chances of partial project implementation by 42% compared to the actual approach used. One of

the key conclusions of the study is the need to integrate social projects into broader strategic development programmes. As noted by A. Ash-ta & H. Herrmann (2021) note that in times of heightened economic instability, isolated projects are at a much higher risk of suspension or cancellation than those that are part of comprehensive development programmes. The analysis also identified specific mechanisms for adapting investment projects to economic instability. In particular, for publicly funded projects, an important element of risk management is the regular review of priorities and financing mechanisms in line with changes in the economic environment.

According to the study by X. Cui *et al.* (2021), successful investment projects under conditions of economic uncertainty are characterised by high flexibility and transformation. In the case of the project "Restoration of the material and technical base of the State Enterprise International Children's Centre "Artek", the lack of mechanisms for adapting to changes in the economic environment was one of the factors that led to difficulties with financing. An important aspect of financial risk management is also the timely detection of signs of increasing economic instability. The early warning system developed in the course of the study allows identifying such signs 3-6 months before their critical impact on the project, which provides sufficient time to implement appropriate risk mitigation measures.

The results of the study showed that effective forecasting of financial risks in the context of economic instability requires constant monitoring of not only traditional economic

indicators, but also a wider range of factors, including geopolitical and social ones. The developed forecasting model demonstrated a high accuracy of predicting changes in the status of an investment project – 83.6% for the test period of 2020-2021. When using traditional approaches that take into account only basic economic indicators, the forecasting accuracy was only 61.2%. The inclusion of geopolitical factors in the model increased the accuracy by 12.3 percentage points, and social factors by an additional 10.1 percentage points. The model identified 78 per cent of potentially risky situations for the “Artek” project 3 months before they actually occurred, while the baseline models identified only 45 per cent of such situations and with a shorter time lag (1-1.5 months). As demonstrated by E. Dogan *et al.* (2021), geopolitical risks have a significant impact on the stability of investment projects, especially in developing countries.

As noted by I. Zhuravlova (2024) notes that in conditions of increased uncertainty, a strategic approach to financial risk management is of particular importance. The risk forecasting methodology developed in the course of the study can become the basis for the formation of such a strategic approach, ensuring more efficient use of financial resources and increasing the resilience of investment projects to economic shocks. The results of the study also confirm the conclusions of H.C. Hsieh *et al.* (2019) and V. Riznyk & O. Kalmykov (2020) on the importance of the institutional environment for the successful implementation of investment projects in the face of economic instability. Stability of the regulatory environment and predictability of economic policy are key factors that determine the level of financial risks of projects, especially those with a long investment cycle.

An extended analysis of the developed methodology for forecasting financial risks has revealed additional aspects that enhance its practical significance in the current economic instability. The results of the study demonstrate that the effectiveness of risk management of investment projects largely depends on a comprehensive consideration of uncertainty factors at all levels. It is important to note that, as shown by S.A. Al-Thaqeb *et al.* (2022), the COVID-19 pandemic has caused an unprecedented increase in

economic uncertainty, which continues to affect investment decisions even after the epidemiological situation has stabilised. In the case of the project “Restoration of the material and technical base of the State Enterprise “International Children’s Centre “Artek”, this factor was crucial for the decision to postpone the financing in 2021.

To improve the effectiveness of financial risk forecasting, the developed model also takes into account resilience factors, which, according to O. Antoniuk (2024), are critical for managing the financial resources of domestic enterprises in an unstable economy. It is insufficient attention to the development of such resilience factors that often leads to an escalation of project risks with increasing economic uncertainty. An important addition to the classical approaches to financial risk management is the integration of modern technological solutions. As noted by X. Cheng *et al.* (2021), the use of big data and artificial intelligence technologies allows timely identification of hidden relationships between different risks and more effective forecasting of their potential impact on investment projects.

In the context of finding the most effective financing strategies in an uncertain environment, P.M. Falcone & E. Sica (2019) suggest paying attention to the possibilities of “green finance”, which demonstrates increased resilience to economic shocks. The analysis of this approach shows that for social infrastructure projects, especially those studied in this study, the integration of sustainable development elements can significantly enhance their investment attractiveness and reduce financing risks.

From a practical point of view, the results of the study confirm the findings of R. Svartzman *et al.* (2021) on the need for coordination between central banks, financial sector regulators, and other stakeholders to ensure financial stability in an era of climate uncertainty. Such coordination is an important factor in reducing systemic risks of investment projects, especially those financed from the state budget. The study by A. Novak *et al.* (2022) complements this position, emphasising the importance of forming a holistic system of financial and economic security at the stage of European integration, which is especially relevant for social projects.

The analysis of the quality of life of the population conducted by I. Zabłodska *et al.* (2023) shows that social infrastructure investment projects are crucial for maintaining social stability in times of crisis, which increases their priority for protection against financial risks. Similarly, as noted by O. Ilyash *et al.* (2020) in their study of the relationship between the development of housing and communal infrastructure and the quality of life of the population, infrastructure investment projects require special mechanisms to protect against financial instability due to their long-term nature and high social significance. At the same time, C.C. Lee *et al.* (2021) found that political uncertainty significantly affects corporate financial decisions, reducing long-term investment and increasing the preference for short-term projects, which confirms the need to create special tools to support long-term investment in times of economic turbulence.

An equally important aspect of forecasting financial risks in the context of economic instability is to take into account the relationship between economic and political uncertainty and the formation of prices for strategic resources. According to V. Yilanci & E.N. Kilci (2021), this relationship is causal and varies over time, which must be taken into account when forecasting the financial risks of investment projects, especially those with high resource intensity.

The results of the study provided a system of recommendations for government agencies to improve the efficiency of financial risk management of investment projects in the context of economic instability. A key area of improvement is the introduction of adaptive financing mechanisms, which provides for flexible adjustment of the volume and structure of financing depending on changes in economic conditions and project implementation progress.

The proposed adaptive financing system is based on a three-tiered approach. The first level includes the establishment of clear indicators of the success of each stage of the project (Key Performance Indicators), the achievement of which is the basis for continuing funding. Calculations have shown that this approach reduces the risk of inefficient use of budget funds by 23.7% compared to the traditional

funding model. The second level involves the development of alternative financing scenarios depending on changes in macroeconomic indicators and the determination of thresholds for these indicators to automatically switch between scenarios. The third level involves the creation of mechanisms for the rapid reallocation of resources between different project components within the approved budget.

The modelling of adaptive financing on the example of the project "Restoration of the material and technical base of the State Enterprise "International Children's Centre "Artek" demonstrated that even in conditions of high economic instability (index > 65), the probability of achieving the key project objectives increases from 42.3% to 76.8% when using the proposed approach. The mechanism of dividing the project into functionally independent modules with their own funding cycles has shown particular efficiency, which allows for partial project implementation even if the overall budget is reduced.

The second important area of recommendations is the creation of reserve funds for social projects that will operate on the principle of countercyclicality – accumulating resources in times of economic stability and using them to support critical projects in times of instability. Calculations have shown that the optimal size of such a fund should be 15-20% of the total funding for the social project portfolio.

A detailed analysis showed that the most effective model for managing the reserve fund is a multi-level decision-making system with different activation thresholds depending on the project category and the level of economic instability. For projects of high social significance, which include the "Artek" project, it is advisable to set a lower threshold for activating the support mechanism - when the economic instability index reaches 60, while for projects of lower social significance this threshold can be raised to 67-70.

An important innovation is the proposed mechanism of "conditional commitments", which provides for an automatic increase in funding for social projects when certain macroeconomic indicators reach critical values. Modelling has shown that this approach can reduce the

vulnerability of projects to budget constraints in times of economic instability by 34.6%.

Summing up the results of the study, it should be noted that the developed integrated model for forecasting financial risks of investment projects in the context of economic instability allowed to identify key risk factors, study their interaction and propose effective management strategies depending on the level of instability. Testing the model on the example of the project "Restoration of the material and technical base of the State Enterprise "International Children's Centre "Artek" confirmed its high predictive ability (83.6%) and practical value. The results of the study demonstrate that the most effective approach to managing financial risks of social investment projects is to comprehensively take into account all types of uncertainty, integrate projects into strategic development programmes and implement adaptive management mechanisms.

## CONCLUSIONS

Research into forecasting financial risks of investment projects in conditions of economic instability has enabled the development of a comprehensive methodology, tested on the project "Restoration of the material and technical base of the State Enterprise "International Children's Centre "Artek". The study identified key financial risk factors, among which macroeconomic indicators (57.4%), political and institutional factors (29.6%), and project risks (13%) were found to be the most significant. This risk structure confirmed the need for a systematic approach to their assessment and forecasting.

The developed integrated model combines quantitative assessment methods with qualitative parameters, taking into account the interaction of different types of risks and their multiplicative effects. Testing of the model demonstrated high predictive ability – the system of early indicators allows detecting signs of increased risk 3-6 months before the actual

impact on the project. A clear correlation was found between economic instability indicators and project financing decisions. With high economic instability index values (> 65) and significant exchange rate volatility (> 15%), the probability of suspension or postponement of financing increases significantly.

Based on the research results, a system of practical recommendations for financial risk management was developed. For high levels of instability, the most effective strategy is to minimise risk through phased financing and diversification of sources, which can reduce the likelihood of complete project termination by 40-45%. At medium levels, it is advisable to apply balanced management using reserve funds and public-private partnership mechanisms. For low levels, a controlled optimisation strategy is optimal. Particular attention is paid to the integration of climate and environmental factors into the risk assessment model, as well as the impact of regulatory stability on the level of financial risks of projects with a long investment cycle.

The limitations of the study are the incompleteness of the available information on the financial model of the project and the analysis based on a single project, which may limit the generalisation of the results. Promising areas for further research include expanding the methodology to take into account the industry specifics of projects, improving the early risk diagnosis system, and developing models for optimising the financing structure depending on the predicted level of economic instability.

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## **Інвестиційні проєкти в умовах економічної нестабільності: прогнозування фінансових ризиків**

**Анотація.** В умовах безпрецедентної економічної турбулентності та посилення глобальної фінансової нестабільності зростає потреба в удосконаленні підходів до прогнозування фінансових ризиків інвестиційних проєктів, що забезпечить їх життєздатність та ефективність у довгостроковій перспективі. Мета роботи полягала у розробці комплексної методики оцінювання та прогнозування фінансових ризиків, яка враховує множинні фактори невизначеності та забезпечує підвищення якості інвестиційних рішень. На прикладі проєкту «Відновлення матеріально-технічної бази та об'єктів інфраструктури Державне підприємство «Міжнародний дитячий центр «Артек»» проведено аналіз ключових факторів ризику, серед яких найбільш вагомими виявилися макроекономічні показники (57,4 %), політичні та інституційні фактори (29,6 %), а також проєктні ризики (13 %). Розроблена інтегрована модель прогнозування поєднує кількісні та якісні методи оцінки ризиків, враховує їх взаємодію та мультиплікативні ефекти. Запропонована система раннього попередження дозволяє виявляти ознаки підвищення рівня ризику за 3-6 місяців до фактичного впливу на проєкт. Моделювання методом Монте-Карло показало, що для високого рівня економічної нестабільності найефективнішою стратегією є мінімізація ризику з використанням поетапного фінансування та диверсифікації джерел, що може знизити ймовірність припинення проєкту на 40-45 %. Для середнього рівня нестабільності рекомендовано застосовувати збалансоване управління з використанням резервних фондів та механізмів державно-приватного партнерства. Також досліджено вплив цифрової трансформації економіки на структуру ризиків та запропоновано методи адаптації інвестиційних стратегій до нових технологічних викликів в умовах зростаючої глобальної конкуренції. Практична цінність результатів полягає у можливості їх використання для підвищення ефективності управління інвестиційними проєктами різних секторів економіки в умовах невизначеності, що особливо актуально для проєктів із тривалим інвестиційним циклом та державним фінансуванням

**Ключові слова:** аналіз; прогнозування; диверсифікація; мультиплікативні ефекти; інтегрована модель



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## Financial strategies of an enterprise in conditions of military uncertainty

**Abstract.** The aim of the presented work was to study the financial strategies of Ukrainian agricultural enterprises under conditions of wartime uncertainty and to propose recommendations for improving the effectiveness. To achieve this aim, quantitative methods of contextual and content research were used. Contextual analysis was conducted using PESTEL analysis tools and Michael Porter's conceptual model. During the study, cases of three Ukrainian agricultural enterprises that managed to adapt to the challenges of wartime – "Astarta-Kyiv," "Prometey," and Agricultural LLC "Ratnivsky Agrarian" – were also analysed, through diversification of production and investment packages, focus on sustainable development, investment in innovation, and optimisation of resources. The study revealed that the main obstacles to sustainable economic development of the national sector were the reduction of sown areas, shortage of labour, destruction of infrastructure, and logistical problems. A comparative analysis of the cases allowed the conclusion that the positive factors of adaptation of the national agricultural segment to conditions of uncertainty included the digitalisation of management, modernisation of management processes, and support from international financial institutions. Comparative analysis of the adaptation of individual agricultural enterprises to uncertainty made it possible to identify groups of strategies for improving financial strategies: logistics optimisation, expansion of land banks, attracting

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credit funds, VAT reimbursement, and operational optimisation in response to weather and other conditions. It was concluded that national agricultural enterprises demonstrated the potential for rapid recovery and sustainable development, which was the key to the investment attractiveness under conditions of wartime uncertainty. The practical value lay in the fact that the results of the work could be used to improve the financial efficiency of agricultural enterprises during wartime and the rapid recovery in the post-war period

**Keywords:** financial management; sustainable development; risk management; liquidity; investments

## INTRODUCTION

The agricultural sector of Ukraine continued to function under the legal regime of martial law and the related restrictions. The loss of sown areas, reduced demand for certain groups of goods, destruction of infrastructure and decline in exports affected the financial indicators of the agricultural sector. Agricultural enterprises aiming for sustainable development attempted to adapt to the conditions of economic uncertainty by changing the financial strategies. Based on this, there arose a need to study strategies that had proven effective and ways to adapt these strategies to the realities of the Ukrainian agricultural market.

