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FINANCIAL RESIELENCE OF UKRAINE UNDER MARTIAL LAW

In martial law conditions, ensuring the country's financial stability and further social and economic development becomes of great importance. The research aims to determine the features of achieving the country's financial stability in martial law conditions. The main scientific methods of research are dialectical and institutional, structural, comparative, the method of scientific abstraction, analysis, and expert assessments, which allow for ensuring the conceptual unity and thoroughness of the study. The research has analyzed the actual state of

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ФІНАНСОВА СТІЙКІСТЬ УКРАЇНИ В УМОВАХ ВОЄННОГО СТАНУ

За воєнного стану вагомого значення набуває питання забезпечення фінансової стійкості країни та подальший суспільно-економічний розвиток. Метою статті є визначення особливостей досягнення фінансової стійкості країни в умовах воєнного стану. Основними науковими методами дослідження є діалектичний та інституційний, структурний, порівняльний, наукового абстрагування, аналізу та експертних оцінок, що дозволили забезпечити концептуальну єдність та ґрунтовність дослідження. У ході дослідження проаналізовано фактичний

ensuring the financial stability of Ukraine in conditions of martial law. It was established that despite the measures taken to curb inflation, the purchasing power of the population decreased, and real GDP during this period did not reach the pre-war level. The level of public debt and budget deficit during the studied period of the war increased significantly, which significantly increased the pressure on the financial system and its stability. Ukraine's gold and foreign exchange reserves increased during the analyzed period, however, given that part of the debt is in foreign currency, the National Bank of Ukraine adheres to a policy of preventing the depreciation of the hryvnia. The research presented in the article is based on the hypothesis of the need to strengthen the country's financial stability under martial law by implementing a balanced and effective policy in the budgetary, tax, customs and monetary spheres. Based on the research, promising areas for strengthening financial stability have been identified, particularly through the development of effective measures to slow down the inflation rate, reduce the budget deficit, and manage the state's external and internal debt.

Keywords: financial stability, financial system, budget deficit, public debt, martial law.

стан забезпечення фінансової стійкості України в умовах воєнного стану. Встановлено, що, попри застосовані заходи стримування темпів інфляції, купівельна спроможність населення знизилася, а реальний ВВП протягом цього періоду не досяг довоєнного рівня. Рівень державного боргу та дефіцит бюджету за досліджуваний період війни суттєво зросли, що значно посилило тиск на фінансову систему та її стійкість. Золотовалютні резерви України впродовж аналізованого періоду зросли, проте, враховуючи, що частина боргу в іноземній валюті, Національний банк України дотримується політики запобігання здешевленню гривні. Дослідження ґрунтується на гіпотезі щодо необхідності посилення фінансової стійкості країни в умовах дії воєнного стану шляхом реалізації виваженої та дієвої політики в бюджетній, податковій, митній та грошово-кредитній сферах. На основі дослідження визначено перспективні напрями посилення фінансової стійкості, зокрема, через розроблення дієвих заходів задля сповільнення рівня інфляції, зниження рівня бюджетного дефіциту, управління державним зовнішнім та внутрішнім боргом.

Ключові слова: фінансова стійкість, фінансова система, дефіцит бюджету. державний борг, воєнний стан.

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Introduction

Financial stability is the basis for ensuring the social and economic development of the country and one of the important factors of the stability of the national economy, the full implementation of state and local budgets, financial support for the country's defense to increase the country's capabilities, as well as maintaining an adequate standard of living for citizens under martial law. Compliance with the country's financial stability involves strengthening the level of budget balance, effective and rational implementation of budget programs, and strengthening the synergistic relationship between the levels of the budget system. In order to strengthen effective budget and tax policy, it is important to use the fiscal regulatory mechanism, particularly in terms of improving the tax administration system. Accordingly, financial stability is a significant tool for the country's social development, which determines the relevance of the study.

Financial sustainability indicators determine the social and economic development of the country (Barua, 2019). In particular, the effectiveness of fiscal and monetary policies contributes to the stability and resilience of public finances (Auerbach, 2010). Also, in conditions of financial system volatility,

price stabilization and maintenance of low inflation caused by sudden changes in interest rates are important to maintain stability (Dinh et al., 2025). As a result, achieving appropriate financial sustainability indicators will contribute to positive dynamics of GDP and social development (Athari, 2023).

It is important to form a mechanism for constantly reviewing and updating approaches to assessing the level of financial stability of a country, taking into account its dynamism and cyclicality (Lupenko & Radionov, 2021). The system of indicators of the country's financial stability covers both generalized data on individual financial institutions and key macroeconomic indicators that determine the state of functioning of the financial system. Such indicators are used in macroprudential analysis and help assess and monitor both the strengths and potential risks of the financial system. The main goal is to increase its stability and minimize the risk of financial crises (Chubenko et al., 2018). According to the requirements of the International Monetary Fund (IMF), countries must collect and publish information on 40 financial stability indicators, in particular, 25 of them relate to the deposit-taking corporations' sector (including 12 basic ones), and another 15 indicators for clients of this sector.

According to the research of Gasiy et al. (2025), the implementation of a new macroprudential strategy by the National Bank of Ukraine contributes to the reduction of systemic risks and strengthening of the financial stability of the banking sector. Despite the difficult conditions caused by the martial law, the banking system demonstrates a tendency to reduce the concentration of credit risks. This indicates an increase in regulatory standards and a more cautious approach of banks to lending. Financial institutions maintain an adequate level of liquidity, which allows them to fulfill their obligations to depositors promptly. At the same time, the investment activity of banks remains low, which is associated with an increased level of uncertainty in financial markets.

A review of the economic literature indicates the lack of unity among researchers in interpreting the definition of "financial stability of the country", which is characteristic of both the domestic and foreign scientific communities. Such ambiguity complicates the formation of a clear idea of the essence of this concept and also prevents the development of unified approaches to ensuring the stability of the financial system and the use of standard indicators for its assessment. Despite the presence of significant scientific achievements and proposed methodological, organizational, and institutional solutions, it should be recognized that this topic requires constant analysis, updating of approaches, and continued scientific research. This is especially relevant in conditions of martial law, which creates additional threats to the national economy.

The aim of the research is to determine the features of achieving the country's financial stability under martial law.

The research presented in the article is based on the hypothesis of the need to strengthen the country's financial stability under martial law by implementing a balanced and effective policy in the budgetary, tax, customs,

and monetary spheres. In particular, important indicators of compliance with financial stability are budgetary policy, budget deficit, internal and external debt, and tax burden, as well as purchasing power, inflation rate, stability of the national currency, gold, and foreign exchange reserves.

The article uses a set of scientific methods and approaches, which allowed the realization of the conceptual unity of the study. During the study, dialectical and institutional methods were used – to reveal the essence of the country's financial stability; generalization and structural methods – to assess the influence of factors on the overall level of stability of the financial system; the method of analysis and comparison – to assess the level of stability of the financial system in conditions of crisis phenomena; methods of scientific abstraction and expert assessments – to determine the directions of strengthening the country's financial stability in conditions of martial law.

Structurally, the main part of the research is divided into three sections, the first of which is devoted to determining the economic essence and main characteristics of the country's financial stability. The second section analyzes the financial stability of Ukraine under martial law, characterizes the main trends and dynamics of macroeconomic indicators under the influence of military-political and social and economic factors. The third section identifies areas for strengthening Ukraine's financial stability.

1. The economic essence and main characteristics of the country's financial stability

Transformational changes that occur in the social and economic environment of the country directly affect the economic and, accordingly, financial stability of the state. The country's financial system is a central link in the process of state management and effective regulation of social and economic processes. Without the stable functioning of the financial system, it is impossible to achieve priorities and important social goals for the population and the state. Financial stability is, first of all, the proper functioning of the national economy, which is a primary task for any country in terms of achieving its main tasks and priorities of social and economic development. In countries with transformational economies, the stability of state institutions is quite low, and accordingly, in the process of policy coordination, the level of intervention of state administration bodies in central bank policy and the achievement of fiscal stability increases (Makohon, 2024).

The beginning of a full-scale invasion has affected the reduction of financial, economic and social stability. This requires appropriate measures and the development of effective scientifically based approaches in budgetary, social, financial, economic policy to strengthen macroeconomic stability, an effective mechanism of the components of the financial system, in particular, the tax, monetary, budgetary, social, investment, foreign

economic, scientific and technological, energy, and production spheres (Barik & Pradhan, 2021). The stability of the financial system is primarily the reliable functioning of its integral mechanism, harmonious interaction with the real sector of the economy, stable implementation of financial transactions, timely response to current and potential risks and destabilizing factors, where its effective functioning is observed in compliance with the appropriate level of employment of the population, stability of the national currency, trust in financial and credit institutions, effective distribution and use of public finances for the benefit of the country, stabilization of the social and economic situation is ensured, the basis for economic growth, sustainable dynamics of social development is formed.

In accordance with the Decree of the President of Ukraine № 170/2015 of March 24, 2015, the Financial Stability Council was established. The main purpose of this body is to identify systemic risks and potential threats to financial stability, and develop recommendations aimed at minimizing their impact on the financial system. The Council has the status of an interdepartmental body and serves as a platform for professional discussions on financial stability issues. The decisions adopted by the Council are of a recommendatory nature, that is, the institution does not interfere in the operational activities of the institutions that are part of it but collectively formulates proposals for the implementation of state policy in the field of ensuring financial stability. The National Bank of Ukraine provides organizational support and analytical support for the functioning of the Council. To increase the efficiency of its work, several working groups (committees) were created to develop mechanisms for interdepartmental cooperation, coordinate actions to stabilize the country's financial system, and formulate sound recommendations to reduce systemic risks in the banking and financial sectors (Decree of the President of Ukraine "On the Financial Stability Council", 2023, May 27).

The Law of Ukraine "On the National Bank of Ukraine" stipulates that the National Bank of Ukraine is the key institution responsible for the formation and development of the financial stability system, cooperating with the Ministry of Finance of Ukraine, the National Securities and Stock Market Commission, and the Deposit Guarantee Fund of Individuals. As the central element of the financial system, the National Bank supervises its main components, manages international reserves, issues national currency, and provides loans to depositors. In addition, the NBU assesses the effectiveness of the functioning of the financial system and its stability, using appropriate quantitative and qualitative indicators. Twice a year, it publishes a Financial Stability Report based on calculations of the Financial Stress Index (FSI) and other indicators, with an emphasis on analyzing the stability of the banking sector (Law of Ukraine "On the National Bank of Ukraine", 2024, December 19).

Financial soundness indicators are indicators that reflect the current state of the financial system, in particular financial institutions, as well as

their interaction with counterparties from the non-financial corporations and households' sectors. This data covers key characteristics of the activities of deposit-taking corporations (banks), in particular the level of capitalization, asset quality, profitability and profitability, the level of liquidity, and sensitivity to market risks. They also include recommended financial soundness indicators and the primary data necessary for their calculation. Thanks to these indicators, it is possible to form an idea of the situation in the markets where financial institutions operate. The assessment methodology proposed by the International Monetary Fund, which is based on 12 basic indicators, although widely used, is not perfect. It requires further improvement, in particular, clarification of the definitions of individual indicators and methods of calculation.

2. Features of Ukraine's financial stability under martial law

The social and economic situation in Ukraine has undergone significant changes as a result of martial law, which has significantly affected the financial stability of the state. One of the key indicators of the well-being of the population, and therefore an indicator of the state of the financial system, is purchasing power, which, along with consumer preferences, reflects consumer sentiment and allows us to assess the impact of military actions on the standard of living of the population. Purchasing power determines the ability of citizens to purchase necessary goods and services for available financial resources, which directly depends on the level of income of the population, inflation, and the general price level. Income growth contributes to an increase in purchasing power, however, in cases where prices grow faster than incomes, it, accordingly, decreases and vice versa – when the growth rate of incomes outpaces inflation, the purchasing power of the population improves. With the beginning of the full-scale invasion of Ukraine, the purchasing power of the population has sharply decreased, as some domestic enterprises have ceased their economic activities, the hryvnia exchange rate has fallen sharply, budget expenditures and the budget deficit have increased, while revenues have fallen significantly, which has increased the risks of financial stability. In such a situation, the main task of the authorities is not to disperse financial resources, but rather to focus budget funds on important, priority areas of ensuring the country's defense capability, humanitarian and social programs to support temporarily displaced persons, and other priority measures.

During 2023, economic activity in Ukraine gradually recovered, resulting in a strengthening of purchasing power, which had previously experienced a significant decline. Although some economic indicators have not yet reached pre-war levels, there has already been a noticeable revival of consumer behavior. In particular, 52% of citizens made purchases with the same frequency as in 2022, and 44% spent about the same amount of money.

This indicates a certain stabilization of purchasing power and adaptation to new realities. Compared to 2022, the number of purchases increased by 9% – in offline stores and by 12% on the Internet. Expenditure volumes also increased by 22% – in regular stores and by 20% online. This demonstrates a gradual restoration of confidence in trade and the activation of consumer demand. The level of spending also depended on the place of residence. Internally displaced persons spent an average of 21% less in physical stores and 7% less in online stores than those who remained in their homes. Overall, the economic situation stabilized somewhat in 2023, but citizens' purchasing power has not yet fully recovered.

During periods of declining purchasing power, the population usually prioritizes expenses related to maintaining health and meeting basic needs. First of all, this applies to the purchase of food, paying for housing (or its rental), using transport services, as well as purchasing medicines. In 2024, according to the State Statistics Service, the level of consumer inflation in Ukraine was 12.0%. In particular, in December it was 1.4%. Inflation processes continued at the beginning of 2025, which is explained by both temporary factors, such as a decrease in harvest volumes, and more persistent ones, including an increase in enterprises' costs for energy resources, labor costs, and the impact of exchange rate fluctuations. The actual inflation rate at the end of 2024 exceeded the forecasts made by the National Bank of Ukraine. The main reason for this discrepancy was a significant increase in food prices, which was caused by weaker harvests. In addition, rising business costs, particularly for electricity and wages, have significantly contributed to the rise in inflationary pressure. To a lesser extent, the weakening of the hryvnia has also contributed to the general increase in the price of goods and services (Law of Ukraine "On the State Budget of Ukraine for 2025", 2024, November 19).

In conclusion, purchasing power is an important factor determining the quality of life of the population. Its decline leads to increased social tension, increased inequality, and can cause social conflicts and political instability. One of the key factors affecting purchasing power is the level of real wages, that is, the amount that an employee receives for his work, taking into account inflationary processes. The consumer price index (CPI) is used to determine it.

In 2024, the average wage of full-time employees increased by 22% and amounted to UAH 20 592. At the same time, this indicator is calculated before deducting mandatory tax payments, in particular personal income tax. Taking into account the tax burden, the actual average wage was about UAH 15 855, which is equivalent to less than USD 380 at the exchange rate for that period. The increase in wages was due to a number of factors, the key to which is the structural shortage of labor respectively employers, needed to increase wages to maintain the existing human resource potential and attract qualified specialists. Despite the formal growth in nominal incomes of the population, real purchasing power has not changed significantly. The main

reason for this is the high level of inflation, which affected the positive effect of wage increases due to the increase in the cost of basic goods and services.

Despite the difficult macroeconomic conditions, in 2024 the national economy showed some signs of stabilization. The persistence of negative trends, in particular, the decline in industrial production volumes, demographic losses and significant dependence on external financial support, indicate a deep economic crisis. In this context, the prospects for economic recovery largely depend on the end of hostilities, as well as the implementation of effective social and economic policies. The moderate growth in nominal wages is associated with a shortage of labor resources, namely: in June 2024, the average wage level was UAH 20.5 thousand, which is 23% higher than the same indicator in 2023. It is expected that by the end of 2025 this indicator may increase to UAH 22–23 thousand. The slowdown in wage growth, which is due to the slow pace of economic recovery, and therefore a likely decrease in the real purchasing power of the population. Despite signs of labor market recovery, the number of current vacancies has still not reached pre-war levels and is approximately 90% of the volume of 2021. The unemployment rate remains high at 15.3%. The labor shortage is projected to persist, and if economic growth accelerates, the problem of staff shortages may become systemic.

The tendency of the Ukrainian population to save against the background of a difficult social and economic situation indicates limited purchasing power of citizens. Despite a certain increase in the level of wages since the beginning of the full-scale invasion, the increase in the minimum wage from UAH 6 500 to UAH 8 000 did not provide a significant improvement in the material situation of the population. According to Article 8 of the Law of Ukraine "On the State Budget of Ukraine for 2025" (2024, November 19), the minimum wage is maintained at the 2024 level and is UAH 8 000, while the subsistence minimum for the able-bodied population is set at UAH 3 028 (Article 7). This ratio demonstrates the limited financial capabilities of the population in conditions of ongoing economic instability.

In 2024, Ukraine’s gross domestic product grew by 3.8%, but its real level remains 17.4% lower than the pre-war period. According to the forecasts of the National Bank of Ukraine, GDP is expected to grow by 3.6% in 2025 compared to the previous year. The main factors in reducing expectations were the overestimation of potential GDP due to further losses of production factors and the continued negative impact of armed aggression. In February 2025, Ukraine’s real GDP grew by 0.7%, and the cumulative growth for the first two months was 1.1%. This dynamic is partly explained by the high base of comparison in 2024. At the same time, the impact of negative factors was partially offset by significant budget financing for measures to restore critical infrastructure and implement state housing programs ("eRecovery", "eHousing") (Law of Ukraine "On the State Budget of Ukraine for 2025", 2024, November 19).

According to the Ministry of Economy of Ukraine, a positive factor in February 2025 was also the revival of domestic consumer demand, in

particular due to the growth of retail trade and the improvement in consumer sentiment, which has been recorded for four consecutive months. At the same time, some sectors showed a decrease in indicators: in particular, in agriculture due to the increase in the cost of livestock products, in the extractive industry due to damage to the gas extraction infrastructure, as well as in the transport sector due to a decrease in export activity. The dynamics of GDP growth in 2024 was uneven: 6.5% in the first quarter (compared to the same period in 2023), 3.7% in the second quarter, and only 2.0% in the third quarter. The forecast included in the state budget for 2025 predicts annual GDP growth of 2.7%.

In February 2025, Ukraine observed a deterioration in the assessment of the current economic situation of the population. The current situation index decreased by 4.6 points and amounted to 53.3 points, which is lower than the indicator of January 2025. The economic expectations index increased by 4.2 points and reached the level of 91.6 points. A decrease in the inflation expectations index by 3.9 points to the level of 181.4 points was also recorded, and the devaluation expectations index decreased by 8.8 points, to 158.3 points. These indicators are components of the Consumer Sentiment Index, which is calculated based on a sample survey of households. The study covers a representative sample of 1,000 people aged 16 and over. The index value ranges from 0 to 200, where 200 points indicate a completely positive assessment of the economic situation by all respondents, and a level of 100 points indicates a balance between positive and negative assessments. A value below 100 points signals the predominance of pessimistic assessments in society.

One of the factors improving expectations is the reduction of social tension related to the exchange rate of the national currency: in January and February 2025, the US dollar exchange rate showed a downward trend, offsetting the growth of more than 10% during 2024. Inflationary processes remain significant: in February 2025, annual inflation was 13.4%, while the growth of consumer prices slowed down to 0.8% per month. The financial and budgetary system is experiencing an increase in structural budget deficit. This trend is due to the growing need to finance the functioning of the state, in particular its defense capability, ensuring social support for the population, as well as in the restoration of critical infrastructure. Ensuring macroeconomic and financial stability depends on the state's ability to accumulate financial resources through tax and budgetary instruments, form an effective system of budget expenditures, and perform strategic functions of public administration (Ministry of Finance of Ukraine, n. d.).

In this context, the concept of the budget mechanism is important, which is interpreted as a set of institutional and instrumental means of state influence on the economy through the system of budgetary relations. The budget mechanism is designed to create favorable conditions for the stable economic and social development of the country, adapting to changes in the external environment. At the same time, uncertainty affected the reduction of

tax revenues to the budget at the initial stage of major armed aggression, the application by the state of a set of tax incentives, which led to the formation of an active budget deficit (Pasichnyi, 2024).

Analysis of the dynamics of revenues and expenditures of the State Budget of Ukraine (*Table*) indicates the systematic presence of a deficit over the past fourteen years. At the same time, the State Budget of Ukraine performs a key regulatory function in the economy, determining the volumes of necessary financial resources to maintain the stability of the financial system, allocate resources according to priority areas and form strategic vectors of the country's social and economic development.

Table

Dynamics of revenues and expenditures of the State Budget of Ukraine, 2011–2024, UAH million

Year	Revenue	Expenditures	Deficit
2011	314616.9	333459.5	23557.6
2012	346054.0	395681.5	53445.2
2013	339180.3	403403.2	64707.6
2014	357084.2	430217.8	78052.8
2015	534694.8	576911.4	45167.5
2016	616274.8	684743.4	70130.2
2017	793265.0	839243.7	47849.6
2018	928108.3	985842.0	59247.9
2019	998278.9	1072891.5	78049.5
2020	1076016.7	1288016.7	217096.1
2021	1296852.9	1490258.9	197937.4
2022	1787395.6	2705423.3	914701.7
2023	2671998.0	4014418.1	1333110.7
2024	3122713.4	4486682.7	1358500.1

Source: (Ministry of Finance of Ukraine, n. d.).

In 2020, the state budget deficit of Ukraine exceeded UAH 217 billion, which was 5.18% of GDP. Similar high deficit levels were recorded in 2013 (4.45% of GDP) and 2014 (4.98% of GDP). In 2021, this figure decreased to 3.63% of GDP, which is 1.55 pp less than the previous year. However, with the beginning of full-scale aggression in 2022, the situation in the field of public finance became more complicated. In particular, a drop in GDP of 28.8%, a reduction in exports by 35%, as well as an increase in budget cash expenditures to UAH 2.702 trillion (92.2% of planned indicators) caused a record deficit of almost UAH 915 billion. In 2023, a similar trend continued, the state budget was executed with a deficit of UAH 1.33 trillion, in particular, the general fund deficit was UAH 1.36 trillion, which is less than the approved plan (UAH 1.83 trillion). The steady growth of the deficit necessitates the active attraction of external and domestic financing, which in turn leads to an increase in public debt. In conditions of martial law, reducing the gap between budget revenues and expenditures is a difficult task due to the priority of financing the defense sector.

According to the Law of Ukraine "On the State Budget for 2024", revenues (excluding transfers) were set at UAH 1,768.5 billion, while

expenditures reached UAH 3 355.0 billion, which is almost twice as much as revenues. Among the largest areas of expenditure are financing education (UAH 179.1 billion), healthcare (UAH 203.4 billion), social protection (UAH 469.4 billion), and veterans' support (UAH 14.3 billion). At the same time, the largest amount of funds was directed to defense and security – UAH 1 692.6 billion, which indicates a reorientation of budget policy towards ensuring national security. The total budget deficit at the end of 2024 reached UAH 1.35 trillion (Ministry of Finance of Ukraine, n. d.).

Financing the state budget deficit under martial law requires the mobilization of additional resources, and in their absence, the risk of a fiscal gap increases. This affects the revision of traditional mechanisms for generating revenues and expenditures. Under martial law, the issue of limited budget resources is important, which affects the optimization of state and local budget expenditures. In August 2024, the "credit holidays" granted to Ukraine under the 2022 agreements with external creditors expired, and accordingly, a new agreement was reached to restructure the external state debt for USD 20 billion by 2029. More than 97% of Eurobond holders supported the agreement, which will allow Ukraine to save USD 11.4 billion in the next three years, providing additional resources to finance critical needs, including defense.

External debt plays a dual role: on the one hand, it contributes to the financial stability of the state in times of crisis, and on the other hand, it forms future fiscal obligations. The main risks remain the increase in the debt burden on future generations, the loss of financial independence, and the decrease in debt sustainability. As of January 31, 2025, the state and state-guaranteed debt of Ukraine amounted to UAH 7 068.00 billion (USD 168.99 billion), of which 72.74% was external debt (UAH 5 141.34 billion or USD 122.93 billion), the rest was domestic debt (UAH 1 926.66 billion or USD 46.07 billion) (Ministry of Finance of Ukraine, n. d.).

The state budget is also supported by external financial assistance. As of December 2024, Ukraine had received a total of USD 105.9 billion in international financial assistance, which averages over USD 35 billion annually. These resources were mostly directed to financing social budget items, while the state covered military expenditures from its own funds. The volume of international assistance varied depending on the foreign policy situation and financial mechanisms, from emergency grants to long-term development programs. To increase the revenue side of the budget, in October 2024 the government increased the military levy from 1.5% to 5%, and also extended it to single tax payers: 1% of income for payers of group III, 10% of the minimum wage (UAH 8 000) for individual entrepreneurs of groups I, II and IV. Ukraine's gold and foreign exchange reserves during martial law showed a growing trend. Thus, at the end of 2022 they amounted to USD 28.5 billion, in 2023 – USD 40.5 billion, and in 2024 – USD 43.8 billion. As of February 28, 2025, reserves decreased to USD 40.1 billion, which indicates partial use of accumulated resources

to stabilize the economy at the beginning of this year (Ministry of Finance of Ukraine, n. d.).

Since the beginning of the full-scale invasion, the issue of demographic indicators has become relevant. According to the Institute of Demography, the population of Ukraine in the government-controlled territory is currently about 31.5 million people, which means that demographic losses due to the war amount to about 10 million people. This is almost a quarter of the country's total population. According to the director of the Institute of Demography and Social Research Libanova (2025), those who left Ukraine are about 4.5 million, of whom a third are adolescents under 18 years of age. In contrast, only 6% are people over 65 years of age, which indicates a significant increase in the aging process of the nation in war conditions. Demographic losses, especially among young people and women of reproductive age, threaten the country's demographic growth and future development. In this regard, we can only note that the demographic situation worsens financial sustainability; therefore, it is important to develop appropriate government programs to address this problem, including encouraging citizens to return to Ukraine and engage in economic activity and the reconstruction of the country.

3. Directions for strengthening the financial stability of Ukraine

The formation of a stable financial system of the country in the conditions of social and economic transformations and in the presence of limited budgetary financial resources should be based on modeling financial relationships, analyzing synergistic interactions between elements of the financial system, and identifying cause-and-effect dependencies (Papadimitriou et al., 2019). It is important to form a comprehensive approach to the use of financial and budgetary instruments, ensuring a balanced combination of the goals of all components of financial policy. This allows us to take into account economic and social factors, while maintaining the stability of the financial system.

The effective use of financial policy instruments should adapt to economic cyclicality and meet the priorities of the social and economic development of the state. It is important to improve the methods of forming budget revenues, taking into account institutional changes in the public finance system, and adaptation to social and economic changes. This will contribute to increasing the adaptability of the budget system and enhancing the efficiency of regulating the revenue part of the budget. It is important to develop conceptual approaches to the functioning of the public finance system, which involves substantiating the principles of forming public revenues and expenditures, the coordinated use of financial instruments to ensure macroeconomic stability, and the activation of the processes of formation and rational redistribution of public financial resources.

One of the priority conditions for the formation of an effective financial policy is the effective distribution of limited financial resources. Tax policy in martial law should be aimed at the formation of stable budget revenues, the development of effective tools for solving tax regulation tasks, taking into account the peculiarities of economic development and social conditions.

The implementation of long-term goals of financial and budgetary policy largely depends on the extent to which the institutional features of the economic environment and the relationships between its elements are taken into account (Chugunov & Liubchak, 2024). The priority tasks of this policy include: systematic improvement of approaches to forecasting budget revenues, in particular tax revenues, taking into account economic dynamics and the impact of both internal and external factors on budget sustainability; optimization of the structure of budget revenues; increasing the level of transparency and sustainability of the fiscal system; effective use of budget funds and the formation of a transparent budget policy.

The development of tax policy in the context of integration into the European space, stimulating the development of the domestic capital market and its interaction with European financial structures, simplifying access to financing for business entities, maintaining financial stability, minimizing the impact of negative factors on the financial system, and reasonable use of external financial resources are important. The implementation of effective budget policy as a priority instrument for regulating macroeconomic balance should be carried out taking into account the dynamics of social and economic changes, an effective mechanism for the formation of state financial resources, a rational approach to managing the budget deficit and public debt, and a reasonable system of intergovernmental relations. Such an approach will contribute to strengthening financial stability, increasing the efficiency of social transformations, and enhancing the effectiveness of fiscal and budgetary policy (Zakhidna et al., 2023). Achieving financial architecture for the budget and tax system will allow the formation of the necessary financial resources to support economic growth. The priority area is the development and implementation of a budget strategy that ensures a balance between aggregate demand and supply, thereby contributing to achieving macroeconomic stability.

The need to ensure budgetary balance necessitates the need to strengthen the influence of budgetary policy in the system of macroeconomic equilibrium through the application of adaptive budgetary architecture, effective management of inter-budgetary transfers, and the establishment of a stronger link between macroeconomic indicators and budgetary policy priorities (Kozlov, 2023). The above will lead to an increase in the efficiency of public finance management. To increase the efficiency of financial and budgetary policy, it is important to ensure coordinated interaction between budgetary, fiscal, customs, and debt policies, which will allow to achieve a synergistic effect in the development of public finances and will contribute to the coordination of actions of all participants in the budgetary process. Effective use

of public resources is possible only under conditions of fundamental structural changes in state institutions (Kaneva & Stadnik, 2023).