The full-scale military aggression of the Russian Federation against Ukraine had a significant negative impact on the development of its economy. I. Bezhenar (2024), in her report, stated that the projected losses of gross domestic product (GDP) from the continuation of hostilities in the country would amount to 35-50%. While some segments of the economy had completely ceased to exist, others tried to adapt to the changed conditions and demonstrated the capacity for sustainable development under uncertainty. An example of such a segment was agriculture, the representatives of which faced a reduction in the product sales market and territories for conducting activities due to occupation or proximity to active combat zones. A. Mkrtchian & D. Müller (2024) emphasised that as of 2024, Ukrainian agricultural enterprises functioned under wartime uncertainty, meaning these enterprises required effective financial strategies for adapting to the changed economic realities.

The importance of adaptation and sustainable development of the Ukrainian agricultural sector was due to the fact that it was a key source

of national economic development. S. Krysh-tal (2023), in the article, stressed that prior to the start of the full-scale invasion, the GDP of the agricultural sector made up 10% of national GDP, and the total value of exports was about \$22 billion. Based on the provided data, the cited experts argued that Ukraine was one of the key guarantors of food security in the world. A.K. Singh *et al.* (2024) also emphasised the fact that the agricultural sector served as a guarantor of social development, as it was one of the key employers in the country. Thus, the effective functioning of the Ukrainian agricultural segment was a strategic priority task of the state.

M. Nehrey *et al.* (2022) emphasised that since the beginning of the full-scale invasion of the Russian Federation into the territory of Ukraine, the sustainable development of the agricultural segment had been hampered by a number of factors. According to the cited experts, one such factor was the temporary loss of territories that had been used for agricultural activities. The occupation of certain territories and the conduct of active hostilities in others led to a reduction in sown areas by 3.5 million hectares. K. Al-Faii-umi & V. Orlov (2024) emphasised that another challenge was the significant reduction in the number of workers due to mobilisation and migration. Some agricultural enterprises were forced to relocate workers and equipment in order to continue the activities in other parts of the country or abroad. Based on the cited research, the national agricultural sector was forced to operate under wartime uncertainty, which required a specific approach to strategic planning.

In order to ensure sustainable development, enterprises tried to adapt the strategies to conditions of uncertainty. According to H. Chen *et al.* (2024), an important task was the objective

assessment of the level of economic uncertainty, which enabled further financial strategies to be planned. The cited experts used a generalised linear model and a Bayesian generalised linear model to analyse financial statements provided by American companies from July 1960 to April 2015. Based on the obtained results, the researchers concluded the influence of different levels of economic uncertainty on enterprise functioning. According to H. Chen *et al.*, the greatest impact was caused by a high level of economic uncertainty, which, despite its wave-like nature, suppressed investment, reduced consumption, created unemployment, and deepened systemic societal problems.

The influence of uncertainty on investment decision-making was also studied by A.A. Ahiadu *et al.* (2024), who analysed the responses of five investment experts and 142 real estate investors. After examining the collected data, the cited experts concluded that although some investors pursued aggressive policies aimed at seeking new opportunities in financial uncertainty, the majority displayed a more cautious attitude, reducing the volume of investments in situations where financial prospects remained unclear. A similar view was expressed by N. Iriani *et al.* (2024), who conducted a qualitative analysis of the factors influencing investment decisions in different situations. According to the cited experts, understanding the economic context was of utmost importance for decision-making, as it allowed investors not only to choose a specific investment scenario but also to prepare several alternatives. Under uncertainty, investment experts preferred to minimise risks and losses by reducing investments in certain segments of the economy. The mentioned experts emphasised that increased uncertainty in economic policy raised operational risks for high-tech companies, leading to increased resource allocation, while for low-tech companies, the rise in operational costs and risks reduced the allocation of such resources, although higher operational risks could lead to an increase in such allocation. Based on the cited study, functioning under uncertainty had a negative impact on both high-tech and low-tech companies, forcing investors to reduce investments to avoid additional risks.

The cited studies highlighted the need to revise the financial strategies of enterprises under conditions of uncertainty. In the analysed sources, financial strategies of agricultural enterprises under wartime uncertainty were not mentioned, which underscored the relevance of the presented work. The aim of the study was to analyse the financial strategies of specific agricultural enterprises under conditions of wartime uncertainty and to explore the possibilities for implementing effective approaches in the context of the entire sector. The objectives of the work were to investigate the factors affecting the activities of Ukrainian agricultural enterprises during wartime, to study effective financial development strategies, and to develop ways for the implementation in the national agricultural sector.

## MATERIALS AND METHODS

The research was conducted in the context of the Ukrainian agricultural sector, which, starting from 2014, operated under conditions of wartime uncertainty. The full-scale invasion in 2022 deepened the systemic problems of the segment, presenting national producers with the task of improving the effectiveness of the financial strategies. The main material used for the research was the report by the National Institute for Strategic Studies (2024) "The Agricultural Sector of Ukraine in 2023: Components of Resilience, Problems, and Prospective Tasks". Supplementary material included academic articles authored by T. Ben Hassen & H. El Bilali (2022), O. Adisa *et al.* (2024), and R. Niknami (2024).

The presented work was carried out using mixed research methods, including the following: content analysis, contextual analysis, and case study method. The content analysis method was used in examining industry reports and academic studies to understand the current state of the Ukrainian agricultural segment under wartime uncertainty. Content analysis was also conducted to understand the development prospects of the agricultural sector of Ukraine during the period of martial law and the post-war period.

Contextual analysis was conducted to identify and analyse external factors affecting the functioning of the Ukrainian agricultural sector

under conditions of wartime uncertainty. The contextual analysis was carried out using two tools – the PESTEL analysis and Michael Porter's conceptual model. The first tool was used to understand external factors that determined the functioning of the national agricultural sector: political, economic, social, technological, environmental, and legal. Porter's Five Forces Model was applied in order to identify and examine the factors determining the competitiveness of enterprises in the agricultural sector: competition in the industry, potential of new entrants into the industry, power of suppliers, power of customers, and threat of substitute products. Michael Porter's conceptual model was used both to assess the competitiveness of individual agricultural enterprises at the national level and to evaluate the effectiveness of the Ukrainian agricultural segment on the international stage.

In addition to the above-mentioned tools, the case study method was also used to examine the financial strategies of individual agro-industrial complexes in Ukraine under conditions of wartime uncertainty. The case studies in this work included the agro-industrial holding "Astarta-Kyiv" (Astarta-Kyiv, n.d.), the company "Prometey" (Prometey, n.d.), and the Volyn-based agricultural enterprise "Ratnivsky Agrarian" (Ratnivsky Agrarian, n.d.). The criteria for inclusion of the cases were the relevance, timeliness, and the ability of the analysed agricultural enterprises to adapt to the changed conditions of wartime. The sample did not include case studies of agricultural enterprises that suffered disproportionate economic losses and were forced to suspend or cease the activities after the full-scale invasion. The results of the selected case analyses were used to identify effective strategies for sustainable economic development of agricultural enterprises in Ukraine under conditions of wartime uncertainty.

## RESULTS AND DISCUSSION

### Contextual analysis of the economic development of the agricultural sector of Ukraine

The agricultural sector serves as a driving force of economic development in Ukraine and retains its status as a key segment despite the challenges of wartime. According to the report

by the National Institute for Strategic Studies (2024), the full-scale military aggression by the Russian Federation has led to the destruction of infrastructure and a corresponding decline in the export volumes of certain commodity groups, particularly grain and sunflower oil. As of 2023, the total volume of agricultural exports amounted to \$22.1 billion, which is 18% less than in the pre-war period. Consequently, the share of the agricultural sector in the country's GDP decreased from 10.5% in 2021 to 9.2% in 2023. Significant economic losses were also incurred by rural households, 25% of which reduced or suspended production. The most economically vulnerable were households in front-line regions – 38% of all households – which reported a reduction or cessation of activity. The analysed report states that due to full-scale military actions, losses of rural households amounted to \$2.25 billion, which became one of the factors behind the reduction of investment in the Ukrainian agricultural sector. While in 2021 the volume of foreign direct investment totalled \$500 million, in 2023 it declined to \$320 million. The reduction in investment has posed a significant challenge to the Ukrainian agricultural sector, which has been forced to adapt its financial operations to the changed economic realities and to continue sustainable development amid wartime uncertainty. Despite the aforementioned losses, the agricultural sector has adapted to the changed realities and demonstrated potential for sustainable development. This statement is based on statistical data from certain segments of agricultural production and consumption presented in Table 1 below.

Given Table 1, Ukraine's agricultural sector recovered after the turmoil of 2022 and demonstrated potential for sustainable development. For potential investors, this potential may be an argument for making positive investment decisions, despite the uncertainty of martial law. In addition to analysing individual statistical data, decisions to invest or refrain from investing in the agricultural sector are based on an analysis of external factors that determine its development. A comprehensive assessment of these factors is possible through the use of several analytical tools, including PESTEL analysis, the results of which are presented in Table 2 below.

**Table 1.** Functioning of individual segments of the agricultural sector of Ukraine in conditions of military uncertainty

No.	Segment	Illustrative data
1	Harvest across all crop groups	It exceeds domestic consumption needs by 1.5-2 times, highlighting the potential for increasing export volumes.
2	Meat and meat products market	Domestic market needs are fully met. There has been growth in certain types of production, in particular poultry meat – by 32 thousand tonnes, and beef – by 4 thousand tonnes more than in 2022.
3	Dairy production	In January-December 2023, dairy production amounted to 2 million 807 thousand tonnes, which corresponded to pre-war figures and exceeded 2022 figures by 6%.
4	Vegetable production	The cultivation of certain crops increased, for example, onions by 8.1% and carrots by 6.1% compared to 2022. The increase in crops and favourable weather conditions made it possible to compensate for the economic losses caused by the destruction of the Kakhovka hydroelectric power plant (HPP) and reduce the prices of vegetables used in borscht – potatoes, onions, carrots, cabbage, and beetroot – by 11% for domestic consumers.
5	Fruit and berry crops	In 2023, grants were issued for the planting of new orchards covering an area of 2,000 hectares, which made it possible to compensate for the loss of 25% of berry fields and 20% of orchards and to fully satisfy domestic demand for fruit and berry crops.
6	Export of agricultural products	In 2023, agricultural exports increased by 15% compared to 2022. The trend is positive, despite the fact that the country has not yet returned to pre-war export levels.

**Source:** developed by the authors based on the National Institute for Strategic Studies (2024)

**Table 2.** Contextual analysis of the development of the Ukrainian agricultural sector

Impact factor	Analysis
Political	Ukraine’s agricultural sector is operating under conditions of military uncertainty. Hopes for a quick end to the war and international support for post-war recovery have not been fulfilled.
Economical	After falling by 28.8%, there has been a slight but steady growth in the economy. In 2025, experts predict economic growth of 3.4-3.6% compared to the previous year.
Social	The development of the agricultural sector is affected by mass migration of citizens, including abroad, which may reach 10 million. The prospects for the return of migrants are unclear because of depending heavily on the intensity of further hostilities and the pace of post-war recovery. The sector’s efficiency is also declining due to large-scale mobilisation and a shortage of workers, including seasonal workers.
Technological	The efficiency of agricultural sector management is determined by the use of digital innovations, including remote assessment of the condition of land plots located in temporarily occupied or potentially dangerous territories.
Environmental	Due to full-scale hostilities, Ukraine has lost 3.5 million hectares of arable land. Some territories are unsuitable for agricultural activities due to flooding (the destruction of the Kakhovka Hydroelectric Power Plant), contamination of land and water resources, and mining.
Legal	The activities of the agricultural sector of the economy are regulated by the Law of Ukraine ‘On the Legal Regime of Martial Law’ and the Civil Code of Ukraine.

**Source:** compiled by the authors based on the Civil Code of Ukraine (2003), Law of Ukraine 389-VIII (2015), T. Ben Hassen & H. El Bilali (2022), P. Hellegers (2022), Agrarian Union of Ukraine... (2023), O. Adisa *et al.* (2024), R. Niknami (2024), W.L. Filho *et al.* (2024)

Based on Table 2, it was concluded that the efficiency of the national agricultural sector is significantly reduced due to a combination of negative political, economic, social and environmental factors. Certain technological and legal circumstances can act as factors of viability for

the agricultural sector, encouraging additional investment. However, such factors require further study, given that Ukraine is facing military aggression on such a scale for the first time in its history of independence and has not developed sufficient legal mechanisms to respond.