Conclusions

The research shows that under martial law and relevant social and economic transformations, the country's financial stability depends on effective policies in the budgetary, tax, customs, and financial and credit spheres, and international financial assistance. Under such conditions, it is important to develop effective financial measures to curb inflation, reduce the budget deficit, and effectively manage the state's external and internal debt.

It is important to maintain the stability of the financial and credit policy, which determines the general level of confidence in the financial system, price policy, and contributes to the country's economic development. The conditions for achieving monetary and credit balance are strengthening financial reserves, controlling inflation, and creating a favorable environment for attracting investments. It is advisable to form an effective foreign financial policy. Cooperation with international institutions and governments of foreign countries allows supporting the country's solvency under martial law. At the same time, it is important to ensure the transparent use of funds raised, which will contribute to the country's social and economic development. The priority is the development of the domestic economic market, the stimulation of entrepreneurship, especially in the field of small and medium-sized businesses, which are important components of financial stability. In conditions of martial law, domestic production meets the needs of the economy, creating jobs and generating tax revenues for budgets of all levels. In order to preserve and strengthen financial stability in conditions of martial law, it is necessary to ensure effective synergy between financial, economic and security policies, maintain the stability of monetary policy and the national currency, and form financial and economic interaction with international partners.

An important task for achieving financial stability is to form appropriate principles for the functioning of the public finance system, in particular, to substantiate the principles of effective distribution and redistribution of state financial resources in the system of financial and economic relations, to ensure coordinated use of financial instruments, methods and levers to support macroeconomic stability. The priority is to develop institutional approaches to improving the criteria for compliance of financial policy components with the standards of financial and economic security of the country. It is necessary to coordinate the mechanisms for forming state financial resources, taking into account financial and institutional capacity, structural transformations in the financial system, macroeconomic trends and features of the financial and budgetary regulation system. The formation of the principles of financial stability should include an analysis of the impact of external and internal factors on financial

indicators, an assessment of the level of financial security of the state, and the establishment of justified institutional measures for managing the budget deficit and public debt.

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CRITERIA FOR ASSESSING FOOD SECURITY ASSURANCE

The article substantiates the criteria and indicators for assessing food security assurance in the state regulation system for post-war revival. The characterization of Ukraine's food security during the war is carried out, covering production, logistics, economics, and international assistance, which demonstrates a decrease in sown areas, since due to active hostilities, mining of territories, occupation, and forced migration, a significant part of agricultural land became inaccessible for cultivation, especially affected were the regions where the main export crops (grains, oilseeds) were traditionally grown; the war complicated access to resources, seeds, fertilizers, fuel, and financing, and prices for all resources increased, which negatively affected production; much agricultural machinery was destroyed and damaged as a result of hostilities, granaries, elevators, and other infrastructure necessary for storing and processing the harvest were also damaged; the mobilization of men into the army and forced migration led to a shortage of labor in agriculture. It is noted that the choice of criteria and indicators for assessing food security assurance in the state regulation system for post-war revival depends on many factors, which are systematized by: context, purpose and objectives of the assessment, methodological dimension, characteristics of the food system and vulnerable population groups. Key and additional criteria and indicators of assessment are proposed, it is argued that they should be used for regular monitoring and assessment of the effectiveness of food security assurance in the state regulation system, for identifying problem areas and developing measures to eliminate them, for the

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КРИТЕРІЇ ОЦІНКИ АСЕКУРАЦІЇ ПРОДОВОЛЬЧОЇ БЕЗПЕКИ

Обґрунтовано критерії та показники оцінки забезпечення продовольчої безпеки в системі державного регулювання післявоєнного відновлення. Охарактеризовано стан продовольчої безпеки України під час війни, яка охоплює виробництво, логістику, економіку та міжнародну допомогу, що свідчить про зменшення посівних площ, оскільки через активні бойові дії, мінування територій, окупацію та вимушену міграцію значна частина сільськогосподарських угідь стала недоступною для обробітку. Особливо постраждали регіони, де традиційно вирощували основні експортні культури (зернові, олійні), до того ж війна ускладнила доступ до ресурсів, насіння, добрив, палива та фінансів, ціни на всі ресурси зросли, що негативно вплинуло на виробництво. Внаслідок бойових дій знищено та пошкоджено багато сільськогосподарської техніки, зерносховища, елеватори та інша інфраструктура, необхідна для зберігання та переробки врожаю; мобілізація чоловіків до армії та вимушене переселення призвели до браку робочої сили. Вибір критеріїв та показників оцінки забезпечення продовольчої безпеки в системі державного регулювання післявоєнного відновлення залежить від багатьох факторів, які систематизовані за: контекстом, метою та завданнями оцінки, методологічним виміром, характеристиками продовольчої системи та вразливих груп населення. Запропоновано ключові та додаткові критерії і показники оцінки, обґрунтовано доцільність їх використання для регулярного моніторингу та оцінки ефективності забезпечення продовольчої безпеки в системі державного регулювання, для виявлення

formation and implementation of state policy for various categories of agricultural producers. Thus, it has been proven that an objective assessment of food security is an integral part of the successful post-war reconstruction of Ukraine, it provides the necessary information for effective planning, attracting international assistance, monitoring progress and adjusting strategies, opens up additional opportunities for innovation, diversification and development of rural areas, contributing to strengthening national security and improving the quality of life of Ukrainians.

Keywords: food security, state regulation system, insurance, assessment, criteria, indicators, agrarian policy, industry policy.

проблемних місць і розроблення заходів щодо їх усунення, для формування та реалізації державної політики щодо різних категорій сільськогосподарських товаровиробників. Сформовано і доведено гіпотезу, що об'єктивна оцінка продовольчої безпеки є невід'ємною частиною успішної повоєнної відбудови України, вона надає необхідну інформацію для ефективного планування, залучення міжнародної допомоги, моніторингу прогресу та коригування стратегій, відкриває додаткові можливості для інновацій, диверсифікації та розвитку сільських територій, сприяючи зміцненню національної безпеки та покращанню якості життя українців.

Ключові слова: продовольча безпека, система державного регулювання, асекурація, оцінка, критерії, індикатори, аграрна політика, галузева політика.

JEL Classification: E27, J43, L51, O13, Q18, R23.

Introduction

The definition of clear criteria and indicators for assessing food security in the system of state security regulation, including during post-war reconstruction, is relevant and important. First of all, food security insurance is an author's generalized concept that encompasses a comprehensive system of measures to ensure, guarantee and insure stable access of the population to a sufficient amount of high-quality and safe food products, which are implemented through mechanisms of state regulation, agricultural insurance, strategic planning, formation of reserves, regulatory and legal support and support for agricultural producers. In contrast to the narrow interpretation of insurance as a purely financial instrument, food security insurance includes both preventive actions to reduce the risks of shortages and adaptive mechanisms to respond to internal and external shocks (war, climate change, economic crises). It combines the principles of food availability (FAO, 2022, May 4), system resilience (Mostova, 2019), agricultural insurance (Gudz, 2019) and state food security policy (Nikonenko, 2022), providing a multi-faceted platform for monitoring, assessing and improving the level of national food security, especially in the post-war period.

The war revealed the vulnerability of supply chains and the criticality of ensuring domestic food production; therefore, an adequate insurance assessment system will make it possible to identify key weaknesses and strengths and priority areas for the development of domestic agricultural production and reduce dependence on external supplies. Guaranteed provision of the population with affordable and high-quality food is a key factor in ensuring social stability, and the monitoring and assessment system will make it possible to identify risks of food shortages, price increases, uneven access to food and take timely measures to minimize them. In addition, food security can be used as a tool of hybrid aggression by enemies,

and an objective assessment will increase the system's resilience to external influences and ensure its smooth functioning in conditions of uncertainty.

The issue of assessing the state of food security in the system of state regulation of the economy is actively studied, which is confirmed by a large number of scientific publications on these and related issues (Babych, 2018; Berezyuk et al., 2023; Hrynyshyn, 2020; Gudz, 2019; Dykha, 2022; Zalizniuk, 2019; Kaletnik & Gontaruk, 2020; Nikishyna & Chebotaryova, 2024; Nikonenko, 2022; Mostova, 2019; Pruntseva, 2020; Tokarchuk & Furman, 2018, etc.).

Thus, Nikonenko (2022) considered current methodological approaches to the formation of food security in Ukraine in the context of global threats, regional crises, and national challenges. The author proposes a systematic model of ensuring food security, which takes into account not only the classical parameters (availability, accessibility, stability and use of food), but also adaptability to socio-economic transformations, climate change and demographic challenges. The practical significance of the publication lies in the possibility of applying the proposed methods in the activities of central and local executive bodies to analyze the situation in the field of food security, forecast crisis phenomena and form preventive policies in the conditions of post-war reconstruction of the agro-food sector of Ukraine.

Mostova (2019) in her monograph carried out a comprehensive study of the mechanisms of strategic provision of food security in Ukraine, taking into account internal and external risks, changes in the global food environment and the features of the transformation of the domestic agri-food system. The author deeply analyzes the institutional environment, legal regulation, the role of state support for the agricultural sector, the formation of strategic reserves, price and subsidy policies, as well as the problems of social inequality in access to food. The scientific novelty of the monograph lies in the combination of strategic and tactical levels of food security planning, taking into account the concept of sustainable development, integration into the international food space and adaptation of Ukrainian policy to European standards. In addition, the scientist offers the author's vision of the structure of the state's food policy in the form of a strategic risk matrix. The practical significance of the work is manifested in the development of specific recommendations for reforming the system of public food security management, implementing monitoring tools, improving the regulatory framework, as well as forming strategic documents for use by government structures, in particular the Ministry of Agrarian Policy, the Ministry of Economy, and regional administrations.

Scientists Melnyk and Tunicka (2020) conducted an analysis of institutional factors that affect the international competitiveness of the agro-industrial complex of Ukraine, considered the role of state policy, regulatory and legal support and institutional infrastructure in shaping the competitive advantages of the Ukrainian agro-industrial complex in world markets, which is important in supporting the competitiveness of Ukrainian products in the world food market, strengthening Ukraine's export potential.

A significant addition to the scientific discussion on this topic is foreign studies that highlight the impact of global risks on food security, in particular in conditions of armed conflicts and climate change. An article published in The Lancet (2022) focuses on the full-scale war in Ukraine, which has caused significant disruptions to global grain supply chains, exacerbating the problem of food insecurity in countries dependent on Ukrainian exports. A systematic review published in Nutrients analyzes the impact of the COVID-19 pandemic on food security and suggests approaches to increasing the resilience of agri-food systems in times of crisis (Gebeyehu et al., 2023).

However, there is no deep scientific research on the definition of criteria and indicators for assessing food security in the system of state regulation of the economy, which determines the relevance of the presented scientific research.

The aim of the article is to substantiate the criteria and indicators for assessing food security in the system of state regulation of the economy for post-war recovery.

The article is based on the hypothesis that an objective assessment of food security as an integral part of the successful post-war reconstruction of Ukraine provides the necessary information for effective planning, attracting international assistance, monitoring progress and adjusting strategies, opens up additional opportunities for innovation, diversification and development of rural areas, contributing to strengthening national security and improving the quality of life of Ukrainians.

The methodological basis of the research is a systematic approach to analyzing the state of food security in the conditions of post-war recovery, which allows for a comprehensive consideration of economic, social, legal and institutional aspects of ensuring insurance. Structural-functional and comparative methods were used to identify the specifics of the functioning of the agri-food system in the conditions of war and post-war transformation. The empirical basis of the study is statistical data from the State Statistics Service of Ukraine, the Ministry of Agrarian Policy, international organizations (FAO, WFP, World Bank), as well as materials from scientific publications and strategic documents. The proposed criteria and assessment indicators are built on the principles of validity, measurability, relevance, sensitivity to changes, as well as practical applicability in the state regulation system. To systematize the factors influencing insurance, the expert assessment method was used, and to form the author's assessment model – elements of index and component analysis.

The main part of the article consists of four sections: the first is devoted to the characteristics of food security during the war; the second is about factors for choosing criteria and indicators for assessing food security assurance in the system of state regulation of the economy; the third contains proposals for criteria and indicators for assessing food security assurance in the system of state regulation of the economy; the fourth is about advantages of the proposed updated system for assessing food security assurance.

1. Food security in time of war

Scientists Tokarchuk and Furman (2018) argued in the pre-war period that Ukraine had sufficient land to guarantee energy security when using agricultural raw materials for biofuel production without threatening food security. Scientists Kaletnik and Hontaruk (2020) supported this position, noting that the production of biogas and bioethanol at the region's distilleries could have the following effects on the economy: increase energy independence; reduce distilleries' energy costs; improve the ecological state of water resources; provide the livestock industry with protein feed. However, russia's full-scale war against Ukraine has halted the progressive development and strengthening of food security in Ukraine, demonstrating the vulnerability of both national and global food systems to anthropogenic (impact of armed conflicts), economic (rising world food prices) and natural factors (increasing impact of crop failures due to disruption of global food supplies) (FAO, 2022, May 4). Due to the start of hostilities, the disruption of the 2022 spring sowing campaign (reduction of sown areas) in regions where active hostilities are underway or which are temporarily occupied posed a threat to food security. Thus, the decrease in yield due to disruption of agro-technological cultivation of lands caused a decrease in grain harvests and, as a result, a decrease in grain exports (Dykha, 2022).

• Ukraine's food security during the war, which encompasses production, logistics, the economy, and international aid, is characterized by a number of features:

• a reduction in sown areas, as active hostilities, land mining, occupation, and forced migration have made a significant portion of agricultural land inaccessible for cultivation, particularly in regions where the main export crops (grains and oilseeds) were traditionally grown;

• difficulties in accessing resources, seeds, fertilizers, fuel, and financing, and rising resource prices have negatively impacted production;

• much agricultural machinery has been destroyed and damaged as a result of hostilities, and grain silos, elevators, and other infrastructure necessary for storing and processing the harvest have been damaged;

• mobilization of men into the army and forced migration have led to a shortage of labor in agriculture;

• the russian blockade of Ukrainian seaports, through which a significant part of grain was traditionally exported, created serious problems for the sale of agricultural products, which led to the overflow of grain storage facilities and a decrease in prices on the domestic market;

• the use of land routes (railway, road transport) faced limited capacity, different standards of railway tracks and increased transport costs for exporting products;

• rising prices for logistics services, including transportation, insurance and storage, which increased the cost of exports;

• the war has led to rising food prices in Ukraine, especially for imported goods, which has become a serious challenge for people with low incomes;

• providing food to the population in active combat zones and occupied territories has become an extremely difficult task due to the destruction of infrastructure, limited access and security risks;

• the government and international organizations are providing humanitarian assistance (food packages to support internally displaced persons, pensioners and other vulnerable groups);

• many countries and international organizations are providing food aid to Ukraine to meet the needs of the population;

• the agreement on grain exports from Ukrainian ports (the Grain Initiative), concluded under the mediation of the UN and Turkey, has made it possible to partially unblock sea grain exports and reduce global food prices;

• the war highlighted the need to diversify global food supply chains and reduce dependence on a single supplier (Berezyuk et al., 2023; Dykha, 2022; Nikishina & Chebotaryova, 2024; Nikonenko, 2022; FAO, 2022, May 4).

Therefore, Ukraine's food security during the war is characterized by major problems, which confirms the need to substantiate objective criteria and indicators for assessing food security assurance in the state regulation system in order to develop adequate strategies and measures.

2. Factors of food security assessment in the state regulatory system

Based on the author's understanding of food security assurance, in particular its clear criteria, it is possible to assess the damage caused by the war to the agro-industrial complex, as well as to determine the needs for the restoration of infrastructure, equipment, seed material, livestock, etc. As Nikonenko (2022) argues, an important condition for achieving food security is the stability of its provision, which provides for: the ability for population groups, households and individuals to have access to a sufficient amount of food at any time and not be under pressure from losing access to food as a result of demand or supply shocks, as well as cyclical fluctuations in the economy, and the system of indicators will help determine priority areas of state support and investment in the agro-industrial complex, directing them to the most important areas for ensuring food security. At the same time, clearly defined criteria and indicators of food security will allow for the well-reasoned attraction of international assistance for the restoration and development of the agricultural sector, demonstrating the transparency and efficiency of the use of the funds received. At the same time, since the national food security system should be based on the principles of self-sufficiency, independence, accessibility, and quality, which should form the

basis for the formation of a strategy and state policy for ensuring food security (Mostova, 2019), the assessment criteria should take into account the impact of agriculture on the environment, stimulate the implementation of environmentally friendly technologies, minimize the use of pesticides and herbicides, contribute to soil conservation, take into account climate change, soil degradation, limited water resources, and other factors that will affect food security in the future. In addition, the assessment criteria and indicators should take into account the role of small and medium-sized farms in ensuring food security, promote their development and competitiveness, and become a platform for developing effective state strategies and programs aimed at ensuring food security and a methodological basis for continuous monitoring of the state of food security in order to identify problem areas and respond to threats in a timely manner. They will allow for an objective assessment of the effectiveness of state policy in the field of food security, make necessary adjustments, and improve management.

Thus, the choice of criteria and indicators for assessing food security assurance in the system of state regulation of the economy for post-war recovery depends on many factors (Babich, 2018; Hrynyshyn, 2020; Gudz, 2019; Zalizniuk, 2019; Kaletnik & Gontaruk, 2020; Mostova, 2019; Pruntseva, 2020; Tokarchuk & Furman, 2019), which are systematized into four main blocks.

The context, purpose and objectives of the assessment should primarily take into account the geographical scale, as the criteria and indicators will differ depending on the level of assessment (global, national, regional, local), which will accordingly affect the purpose of the assessment, on which aspects and components of food security should be focused, in particular, whether the assessment is assessing the availability of food, its nutritional quality, stability of supply, or the vulnerability of certain population groups. The choice of indicators, especially in wartime, is significantly influenced by the availability of data and resources for collecting and analyzing information, i. e. it is important to choose those indicators for which there are reliable objective sources of information. National and international political priorities also influence the choice of criteria and indicators, in addition, some developed countries prioritize the strategy of combating obesity, therefore indicators related to the quality of nutrition and the consumption of sugar and fat are included in the assessment of food security.

The methodological dimension requires that indicators be valid (show what they are supposed to show) and reliable (give consistent results when measured repeatedly). They should also be measurable, understandable, and easy to interpret and compare; if the assessment involves comparisons across regions or time periods, standardized indicators should be used; and they should be sensitive to changes in the food system and responsive to the implementation of different policies, strategies, and programs.

The characteristics of the food system should include the volume and structure of food production, technologies, resources used (water, land, fertilizers), climatic conditions, efficiency of supply chains, infrastructure, pricing, the role of intermediaries, economic accessibility of food for different population groups, physical accessibility (distance from places of production and sale), take into account the eating habits of the population, sanitary conditions, access to clean water, the level of education on nutrition, the resilience of the food system to external shocks such as war, climate change, economic crises, political conflicts, etc.

Vulnerable population groups are the selection of criteria and indicators should take into account the specificities and needs of vulnerable population groups such as children, pregnant women, the elderly, people with disabilities, internally displaced persons, refugees, and low-income groups, i. e. it is imperative to take into account the specific nutritional needs and risk factors that affect the food security of these groups. The selection of criteria and indicators for assessing food security assurance in the state regulation system for post-conflict reconstruction is a complex and comprehensive process that requires taking into account many different factors, i. e. it is important to choose indicators that are relevant for a specific country or region and available for data collection. It is necessary to use reliable and up-to-date data from official sources (statistical offices, ministries, international organizations), it is important not only to collect data, but also to analyze it and identify key trends and problems, it is useful to compare indicators with other countries or regions to assess progress and identify areas for improvement, and most importantly, it is necessary to regularly monitor indicators to identify problems in a timely manner and take measures.

3. Recommendations for criteria and indicators for assessing food security accretion in state regulation of the economy

Based on the specified requirements for the selection of criteria and indicators for assessing food security assurance in the system of state regulation of the economy for post-war recovery, recommendations of international and scientific organizations (Berezyuk et al., 2023), proposals of scientists (Babych, 2018; Hrynyshyn, 2020; Gudz, 2019; Zalizniuk, 2019; Kaletnik & Gontaruk, 2020; Mostova, 2019; Prunt-seva, 2020; Tokarchuk & Furman, 2018) and conducted research, proposals have been developed for the criteria and indicators that should be used for such an assessment.

The author's interpretation of the key criteria and their indicators is presented in *Table 1*.

Table 1

Basic criteria and indicators of food security in the system of state regulation of the economy

Criteria	Content	Indicator	Unit of measurement
Availability	Physical availability of food in sufficient quantity	Food production per capita	tons/year
		Food imports	tons/year; % of domestic consumption
		Food exports	tons/year; % of domestic consumption
		Food stocks	tons; % of domestic production
		Agricultural land area	tons, % of domestic consumption for a certain period
		Yield of major crops	tons/hectares
		Degree of diversification of agricultural production	Index
		Use of modern agricultural technologies	% of domestic consumption
		Post-harvest food losses	%
Accessibility	Economic and physical access to food for all population groups	Per capita income	USD/year
		Percentage of population living below the poverty line	%
		Cost of a basket of basic food products	USD/month
		Ratio of the cost of a basket of basic food products to the minimum wage	%
		Consumer food price index	Reference year = 100
		Availability of food markets and shops in rural areas	Number per capita
		Condition of road infrastructure	Index
		Availability of social support programs	% coverage, amount of payment, UAH
		Unemployment rate	%
		Share of food expenditure in the total household budget	
		Poverty rate	
Utilization	The body's ability to effectively absorb nutrients from food, which depends on sanitation, access to clean water, medical care, and knowledge about nutrition	Rate of malnutrition	%
		Prevalence of stunting among children under 5 years of age	
		Rate of maternal mortality	Number of deaths per 100,000 newborns
		Provision of clean drinking water and sanitation	%
		Coverage of health care	
		Rate of infectious diseases	
		Level of knowledge about proper nutrition	Index
		Rate of consumption of different food groups	Index for each age group
Stability	Ensuring the availability, accessibility and use of food on a permanent basis, without the risk of losing access to it due to economic crises, natural disasters, political instability, etc.	Volatility of prices for basic food products	Volatility index
		Dependence on external energy sources	%
		Number and scale of natural disasters	Quantity, area, losses
		Political stability	Index
		Economic stability	GDP growth rate, inflation rate
		Level of economic diversification	Diversification index
		Existence of an early warning system for emergencies	Coverage, accuracy
		Dependence on climatic conditions	Index

Source: compiled by the author from (Zalizniuk, 2019).

For an objective and adequate assessment of food security assurance in the state regulation system, since assurance includes provision, guaranteeing, and insurance, additional criteria and indicators should be added to the key criteria and indicators (Gudz, 2019), which take into account the availability of the necessary instruments of provision, guaranteeing, and insurance, their effectiveness, impact on various market participants, and the ability to adapt to changes (*Table 2*).

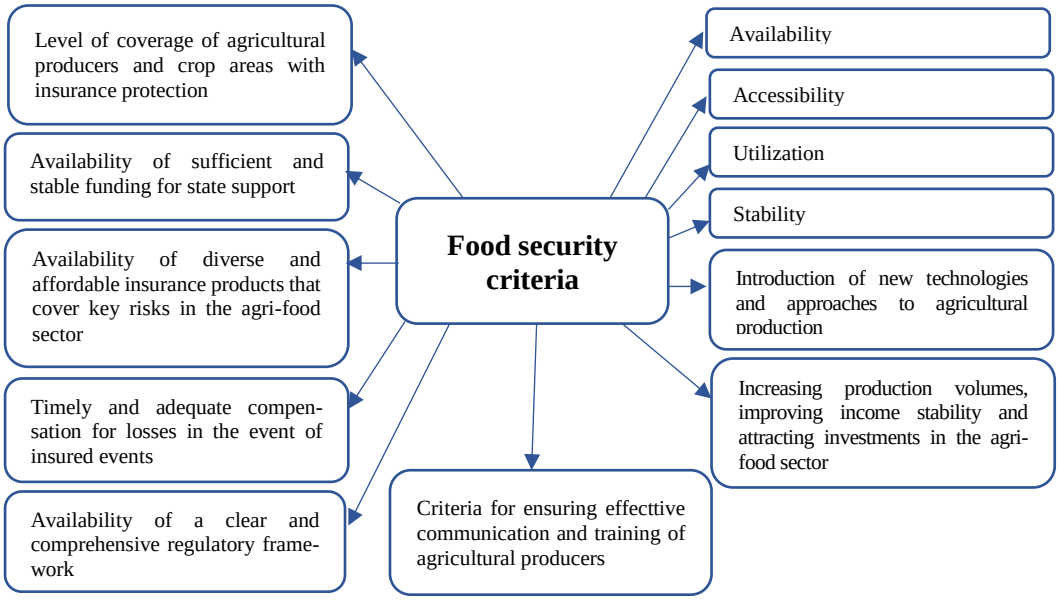
Table 2

Additional criteria and indicators of food security in the system of state regulation of the economy

Criteria	Indicator
A clear and comprehensive regulatory framework governing food security insurance	The presence of laws, resolutions, orders and other regulatory acts that determine the types of risks subject to insurance, mechanisms for state support of insurance (subsidies, guarantees, insurance)
	Requirements for insurance companies engaged in agricultural insurance, the procedure for concluding and executing insurance contracts
	Mechanisms for settling insured events, regular review and updating of the regulatory framework, the presence of a clear division of responsibility between state bodies and insurance companies
Availability of diverse and affordable insurance products covering key risks in the agri-food sector	The number of available insurance products for different categories of producers
	The presence of agricultural insurance products that cover risks associated with weather conditions (drought, frost, hail, floods), plant and animal diseases and pests
	Simplicity and clarity of insurance terms
Availability of sufficient and stable funding for state support	Amount of funds allocated for state support, including for agricultural insurance
	Share of state support in the total volume of insurance premiums
	Effectiveness of budget funds use
	Availability of alternative sources of financing
Level of coverage of agricultural producers and crop areas with insurance protection	Share of agricultural producers with insurance protection
	Share of insured crop areas out of total crop areas
	Share of insured livestock out of total livestock
	Regular review and adaptation of insurance terms to changing climatic conditions
Timely and adequate compensation for losses in the event of insured events	Average term of insurance compensation payment
	Relationship between the amount of insurance compensation and actual losses
	Number and amount of settled insurance claims
	Level of satisfaction of agricultural producers with the process of settling insurance claims
Increasing production volumes, improving income stability and attracting investments in the agri-food sector	Change in agricultural production volumes
	Stability of agricultural producers' incomes
	Volume of investments in the agri-food sector
Introduction of new technologies and approaches to agricultural production	Level of digitalization of business processes, use of agro-innovations (precision farming)
	Share of production of environmentally friendly products
	Development of Internet networks
	Use of satellite data and remote sensing, introduction of index insurance, use of digital platforms
Introduction of new technologies and approaches to agricultural production	Staff training
	Number of information campaigns and training seminars for agricultural producers
	Accessibility of information

Source: compiled and supplemented by the author according to (Gudz, 2019).

Thus, we get a system of criteria for assessing food security (*Figure*).



System of food security criteria

Source: compiled by the author.

The outlined criteria and indicators should be used for regular monitoring and assessment of the effectiveness of food security assurance in the state regulation system, identification of problem areas and development of measures to eliminate them, formation and implementation of state policy for various categories of agricultural producers. At the same time, along with the national level, it is recommended to apply them also taking into account regional characteristics and ensuring transparency and openness in the assessment and reporting process. That is, the use of these criteria and indicators will allow a more objective assessment of the effectiveness of food security assurance in the state regulation system and develop measures to improve it.

As of January 1, 2025, Ukraine's food security remains under the influence of the long-term consequences of full-scale armed aggression, *which significantly affected all aspects of the agri-food system. In Table 3, 4* systematize quantitative and qualitative indicators that reflect the current state of food security assurance.

Quantitative indicators of food security insurance as of January 1, 2025 indicate a gradual stabilization of the agri-food system of Ukraine. The production volumes of grain crops remain at a sufficient level to meet domestic needs, however, the share of imports in total consumption continues to exceed optimal limits, which indicates continued dependence on external sources. The high share of household spending on food and inflationary pressure on food products are indicators of limited economic accessibility of food for broad segments of the population. Despite moderate GDP growth and increased investment in the agricultural sector, the level of insurance coverage of farmers, as well as the share of the

introduction of innovative technologies, remains insufficient. This necessitates the strengthening of state policy on the development of agro-insurance institutions, stimulation of digitalization and diversification of production in the context of strengthening national food security.