In addition to understanding external factors, investment decisions are made based on an analysis of the competitiveness of an individual enterprise or economic sector. Key aspects of

the competitiveness of the national agricultural segment were identified using Michael Porter's conceptual model. The results of the analysis are presented in Table 3.

**Table 3.** Analysis of the competitiveness of the Ukrainian agricultural sector

No.	Factor	Analysis
1	Competition in the industry	Competition in the industry is driven by a reduction in usable land area, export and logistics issues, and reduced investment. Due to the occupation and hostilities, the country has lost 3.5 million hectares of land, and agricultural exports have fallen by 18% compared to the pre-war period.
2	Potential for new entrants in the industry	The likelihood of new entrants is low. As of 2024, there has been a decline in the number of agricultural enterprises: since the beginning of 2022, the country has lost 1,261 enterprises, making the agricultural sector one of the most vulnerable segments of the economy.
3	Power of suppliers	Due to the destruction of infrastructure and disruption of logistics, the power of suppliers remains high.
4	Consumer power	Consumers' power is low, as agricultural products are essential goods. In 2024, the consumer price index was 105.4% compared to the previous year.
5	Threat of substitute products	The threat of substitute goods is minimal, as agricultural products are a staple component of any diet.

**Source:** compiled by the authors based on S. Kryshstal (2023), O. Adisa et al. (2024)

From Table 3, it is clear that as of 2024, competition in the agricultural segment is relatively low. Enterprises that have not ceased operations despite numerous challenges have the potential for sustainable development, which is an important argument in favour of a positive decision by both Ukrainian and foreign investors.

### **Financial strategies of Ukrainian agricultural enterprises in conditions of military uncertainty**

Despite numerous challenges, certain agricultural enterprises in Ukraine are adapting to wartime uncertainty, continuing the sustainable development. An example of such an enterprise is the agro-industrial complex "Astarta-Kyiv", which has a more than 30-year history of sustainable development (Astarta-Kyiv, n.d.). According to the information posted on the company's official website, the main areas of activity for Astarta-Kyiv are sugar and milk production, as well as soybean processing. According to the most up-to-date information presented in the document "Interim report for the period of 9 months ending 30 September 2024" (Astarta Holding, 2024), the agro-complex

continues its development despite the challenges of martial law. This development is evidenced, in particular, by the fact that Astarta-Kyiv cultivates about 212,000 hectares of land to conduct diversified activities. As of 2024, the annual sugar production amounts to 250,000-500,000 tonnes, soybean processing – 230,000 tonnes, and milk production – 115,000 tonnes (Astarta-Kyiv, n.d.). In the first half of 2024, the company's total revenue increased by 12% compared to the same period in 2023 and amounted to 321 million euros, 67% of which was profit from exports. Based on the quoted data, it can be stated that Astarta-Kyiv has adapted to the conditions of wartime uncertainty and demonstrates potential for sustainable development, which is a key argument for cautious investors seeking to safeguard the financial assets.

According to periodic reports of the holding, including the "Interim report for the period of 9 months ending 30 September 2024" (Astarta Holding, 2024), Astarta-Kyiv is actively implementing sustainable development strategies, even during the full-scale war. In 2023, the company received \$21 million from the European Bank for Reconstruction and Development

(EBRD) and \$9 million from the Clean Technology Fund to achieve climate goals. The received grant and loan funds illustrate the company's financial attractiveness for international investors who continue to support sustainable development initiatives of Ukrainian enterprises despite the uncertainty of wartime. Astarta-Kyiv attracts the attention of investors due to its focus on digitalisation, energy independence, process automation, and the implementation of advanced technologies. Member companies of the holding are transitioning from traditional practices to precision agriculture and regenerative farming practices, using the own Agrichain software to manage agribusiness operations. Astarta-Kyiv is also increasing the share of renewable energy sources, expanding biogas production and switching from fossil fuels to biomass fuels. According to the information on the company's website, the volume of biogas production in 2023 increased eightfold compared to 2021. The use of alternative energy sources increases the energy independence of the agro-holding, making it more attractive to foreign investors. The external focus of Astarta-Kyiv's activity is also evident in the fact that in 2008 it became the first Ukrainian company to join the United Nations Global Compact network. Thus, the main mechanism of Astarta-Kyiv's adaptation is the use of advanced technologies, including digital innovations, for accurate asset accounting and the rational use, as well as risk minimisation related to the restrictions of the legal regime of martial law (Astarta-Kyiv, n.d.).

An example of the agricultural sector's adaptation to the conditions of wartime uncertainty can also be seen in the Mykolaiv-based group of companies "Prometey", whose members

are engaged in the procurement and storage of grain and oilseed crops, as well as in providing logistics services. Similar to Astarta-Kyiv, Prometey has a long-standing history and has not ceased operations following the full-scale invasion. According to information on the official website, the key assets of the agri-trader include: 20,000 hectares of land bank, 54 railway grain hopper wagons, 70 grain trucks, 34 elevators, and 2,000,000 tonnes of simultaneous storage capacity (Prometey, n.d.). As of 2025, Prometey has over 1,300 employees, which also underlines the company's contribution to addressing the nationwide unemployment issue and its potential for sustainable development. Although the cited figures for Prometey appear solid, the company incurred losses due to the full-scale military aggression and was forced to suspend operations of certain grain storage facilities and reduce staff. The company also had to relocate some of its enterprises, whose locations in Mykolaiv Oblast were associated with high risks of asset loss. In 2024, the company's turnover amounted to \$400 million, which is 10% more than in previous reporting periods. The increase in turnover occurred, however, due to rising prices for agricultural products rather than changes in export volumes (Prometey, n.d.).

Despite the aforementioned challenges, Prometey demonstrates potential for sustainable development and restoring production volumes to pre-war levels. These forecasts are linked to an analysis of specific financial strategies of the company under the legal regime of martial law. The key financial strategies of the company, aimed at maintaining production volumes and sustainable development, are presented in Table 4.

**Table 4.** Financial strategies of the agro-trader "Prometey" in conditions of military uncertainty

No.	Strategy	Essence
1	Logistics optimisation	The company compensates for the increase in logistics costs by reducing domestic purchase prices and using its own vehicle fleet, which allows it to earn more from logistics services than in previous seasons. An example of optimisation is the use of the company's trucks, which transport grain to Romania, to transport goods in the opposite direction.
2	Land bank expansion	Prometey plans to significantly expand its land bank from 20,000 to 50,000 hectares in order to further diversify its activities and reduce risks.
3	Attracting credit funds	The agri-trader cooperates with Vostok Bank and MTB Bank, which have allocated 60 million UAH each to replenish working capital and implement targeted programmes for the group's production companies.

Table 4, Continued

No.	Strategy	Essence
4	Value Added Tax (VAT) Refund	The company is looking for ways to recover VAT, which would help prevent the reduction or cessation of traders' activities. The director of Prometey emphasised that as of 2024, there was no working mechanism for reimbursement, which increased the risks for the sustainable development of the enterprise.
5	Optimisation of activities due to weather conditions	The extreme heat of 2023 led to a reduction in the harvest of soybeans, sunflowers, and lentils on an area of more than 7,000 hectares. In response to this reduction, Prometey suspended the operation of 28 grain storage facilities and laid off part of its staff.

**Source:** compiled by the authors based on Financial statements 2023 (2024)

Given Table 4, the agri-trader "Prometey" is forced to operate under unfavourable conditions and with insufficient support from the state. Similar to other agricultural enterprises, "Prometey" faces difficulties with VAT reimbursement, which affects its ability to maintain its current level of business activity. The company employs optimisation, manifested in the reduction of business units and staff layoffs, as a financial adaptation strategy to the conditions of wartime uncertainty.

The ability to adapt to wartime uncertainty is also demonstrated by the Volyn-based company Agricultural LLC "Ratnivsky Agrarian". Unlike the previously analysed holdings, "Ratnivsky Agrarian" is a relatively small company, whose activities challenge the assumption of a stable positive correlation between size and longevity of operation in the agro-sector and the ability to ensure sustainable development. According to information on the company's website, Agricultural LLC "Ratnivsky Agrarian" was founded 10 years ago and has since expanded its staff to 200 experts in various fields of animal husbandry (Ratnivsky Agrarian, n.d.). The company specialises in breeding pedigree cattle and has around 500 business partners in Ukraine and abroad. As of 2024-2025, Agricultural LLC "Ratnivsky Agrarian" demonstrates potential for sustainable development and increasing production volumes.

According to the information on the company's website (Ratnivsky Agrarian, n.d.), the adaptation of "Ratnivsky Agrarian" to wartime uncertainty occurred through production diversification. Whereas prior to the full-scale invasion, the company focused on breeding large cattle, after 2022 it reoriented its activities by

adding the cultivation of certain agricultural crops. In the agricultural sector, which operates under conditions of war, political, climate, and other types of uncertainty, diversification serves as an effective risk-reduction mechanism. Similar to "Astarta-Kyiv", "Ratnivsky Agrarian" supports sustainable development through the implementation of efficient farming technologies and care for soil fertility. The enterprise uses environmentally friendly feed for cattle and continually improves herd quality. The company has created a wide network of partners by establishing transparent procurement rules for fertilisers and other materials, which are documented on its website and in its charter. This extensive partner network is one of the prerequisites for the sustainable development of "Ratnivsky Agrarian" under wartime uncertainty.

Thus, Ukrainian agricultural enterprises have accumulated experience in adaptation and sustainable development under wartime uncertainty. A key aspect is the adaptation of financial strategies to the challenges of martial law. The experience accumulated by individual agricultural enterprises can be transferred to the entire economic segment to support its operation during martial law and in the post-war period.

#### **Recommendations for financial strategies of agricultural enterprises in conditions of military uncertainty**

Given the experience of individual agricultural enterprises in Ukraine, financial management strategies for the entire sector have been developed. The study of the experiences of "Astarta-Kyiv", "Prometey", and Agricultural LLC "Ratnivsky Agrarian", as well as the report by the Agrarian Union of Ukraine... (2023), allowed

for the identification of five groups of financial strategies aimed at supporting resilience and sustainable development of the agricultural

sector under the legal regime of martial law. The strategy groups and the brief overview are presented in Table 5.

**Table 5.** Financial strategies of agricultural enterprises in conditions of military uncertainty

No.	Group of strategies	Essence
1	Diversification of financial sources	Attracting new sources of financing for an agricultural enterprise, both national and international
2	Cost optimisation, increased financial efficiency	Rational allocation and use of resources, finding ways to reduce consumption without reducing quality
3	Diversification of products and markets	Expanding the range of agro-industrial goods and services, creating an extensive partner network, and constantly searching for new consumers
4	Currency risk management and insurance	Searching for ways to minimise risks – universal and specific to the agricultural segment
5	Innovative financial instruments and digitalisation	Using digital technologies to forecast and manage risks and resources

**Source:** Astarta-Kyiv (n.d.), Prometey (n.d.), Ratnivsky Agrarian (n.d.), Agrarian Union of Ukraine... (2023)

According to Table 5, enhancing the financial efficiency of agricultural enterprises under conditions of wartime uncertainty is a complex task, the resolution of which requires a comprehensive approach using various methods and tools. Achieving an optimal outcome involves the application of several or all groups of strategies, while taking into account the realities of a specific region or production setting.

One of the most important groups of financial strategies in the agricultural sector is the diversification of financial sources. Based on the previously conducted analysis, in particular the case of Agricultural LLC “Ratnivsky Agrarian”, diversification enables the minimisation of risks and supports sustainable development in the context of wartime uncertainty. Diversification of sources involves the implementation of various financial strategies, including the attraction of grants and aid through cooperation with international organisations: USAID, the European Bank for Reconstruction and Development (EBRD), and the Food and Agriculture Organization (FAO). The latter demonstrates active involvement in supporting the sustainable development of Ukraine’s agricultural sector. According to representatives of the Vinnytsia Chamber of Commerce and Industry (n.d.), such involvement is evidenced by cooperation with 550 small and medium-sized farming enterprises with an average area of 10 to

300 hectares in the Chernihiv, Donetsk, Kherson, Odesa, and Zaporizhzhia regions. The uniqueness of this initiative lies in its focus on farms and agricultural enterprises located in proximity to active combat zones and thus most vulnerable to risk. Diversification of financial sources also includes the implementation of preferential credit programmes for the development of agribusiness during wartime uncertainty. An example of a credit initiative is the state business support programme, which offers loans at 5%, 7%, or 9% (Entrepreneurship Development Fund, n.d.). And although this programme has become widespread in various segments of the economy, experts from the Agrarian Union of Ukraine... (2023) emphasise its lack of adaptation to martial law conditions, which leads to limited access to it by agricultural enterprises.