Table 3

Quantitative indicators of food security assessment in Ukraine as of 01.01.2025

Criteria	Indicators	Value
Availability	Grain production, million tons (State Statistics Service of Ukraine, 2025)	55
	Share of imports in total consumption, % (Ministry of Agrarian Policy and Food of Ukraine, 2025)	12
	Food stocks, days of consumption (FAO, 2025)	45
Accessibility	Share of household expenditure on food, % (State Statistics Service of Ukraine, 2025)	48
	Consumer food price index (annual increase), % (National Bank of Ukraine, 2025)	+8.2
	Unemployment rate, % (State Statistics Service of Ukraine, 2025)	9.5
Utilization	Prevalence of malnutrition among the population, % (WFP, 2025)	6.3
	Stunting in children under 5 years of age, % (UNICEF Ukraine, 2025)	9.1
	Access to safe drinking water, % (WHO, 2025)	92
Stability	Food price volatility index, % (FAO, 2025)	12.4
	Number of natural disasters affecting the agricultural sector, cases (State Emergency Service of Ukraine, 2025)	7
	GDP growth rate (annual), % (Ministry of Economy of Ukraine, 2025)	3.1
Insurance coverage	Share of insured agricultural areas, % (Ministry of Agrarian Policy and Food of Ukraine, 2025)	18
	Share of insured livestock, % (AgroPortal, 2025)	11
	Average term for payment of insurance compensation, days (National Commission for Regulation of Financial Services Markets, 2025)	45
Financing	Volume of state financing of agricultural insurance, UAH billion (Ministry of Finance of Ukraine, 2025)	1.2
	Share of subsidies in insurance premiums, % (Ministry of Agrarian Policy and Food of Ukraine, 2025)	35
	Number of available financial instruments for farmers (Ukrainian Agrarian Fund, 2025)	5
Technologies	Share of innovative technologies implemented in agriculture, % (Institute of Agrarian Economics, 2025)	22
	Level of digitalization of the agricultural sector, % (Ministry of Digital Transformation of Ukraine, 2025)	28
	Share of organic products in total production, % (Federation of the Organic Movement of Ukraine, 2025)	3.5
Investments	Volume of investments in the agricultural sector, billion UAH (State Statistics Service of Ukraine, 2025)	4.8
	Growth of agricultural production (annual), % (Ministry of Agrarian Policy and Food of Ukraine, 2025)	+2.7
	Stability of agricultural producers' incomes, coefficient of variation (Institute of Agrarian Economics, 2025)	0.5

Source: compiled by the author based on the above sources.

Table 4

Qualitative indicators of food security assurance in Ukraine as of 01.01.2025

Criteria	Indicators	Assessment
Legal framework	Relevance of legislation in the field of food security	Partially updated in accordance with EU requirements; requires further harmonization (State Service of Ukraine on Food Safety and Consumer Protection, 2024)
	Availability of strategic documents and action plans	Food Security Strategy of Ukraine until 2027 approved; operational implementation plan in place (Cabinet of Ministers of Ukraine, 2024)
Insurance products	Availability of insurance products for farmers	Limited; mainly for large farms; needs expansion for small and medium-sized producers (AgroPortal, 2025)
	Coverage of risks related to climate change and natural disasters	Partial; introduction of new products that take into account modern climate challenges is necessary (AgroPortal, 2025)
Communication and training	Availability of awareness-raising and training programs for farmers	Limited number of programs (Caritas Ukraine, 2024)

Source: compiled by the author based on the sources indicated.

Qualitative indicators allow assessing the systemic and institutional prerequisites for ensuring food security. As of the beginning of 2025, there has been a partial update of the regulatory framework in accordance with European standards, however, there is still a need for harmonization and development of by-laws regulating agricultural insurance. Strategic documents, in particular the Food Security Strategy of Ukraine for the period until 2027 (Cabinet of Ministers of Ukraine, 2024, July 23), create the basis for medium-term planning, however, the effectiveness of implementation remains limited due to low awareness of producers and the lack of systematic training programs. The offer of insurance products is uneven and focused mainly on large enterprises, which creates a risk of deepening disparities between producers. In general, qualitative indicators confirm the need to strengthen the institutional capacity of the state regulatory system in the field of food security by expanding the functionality of insurance mechanisms, increasing transparency and developing communication mechanisms with the agricultural environment.

Defining clear criteria and indicators for assessing food security assurance in the state regulatory system is an urgent need for the successful recovery and development of Ukraine in the post-war period, which will contribute to ensuring national security, effective restoration of the agro-industrial complex, development of sustainable agriculture and improvement of the state regulatory system, thereby guaranteeing access to high-quality and safe food for every Ukrainian. This task requires consolidated efforts of the state, scientists, business and the public.

4. Advantages of the proposed updated food security assessment system

In fact, an objective assessment of food security assurance in the state regulation system according to the proposed criteria and indicators reveals significant advantages for the rapid recovery and rapid development of Ukraine, since:

• accurately outlines the scale of the problem, provides a clear understanding of the current state of food security, identifying specific regions, population groups and sectors of the economy that have suffered the most from the war, which allows for targeted allocation of resources and development of effective assistance strategies;

• provides objective data on losses in the agricultural sector, destruction of infrastructure and changes in consumer habits, contributes to the development of substantiated specific plans and measures aimed at restoring production capacities (agricultural machinery, seeds, fertilizers), rebuilding logistics chains (elevators, ports, roads), supporting agricultural enterprises;

• becomes a convincing argument for attracting financial and technical assistance from international organizations, governments of other countries and donors, as it is supported by independent research and international standards on needs and recovery plans, which increase confidence in Ukraine and contribute to the mobilization of necessary resources;

• allows to monitor progress in restoring food security, identify new challenges and timely adjust strategies and programs, which will ensure flexibility and adaptability in the recovery process;

• allows to identify vulnerabilities and develop measures to address them, reducing dependence on imports and increasing resilience to external shocks;

• promotes transparency and accountability in the use of resources aimed at restoring food security, which increases public trust in the government and other stakeholders.

At the same time, an objective assessment of food security assurance in the state regulation system according to the proposed criteria and indicators generates additional opportunities:

• helps to identify the most promising areas for investment in the agricultural sector, such as the development of irrigation systems, the introduction of modern technologies and support for organic farming;

• outlines such guidelines for stimulating innovation in the agricultural sector as the development of new varieties of agricultural crops that are resistant to climate change and the development of alternative food sources, which contributes to the diversification of production, reducing dependence on certain crops;

• allows for the development of more effective risk management systems in the agricultural sector, including crop insurance, the creation of reserve food stocks and the development of emergency response plans;

• helps to develop integrated recovery programs aimed at the development of rural areas, job creation, infrastructure improvement and improving the quality of life in rural areas;

• serves as the basis for developing a more effective and targeted state policy in the field of food security, including supporting producers, regulating prices, and ensuring access to food for vulnerable groups of the population.

Thus, an objective assessment of food security is an integral part of the successful post-war reconstruction of Ukraine, providing a basis for effective planning, attracting assistance, monitoring results, and opening up new opportunities for innovation, diversification and development of rural areas, strengthening national security and improving the well-being of citizens.

Conclusions

Based on the results of the research, the criteria and indicators for assessing food security in the system of state regulation for post-war recovery are substantiated. The food security system of Ukraine during the war is characterized, including production, logistics, economics, and international assistance.

The choice of criteria and indicators for assessing food security in the system of state regulation of the economy for post-war recovery depends on many factors, which are systematized by: the context, purpose and objectives of the assessment, methodological dimension, characteristics of the food system and vulnerable population groups. Key and additional criteria and indicators for assessment are proposed, and it is argued that they should be used for regular monitoring and assessment of the effectiveness of food security in the system of state regulation, for identifying problem areas and developing measures to eliminate them, for forming and implementing state policy for various categories of agricultural producers.

Thus, the hypothesis that an objective assessment of food security is an integral part of the successful post-war reconstruction of Ukraine is confirmed. It provides the necessary information for effective planning, attracting assistance, monitoring progress and adjusting strategies, opens up additional opportunities for innovation, diversification and development of rural areas, strengthening national security and improving the well-being of citizens.

Prospects for further research include the development of an integrated system of digital monitoring of food security assurance using geo-information technologies and artificial intelligence. It is also advisable to conduct an in-depth study of regional features of food security in the context of decentralization and development of territorial communities.

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DIGITALIZATION IN ENSURING THE RESIELENCE OF TRADE ENTERPRISES

The full-scale invasion of the russian federation into Ukrainian territory has significantly changed the operating conditions for trade enterprises, forcing them to adapt their business processes to new challenges. Traditional management methods used before the crisis proved inadequate for ensuring stable operations. This has created the need for the implementation of new approaches focused on digital transformation. The hypothesis of the research is that the implementation of digital technologies, such as CRM and ERP systems, cloud services, analytical platforms, and artificial intelligence, positively impacts the stability of trade enterprises under martial law and helps maintain their competitiveness in crisis conditions. The research applies methods of generalization, analysis, synthesis, systematization, comparison, and scientific abstraction. It examines how digital technologies contribute to improving management efficiency, minimizing risks, and maintaining the competitiveness of enterprises. The results of the research indicate

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ЦИФРОВІЗАЦІЯ У ЗАБЕЗПЕЧЕННІ СТІЙКОСТІ ТОРГОВЕЛЬНИХ ПІДПРИЄМСТВ

Повномасштабне вторгнення російської федерації на територію України значно змінило умови функціонування торговельних підприємств, змушуючи їх адаптувати бізнес-процеси до нових викликів. Традиційні методи управління, що застосовувалися до кризи, виявилися недостатніми для забезпечення стабільної діяльності підприємств. Це створило необхідність впровадження нових підходів, орієнтованих на цифрову трансформацію. Висунуто гіпотезу, що впровадження таких цифрових технологій, як CRM- та ERP-системи, хмарні сервіси, аналітичні платформи та штучний інтелект, позитивно впливає на стійкість торговельних підприємств в умовах воєнного стану та допомагає зберігати їх конкурентоспроможність у кризових умовах. Застосовано методи узагальнення, аналізу, синтезу, систематизації, порівняння та наукового абстрагування. Досліджено, що цифрові технології сприяють підвищенню ефективності управління, мінімізації ризиків і збереженню конкурентоспроможності підприємств.

that digitalization is one of the key factors in business stability during crises. The implementtation of digital technologies allows trade enterprises not only to adapt to unstable conditions but also to lay the foundation for long-term development. The main challenges related to digital transformation have been identified, and recommendations for overcoming them have been proposed.

Keywords: digitalization, business resilience, trade enterprises, digital technologies, martial law, digital transformation.

Результати дослідження свідчать, що цифровізація є одним з ключових факторів стабільності бізнесу в умовах кризових явищ. Впровадження цифрових технологій дозволяє торговельним підприємствам не лише адаптуватися до нестабільних умов, а й закладати основу для довгострокового розвитку. Визначено основні труднощі, пов'язані з цифровою трансформацією, та запропоновано рекомендації щодо їх подолання.

Ключові слова: цифровізація, стійкість бізнесу, торговельні підприємства, цифрові технології, воєнний стан, цифрова трансформація.

JEL Classification: D21, J32, L23.

Introduction

In the context of global economic instability, exacerbated by the full-scale war in Ukraine, the digital transformation of business has transformed from an innovative trend into a necessary condition for the survival and sustainability of enterprises. These challenges are especially acute in the field of trade, where the destruction of logistics chains, changes in consumer behavior, infrastructure disruptions, and reduced demand require a radical revision of management models.

The problem addressed by this research is the need to ensure the sustainability of trade enterprises in conditions of exogenous shock, in particular armed conflict, by implementing digital tools that will allow maintaining operational efficiency, optimizing processes, and minimizing risks.

The issue of digitalization of the national economy is currently being actively studied by scientists. The scientists who conducted research on current trends in the development of the digital economy in Ukraine include: I. Aksyonova, V. Apalkova, K. Buzhymska, O. Dannikov, M. Kyzym, G. Kopteva, N. Kraus, N. Levitska, I. Odotyuk, O. Pizhuk, O. Raevneva, O. Reshetnyak, A. Semenog, I. Strutynska, V. Haustova, K. Shaposhnikov, S. Scarlett, H. Yarovenko and others.

In particular, the work of Zaman et al. (2024) investigated the impact of management on the effectiveness of digitalization processes in enterprises. The need to apply personalized approaches to digitalization depending on the company's position in the market and the specifics of its activities was noted by scientists Parviainen et al. (2022).

One of the works by scientists Bai and Kalinichenko (2023) emphasized the importance of digitalization of society in general, in particular educational processes and personnel training to increase the innovative potential of enterprises.

For their part, Fedulova and Dzhulay (2020) study best practices aimed at supporting the internal and external brands of companies in various areas of activity in crisis conditions.

However, the practical aspects of using digital solutions in trade during the war by companies such as Rozetka, Silpo, and Epicenter remain insufficiently covered. Therefore, this scientific gap became the subject of the research.

The aim of the research is to determine the role of digital technologies in ensuring the stability of trade enterprises in martial law, to analyze the effectiveness of the use of specific IT solutions (CRM, ERP, clouds, analytics), and to formulate recommendations for the implementation of digital tools in a crisis environment.

To achieve the aim, it is necessary:

- to summarize theoretical approaches to the concept of digital transformation in business;
- to investigate modern digital practices of Ukrainian retailers;
- to assess the effectiveness of implemented solutions using quantitative indicators;
- to identify barriers to digitalization and provide recommendations for overcoming them.

The hypothesis of the research is the assumption that the implementation of digital tools allows significantly increase the resilience of retail enterprises to external shocks, in particular to the consequences of armed conflict.

To test the hypothesis, a combined methodological approach was used: comparative analysis before/after the implementation of digitalization (using the examples of the companies Epicenter, Silpo, Rozetka); case method in-depth study of Bitrix24, Power BI, Google Cloud application models; elements of statistical analysis – assessment of performance indicators; content analysis of public reports, regulatory legal acts and expert interviews.

Information base is official company reports, Opendatabot data, Microsoft Ukraine publications, Kyivstar Business Hub, documents on the use of CRM/ERP in the retail sector.

Structurally, the article has three main sections. The first section examines the theoretical aspects of digitalization, in particular the concept, meaning and main directions of digital transformation. The second section is devoted to the analysis of the impact of digitalization on the sustainability of retail enterprises, in particular its role in improving operational activities, increasing competitiveness and minimizing risks. It also highlights the key digital tools and technologies used by enterprises, in particular CRM and ERP systems, cloud platforms, analytical systems and artificial intelligence. The third section characterizes the challenges and risks of digital transformation, issues of cybersecurity, financial constraints and the need to develop digital literacy of personnel. The conclusions summarize the results of the research and formulate practical recommendations for the effective implementation of digital technologies in the retail sector.

1. Theoretical aspects and concepts of digitalization

1.1. The concept and meaning of digitalization

Digitalization is the process of introducing digital technologies into all areas of an enterprise's functioning, which involves transforming business models, automating processes, integrating analytics and digital platforms to increase the efficiency and adaptability of the organization. Unlike computerization, which focuses on automating individual tasks, digitalization encompasses changing organizational logic and creating new forms of value for customers (Parviainen et al., 2017).

The European Commission defines digital transformation as the use of digital technologies to significantly improve productivity, competitiveness of enterprises and interaction with customers (European Commission, 2020). According to Schwab's study (2017), digitalization is the foundation of the Fourth Industrial Revolution, which is shaping new economic paradigms.

In the context of martial law in Ukraine, the importance of digital technologies has grown rapidly. Retail companies are forced to restructure their operating models, switch to remote service formats, and automate logistics and financial processes. According to Opendatabot data (2023, October 23), over 60% of enterprises in the retail sector in Ukraine have implemented new digital solutions, including CRM, ERP, cloud services, and analytical platforms, in the past two years.

1.2. The main directions of digital transformation of trade enterprises

Business process automation. The implementation of digital platforms (ERP, SCM, BPM systems) allows enterprises to automate routine operations: order processing, inventory management, logistics, accounting. This reduces the impact of the human factor, increases the accuracy and speed of operations (Davenport & Harris, 2007).

Cloud technologies. The transition to cloud services (Google Cloud, AWS, Microsoft Azure) provides continuous access to data, flexibility of scaling, and reduced costs for IT infrastructure. In wartime, clouds become critically important for data storage and ensuring work during relocation (Bhandari et al., 2025).

Development of e-commerce. Digital trading platforms allow enterprises to sell online, reducing dependence on physical infrastructure. Marketplaces, mobile applications, integration with payment systems allow you to expand markets and maintain a customer base (Natorina, 2021).

Big Data Analytics. Using analytics platforms (Power BI, Tableau, Qlik) helps businesses analyze customer behavior, forecast demand, optimize

inventory, and evaluate the effectiveness of marketing campaigns in real time.

Artificial intelligence and machine learning. The use of AI for chatbots, recommendation systems, and query recognition allows for personalized service and reduced customer support costs.

Cybersecurity. The increase in the volume of digital transactions requires new approaches to data protection. The implementation of multi-factor authentication, backups, and intrusion detection systems (IDS) are critically needed, especially given the increase in the number of cyberattack attempts. From the beginning of January to February 20, 2025, cyberattacks were carried out on at least 25 Ukrainian enterprises engaged in the development of automated process control systems and related to electrical installation work, and on four more enterprises specializing in the design and production of equipment for drying, transporting, and storing grain (State Service for Special Communications and Information Protection of Ukraine, 2025, March 20).

Electronic interaction with government agencies. Electronic document management (Vchazno, 2021), reporting through digital channels, and digital signatures reduce time, costs, and bureaucratic barriers.

Thus, the main directions of digital transformation of commercial enterprises cover a wide range of technologies from the automation of internal processes to the use of cloud services, analytics, artificial intelligence and digital channels of interaction with the state. Each of these directions not only increases operational efficiency, but also ensures the adaptability and stability of business in martial law conditions. Therefore, digitalization becomes not just a tool for optimization, but a key factor in the survival and development of enterprises in conditions of high uncertainty and risks.

1.3. The impact of digitalization on the resilience of trade enterprises

In modern business conditions, especially during martial law, ensuring the sustainability of commercial enterprises is becoming one of the key management tasks. Business sustainability is understood as its ability to function effectively in conditions of uncertainty, maintain competitive positions, ensure financial stability and adapt to changes in the external environment. The introduction of digital technologies is a powerful tool that allows you to achieve these goals by increasing the level of automation, accelerating decision-making processes and reducing operating costs.

One of the key factors that determines the need for digital transformation of commercial enterprises is the growing volatility of the market and the uncertainty of the economic situation. Changes in consumer

behavior, disruptions in supply chains, fluctuations in demand and the need to quickly respond to new challenges require businesses to increase flexibility and adaptability. In this context, digitalization allows you to create effective business process management mechanisms that provide operational control over key aspects of the enterprise's activities, such as logistics, finance, marketing and personnel management.

Digital technologies are significantly changing the mechanisms of interaction between enterprises and their customers. The implementation of CRM systems, chatbots, personalized electronic services and mobile applications contributes to the formation of a better customer experience, which in turn increases the level of consumer loyalty and ensures the stability of sales. The use of analytical platforms allows enterprises to receive timely information about the market, analyze consumer behavior and predict trends, which allows them to make more informed strategic decisions.

No less important is the impact of digital technologies on cost optimization. Automation of business processes helps to increase labor productivity and reduce the need for human resources to perform routine operations, which reduces the operating costs of enterprises. The use of cloud technologies allows you to reduce costs for supporting IT infrastructure, and the introduction of digital payment systems simplifies financial management processes and helps increase the transparency of financial flows.

Digitalization is a powerful factor in increasing the resilience of commercial enterprises, allowing them to quickly adapt to changes, ensure operational continuity, minimize risks and open up new opportunities for development. In conditions of martial law, this process becomes even more relevant, as digital technologies help enterprises continue their activities even in conditions of limited physical access to resources, logistical problems and instability of the economic environment (Blakyta et al., 2025).

2. Digital tools and technologies

2.1. Types of digital technologies

Digitalization has become one of the key transformation areas of commercial enterprises in the 21st century. It has become particularly relevant in wartime, when traditional business processes have undergone significant changes due to logistical difficulties, risks to personnel and infrastructure, and the need for rapid adaptation to an unstable environment. Digital tools make it possible to ensure the stability of enterprises, the efficiency of management decisions, the preservation of the client base, and adaptation to new realities (*Table 1*).

Table 1

Functions and benefits of key digital tools

Category	Functions	Benefits
CRM-systems	Customer database management; automatic generation of offers; integration with call center and social networks; automated sales funnels	Increase conversion; reduce churn; fast service; customer satisfaction
ERP-systems	Inventory control; supply management; financial accounting and reporting; personnel management	Synchronization of departments; minimize errors; reduce costs; efficiency
BI-systems	Sales analysis; demand forecasting; comparison of planned and actual indicators; identify trends	Data-driven solutions; performance monitoring; shortage forecasting; assortment optimization
Power BI	Integration with Excel, SQL, CRM, ERP; publishing reports online; auto-update data; adaptive dashboards	Operational procurement management; control of logistics costs; tracking consumer behavior
Electronic document management systems	Creation and signing of electronic documents; electronic signature; integration with accounting	Time reduction; avoidance of document losses; continuity of document flow
Cloud services	Collaboration; backup; remote access; data protection	Business continuity; data protection; team collaboration
SCM systems	Supply planning; inventory management; logistics optimization	Reducing warehousing costs; fast delivery; coordination with suppliers
E-commerce platforms	Catalog management; integration with CRM, ERP, payment systems; logistics automation; sales analytics	Reducing costs; access to new markets; flexible pricing
Marketing platforms	Customer segmentation; launching newsletters; multi-channel campaigns; click-through rate analytics	Increasing engagement; repeat sales; saving marketers' time
Chat bots and omnichannel platforms	Autoresponders; ordering in messenger; forwarding to the operator	24/7 availability; reducing load; quick response
Project management systems	Creating tasks; controlling deadlines; productivity analytics	Transparency of work; timely execution; responsibility in the team
HRM/HCM systems	Electronic personnel files; vacation schedules; time tracking; staff turnover analytics	Less paperwork; convenience for HR and accounting; quick processing of changes

Source: compiled by the authors.

CRM systems (Customer Relationship Management) are an integral part of modern customer relationship management. In the field of trade, they allow not only to keep a complete history of interactions with each buyer, but also to segment the audience, analyze behavioral patterns, and automate marketing and sales processes.

ERP systems allow you to centrally manage all key processes of the enterprise: from accounting for goods to logistics, procurement, finance, and personnel management. This is especially important in times of crisis, when the efficiency and accuracy of data are crucial.

BI platforms provide analytical support for decision-making. They collect large amounts of data from various sources and provide tools for their visualization and in-depth analysis.

Cloud services provide access to enterprise resources from anywhere in the world. This is especially important when part of the staff is located in another region or country, or when offices and warehouses are physically inaccessible.

Supply chain management (SCM) systems allow you to forecast needs, manage supplies, and reduce the risks associated with shortages or excesses of goods, which is especially critical in conditions of wartime resource shortages.

Digital platforms for e-commerce allow you to organize online sales – both through your own website and through marketplaces. In conditions of physical restrictions, destruction of trade infrastructure or the impossibility of conducting offline trade, these platforms have become the only channel of interaction with the consumer for many enterprises.

Marketing platforms and automators (Marketing Automation Platforms). In the context of the digital transformation of trade, it is important not only to establish operational activities, but also to maintain communication with customers. Marketing automation systems allow you to create personalized e-mail, SMS, Viber or push campaigns, track the effectiveness of advertising activities and conduct A/B testing.

Chatbots and omnichannel service platforms. Automated service has become not only a trend, but also a necessity during wartime, when physical contact is limited and the load on contact centers is maximum. Chatbots allow you to process thousands of requests without human intervention, and omnichannel support platforms combine all communication channels in a single window.

Project and task management systems (Project Management Systems). Effective team management is especially important in conditions of remote work, changing schedules and geographical dispersion of employees. Task management systems help maintain clarity in the implementation of plans, delegation and reporting (Ministry of Digital Transformation of Ukraine, 2023).

HRM/HCM systems (Human Capital Management). In crisis conditions, when teams change frequently or are under stress, automation of HR processes allows you to maintain order and control over personnel processes. This is also critical for ensuring legal compliance and labor accounting.

These tools form a digital infrastructure that supports the vital activities of the enterprise in extraordinary circumstances. Their systemic integration and strategic use are the basis of resilience, productivity and flexibility of modern trade.

2.2. The use of digital technologies in Ukraine

In the context of a full-scale war, Ukraine has become an example not only of resilience, but also of the dynamic implementation of digital innovations in the field of trade. A significant number of enterprises, in particular national retailers, have adapted their business models through digital transformation, which allowed them to maintain competitiveness and ensure operational sustainability. One of the most illustrative cases is the Epicenter. The company invested in IT infrastructure even before the start of hostilities, but it was the hostilities that became the impetus for accelerating digital transformation. Due to the disruption of logistics chains and the loss of warehouses, a significant part of operations was transferred to the digital environment. In particular, in July 2020. Epicenter switched to electronic document management using the Vchasno platform: up to 95% of contracts and acts are executed electronically, up to 100 documents are signed daily, and on peak days, about 300 contracts are signed monthly, and the transition itself, along with employee training, took only 15 minutes. In addition, the SAPS/4HANA system was implemented to automate accounting, logistics, finance, and procurement, as well as a CRM module to personalize interaction with customers. The use of cloud solutions ensured continuous access to data even in the event of physical damage to the center servers. The result was a reduction in the time it takes to complete online orders, a decrease in the share of delivery errors, and a significant increase in the share of online sales in the overall revenue structure (Bezruk, 2023; Vchasno, 2021).

Retailer Rozetka consistently integrates advanced digital solutions to improve operational efficiency and customer service quality. By implementing the Google Analytics 360 platform in combination with BigQuery cloud storage and integrating data from the ERP system, the company was able to process huge amounts of data in real time and generate high-quality recommendations for consumers (Google, 2016). This allowed it to increase revenues from direct SMS mailings by 18%, and the average check by 9%. The new architecture allows sending personalized e-mail mailings taking into account ERP data, inventory and customer behavioral patterns.

In parallel, to optimize customer support, Rozetka implemented an omnichannel service based on Zendesk in partnership with the integrator Cloudfresh. The implementation of basic Zendesk modules, in particular HelpCenter, allowed the retailer to increase the productivity of the support service by 1.5 times and reduce the time to first response by 65% without the

need to expand the staff. These activities have shown that a well-thought-out digital architecture not only enhances the customer experience, but also improves the resource efficiency of business processes. The strategic use of data and digital platforms allows Rozetka not only to optimize internal operations, but also to increase the return on marketing campaigns, while strengthening its competitive advantages in the e-commerce market (Cloudfresh, 2019).

The Silpo chain confirms its strategic course for digital transformation aimed at optimizing services and improving customer experience. In July 2020, the chain introduced the Scan & Go system ("Free Checkout") – a technology for self-scanning goods via a mobile application and self-service checkouts ("Self-checkouts"). As part of the pilot launch, more than 75,000 participants of the "Own Account" program used this service; Scan & Go is currently available in 59 supermarkets, which significantly reduced time at the checkout, minimized queues, and increased service speed in conditions of mass customer presence in shopping centers. In addition, back in December 2018, Masterpass QR was integrated into the Silpo application, thanks to which buyers can make payments in one scan in more than 230 stores. This supports a wide range of customers – even those whose devices do not support Apple Pay or Google Pay – and indicates universality, inclusiveness, and high-tech use. The Silpo chain is actively modernizing both the front office through innovative customer interactions and the back office through digital systems. Currently, the Silpo chain has established itself as one of the leaders of innovative retail in Ukraine, ensuring operational stability, reducing the load on cash registers, and significantly improving customer convenience (Silpo, 2018, December 22).

Kasta also demonstrates high adaptability. In particular, the use of the Similarweb platform has expanded its capabilities for analyzing the competitive environment and optimizing marketing costs. Using the IT tool, Kasta tracks competitors' investments, analyzes changes in advertising strategies, and identifies new product categories, which resulted in a 2.5-fold increase in sales in the second half of 2024. The digital direction also accompanied the optimization of sales channels and the adaptation of marketing strategies in real time, which helped Kasta maintain flexibility in the face of crisis changes in the market (Similarweb, 2024).

This experience illustrates the importance of a multi-level digital strategy: competitive analysis tools, big data analytics, and cloud solutions help not only optimize current operations, but also quickly respond to market changes, increase profitability, and strengthen positions in the Ukrainian e-commerce arena.

Comparative characteristics of the digital tools used and the achieved results are presented in *Table 2*.

Table 2

Digital tools and prospects for the development of trade enterprises

Chain	Digital tools	Achievements	Prospects for the development
Silpo	Scan & Go via mobile application ("Vilnokasa") QR payment Masterpass	Over 75,000 users of the "Vlasny Rahunok" program Deployed in 59 stores Payment with one scan in over 230 points	Expansion of self-service checkouts CRM integration for personalization Implementation of AI analysis of user behavior
Rozetka	Google Analytics360 + BigQuery Zendesk for omnichannel support	Increased marketing revenue, customer support productivity, response speed	AI personalized recommendations Chatbot and bot support expansion Deep CRM + BI integration
Kasta	Competent analysis via Similarweb	Analytics gave 2.5 times sales growth in 2024	AI variable pricing Realtime BI dashboards Internal BI infrastructure for marketing and logistics
Epicenter	SAPS/4HANA ERP CRM module Cloud solutions for data availability	Cloud solutions for data availability Transferring business operations to the cloud Continuous access to data in case of loss of physical infrastructure Reduction of online order time, delivery errors, growth of online sales	Integration of AI logistics and analytics Deep CRM communication Development of mobile channels for customers

Source: compiled by the authors based on (Cloudfresh, 2019; Fozzy Group, 2020, July 2; Silpo, 2018, December 22; Similarweb, 2024).

Therefore, *Table 2* shows the formation of a new paradigm in the management of trade enterprises where digitalization is not only a tool for increasing efficiency, but also a means of ensuring flexibility, stability, and strategic advantage in an unstable environment.

3. Risks and challenges of digitalization

Despite the numerous advantages of digital transformation, its implementation is accompanied by a number of complex risks that can significantly affect the effectiveness of the implementation of digital solutions in commercial enterprises. One of the most acute of them is the growth of cyber threats, which has become especially relevant in war conditions. The intensification of hacker attacks, the spread of malicious software, phishing campaigns, and the increase in the use of ransomware create serious threats to the continuity of business processes. System vulnerability is often exacerbated by the lack of multi-layered protection, outdated software, or a low level of staff awareness of the basics of cyber hygiene (Bezhan & Rozhko, 2023).