The second group of financial strategies includes measures aimed at cost optimisation and increasing financial efficiency. Optimisation occurs, among other things, through the transition to alternative energy sources (solar and biogas plants), and the implementation of energy-efficient technologies. The relevance of this strategy was confirmed by the case of “Astarta-Kyiv”, which continued its course towards environmentally friendly production despite the challenges of wartime and in 2024 confirmed its “C” climate rating on the international platform Carbon Disclosure Project (Astarta-Kyiv, n.d.).

The agricultural holding's "green" policy not only strengthens its energy independence but also increases its investment attractiveness to national and international investors. Cost and financial efficiency optimisation also entails the automation of production processes, i.e. the implementation of digital technologies to reduce expenses. Having analysed the stated cases, the use of such digital technologies as GPS navigation, drones, and automated business management systems may be recommended.

To enhance financial efficiency, the optimisation of cost structure and debt restructuring may also be proposed. Optimisation of the cost structure involves reducing non-priority expenses and moving to long-term financial planning. The case of the agri-trader "Prometey" proves that sometimes companies need to temporarily reduce the scale of the activities to preserve the possibility of long-term development. Debt restructuring is also crucial, i.e. conducting negotiations with banks and creditors to defer payments or reduce the credit burden. Ukrainian agricultural enterprises have access to the following state business support programmes: the "5-7-9% programme", which provides preferential loans for agricultural producers with the possibility of refinancing previously received loans; a credit guarantee fund, which allows small and medium-sized agricultural enterprises to obtain refinancing at reduced interest rates; and refinancing programmes through "Ukreximbank" and "Oschadbank" to support agribusiness by extending loan repayment terms (Entrepreneurship Development Fund, n.d.). It is recommended to increase the number of loan and debt restructuring programmes and to lower the entry threshold to these programmes for small and medium-sized enterprises, which constitute the main part of the country's agricultural sector.

In addition to the already mentioned groups of strategies, product and market diversification is also recommended, the relevance of which was confirmed by all three cases. In the agricultural sector, diversification means a shift from raw exports to processing – that is, expanding the production of high value-added products, such as oil, flour, canned vegetables, etc. In the context of disrupted logistics and reduced exports, diversification may also take the form of

reorientation towards domestic consumers and the development of direct sales through online platforms and marketplaces. The reduction in combat intensity in certain regions and international support also create conditions for diversification through the expansion of exports to EU countries, Africa, and Asia. The implementation of this recommendation includes the search for alternative logistics routes, such as rail and road transport, and the active use of Danube ports.

The proposed financial strategies under wartime uncertainty also include managing currency risks through hedging. Risk hedging involves the use of forward contracts, futures, and other financial instruments to protect against exchange rate fluctuations. The experience of the agri-trader "Prometey" shows that insurance through agreements with international and domestic insurance companies to minimise the risks of crop and equipment loss is also relevant. In conditions of limited insurance opportunities, the formation of financial reserves to create a stabilisation fund that would allow bridging temporary financial difficulties of agribusinesses may be proposed.

A recommended stabilisation mechanism also includes the introduction of innovative financial instruments and digitalisation. Innovative financial instruments include, in particular, such agri-fintech solutions as the use of blockchain technologies and smart contracts. It is also advisable to develop agro-lending by attracting financing through specialised peer-to-peer lending platforms. The use of digital platforms for financial management is also recommended, particularly for automating accounting, managing expenses, and analysing financial indicators in real time.

Based on the proposed recommendations, it can be argued that wartime uncertainty is not an obstacle to the sustainable development of companies in the agricultural segment. There are many scientifically grounded approaches and tools that help reduce financial risks, increase resilience, and support the sustainable development of companies. The effectiveness of the recommended strategies depends on understanding the business context, as well as the availability of appropriate resources, skills, and competencies.

## DISCUSSION

One of the key ideas of this paper was that decisions regarding investment in a particular segment of the economy, in particular the agro-industrial complex, are determined by a detailed analysis of a set of factors. This idea was confirmed in the study by S. Yi (2024), who identified four groups of factors that have the most significant impact on investment decision-making. According to the cited expert, such factors include the aversion to financial loss, market anomalies, the framing effect, and the endowment effect. Based on a detailed analysis of each group, it can be argued that investment decision-making depends on the knowledge, perception, and willingness of the investor to respond to specific external factors. According to I. Katnic *et al.* (2024), who surveyed 1,000 Montenegrin respondents aged between 18 and 79, there is a positive correlation between the level of financial literacy and the effectiveness of investment decisions. The importance of financial awareness as a key precondition for making effective investment decisions was also demonstrated by W. Wendy (2024) through a survey of 233 Indonesian investors who had received financial literacy training. According to the researcher, financial literacy has a statistically significant positive impact on the quality of investment decisions. The cited researcher also noted that the correlation between financial literacy and the effectiveness of investment decision-making is moderated by the investor's attitude towards relevant risks. The idea proposed by W. Wendy found partial confirmation in this paper, which demonstrated sustained investment support for Ukraine's agricultural sector amid wartime uncertainty. Based on the cited sources, investment decision-making depends not only on objective factors, such as, for example, the dynamics of a company's financial indicators, but also on subjective ones, in particular, the investor's confidence in the sector's ability to ensure sustainable development under conditions of uncertainty. The view presented in this paper regarding the importance of attracting and diversifying investments during wartime has been confirmed in previously conducted studies, which is important for understanding the development prospects of the country's

agricultural sector during martial law and after its cancellation. Based on the cited sources, the economic potential of a specific segment of the economy can minimise development risks, thereby facilitating the attraction and diversification of investments.

Pursuant to M. Sachdeva & R. Lehal (2022), the development of financial literacy and effective investment decision-making is influenced, in particular, by the corporate image. This conclusion was drawn based on a survey of 402 respondents from Northern India who were identified as individual investors. A correlation was noted between the research of M. Sachdeva & R. Lehal and this paper, which paid attention to the analysis of the formation of a positive image of selected agricultural enterprises under conditions of wartime uncertainty. A correspondence was also observed between this paper and previous studies by N.T.P. Dung *et al.* (2024) and J. Ronen *et al.* (2023), which emphasised the relationship between company policy, the reputation formed as a result of this policy, and the willingness of investors to cooperate further. An example of this correlation is the case of "Astarta-Kyiv" – a company that, under wartime uncertainty, not only maintained and increased production volumes but also continued its strategies for sustainable development and environmental protection.

J.A.K. Aburasul *et al.* (2024), in the study, confirmed that investment decision-making is determined by a prior analysis of a combination of internal and external factors. The cited researchers identified groups of factors such as currency, inflationary and political risks, as well as liquidity risk. The classification of investment risks proposed by J.A.K. Aburasul *et al.* confirms the relevance of the analysis conducted in this paper, particularly through the use of the PESTEL tool. Understanding investment risks enables the development of effective strategies to mitigate these risks, including through diversification. The validity of this assertion was confirmed in the study by S. Mirkovic & L. Mirkovic (2024), where investment strategies were considered in the context of an inverted U-shaped model. According to this model, diversification is one of the effective tools for resource management and maintaining a company's sustainable

development. Thus, the recommendation presented in this paper regarding the diversification of agricultural production as a means of preserving investment attractiveness has been confirmed in previously conducted studies.

The recommendation presented in this paper on the implementation of innovations as a guarantee of effective financial management also received academic support. Evidence of this was found, in particular, in the work of M.R. Hossain *et al.* (2024), who studied the impact of innovations on the transition to alternative energy sources in the context of 15 countries with varying levels of economic development. According to the cited experts, investments in alternative energy sources generate long-term financial benefits for companies focused on sustainable development. The case of "Astarta-Kyiv" presented in this paper proves that investment in environmentally friendly enterprises as a financial growth strategy remains relevant even in times of wartime uncertainty. The importance of innovation as a financial strategy was also demonstrated by I. Bohdaniuk (2024) and Y. Dai *et al.* (2024), who explored the relationship between economic uncertainty, innovation development, and the investment attractiveness of companies. The two-way relationship outlined by the experts suggests that, in conditions of economic uncertainty, there is a decline in investments in the innovative development of enterprises. Such investments can serve as a safeguard against significant declines in financial indicators in times of uncertainty. An illustration of this idea is the case of Agricultural LLC "Ratnivsky Agrarian" proposed in this paper – a company that continues to invest in environmentally friendly agricultural management methods, including fertiliser certification, despite wartime uncertainty and the economic crisis. The idea of sustainable innovative development amid crisis also found confirmation in the study by R. Finger (2023) and C. Yang *et al.* (2024), who analysed the impact of the digital economy, as one of the key innovations, on the development prospects of the agro-industrial complex. According to the cited experts, innovations not only help maintain companies' financial indicators during economic downturns but can also become a tool for recovery in the

post-crisis period. Based on previously conducted studies, the recommendation presented in this paper regarding innovative development as a tool of financial resilience is well-founded.

In addition to the above, a correlation was also noted between the recommendation in this paper regarding strengthening state support for the agricultural sector under uncertainty and the data from previously conducted studies. According to S.M.W. Murad (2024), based on data from 142 countries collected between 1993 and 2022, there is a statistically significant correlation between the national level of uncertainty and the quality of governance. The data presented by S.M.W. Murad indicate that an increase in national uncertainty by even 1 point reduces governance quality by 6-28%, depending on the aspect. The cited relationship implies that effective governance reduces the level of uncertainty while increasing the investment attractiveness of the national economy. In the context of this paper, the cited study supports the recommendation to review and expand the state loan programme at 5%-7% or 9%. Government initiatives to support the agricultural sector during wartime uncertainty can be considered a prerequisite for the revival of the national economy in the post-war period. The validity of the recommendation presented in this paper was also demonstrated by K.M. Gomado (2023), who studied the economic indicators of 61 developing countries and argued that state support, including for pro-market institutions, can reduce economic uncertainty by 93%, contributing to GDP growth.

Based on the cited studies, the topic of this paper is relevant, as it addresses pressing economic challenges in the context of ongoing military conflict. The recommendations provided are grounded in both theoretical analysis and practical experience, making them applicable to real-world conditions. Ukraine's agricultural sector, despite the wartime uncertainty and instability, continues to demonstrate significant potential for sustainable growth and resilience. This underlines the importance of strategic planning and adaptive financial management. The key task, therefore, is to ensure the continuation and enhancement of this development by introducing and implementing effective, flexible, and forward-looking financial strategies.

## CONCLUSIONS

The study of financial strategies of Ukrainian agricultural enterprises under conditions of wartime uncertainty has shown that this sector plays a key role in supporting the national economy, despite the challenges posed by the full-scale war. Ukraine's agricultural sector has demonstrated potential for sustainable development and the ability to recover quickly, despite existing risks and challenges. The analysis revealed that the effective functioning of the agricultural segment depends on the adaptation of financial strategies to crisis conditions, including cost optimisation, diversification of financial sources, currency risk management, and the implementation of innovations.

A contextual analysis of the economic environment made it possible to identify the main factors affecting the activities of agricultural enterprises. Among the negative factors were the reduction of sown areas, migration of the labour force, logistical problems, and infrastructural destruction. In addition to these risks, enterprises in the segment also face environmental challenges, particularly droughts, which force enterprises to reduce sown areas and the number of storage facilities, as well as to cut some staff members. At the same time, adaptive measures have had a positive impact, including the introduction of digital technologies, modernisation of production processes, and support from international financial institutions. Certain enterprises, such as "Astarta-Kyiv", continue to implement environmentally friendly production policies, which are becoming one of the sources of resilience under wartime uncertainty.

The analysis of the cases of agrohholdings "Astarta-Kyiv", "Prometey", and the enterprise "Ratnivsky Agrarian" demonstrated different approaches to ensuring sustainable development. The implementation of digitalisation strategies, use of alternative energy sources, logistics optimisation, and active business diversification

enabled these enterprises not only to maintain the operations but also to ensure stable growth. Based on the results obtained, recommendations have been developed to enhance the financial resilience of the agricultural sector. The key recommendation is the diversification of funding sources, i.e. attracting international grants, credit programmes, and investment mechanisms. In addition to financial diversification, product and market diversification is relevant, which involves reorientation towards domestic consumers and the search for new export logistics routes. Cost optimisation through the introduction of energy-saving technologies and automation of production processes is also essential. The recommendation on risk management includes the use of insurance mechanisms and hedging of currency risks. The paper also proposed the development of digital technologies through the introduction of innovative financial instruments, in particular blockchain technologies, smart contracts, and digital business management platforms.

One of the limitations of the study is the insufficient amount of empirical data regarding the long-term impact of the war on agricultural enterprises, which may affect the accuracy of forecasts. Prospects for further research include expanding the analysis to other sectors of the economy, evaluating the effectiveness of state support programmes for agribusiness, and conducting a detailed study of the impact of digital technologies on enterprise resilience in times of crisis.