Another significant barrier to digital transformation is the high financial cost of implementing technologies. Small and medium-sized enterprises often do not have the opportunity to invest in the purchase of licensed software, hardware upgrades, payment for IT consulting, or provision of continuous technical support. In addition to initial costs, digitalization requires sustained investments in infrastructure support, system upgrades, cybersecurity, and staff training, which places additional strain on enterprise budgets (Omowole et al., 2024).

There is also a low level of digital literacy among staff. Employees who are not prepared to work with new digital platforms may make mistakes, which reduces the effectiveness of automation. Insufficient understanding of the principles of CRM, ERP and BI systems leads to an increase in the workload of technical departments and slows down the company's adaptation to new digital formats. The formation of an internal culture of digital competence requires time, resources and additional organizational efforts (Sytnyk & Tarkanii, 2024).

The instability of telecommunications infrastructure, which arises as a result of military operations, power outages or cyberattacks on critical facilities, creates additional risks. In the event of loss of communication or access to cloud services, companies may lose control over supply chains, electronic document management, warehouse accounting or interaction with customers. The reliability of digital systems in such conditions requires not only high technical stability, but also the availability of backup scenarios and autonomous recovery tools.

In addition to technical and organizational barriers, enterprises face regulatory restrictions and legal uncertainty. The implementation of international standards for the protection of personal data, such as GDPR, or national requirements for electronic document management requires companies to make changes to the internal regulatory framework, which is often accompanied by additional costs for legal support and auditing.

Separately, it is necessary to dwell on the factors of resistance to change from the side of personnel and management. Digital transformation, like any strategic change, is inevitably accompanied by psychological discomfort, doubts about the feasibility of innovations, fears of losing a job or excessive control. The lack of proper communication of the benefits of digitalization leads to passive or even active resistance from employees. To overcome this challenge, it is necessary to implement motivation programs, internal training and employee involvement in the transformation process at the early stages (Ministry of Digital Transformation of Ukraine, 2023).

In the context of a full-scale war, the role of cyber threats is especially growing. With the beginning of a full-scale war, Ukraine has become a target for numerous cyber-attacks aimed at destabilizing critical infrastructure, financial institutions, and government agencies. According to research, in 2023, Ukraine suffered more than 600 cyber-attacks, which is a fifth of all

cyber-attacks in the world (Center for Democracy and the Rule of Law, 2024, September 4; Olteanu, 2024). Such attacks are diverse in execution and can lead to reputational or financial losses and disruption of business operations:

data leakage – unauthorized movement or theft of confidential information can cause financial and reputational losses;

social engineering – attacks that use psychological manipulation to gain access to company systems;

phishing – fraudulent emails or messages aimed at obtaining confidential information;

DDoS attacks – overloading a system with requests with the aim of disabling it.

To effectively counter malicious intrusion, it is advisable for enterprises to follow a number of recommendations:

- Implementing multi-layered protection: using modern solutions to protect the network and devices, such as FortiGuard, FortiMail, and FortiAI.
- Staff training: increasing employee awareness of cyber threats and methods for avoiding them.
- Regular cyber diagnostics: conducting penetration tests and assessing the vulnerabilities of the information environment.
- Data backup: creating backup copies of important information for recovery in the event of an attack.
- Collaboration with specialists: involving cybersecurity experts to develop and implement effective protection strategies (Yilmaz et al., 2023).

Despite the obvious advantages of digital transformation, its implementation is accompanied by a number of serious challenges, both technical and organizational and psychological in nature. The most threatening are the growing cyber risks, which in wartime conditions have acquired a systemic scale, creating a potential danger to the continuity of business processes and the preservation of critical data. Additional barriers remain high costs of digitalization, low digital literacy of personnel, infrastructural instability, legal uncertainty and resistance to change from the side of employees. To overcome these difficulties, commercial enterprises need to implement comprehensive approaches to cyber protection, systematically invest in personnel training, modernization of IT infrastructure and the formation of a digital culture in the organization.

Conclusions

The research analyzed key digital tools implemented by Ukrainian retail enterprises under martial law, including CRM and ERP systems, cloud services, analytical platforms, electronic document management, and solutions based on artificial intelligence. Based on the analysis of practical cases of the companies Epicenter, Rozetka, Silpo, and Kasta, it was proven that digitalization significantly increases adaptability, operational efficiency,

and business resilience to crisis conditions. The hypothesis about the positive impact of digitalization on the viability of retail enterprises under war conditions was confirmed by both quantitative and qualitative indicators, in particular, in reducing order processing time, increasing NPS, reducing logistics costs, and increasing document flow efficiency.

The scientific novelty of the research lies in the integrated approach to studying the impact of digitalization on the resilience of retail enterprises under armed conflict. Unlike previous developments, the research analyzes in detail the military challenges of digital transformation in Ukraine: cyberattacks, infrastructure instability, and resource limitations.

The implementation of digital tools covers several key areas: business process automation, the use of cloud services, resource management systems (ERP), customer databases (CRM), analytics tools (BI) and electronic document management platforms. CRM systems contribute to increased personalization of service, customer retention and increased sales. ERP platforms integrate finance, logistics, inventory and human resources into a single management system, which allows for better coordination and transparency. BI tools play a critical role in data-based decision-making, and cloud technologies guarantee business availability regardless of geographical location and physical infrastructure security.

At the same time, digitalization is accompanied by a number of risks, the most important of which is the growth of cyber threats. This is all the more relevant now that cyber-attacks from the aggressor state, data leaks, phishing and social engineering are becoming regular threats to Ukrainian business. Low levels of digital literacy among employees, high initial investments, unstable internet connections, legal uncertainty, and resistance to change form a multifactorial barrier to effective transformation.

However, the existing threats do not negate the potential of digitalization; on the contrary, enterprises that integrate digital tools systematically and strategically demonstrate a higher level of adaptability, scalability, and readiness for future challenges. Retail chains that previously automated key processes turned out to be better prepared for war, retained customers and assets, and also entered new sales channels. Thus, digitalization is not just a tool for modernization, but a condition for survival and sustainable development of business in conditions of uncertainty.

To ensure effective digital transformation, it is necessary to apply a comprehensive approach that includes investments in technology, formation of digital skills of personnel, strengthening cyber defense, adaptation of regulatory processes, and change of organizational culture. Only under such conditions will retail enterprises be able not only to overcome modern crises, but also to gain long-term competitive advantages in the digital economy.

Future scientific research should focus on several areas. First, it is modeling the economic efficiency of digital investments in crisis conditions, taking into account industry specifics and business scale. Second,

it is promising to study the social and psychological factors of digital transformation, in particular, resistance to change, the level of digital culture, and staff motivation. Third, it is necessary to conduct a deeper analysis of the relationship between the level of cyber protection and customer trust in trading platforms in conditions of military and post-war instability. It is also relevant to study the impact of state regulatory policy on the intensity of digitalization of small and medium-sized businesses. Special attention should be paid to the development of artificial intelligence in the management of trading enterprises, in particular in the field of demand forecasting, assortment formation, and service personalization.

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REVENUE PLANNING OF PHARMACEUTICAL COMPANIES

The exceptional circumstances of martial law, economic turbulence in the country, and the dynamic development of the global pharmaceutical market influence the financial planning approaches of pharmaceutical enterprises. Under these conditions, combining traditional financial planning methods with modern analytical and statistical tools becomes crucial. This integration enables adaptation to external conditions and ensures sustainable revenue growth. The research is based on the hypothesis that a correlation exists between key financial indicators of pharmaceutical companies (specifically net sales) and the level of investment, intangible assets, and labor resources. The aim of the research is to identify and assess the impact of key factors on the revenue of pharmaceutical enterprises. The research employs methods including theoretical generalization, system analysis, grouping, abstraction, statistical methods for information collection and processing, deduction, induction, and regression analysis. The research utilizes data from the State Statistics Service of Ukraine, financial statements of pharmaceutical companies obtained from analytical systems and open data portals (YouControl, Opendatabot, Clarity Project), and relevant scientific articles. Based

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ПЛАНУВАННЯ ДОХОДІВ ФАРМАЦЕВТИЧНИХ ПІДПРИЄМСТВ

Виняткові обставини воєнного стану, економічна турбулентність в країні, динамічний розвиток глобального фармацевтичного ринку впливають на підходи до фінансового планування фармацевтичних підприємств. Важливим за таких умов стає поєднання традиційних методів фінансового планування з сучасними аналітичними та статистичними інструментами, що дозволяє адаптуватися до зовнішніх викликів та забезпечити стійке зростання доходів. Дослідження ґрунтується на гіпотезі про існування кореляції між фінансовими показниками фармацевтичних компаній (чистим доходом) і рівнем інвестицій, обсягом нематеріальних активів й трудовими ресурсами. Метою статті є виявлення та оцінка впливу ключових чинників на дохід фармацевтичних підприємств. У дослідженні застосовано методи теоретичного узагальнення, системного аналізу, групування та абстрагування, статистичні методи збирання та обробки інформації, дедукції та індукції, статистичний метод регресійного аналізу. Дослідження виконане за даними Державної служби статистики України, фінансової звітності підприємств фармацевтичної галузі, отриманої з аналітичних систем та порталів відкритих даних: YouControl,

on this data, the study generated consolidated financial statements for Ukraine's leading pharmaceutical companies (those with the highest net sales) for 2024. The impact of specific factors on these companies' revenue levels was analyzed using regression analysis. This allowed for an assessment of the strength and direction of the influence exerted by internal factors: investment levels, the share of intangible assets, and the number of employees. The obtained results can be used for more informed revenue planning by pharmaceutical companies. The identified relationships between revenue and key factors enable the modeling of potential financial outcomes under various development scenarios. This empowers enterprises to optimize cost structures, investments, and resource management by focusing on indicators that demonstrate a statistically significant impact on revenue. Consequently, the study's findings serve as a valuable tool for supporting strategic management decision-making.

Keywords: revenue, revenue planning, investments, intangible assets, labor resources, regression model.

JEL Classification: L52, O21, C60.

Опендатабот, Clarity Project, наукових джерел. Сформовано узагальнені дані фінансової звітності провідних фармацевтичних компаній України за 2024 р., які мають найбільші обсяги чистого доходу. Проведено аналіз впливу окремих чинників на рівень доходу фармкомпаній з використанням регресійного аналізу, що дозволило оцінити силу та напрям впливу внутрішніх факторів: рівня інвестицій, частки нематеріальних активів та кількості працівників. Отримані результати можуть бути використані для більш обґрунтованого планування доходів фармацевтичних компаній. Виявлені залежності між доходом та ключовими чинниками дозволяють моделювати можливі фінансові результати за різних сценаріїв розвитку. Це дає змогу підприємствам оптимізувати структуру витрат, інвестицій та управління ресурсами, орієнтуючись на ті показники, які мають статистично значущий вплив на дохід. Результати дослідження можуть слугувати інструментом підтримки прийняття стратегічних управлінських рішень.

Ключові слова: дохід, планування доходів, інвестиції, нематеріальні активи, трудові ресурси, регресійна модель.

Introduction

The use of adaptive and flexible revenue planning methods to ensure the financial stability and competitiveness of enterprises is one of the main functions of financial management of pharmaceutical companies in conditions of market uncertainty. Domestic pharmaceutical enterprises during martial law in Ukraine not only provide critical needs for medical care, but also contribute to the development of the country's export potential, strengthening its competitiveness in the global market. The volume of production of basic pharmaceutical products and preparations in 2024 reached UAH 63 496 million, which is 14.7% more than in 2023. Pharmaceutical products worth UAH 9 898.2 million were sold outside Ukraine, in the total volume of exported industrial products this share is 15.9% (State Statistics Service of Ukraine, n. d.).

It is export that largely stimulates the development of necessary research in this area, since pharmaceuticals is a science-intensive industry that cannot develop without the introduction of technological innovations. An important direction of the pharmaceutical business is R&D (research and development work), which ensures the creation of new drugs, prolongs the life cycle of products, and competitive advantages of companies in the market. Pharmaceutical companies need to modernize production facilities, which requires significant financial resources, the main source of which is revenue.

Therefore, the issue of effective planning of income of pharmaceutical enterprises is a relevant part of scientific research, which affects the effectiveness of their activities, competitiveness in domestic and international markets and contributes to the development of the Ukrainian economy and strengthening the export potential of the country.

Given the significant importance of the pharmaceutical industry for the economic and social development of the country, it is advisable to use the generalized linear regression model with negative binomial distribution to assess the dependence of the revenue of pharmaceutical enterprises on a number of factors: the level of investment, the share of intangible assets in the total assets of the enterprise and the number of employees.

The diverse financial and economic aspects of the functioning and development of the pharmaceutical business are disclosed in the scientific works of Ukrainian and foreign scientists, experts of international consulting agencies.

The issue of improving the system of indicators for assessing financial condition, taking into account international standards of financial analysis, is considered in the work (Posylkina & Gladkova, 2020). A comparative analysis of national and foreign financial analysis systems was conducted; the most significant differences were identified, it was proposed to unify and bring the national practice of financial analysis closer to foreign experience and IFRS, introducing it into the activities of domestic pharmaceutical manufacturers, which will contribute to increasing the transparency of their activities and investment attractiveness for foreign investors.

A significant part of scientific research in the field of pharmaceuticals is devoted to the impact of the COVID-19 pandemic on financial performance. In particular, an economic review of the state and trends in the development of the global pharmaceutical market was conducted by the authors (Voytko & Koroleva, 2021), in addition, an analysis of the indicators of the state of functioning of the largest pharmaceutical companies in the world was carried out and a correlation was established between the total income of companies and expenses for research and development. The conclusion of scientists about the significant impact of R&D investment on the revenue of pharmaceutical companies is important. This conclusion is also confirmed by Greek researchers in a scientific article devoted to the search for a connection between the financial indicators of pharmaceutical companies in Europe and investments in scientific research and development. Based on the results of regression analysis, scientists have proven the presence of a positive and significant correlation between R&D spending and the operating profit of the enterprise (Asad & Homolka, 2023).

The results of the analysis of profitability trends of pharmaceutical business entities in Ukraine are presented in the article (Shostak et al., 2022). The authors present the dynamics of financial results and profitability indicators of pharmaceutical companies over 10 years. The study showed that in the period before the start of the full-scale war in Ukraine, the volumes of production and sales of products manufactured by pharmaceutical industry enterprises, operating profit and profitability level had positive dynamics.

Scientists Zhaldak and Tokarskaya (2023) analyzed the impact of the full-scale war of the Russian Federation against Ukraine on the activities of domestic pharmaceutical companies. The authors substantiated the changes that occurred in the volumes and structure of demand for medicines in accordance with the latest trends in the external environment, and also focused on the growth of innovativeness in drug production, the development of digitalization of business processes of pharmaceutical companies and their orientation towards cooperation with foreign partners.