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## **Фінансові стратегії підприємства в умовах воєнної невизначеності**

**Анотація.** Метою представленої роботи було вивчити фінансові стратегії аграрних підприємств України в умовах воєнної невизначеності та запропонувати рекомендації для покращення їхньої ефективності. Для досягнення мети були використані кількісні методи контекстуального та контент-дослідження. Контекстуальний аналіз був проведений із використанням інструментів PESTEL-аналізу та концептуальної моделі Майкла Портера. Під час дослідження були також проаналізовані кейси трьох агропідприємств України, які змогли адаптуватися до викликів воєнного часу – «Астарта-Київ», «Прометей» та СТОВ «Ратнівський аграрій» шляхом диверсифікації виробництва та інвестиційного пакету, орієнтації на сталий розвиток, інвестування в інновації та оптимізації ресурсів. В ході дослідження було виявлено, що основними перешкодами до сталого економічного розвитку національного сектору є скорочення посівних площ, брак робочої сили, руйнування інфраструктури та логістичні проблеми. Порівняльний аналіз кейсів дозволив зробити висновок, що до позитивних факторів адаптації національного аграрного сегменту до умов невизначеності належать цифровізація управління, модернізація управлінських процесів та підтримка міжнародних фінансових установ. Порівняльний аналіз адаптації окремих аграрних підприємств до умов невизначеності дозволив виділити групи стратегій на підвищення ефективності фінансових стратегій: оптимізацію логістики, розширення земельного банку, залучення кредитних коштів, відшкодування податку на додану вартість та оптимізацію діяльності через погодні та інші умови. Був зроблений висновок, що національні аграрні підприємства демонструють потенціал до швидкого відновлення та сталого розвитку, що є запорукою їхньої інвестиційної привабливості в умовах воєнної невизначеності. Практична цінність полягає в тому що результати роботи можуть бути використані для підвищення фінансової ефективності аграрних підприємств в умовах воєнного часу та їхнього швидкого відновлення у повоєнний період

**Ключові слова:** управління фінансами; сталий розвиток; управління ризиками; ліквідність; інвестиції



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## **International Financial Reporting Standards in the national practice of accounting for revaluation and impairment of fixed assets**

**Abstract.** This study aimed to examine the impact of adopting International Financial Reporting Standards on the accounting practices related to fixed assets in Ukraine, particularly concerning their revaluation and impairment. The research focused on the application of International Financial Reporting Standards in Ukraine's agricultural sector during the period 2022-2024. It analysed the implementation of International Accounting Standard 16, Property, Plant, and Equipment, and IAS 36, Impairment of Assets, as well as the influence of economic instability on the financial performance of enterprises. The findings indicate that the adoption of International Financial Reporting Standards has enhanced the transparency of financial reporting and improved the accuracy of fixed asset valuation, thereby strengthening trust in companies' financial

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statements. However, the implementation of International Financial Reporting Standards has been accompanied by several challenges, largely due to economic instability, high inflation, and fluctuations in the fixed asset market. Taking into account data from 2023 to 2024, the average value of agricultural land in Ukraine in 2024 was 46,678 UAH per hectare, representing a 21% increase compared to the previous year. The study found that in 2024, the prices of agricultural machinery, particularly tractors, rose by 6.8% 7%; however, sales of combine harvesters and sprayers declined by 25%-30% due to economic uncertainty. Impairment of assets, especially machinery, remains a significant factor affecting the valuation of fixed assets. The adoption of International Financial Reporting Standards has enabled the timely reduction of the carrying amount of such assets, thereby enhancing the predictive value of financial information for users of financial statements. The practical significance of this study lies in developing recommendations for improving fixed asset accounting in Ukraine's agricultural sector through the application of International Financial Reporting Standards. This approach will help increase the transparency of financial reporting and strengthen the financial stability of enterprises amid ongoing economic uncertainty

**Keywords:** non-current assets; utility of assets; impairment; fair value; national standards; international accounting standards

## INTRODUCTION

In the context of globalisation and the integration of the Ukrainian economy into international financial systems, the implementation of International Financial Reporting Standards (IFRS) has become particularly significant in ensuring compliance with requirements commonly accepted in most countries. The revaluation of fixed assets and the impairment of assets serve as essential tools for adjusting asset values in accounting, exerting a substantial impact on companies' financial performance and their competitiveness in both domestic and international markets.

The introduction of IFRS in Ukraine is crucial for the development of accounting and financial reporting, particularly within the agricultural sector. N. Tsitska *et al.* (2024) highlighted that it has improved management efficiency and helped attract investment – factors of particular importance in the context of European integration. The authors noted, however, that despite its advantages, adapting IFRS to national conditions has presented several challenges. These have included technical difficulties, a shortage of qualified accounting professionals, and insufficient financial capacity within enterprises. To enable effective adaptation of IFRS at the enterprise level and to address the training and resource-related challenges associated with its implementation, further research is required. Incorrect recognition and valuation of

fixed assets have remained among the key issues in accounting practice, adversely affecting the reliability of companies' financial reporting. M.M. Kruhla (2024) examined the similarities and differences between national and international standards for accounting fixed assets. The author noted the use of comparable terminology, particularly concerning depreciation and useful life, but also highlighted differences in asset classification and valuation approaches.

The recognition and classification of fixed assets in financial statements are critical to the accuracy of information provided to users. N.D. Rizky & W.A. Sutrisna (2023) found that the implementation of IFRS had no significant impact on fixed asset disclosures in financial statements during the period 2019-2022. These findings contradict other studies that suggest an improvement in disclosure levels following the adoption of IFRS. In Ukraine, the application of IFRS in fixed asset accounting has faced difficulties due to inconsistencies between national and international standards. L. Sas *et al.* (2023) explored the process of aligning Ukraine's financial reporting with international standards, noting that this has contributed to enhanced transparency and trust in financial statements. The authors identified key challenges, particularly differences in asset classification and depreciation methods between national and international frameworks. They concluded that

the implementation of IFRS could significantly improve the quality of financial disclosures.

The implementation of international accounting and auditing standards in Ukraine during wartime has been vital for ensuring business transparency and financial stability. I. Nykyforak *et al.* (2024) examined the specific features of applying international accounting and auditing standards under martial law, emphasising their importance in strengthening investor confidence and supporting economic stabilisation. The authors noted that introducing international standards required a comprehensive approach involving organisational, financial, and control measures. However, significant challenges have emerged in this process, including infrastructure destruction – the loss of offices, archives, accounting databases, or servers has made the implementation of new standards or updates to existing ones technically difficult; staff shortages – the adoption of IFRS demands highly qualified accountants, auditors, and financial specialists, whose availability has been severely reduced due to evacuation, mobilisation, relocation abroad, and other factors; financial constraints – staff training, consultancy services, and software upgrades represent only a portion of the expenses associated with transitioning to IFRS, while Ukrainian enterprises must prioritise recovery efforts and the fulfilment of basic operational needs. In summary, Ukraine faces considerable difficulties in applying international accounting standards, primarily due to the need to adapt them to the country's current national circumstances.

I. Hetmanchenko (2024) analysed the impact of implementing international accounting standards on the financial stability of enterprises in Ukraine. The author noted that compliance with the adopted standards improved the transparency of financial reporting and reduced risks for investors. At the same time, she also confirmed the presence of the previously mentioned challenges in the process of integrating IFRS into the accounting system, highlighting the existence of serious difficulties. The author further emphasised the substantial resources required for adaptation, the shortage of qualified personnel, and the high costs associated with training. The article by R. Sydorenko &

I. Zhurakovska (2022) explored the implementation of IFRS in national accounting practice using the example of grant accounting. The authors stressed the importance of adapting international standards to the realities of the domestic economy. The experience of grant reporting following IFRS illustrates the general difficulties of adopting new approaches, such as asset revaluation and the recognition of impairment losses. The study highlights the need for robust methodological support and the continuous professional development of accounting personnel.

It is noteworthy that in Ukraine's public sector, the implementation of international standards is accompanied by challenges related to the need to harmonise national and international regulations. O. Hryhoriv *et al.* (2024) examined how the adoption of IFRS enhanced the transparency of financial reporting and improved the efficiency of public fund utilisation. The authors stressed the importance and necessity of unifying accounting approaches and standardising reporting practices. The topic of fixed asset accounting under national and international standards was addressed in the study by T.N. Ivanova (2023). Her research identified key differences between national and international standards concerning the definition of fixed assets, methods of valuation, depreciation, and revaluation. The researcher pointed to the need for clearer requirements to achieve greater alignment between national and international practices in the accounting of fixed assets.

The main conclusions of the research emphasise the necessity to refine accounting policies to reflect more accurately the market value of fixed assets, to assess the extent to which national conditions align with international standards, and to explore the impact of economic instability and war on the adaptation of IFRS – particularly in the context of staffing and infrastructure-related issues, which require further investigation. This study aimed to determine how the implementation of International Financial Reporting Standards has affected the practice of accounting for fixed assets in Ukraine, particularly with regard to their revaluation and impairment. The objectives were to analyse the key aspects of IFRS application in fixed asset accounting in Ukraine and to assess the main

challenges arising during the adaptation of international standards in national fixed assets accounting practice.

## MATERIALS AND METHODS

The study covered the period from 2022 to 2024 and focused on examining the specifics of IFRS application in Ukraine's agricultural sector. In particular, it investigated the impact of these standards on the revaluation and impairment of fixed assets – issues that are critical for agricultural enterprises, where machinery and infrastructure represent core assets. As the accurate representation of such assets in accounting reports is essential for ensuring the financial stability of these enterprises, the research explored how agricultural businesses are adapting to IFRS requirements concerning the periodic revaluation and depreciation of their fixed assets.

A key stage of the research involved a detailed review of the International Accounting Standard (IAS) 16 (n.d.) and the International Accounting Standard (IAS) 36 (n.d.), which govern the valuation of fixed assets and the procedures for determining the need for revaluation or adjustment of depreciation charges in light of changes in asset utility. In addition, the study considered the average value of agricultural land in Ukraine for 2023-2024 (Agronews, 2024). This indicator was significant for assessing the financial resilience of agricultural enterprises, as land represents a fundamental production asset and plays a vital role in attracting investment.

The costs associated with IFRS implementation for medium and large enterprises were also examined (Accounting Services Kyiv..., n.d.). These included expenses related to accounting services and the adaptation of financial reporting in line with IFRS requirements, which often represent a significant portion of the budget for enterprises transitioning to international standards. The study also considered the costs of training accountants, essential for the effective adoption of IFRS, including certification courses and specialised training programmes (Accounting and Taxation..., 2024). Particular attention was given to analysing investment in the modernisation of Ukraine's agricultural sector during 2022-2024, notably through international support programmes such as the United States

Agency for International Development (USAID) initiative (USAID Expands Agricultural Sustainability..., 2024). Data on these investments enabled the assessment of funding levels that contributed to the development of the agricultural sector and the enhancement of its competitiveness amid Ukraine's volatile economic conditions.

In addition, inflation data for Ukraine covering 2022-2024 were collected, forming an important element in evaluating the economic impact on the agricultural sector and the implementation of IFRS under conditions of high economic volatility. The data, sourced from official reports by the National Bank of Ukraine for 2022-2024 (National Bank of Ukraine, 2023; 2024; Summary table of..., n.d.), enabled a precise assessment of the impact of inflationary trends on the financial performance of agricultural enterprises.

## RESULTS

Property, plant and equipment represent a significant component of a company's assets, playing a key role in supporting the efficient operation of production and business processes. Within the framework of the IFRS, the accounting for such assets is governed by IAS 16 (n.d.). This standard sets out the rules for the recognition, measurement, depreciation, and derecognition of property, plant and equipment, thereby ensuring an objective and transparent representation of asset value in financial statements. One of the core principles of IAS 16 is that an item is recognised as property, plant or equipment if it is intended for use in the production or supply of goods or services, for rental to others, or administrative purposes, and is expected to be used for more than one year. Under this principle, property, plant and equipment are not held for resale but are assets used by an enterprise to achieve its production and commercial objectives. Another key IFRS principle concerns the valuation of property, plant and equipment at initial recognition. International standards permit the measurement of these assets at cost, which includes the purchase price, transportation and installation costs, as well as other expenses directly attributable to bringing the asset to the location and condition necessary for its intended use. This means that all costs directly related to

the acquisition and commissioning of the asset should be included in its initial carrying amount.

One of the key features of accounting for property, plant and equipment under IFRS is the possibility of applying one of two models for valuation after initial recognition: the cost model and the revaluation model. The choice of model depends on the entity's accounting policy and is not contingent upon the existence of an active market in which the fair value of an asset can be determined. The fair value may be established using either the income or cost approach if market-based data are unavailable. Under the cost model, assets are carried at their original cost less accumulated depreciation and any impairment losses. The revaluation model, on the other hand, requires entities to periodically revalue their assets and reflect their fair value in the financial statements. If the revaluation model is selected, the company must ensure that asset values are kept reasonably in line with their fair value and that revaluations are conducted regularly enough to prevent material discrepancies. Another essential principle concerns the depreciation of property, plant and equipment. IFRS stipulates that such assets must be depreciated over their useful lives. Depreciation should be applied on a systematic basis over this period unless another method more accurately reflects the pattern in which the asset's economic benefits are consumed. The useful life of assets must be reviewed annually, and any changes in the estimated life or residual value of the asset should be reflected in the accounting records (Umantsiv *et al.*, 2023).

In addition, IFRS requires the recognition of impairment losses on property, plant and equipment. If there are indicators that an item of asset (or the cash-generating unit to which it belongs) may be impaired, the entity is obliged to conduct an impairment test on that asset (or cash-generating unit). Should the asset's carrying amount exceed its recoverable amount, the entity must reduce its carrying amount. This ensures that assets are reported in the accounts at a value that does not exceed their recoverable amount. Overall, the IFRS principles relating to property, plant and equipment promote transparency, accuracy, and consistency in financial reporting. This is particularly important for businesses operating in international markets,

where maintaining a high level of trust in financial statements is essential (IAS 36, n.d.).

The agricultural sector represents one of the most important components of Ukraine's economy, contributing significantly to gross domestic product and playing a key role in the country's export activities. In this sector, fixed assets – such as land, agricultural machinery, buildings and other infrastructure – are critical to production processes. The application of IFRS to accounting for fixed assets in agriculture has several specific features, particularly in the areas of revaluation and impairment of assets, which require detailed consideration. One of the key aspects of applying IFRS in the agricultural sector is the revaluation of property, plant and equipment. Under IFRS, enterprises may opt for the revaluation model to reflect the value of their fixed assets, which allows the carrying amount to be updated in line with market conditions. In agriculture, revaluation is particularly important, as many assets – such as land, buildings, and machinery – are subject to value fluctuations driven by external factors: changes in agricultural commodity markets, price volatility for equipment, and shifts in land and credit relations. Revaluation enables these factors to be considered, ensuring a more accurate representation of asset value in financial statements. This, in turn, is essential for assessing a company's financial stability and attracting investment.

In 2024, the average value of agricultural land in Ukraine reached 46,678 UAH per hectare, representing a 21% increase compared to 2023. Land prices vary significantly across regions: in Ivano-Frankivsk Region, prices range from 89,744 UAH to 105,703 UAH per hectare; in Lviv Region, from 71,390 UAH to 74,561 UAH per hectare; and in Poltava Region, approximately 66,232 UAH to 69,170 UAH per hectare. In contrast, prices in the Zaporizhzhia Region are considerably lower at 27,944 UAH per hectare, due to the impact of military actions and reduced demand. According to available data, in the first quarter of 2024, the average price of agricultural land in Ukraine was 45,230 UAH per hectare, with the highest value recorded in October at 52,420 UAH per hectare (Agronews, 2024). This indicates significant market volatility, underscoring the need to revalue land assets in the

agricultural sector to maintain the accuracy of financial reporting.

Impairment of fixed assets is another key aspect of accounting under IFRS. In accordance with IAS 36 (n.d.), entities are required to assess whether there is any indication that an asset may be impaired – namely, that its recoverable amount has fallen below its carrying amount. This is particularly relevant in agriculture for machinery, buildings, and facilities affected by changing agronomic conditions or natural resource depletion. For example, in the first quarter of 2024, sales of agricultural tractors increased by 6.8%-7%, with over 450 units sold in the large-brand segment. However, sales of combine harvesters and sprayers declined by 25%-30%, reflecting cyclical demand and economic uncertainty. Additionally, imported tractors, priced between 30,000 USD and 100,000 USD, remain inaccessible for smaller farms, potentially reducing the efficiency of equipment utilisation (Artim, 2024)

Impairment of assets, particularly agricultural machinery, may result from various factors, including changes in market conditions, equipment ageing, declining land productivity, or other external influences such as shifts in government policy. This often leads to increased production costs, driven by frequent equipment repairs and inefficient resource use. To optimise the accounting of revaluation and impairment of assets in agricultural enterprises – drawing on international experience – it is essential to develop innovative technologies and implement precision farming. These practices can reduce fertiliser costs by 20%-25% and enhance overall agricultural productivity (Problems and prospects..., 2024). In summary, the revaluation and impairment of fixed assets in the agricultural sector are key aspects of the IFRS application. They present specific challenges due to the influence of external factors and the characteristics of the market. Careful implementation of these standards improves the transparency of financial reporting, which is crucial for maintaining the stability and development of agricultural enterprises amid fluctuating market conditions and economic uncertainty.

The adaptation of IFRS in Ukraine is a complex, multi-stage process that requires

substantial financial, human, and technical resources. Key aspects include the costs of implementing the standards, staff training, the need for technical upgrades, and the engagement of consultancy services. This is particularly relevant to the agricultural sector, where investments in modernising infrastructure and equipment are critical for improving financial reporting and attracting investment. The costs of IFRS implementation for medium and large enterprises consist of several components. One of the most significant is conducting audits and adapting financial statements. The fees charged by audit firms vary depending on the size of the enterprise, starting from approximately 53,000 UAH for medium-sized companies, with higher costs for larger enterprises (Accounting services Kyiv..., n.d.). This includes a thorough analysis of existing financial reports to ensure compliance with IFRS requirements, which often entails considerable expenditure on auditing and revising the company's accounting policies. Staff training is another essential component of IFRS adaptation. For accountants and financial managers in Ukraine, training costs range from 14,000 UAH to 89,900 UAH, depending on the training format and level of certification (Accounting and taxation..., 2024). In particular, for enterprises with a large workforce, training costs can be substantial, as a significant number of employees require specialised instruction to meet the demands of international standards. Another major expense is the implementation of software compatible with IFRS requirements. Software products such as M.E.Doc (n.d.), SOTA (Sota, n.d.) and FREDO (n.d.), which are adapted for IFRS-compliant operations, may cost between 5,000 USD and 20,000 USD, depending on their functionality and the number of licences required (Savytska & Mordyuk, 2024). These systems are essential for automating financial reporting, significantly improving both the efficiency and accuracy of accounting processes.

In Ukraine's public sector, several key programmes are in place to support agricultural enterprises in implementing IFRS, thereby reducing the financial burden on businesses. The most notable include the agricultural equipment cost reimbursement programme, the AGRI-Ukraine

initiative, and the Affordable Loans 5-7-9% programme. In 2024, a total of 900.2 million UAH was allocated to reimburse 25% of the cost of agricultural machinery purchased by enterprises (December 5<sup>th</sup> is the deadline..., 2024). This funding enabled 3,419 agricultural enterprises to acquire 5,311 units of equipment, contributing to the significant modernisation of the agricultural sector and improvements in financial reporting (Dyachkina, 2024)

Investments in the modernisation of Ukraine's agricultural sector between 2022 and 2024 have also played a key role in this process. During this period, investments focused on supporting production, logistics, and technological upgrades, particularly through the AGRI-Ukraine initiative (USAID), which attracted over 2.26 billion USD since July 2022, of which 1.75 billion USD was invested in 2024. Key areas of investment included the provision of seeds, fertilisers, and plant protection products, as well as support for farmers and grain storage. According to the programme, assistance was provided to 15,000 farms – representing 34% of all registered farms in Ukraine – and 5.5 million tonnes of grain were preserved, generating approximately 1 billion USD in revenue for the economy (USAID expands agricultural sustainability..., 2024). In addition, the Ukrainian government allocated 4.9 billion UAH in 2024 to support the agricultural sector, including subsidies per hectare, livestock support, and demining operations (Kyivstar Business Hub, 2024). For 2025, more than 6 billion UAH in further modernisation funding is planned, with 1 billion UAH earmarked for livestock farming and agro-processing support. The Affordable Loans 5-7-9% programme (Privatbank, n.d.) offers financing for the purchase of machinery and equipment, particularly for farmers acquiring Ukrainian-made equipment with more than 60% local content (Conditions for increasing..., 2024). In total, between 2022 and 2024, investments in the modernisation of Ukraine's agricultural sector exceeded 2.5 billion UAH, comprising government, international, and private funding sources.

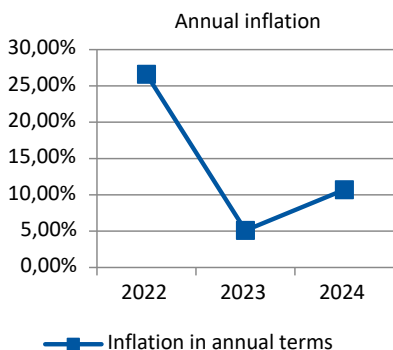
The increasing number of enterprises reporting under IFRS indicates gradual and consistent progress towards greater transparency and efficiency in financial reporting in Ukraine.

This is a positive signal for both businesses and international partners, as it enhances confidence in the reliability of financial information and improves the country's investment appeal. However, to achieve more substantial results, further efforts are needed to improve infrastructure, enhance staff qualifications, and ensure access to appropriate technological solutions. These measures will support the sustainable development of the agricultural sector and Ukraine's integration into the global economy.

The process of IFRS adoption in Ukraine – particularly within the agricultural sector – is accompanied by considerable challenges, driven by economic instability, inflation, and changes in legislation. One of the main influencing factors is market volatility, especially price fluctuations in agricultural products, which require constant adjustment of asset values – such as land and equipment – based on fair value in accordance with IFRS. As the Ukrainian agri-food market undergoes significant shifts, the effects of economic instability, and particularly the war, frequently alter the value of fixed assets, complicating their accounting under international standards (Hutsalenko & Mulyk, 2024).

Inflation, which in Ukraine reached 26.6% in 2022 (National Bank of Ukraine, 2023) and decreased to 5.1% in 2023 (National Bank of Ukraine, 2024), has had a significant impact on the implementation of IFRS. The high inflation rate in 2022 led to a substantial increase in production costs, particularly for raw materials, machinery, and fertilisers, which in turn affected the financial performance of enterprises. Under such inflationary conditions, businesses are required to adjust the value of their assets and liabilities in line with the current economic environment. In 2023, although inflation fell to 5.1%, enterprises still had to revalue their assets – especially fixed assets – making this an especially challenging task amid ongoing economic fluctuations. In 2024, inflation rose again to 11.7%, once more creating additional difficulties for enterprises in the revaluation of assets and the adjustment of financial outcomes (Summary Table of..., n.d.). The high inflation rate in 2024 requires constant monitoring of asset values, particularly for agricultural enterprises, as it directly affects the accounting and

reevaluation of fixed assets in accordance with IFRS requirements. Under IFRS, businesses must periodically revalue their assets, including fixed assets, based on market prices – a process made significantly more complex in an inflationary environment. Inflation also affects the ability of enterprises to meet their obligations on time, which may impact their solvency and, consequently, reduce the attractiveness of their financial reporting for investors. The annual inflation trend for 2022-2024 is presented in Figure 1.



**Figure 1.** Annual inflation in Ukraine, 2022-2024

**Source:** compiled by the authors based on National Bank of Ukraine (2023; 2024), Summary table of... (n.d.)

Changes in legislation have also significantly complicated the implementation of IFRS in Ukraine. Legislative amendments concerning the accounting of assets and liabilities, reporting requirements, and tax-related issues create additional challenges for agricultural enterprises. Moreover, the constant changes in tax legislation – particularly in the area of value-added tax – require continuous adjustments to accounting policies in order to comply with updated regulations. This can considerably affect financial statements and complicate their audit under international standards.

According to the machinery cost compensation programme, 900.2 million UAH was allocated in Ukraine for 2024 to subsidise 25% of the cost of agricultural machinery purchased by enterprises. This enabled 3,419 agricultural enterprises to acquire 5,311 units of machinery, contributing significantly to the modernisation of the agricultural sector and improving financial reporting (Ministry of Economy of Ukraine, 2024). To visually compare levels of government support for the agricultural sector across different years, Table 1 presents relevant data illustrating changes in state allocations and compensations for machinery, business grants, and other support programmes.

**Table 1.** Comparison of government support for Ukraine's agricultural sector, 2022-2024

Category	2022	2023	2024
Subsidy per hectare	3,100 UAH	3,100 UAH	4,000 UAH
Machinery compensation	25% (budget unspecified)	25% (partial payments)	1 billion UAH
Business grants	500 million UAH	997 million UAH	1.37 billion UAH

**Source:** developed by the authors based on State support for farmers in 2024... (2024), Ministry of Agrarian Policy and Food of Ukraine (2024)

An analysis of the data presented in Table 1 reveals several notable changes in the level of financial support provided to agricultural enterprises. In both 2022 and 2023, the subsidy per hectare remained at 3,100 UAH, indicating a stable level of funding in this category. However, in 2024, the subsidy increased to 4,000 UAH – an additional 900 UAH per hectare compared to the previous period. This increase is significant for agricultural producers, as it helps partially offset the rising costs of agricultural activities amid economic instability. Regarding machinery compensation, the support programme covered

25% of machinery costs in both 2022 and 2023. However, in 2022, the specific budget allocation for this category was not indicated, and in 2023, the payments were only partial. In contrast, the programme was considerably expanded in 2024, with a dedicated budget of 1 billion UAH. This expansion enables a greater number of agricultural enterprises to benefit from the scheme, thereby contributing to the modernisation of their technical infrastructure. Such support has a positive impact on reducing financial risks and ensures a higher level of development within the sector. In terms of business grants, there has been

a steady increase in funding for this category: 500 million UAH was allocated in 2022, 997 million UAH in 2023, and 1.37 billion UAH in 2024. The growth in grant funding enables agricultural enterprises to access additional resources for investment in new technologies, the expansion of production capacity, and infrastructure development. This contributes to enhancing the competitiveness of Ukrainian enterprises in the international market. Thus, a comparison of government support for the agricultural sector between 2022 and 2024 shows a substantial increase in both funding and assistance. This has a direct impact on the modernisation of agricultural enterprises, improving their financial resilience and competitiveness, and supporting the sustainable development of the sector in the face of ongoing economic challenges.

Overall, economic instability in Ukraine – particularly high inflation, legislative changes, and insufficient funding – significantly complicates the implementation of IFRS in the agricultural sector. However, government support, investment, and compensation programmes help enterprises adapt to new requirements, which in the long term will contribute to greater financial transparency and attract further investment in agriculture. At the same time, successful implementation of this process requires effective state support, the training of qualified personnel, and the introduction of modern information technologies. These measures will facilitate the sustainable development of the agricultural sector and Ukraine's integration into the global economy. The prospects and means of improving the accounting of fixed assets in the agricultural sector under the application of IFRS are crucial for ensuring transparency, stability, and effective management of enterprises' financial assets. The agricultural sector, which operates under numerous economic challenges – such as inflation, legislative changes, market volatility, and natural disasters – requires the adaptation of international standards to the specificities of fixed asset accounting, particularly in the context of ongoing economic fluctuations.

One of the key aspects of enhancing fixed asset accounting is the implementation of a system for the periodic revaluation of assets. In conditions of economic instability, high inflation,

and fluctuations in the market for land and agricultural machinery, it is essential to provide a more accurate reflection of the market value of assets. According to international financial reporting standards, fixed assets should be measured either at fair value or at historical cost with depreciation. Regular revaluation allows for the adjustment of asset values in line with current economic conditions, thereby enabling a more accurate representation of their real worth on the balance sheets of enterprises. In Ukraine, where economic conditions are frequently changing, the introduction of such a system would help to reduce the risk of accounting discrepancies with actual market conditions.

For the effective implementation of IFRS in the agricultural sector, it is also essential to develop a clear methodology for assessing the value of agricultural machinery and equipment. Machinery constitutes one of the key components of fixed asset accounting in agriculture, and its value depends on various factors, including the level of wear and tear, technological advancement, and duration of use. The specific conditions under which machinery is operated in the agricultural sector require consideration of characteristics such as usage intensity and environmental conditions, both of which significantly affect its value and service life. Therefore, the development of new approaches to equipment valuation and the determination of residual value is a necessary step in adapting IFRS to national circumstances.

An important related aspect is the improvement of methods for the recognition and depreciation of assets. According to IFRS, the useful life of each category of fixed asset must be determined, which is crucial for accurate depreciation calculations. This issue is particularly relevant in agriculture, as most fixed assets – especially machinery and buildings – require a specialised approach to depreciation. For agricultural enterprises, it is vital not only to ensure reliable asset valuation but also to establish an appropriate accounting strategy that includes depreciation adjustments in response to changes in asset valuations.

Impairment of assets is another key aspect in the implementation of IFRS in the agricultural sector. Given that agricultural assets are

subject to considerable fluctuations due to natural conditions – such as climate change, droughts, or floods – it is essential to ensure a reliable assessment of asset impairment. In the context of market instability and frequent natural disasters, accounting for impairment becomes particularly important for the accurate presentation of financial information related to assets. Recognising asset impairment also allows for the identification and analysis of factors that reduce the utility of fixed assets, thereby enhancing risk management procedures within an enterprise. Adapting international standards to these conditions requires the development of mechanisms for assessing impairment, enabling agricultural enterprises to respond promptly to changes in the economic environment and adjust their financial reporting accordingly. The adaptation of IFRS in the agricultural sector also entails overcoming a number of challenges, particularly with regard to workforce qualifications. The transition to new standards demands skilled professionals capable of ensuring the correct application of IFRS in the accounting of fixed assets. It is therefore crucial to focus on improving the qualifications

of accountants and financial managers working within the sector. Training and retraining should become a priority in order to support the effective implementation of international standards.

Improving the efficiency of fixed asset accounting in the agricultural sector also depends on the application of modern information technologies. The introduction of automated systems for the accounting and revaluation of assets can significantly reduce the time required to prepare financial statements and ensure a more accurate reflection of asset values. Integrating such technologies into the management accounting system is a crucial step towards ensuring the stability and transparency of financial reporting in agricultural enterprises. These recommendations for enhancing national practices in the accounting of fixed assets in accordance with IFRS have been developed with consideration for the specific characteristics of Ukraine’s agricultural sector. They aim to improve the accuracy of financial reporting, ensure compliance with international standards, and support the sustainable development of agricultural enterprises. Table 2 presents strategies for improving fixed asset accounting in the agricultural sector.

**Table 2.** Key strategies and recommendations for improving fixed asset accounting in the agricultural sector

Strategy / Recommendation	Description	Expected outcomes
Implementation of regular asset revaluation	Periodic revaluation of fixed assets in line with market conditions	More accurate reflection of asset values on the balance sheet; error margin reduced to 5%-7%
Development of a clear methodology for equipment valuation	Adoption of new methods for assessing the value of agricultural machinery and equipment	Reduced risk of undervaluation by 10%-15%
Establishment of clear depreciation criteria	Formulation of precise rules for the depreciation of machinery and buildings in the agricultural sector	Improved depreciation accounting accuracy by 20%-25%; adjustment of service life by 15%
Enhancement of impairment accounting	Assessment of asset value reduction due to natural or economic factors	Early detection of asset impairment; reduction of financial losses by 10%12%
Use of information technologies	Introduction of automated accounting systems for faster and more accurate asset revaluation	Reduction in financial reporting time by 30%-50%; error rate decreased by 15%-20%

**Source:** developed by the authors based on M.O. Rodríguez Saavedra (2023)

Considering the challenges faced by Ukraine’s agricultural sector in implementing IFRS, it is essential to emphasise the need to improve the accounting of fixed assets to ensure transparency and objectivity in financial reporting. The introduction of regular asset revaluation

by market conditions would help reduce the risk of inaccurate valuation of machinery and equipment, thereby enhancing the reliability of companies’ financial statements. The use of a clear methodology for valuing equipment and determining depreciation rates will also

contribute to more accurate asset representation on the balance sheet, which is particularly important in agriculture, where machinery plays a critical role in production processes. One of the key priorities is the implementation of modern software solutions for automating accounting processes. This would significantly reduce the time required for preparing financial reports and lower the risk of errors. As a result, agricultural enterprises would be able to manage their assets more efficiently – an important factor in maintaining financial stability in a volatile economic environment.

Overall, the adoption of International Financial Reporting Standards in Ukraine's agricultural sector represents a crucial step towards integrating the national economy into the global market. However, for successful implementation, it is necessary to take into account the sector's specific conditions, including economic instability, inflation, and dependency on external factors such as climate-related risks. The implementation of the proposed recommendations will improve the quality of financial reporting, enable a more accurate reflection of fixed asset values, and reduce the risk of economic losses for agricultural enterprises.

## DISCUSSION

The relevance of implementing IFRS in conditions of economic instability is a crucial aspect of ensuring the transparency and reliability of corporate financial reporting. In the context of globalisation and economic transformation, it is necessary to adapt international standards to national realities to enable the accurate valuation of assets, particularly in the agricultural sector, which represents a significant part of Ukraine's economy. This study, along with the research of G. Thoumi (2020), focused on the impact of economic instability on asset accounting under IFRS. Both studies highlighted the importance of enhancing accounting transparency through the application of international standards. However, G. Thoumi concentrated on the general aspects of IFRS implementation during periods of economic transformation, without a specific focus on the agricultural sector. His research examined the challenges faced by countries undergoing economic crises, whereas the

present study explored the practical challenges of applying IFRS in Ukrainian agriculture – particularly in relation to asset revaluation and impairment in a volatile market environment.

With regard to the work of N.K. Rizaev (2022), both studies addressed the issue of IFRS implementation in the agricultural sector. However, N.K. Rizaev's research focused on the adaptation of IFRS in Uzbekistan, with particular emphasis on government initiatives and the development of national standards. In contrast, the present study analysed the specific challenges facing Ukraine's agricultural sector, including market instability and economic difficulties. While N.K. Rizaev's research concentrated on broader economic transformations, this study provided a more detailed examination of asset revaluation within Ukraine's agricultural economy, highlighting the influence of both external and internal factors on financial reporting.

The study by R.D. Marrufo Garcia & A.M. Cano Morales (2021) also considered the implementation of IFRS but focused on developed economies. Whereas their research addressed general issues concerning the application of IFRS, the present study concentrated on the specific challenges of Ukraine's agricultural sector, particularly in relation to the revaluation of fixed assets and asset impairment amid economic instability. Furthermore, the research by R.D. Marrufo Garcia & A.M. Cano Morales paid greater attention to regulatory aspects, while this study emphasised practical issues, such as human resources and available infrastructure, which are essential for the successful implementation of IFRS in Ukraine.

The studies by M.G. Ferati *et al.* (2021) and L. Marmul *et al.* (2023), and the present research all share a common focus on the application of IFRS in the agricultural sector, albeit with different emphases. While all three studies highlighted the importance of IFRS for ensuring transparency in financial reporting, M.G. Ferati *et al.* placed greater emphasis on the theoretical aspects of accounting for biological assets and agricultural produce. In contrast, the present study focused on practical challenges, such as market instability, inflation, and legislative changes in Ukraine. This research also addressed the role of state support in facilitating IFRS adaptation in

Ukraine – an issue not explored in the articles of M.G. Ferati *et al.* or L. Marmul *et al.* concentrated more on the general principles of IFRS application. Furthermore, M.G. Ferati *et al.* did not consider the specific context of Ukraine, including economic instability and political risks, which have a significant impact on the effectiveness of IFRS implementation.

H. Hussinki *et al.* (2023) focused on the impact of digitalisation and emerging technologies, particularly blockchain, on accounting practices, whereas the present study did not explore these innovations in such depth. Their research examined the relationships between intellectual assets and financial indicators, comparing national accounting standards. Both studies highlighted the importance of adjusting standards to better reflect intangible assets. However, H. Hussinki *et al.* emphasised the broader conceptual implications of these changes, particularly in relation to intellectual capital. In contrast, the present study concentrated on the Ukrainian context and the implementation of IFRS. The key distinction lies in the scope: while H. Hussinki *et al.* addressed global trends, particularly accounting issues in the USA and Europe, this study focused on local specificities in Ukraine.

As previously noted, the relevance of implementing IFRS is increasing in the context of globalised economic processes, as these standards enhance the transparency, comparability, and reliability of financial data – factors that are essential for attracting investment and supporting international trade. Both studies emphasised the importance of IFRS adoption for ensuring transparency and the accurate presentation of financial information. The study by M. Akpan & H. Ukwu (2023) focused more specifically on the accounting of intangible assets such as brands, patents, and other intellectual property. While both studies discussed general challenges – including the need for accurate asset valuation, appropriate accounting policies, and adaptation to unstable conditions – this study provided specific examples from the Ukrainian agricultural sector. In contrast, the research by M. Akpan & H. Ukwu addressed these issues in a broader context, focusing on the theoretical aspects of intangible asset accounting. The main difference was that this study concentrated on the

implementation of IFRS in Ukraine's agricultural sector, where particular economic conditions – such as inflation and instability – pose additional challenges. Meanwhile, the study by M. Akpan & H. Ukwu was more theoretically oriented and lacked a specific focus on either the agricultural sector or a particular country context.

In contrast, the study by J. Lawalata & I. Salle (2024) focused on broader issues related to the application of IFRS in the context of economic and financial challenges affecting enterprises under conditions of market volatility. Their research placed greater emphasis on the use of IFRS by large businesses and corporations, rather than on the specific challenges faced by the agricultural sector, particularly in countries experiencing economic hardship. Overall, both studies highlight the need to adapt IFRS to the conditions of unstable markets and economies. However, the present research places particular emphasis on agriculture, underlining the importance of accurately valuing fixed assets, land, and equipment. In turn, J. Lawalata & I. Salle concentrated more on general principles for implementing IFRS in economically unstable countries, without a specific focus on the agricultural sector or the particularities of agricultural accounting.

This study and the research conducted by M. Hakimova & J. Shaturaev (2024) shared a common focus on the implementation of IFRS under conditions of economic instability. Both emphasised the importance of ensuring transparency in financial reporting through the adoption of IFRS. However, the study by M. Hakimova & J. Shaturaev concentrated more on the general theoretical aspects of applying IFRS in transitional economies, without a specific focus on the agricultural sector. The key distinction lies in the fact that the present study examined the real challenges faced by agricultural enterprises in Ukraine, whereas the research of M. Hakimova & J. Shaturaev considered IFRS implementation in a broader context of economic instability, particularly in countries with transitional economies. While both studies highlight the need to adapt accounting policies and procedures to meet IFRS requirements, the present research provides more practical examples from Ukraine's agricultural sector.

In study O. Georgiou (2024) emphasised the importance of harmonising international accounting standards, particularly IFRS, to ensure transparency in financial reporting amid globalisation. The author's focus was on the political aspects of IFRS implementation, highlighting the challenges of aligning national standards with international ones in the context of differing political interests. O. Georgiou noted that a cautious approach to the valuation of financial assets is essential for maintaining the reliability of financial reporting during periods of economic instability. In contrast to the present study, which concentrated on the specific challenges faced by Ukraine – particularly within the agricultural sector – O. Georgiou's research did not focus on issues related to a specific economic context, such as inflation or instability affecting asset valuation. Another key difference is that O. Georgiou's research was more concerned with the theoretical aspects of IFRS harmonisation, whereas the current study addressed the practical challenges involved in implementing IFRS in the context of a specific country and its agricultural sector.

The study by H.T.T. Nguyen *et al.* (2023) and the present research shared a common focus on the implementation of International Financial Reporting Standards (IFRS) to enhance the transparency of financial reporting. However, the study by H.T.T. Nguyen *et al.* placed greater emphasis on general trends typical of countries with transitional economies, whereas the present research concentrated on the specific challenges faced by Ukraine's agricultural sector. Particular attention was given to issues such as economic instability, inflation, and other external factors affecting asset accounting in Ukraine. While both studies acknowledge the need to adapt IFRS to national contexts, H.T.T. Nguyen *et al.*'s research took a more general approach and did not focus on the specific problems encountered in Ukraine's agricultural sector. In contrast, this research highlighted the role of government support in facilitating IFRS adaptation, including compensation programmes for enterprises – an aspect not covered in the work of Nguyen *et al.*, which focused more on corporate management strategies.

Similarly, the study by A. Epizitone & S.C. Nxumalo (2021) shared a common focus with the

present research on the implementation of IFRS, though with different emphases. Both studies highlight the importance of adapting IFRS to ensure transparency in financial reporting under economic challenges. However, the article of A. Epizitone & S.C. Nxumalo concentrated primarily on the general issues of IFRS adoption in developing countries, without a specific focus on the agricultural sector. Their research was more oriented towards general principles of international standards implementation, whereas the present study provided an in-depth analysis of the specific difficulties facing Ukraine's agricultural sector – particularly issues related to asset revaluation and impairment due to inflation and market instability.

The study by A. Johri (2024) also shared a focus with this research on the significance of IFRS implementation amid economic instability. However, A. Johri's study examined global aspects of how economic and political shifts influence the application of IFRS, while this research concentrated on the specific challenges of Ukraine's agricultural economy. A. Johri approached IFRS from a global perspective, focusing on theoretical aspects and general requirements, whereas the present research addressed the real-world problems encountered by Ukrainian agricultural enterprises, particularly the difficulties of adapting the standards under conditions of war and economic crisis.

The study by T.A. Jasim & M.A. Ibrahim (2023), along with the present research, underscores the importance of implementing IFRS to ensure transparency in financial reporting. However, T.A. Jasim & M.A. Ibrahim focused more on the adaptation of IFRS in developing countries, with particular attention to national specifics, whereas the present study examined the revaluation of fixed assets in Ukraine's agricultural sector, especially under conditions of economic instability. A common feature is the shared objective of enhancing financial reporting transparency through IFRS, which has a positive impact on attracting investment. Nevertheless, T.A. Jasim & M.A. Ibrahim's study addressed general aspects of IFRS adoption, while the present research analysed the specific challenges faced by the Ukrainian agricultural sector due to high inflation and market instability.

This study and the research of M.E. Barth (2022) also share a focus on the need to adapt accounting standards to evolving economic conditions. M.E. Barth concentrated on the accounting of digital assets and the impact of climate change, highlighting the limitations of existing standards in relation to these emerging asset classes. He proposed expanding accounting frameworks to include non-financial information, enabling investors to better assess risks. In contrast, the present study focused on adapting IFRS to the conditions of Ukraine's agricultural sector, taking into account economic challenges such as inflation and market instability. Particular emphasis was placed on issues related to the revaluation of fixed assets and the application of international standards in a constantly changing market – challenges that are specific to Ukraine's agricultural economy.

Similarly, the study by M.S. Avi (2022) and the present research shared a common focus on the adaptation of accounting standards to new economic conditions. Both studies emphasised the importance of implementing IFRS in contexts of economic instability and change. However, M.S. Avi's research concentrated on the theoretical aspects of IFRS application across different countries, whereas the present study focused on the practical challenges involved in implementing these standards in Ukraine, particularly within the agricultural sector. The key difference lies in the fact that M.S. Avi examined IFRS from a global perspective, while this research highlighted the specific issues affecting Ukraine's agricultural sector, such as inflation and market instability, which complicate asset revaluation and impairment processes.

The study by J. Prather-Kinsey *et al.* (2022) and the present research also shared an emphasis on the importance of adapting IFRS to ensure transparency in financial reporting. Both studies stressed the significance of IFRS implementation in times of economic instability. However, the main distinction is that this study concentrated on the specific challenges of adopting IFRS in Ukraine, especially within the agricultural sector, whereas Prather-Kinsey *et al.* addressed broader global issues in IFRS adoption, focusing on general regulatory challenges. Therefore, this study focused on

national-level issues, particularly those affecting Ukraine's agricultural sector, whereas the research of J. Prather-Kinsey *et al.* addressed broader global aspects of international standards adaptation. Both studies highlighted the need to align financial reporting with changing economic conditions and national market contexts, as well as the importance of ensuring the transparency and reliability of financial information to attract investors. A key similarity lies in the examination of the challenges involved in adapting IFRS amid economic instability and market fluctuations. Both studies stressed the importance of accurate asset valuation, particularly for land and machinery – issues especially relevant to Ukraine's agricultural sector. However, the study by T. Polzer *et al.* (2022) covered more general aspects, including the adaptation of IFRS within the public sector and at a global level, while the present research concentrated on the specific challenges facing the agricultural sector in Ukraine, notably the revaluation of fixed assets. T. Polzer *et al.* also drew attention to differences between national systems and the need to adapt standards to ensure comparability across countries.

The relevance of this comparative analysis lies in the need to adapt International Financial Reporting Standards (IFRS) to diverse national contexts, which is particularly important for ensuring the transparency and comparability of financial reporting in an increasingly globalised environment. Both studies focus on the implementation of IFRS, yet each examines the process within a different framework. The present study concentrates on Ukraine's agricultural sector, particularly on issues related to the revaluation and impairment of assets caused by economic instability, whereas the research of S. Chegade & D. Prochazka (2024) explores the impact of IFRS on the Saudi Arabian market, focusing on the value of financial reporting and the stock market. The key distinction is that this study addresses the specific challenges facing Ukraine's agricultural sector, while the study by S. Chegade & D. Prochazka centres on financial markets in a developing country. Both studies highlight the importance of adapting standards to national conditions, albeit within different economic contexts.

This study and the research by B. Hartmann *et al.* (2020) share a common focus on the challenges of implementing IFRS within a national context. Both studies emphasise the difficulties involved in adapting global standards to local conditions. This study concentrates on the application of IFRS in Ukraine, particularly within the agricultural sector, where economic instability necessitates a tailored approach to asset revaluation. In contrast, the study by B. Hartmann *et al.* examined the implementation of IFRS in Sweden, with a focus on the integration of international standards into the national regulatory framework. Both studies highlight the importance of aligning international standards with national specificities to ensure transparency in financial reporting. However, while B. Hartmann *et al.* stressed cultural and regulatory differences in Sweden, and the present study focused on the economic challenges faced in Ukraine.

The study by K. Savova (2021) focused on the application of IFRS to both public and nonpublic companies in Bulgaria, particularly small and medium-sized enterprises, and emphasised the need to improve the integration of national and international standards. In contrast, the present study examined the specific challenges of IFRS implementation in Ukraine, especially within the agricultural sector, where economic instability has necessitated asset revaluation and adjustments to financial reporting. The key difference lies in the fact that K. Savova's research addressed both global and national aspects, whereas the present study concentrated on the practical challenges facing Ukraine, particularly in the agricultural sector.

In light of the aforementioned studies, it is clear that they collectively highlight the importance of adapting IFRS to national contexts, particularly for the agricultural sector. This study also underscored the significance of accurate accounting for fixed assets and impairment, noting that such issues are especially relevant to the agricultural sector due to market fluctuations and economic hardship.

## CONCLUSIONS

The findings of the study highlight the importance of adapting IFRS to the specific conditions

of Ukraine's agricultural sector, particularly in the context of fixed assets revaluation and impairment. As a key component of the national economy, the Ukrainian agricultural sector faces numerous economic challenges, including market instability, inflation, and legislative changes, all of which significantly complicate the implementation of international accounting standards. One of the main barriers is the ongoing need to revalue assets such as land and machinery – an issue that is especially pressing given the high volatility in the market for agricultural products and equipment. For example, in 2022, inflation in Ukraine reached a record 26.6%, directly affecting the value of fixed assets as well as the overall valuation of agricultural holdings. This has made it more difficult to determine their fair value accurately, which is essential for proper accounting and reliable financial reporting.

The study also confirms the importance of government support, particularly compensation programmes for agricultural machinery, which assist farming enterprises in reducing financial risks and modernising their production base. In 2024, over 900 million UAH was allocated for the reimbursement of agricultural machinery costs, enabling the purchase of more than 5,000 units of equipment for agricultural enterprises. However, even such support does not eliminate the core challenges, notably the difficulties in aligning national standards with IFRS. These include issues related to the correct recognition and classification of assets, as well as the application of depreciation methods under conditions of economic instability. One particular problem is the lack of a unified approach to the valuation of machinery and land, along with challenges in determining the useful life of fixed assets in a constantly changing market environment.

A key aspect requiring attention is the need for regular revaluation of fixed assets in line with market changes. This would allow for a more accurate reflection of asset values in financial statements, thereby improving the reliability of financial reporting and enabling enterprises to assess more effectively their financial performance and asset utilisation. To achieve this, it is essential to develop a clear methodology

for valuing agricultural machinery and equipment, taking into account factors such as usage intensity, degree of wear, and fluctuating market conditions. Considering these factors would help reduce the risk of undervaluing machinery on company balance sheets, which in turn would enhance financial indicators and improve access to additional investment.

Overall, the successful implementation of IFRS in Ukraine's agricultural sector would contribute to improved financial transparency, which is a key factor for the stable development of enterprises. However, this requires the continuous refinement of fixed asset accounting methodologies, tailored to the specifics of the national market and responsive to external economic challenges. It is also essential to ensure adequate staff qualifications, as the effective adoption of international standards is not possible without trained professionals. Systematic training of accountants and financial managers,

along with the development of modern information technologies, will support the successful adaptation of IFRS in Ukraine and enhance financial reporting in the agricultural sector, thereby fostering the stable growth of this vital industry. Future research should focus on developing more detailed methodologies for asset valuation under conditions of economic instability, as well as examining the impact of international financial reporting standards on the effectiveness of managerial decision-making within Ukraine's agricultural sector.

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## **Міжнародні стандарти фінансової звітності в національній практиці обліку переоцінки та зменшення корисності основних засобів**

**Анотація.** Метою цього дослідження було вивчення впливу впровадження Міжнародних стандартів фінансової звітності на практику обліку основних засобів в Україні, зокрема переоцінки та зменшення їх корисності. Дослідження базувалося на аналізі застосування

Міжнародних стандартів фінансової звітності в аграрному секторі України протягом 2022-2024 років. Для цього було проаналізовано застосування стандартів International Accounting Standard 16 «Основні засоби» та International Accounting Standard 36 «Зменшення корисності активів», а також вплив економічної нестабільності на фінансові результати підприємств. У процесі дослідження було виявлено, що впровадження Міжнародних стандартів фінансової звітності дозволило підвищити прозорість фінансової звітності та покращити точність відображення вартості основних засобів, що, в свою чергу, сприяло зміцненню довіри до фінансових звітів підприємств. Однак впровадження Міжнародних стандартів фінансової звітності супроводжувалося низкою труднощів, через економічну нестабільність, високий рівень інфляції та коливання на ринку основних засобів. Враховуючи дані з 2023 по 2024 роки, середня вартість землі сільськогосподарського призначення в Україні у 2024 році становила 46 678 грн за гектар, що на 21 % більше, ніж у попередньому році. У результаті дослідження було виявлено, що в 2024 році ціни на техніку, зокрема трактори, зросли на 6,8-7 %, проте продажі комбайнів та обприскувачів знизились на 25-30 % через економічну невизначеність. Зменшення корисності активів, особливо техніки, є ще одним важливим аспектом, що впливає на оцінку основних засобів. Впровадження Міжнародних стандартів фінансової звітності, дозволило своєчасно знижувати балансову вартість таких активів, що сприяло підвищенню прогностичної цінності фінансової інформації для користувачів фінансової звітності. Практичне значення дослідження полягає в розробці рекомендацій щодо удосконалення обліку основних засобів в аграрному секторі України шляхом застосування Міжнародних стандартів фінансової звітності. Це дозволить підвищити прозорість фінансової звітності підприємств та зміцнити їх стабільність в умовах економічної невизначеності

**Ключові слова:** необоротні активи; корисність активів; знецінення; справедлива вартість; національні стандарти; міжнародні стандарти обліку

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