The issue of the influence of exogenous and endogenous factors on the innovative potential of the pharmaceutical business is presented in Kudyrko's work (2025). Among the main factors that contributed to the development of innovations, the impact of COVID-19, the development of artificial intelligence processes and modern marketing technologies were identified.

The challenge of ensuring the efficiency of the pharmaceutical business through the implementation of the latest marketing strategies and innovative marketing tools were considered by scientists Melnychenko (2024), Lyutak et al. (2025).

Despite the availability of thorough research on the financial and economic problems of the development of companies in the pharmaceutical sector, the main attention in the publications is focused on such factors of influence on financial results as innovations and marketing tools. These factors are certainly significant and should be taken into account when planning the income of a pharmaceutical enterprise. At the same time, identifying and taking into account such internal factors as the level of investment, the share of intangible assets, and the number of personnel in the pharmaceutical business are critically important for ensuring financial stability and sustainable revenue growth in a volatile market environment, which makes the study relevant.

The research is based on the hypothesis that there is a relationship between the revenue of a pharmaceutical company, the level of investment, the share of intangible assets and the number of employees, which affect the forecast indicators of net sales.

The aim of the research is to identify and assess the impact of key factors on the revenue of pharmaceutical companies.

The authors set key tasks, such as: to form a group of pharmaceutical companies that are leaders in terms of net sales and to investigate on their basis the existence of a relationship between the level of income and investments, intangible assets and the number of personnel in order to further use the results in the process of income planning. To carry them out, a complex of general scientific methods was used, in particular theoretical generalization, system analysis, grouping and abstraction, statistical methods of collecting and processing information, deduction and induction, statistical method of regression analysis – generalized linear regression with negative-binomial distribution.

The research was conducted on the basis of financial reporting data of pharmaceutical companies, whose type of economic activity according to the classifier of types of economic activity (National Classifier of State Statistics

of Ukraine 009:2010, 2010) belongs to groups 21.1 "Production of basic pharmaceutical products" and 21.2. "Production of pharmaceutical preparations and materials".

To create an empirical database for economic research, data from the State Statistics Service of Ukraine, analytical systems and open data portals, in particular, (YouControl, n. d.; Opendatabot, n. d.) were used.

In the first section of the main part of the article, generalized financial reporting data of the leading pharmaceutical companies of Ukraine for 2024, which have the largest volumes of net sales, an analysis of the main indicators of their performance was conducted. The sample covers about 18% of pharmaceutical companies in the industry on the Ukrainian market, it accounts for the main share of the volumes of products sold (works, services) and resources used. The second part conducts a regression analysis between revenue (net sales) for a sample of pharmaceutical companies and factors such as the level of investment and the number of employees. The third section is devoted to conducting a regression analysis of the impact of the level of investment and the share of intangible assets on revenue for a sample of research companies.

Given the significant impact of the pharmaceutical industry on the economic and social development of the country, the study, based on the use of statistical tools, analyzed the dependence of pharmaceutical companies' revenues on a number of factors: the share of investments, the share of intangible assets, the number of employees. Confirmation of the hypothesis is of fundamental importance for planning the development strategy of the pharmaceutical business, given the need for GDP growth in the country, increased competitiveness, and increased export and innovation potential.

1. Analysis of the activities of pharmaceutical companies in Ukraine

The full-scale war in Ukraine significantly affected the state and prospects for the development of the pharmaceutical market. Before the full-scale invasion of the Russian Federation, the Ukrainian pharmaceutical market grew by 10–12% annually. According to Proxima Research, the total sales volume in hryvnia terms for 8 months of 2022 decreased by 5% (Farmak, 2022).

Despite the increase in demand for medicines in the first days of the war, pharmaceutical manufacturers in 2022 had to overcome challenges that arose due to the loss of infrastructure facilities, logistics complications, rising prices for fuel and raw materials, a decrease in consumer solvency, staff turnover, etc. At the same time, demand for domestic drugs increased due to their lower price compared to imported analogues. In terms of physical quantities (packaging), 65% of the market is occupied by Ukrainian companies, which produce 61% of medicines from the National List of Medicines, while in monetary terms, 64% of products on the market are foreign-made products, which are presented in a more expensive segment (Farmak, 2022).

There are about 220 companies operating in the pharmaceutical market of Ukraine – manufacturers of pharmaceutical products, preparations and materials (State Statistics Service of Ukraine, n. d.). The main absolute indicators of the activities of the 20 pharmaceutical companies that received the largest amounts of revenue in 2024 are given in *Table 1*.

The leader among pharmaceutical enterprises in Ukraine in terms of net sales in 2024 and net profit is JSC "Farmak". The second place in terms of net income is occupied by PrJSC "Pharmaceutical Firm "Darnytsia".

Despite lower income and a small number of employees, the profit received by the company "Pharma Start" indicates high efficiency of activity. In contrast, the Corporation "Arterium" with a fairly high level of income has a 100 times lower profit indicator.

Investment costs of pharmaceutical companies, in particular investments in research and development (R&D), in new production facilities or technologies, are one of the key factors that shape their revenue in the long term. In the pharmaceutical industry, the life cycle of products is closely related to scientific discoveries and patent protection; investments allow creating new products that ensure the formation of a significant share of income. JSC "Farmak", PrJSC "Pharmaceutical Firm "Darnytsia" and LLC "Pharma Start" are the leaders in terms of investment costs.

A key role in generating revenue in the pharmaceutical sector is played by the presence of intangible assets, which include patents for medicines, licenses and trademarks, which are critically important in a highly competitive market. Companies with large intangible assets usually have a sustainable competitive advantage, as they have exclusive rights to produce medicines, which allows them to receive stable income from the sale of patented products. Among the studied group of companies, the largest volumes of intangible assets are held by PrJSC "Kyivmedpreparat", JSC "Farmak" and PrJSC "Pharmaceutical Firm "Darnytsia".

In conditions of martial law, the outflow of personnel is a serious challenge for companies in the pharmaceutical industry. The company’s staffing directly affects its operational capacity and scale of activities, and therefore the amount of revenue e. A sufficient number of employees contributes to the more effective functioning of the company’s production, research and development and other divisions. Staff growth is usually associated with business expansion, increased sales volumes and entry into new markets. Not only the quantitative, but also the qualitative composition of the staff is important, companies that invest in the development of employee qualifications, avoid unnecessary duplication of functions and optimize management structures are able to achieve higher labor productivity and, accordingly, higher revenue. Among the studied sample of enterprises, JSC "Farmak" has the largest number of personnel and the largest amount of income for 2024.

Relative indicators that characterize the efficiency of the activities of pharmaceutical enterprises, the share of investments and intangible assets in the total assets of enterprises are given in *Table 2*.

Table 1

Key absolute performance indicators for pharmaceutical companies in Ukraine (2024)

Company title	Revenue, thousand UAH	Net profit, thousand UAH	Investment expenses, thousand UAH	Total intangible assets, thousand UAH	Total assets, thousand UAH	Number of employees, persons
Farmak JSC	10 783 728	1 639 761	990 756	292 495	15 101 930	2 610
PJSC Pharmaceutical Company "Darnytsia"	6 875 780	656 781	623 177	256 022	8 124 203	1 223
Yuria Farm LLC	5 741 656	752 103	437 874	5 532	6 243 441	1 666
Arterium Corporation	5 235 605	51 825	4 472	81 890	2287104	500
Kyiv Vitamin Plant JSC	4 944 130	156 840	203 996	0	3 212 056	457
TEVA Ukraine LLC	3 839 622	27 629	0	4 247	3 497 393	873
Kyivmedpreparat PJSC	3 568 427	73165	106 489	1 226 649	3 374 986	850
Biofarma Plasma LLC	3 550 542	852 408	310 938	0	3 101 801	813
Servier Ukraine LLC	2 481 518	42 469	12 888	41	1 199 697	1 257
Pharma Start LLC	2 337 352	761 271	285 722	6 194	3 487 167	176
Borshchahivskyi Chemical and Pharmaceutical Plant PJSC	2 078 848	273 402	109 041	20 303	3 091 067	1 020
LLC Pharmaceutical Company "Zdorovya"	2 031 665	146 468	28 737	2 630	2 050 619	300
Sandoz Ukraine LLC	1 996 884	260 342	1 784	2	1 232 161	122
Sanofi-Aventis Ukraine LLC	1 918 229	146 519	14 519	0	1 343 873	311
GlaxoSmithKline Pharmaceuticals Ukraine LLC	1 845 220	62 540	81 146	7	957 820	274
Polpharma UA LLC	1 372 645	13 069	0	1 961	519 074	2 370
Sperco Ukraine LLC	1 253 831	168 298	14 243	9 053	914 003	277
Interchem LLC	1 212 205	200 561	267 997	15 332	125 8107	293
DKP Pharmaceutical Factory LLC	1 210 809	53 581	28 401	420	763 920	221
Movi Health LLC	915 053	22 773	0	195	599 593	108

Source: compiled by the authors based on data (YouControl, n. d.; OpenDataBot, n. d.).

Table 2

Key relative performance indicators of Ukrainian pharmaceutical companies (2024)

Company title	Return on sales, %	Return on assets, %	Share of investments in assets, %	Share of intangible assets, %	Labor productivity, thousand UAH per employee
Farmak JSC	15.2	10.9	6.6	1.9	4 132
PJSC Pharmaceutical Firm "Darnytsia"	9.6	8.1	7.7	3.2	5 622
Yuria Farm LLC	13.1	12.0	7.0	0.1	3 446
Arterium Corporation	1.0	2.3	0.2	3.6	2 209
Kyiv Vitamin Plant JSC	3.2	4.9	6.4	0	5 817
TEVA Ukraine LLC	0.7	0.8	–	0.1	13 105
Kyivmedpreparat PJSC	2.1	2.2	3.2	36.3	2 839
Biofarma Plasma LLC	24.0	27.5	10.0	0	7 101
Servier Ukraine LLC	1.7	3.5	1.1	0	9 057
Pharma Start LLC	32.6	21.8	8.2	0.2	5 115
Borshchahivskyi Chemical and Pharmaceutical Plant PJSC	13.2	8.8	3.5	0.7	2 557
LLC Pharmaceutical Company "Zdorovya"	7.2	7.1	1.4	0.1	1 992
Sandoz Ukraine LLC	13.0	21.1	0.1	0	7 209
Sanofi-Aventis Ukraine LLC	7.6	10.9	1.1	0	15 723
GlaxoSmithKline Pharmaceuticals Ukraine LLC	3.4	6.5	8.5	0	10 484
Polpharma UA LLC	1.0	2.5	–	0.4	12 710
Sperco Ukraine LLC	13.4	18.4	1.6	1.0	4 032
Interchem LLC	16.5	15.9	21.3	1.2	1 389
DKP Pharmaceutical Factory LLC	4.4	7.0	3.7	0.1	4 036
Movi Health LLC	2.5	3.8	–	0	4 141

Source: compiled by the authors based on data (YouControl, n. d.; OpenDataBot, n. d.).

The highest profitability of sales was demonstrated by the enterprise "Pharma Start" and LLC "Biopharma Plasma", these same companies have the highest indicators of profitability of assets. The largest share of investments in assets is held by TDV "Interkhim". The share of intangible assets is the highest in PrJSC "Kyivmedpreparat". As for labor productivity, the highest values are observed in LLC "Sanofi-Aventis Ukraine" and LLC "GlaxoSmithKline Pharmaceuticals Ukraine". Thus, the efficiency indicators of the studied enterprises vary significantly and depend on many factors.

The level of investment determines the opportunities for modernization of production processes, development of new products and implementation of innovative technologies. The share of intangible assets, in particular patents, trademarks and know-how, plays an important role in forming a market advantage and protecting intellectual property. The number and qualification of personnel directly affect the efficiency of operational activities, the quality of research and the ability of the enterprise to adapt to changes in the market environment. Comprehensive analysis and consideration of these factors during revenue planning allow developing effective development strategies, minimizing risks, and ensuring stable growth in the financial results of a pharmaceutical company.

2. Regression analysis of the relationship between investment levels, number of employees, and income

In order to analyze the impact of individual factors on the level of income of pharmaceutical companies, a statistical method of regression analysis was used, namely: a generalized linear regression model with a negative binomial distribution.

To conduct regression analysis and determine the impact of individual factors on revenue, this study used financial reporting indicators of 39 pharmaceutical companies in Ukraine that carry out production activities.

The final set of independent variables after conducting a certain number of experiments included:

- the share of the company's investment costs *(iv_as)*;
- the number of employees of the company (*sp*).

Since the model used variables with different measurement scales, all numerical indicators were standardized by converting them to z-scores: $Z = (X - \mu)/\sigma$, where X is the variable value, μ is the mean, σ is the standard deviation.

This allowed us to avoid the scaling problem and improved the interpretation of the coefficients. After modeling, we obtained estimates of the coefficients of the negative binomial regression model and the free term. The logarithmic equation of the model has the form:

$$\log(\hat{y}) = 14.1485 + 0.1579 \cdot \text{iv\_as}_{\text{stand}} + 0.6625 \cdot \text{sp}_{\text{stand}} \quad (1).$$

To calculate the value of ŷ, we need to use the expression:

$$\hat{y} = \exp(14.1485 + 0.1579 \cdot iv\_as_{stand} + 0.6625 \cdot sp_{stand}), \quad (2)$$

where: iv_as_{stand} and sp_{stand} – standardized values of the variables "share of company investment costs" and "number of employees"; const = 14.1485 – value of the free member of the model.

The model coefficients and their significance are shown in *Table 3.*

Table 3

Model coefficients and their significance

Variable	Coefficient	P-values
Free member (constant)	14.1485	<0.001
Share of the company's investment costs in its assets	0.1579	<0.05
Number of employees	0.6625	0.001

Source: the result of the authors' modeling using the Python program and a set of generated data (YouControl, n. d.; Opendatabot, n. d.).

The free term and both coefficients for independent variables are statistically significant ($p<0.05$), which confirms the reliability of the model and indicates the presence of a significant relationship between the explanatory variables and the dependent variable.

The Pseudo R^2 indicator of the model is 95.15%, i. e. about 95.15% of the variation in the sales volume of pharmaceutical companies is explained by the combination of the variables "share of investment expenses of the company" and "number of employees".

In order to interpret the influence of the coefficients for independent variables on the dependent variable, we will transform the model with standardized variables into a model with natural units. In the initial form, the generalized linear regression model with negative binomial distribution was presented in the form:

$$log(\hat{y}) = \beta_0 + \beta_1 \cdot z_{iv\_as} + \beta_2 \cdot z_{sp},$$

where: $\hat{y}$ – expected value of the dependent variable (company revenue), z_{iv_as}, z_{sp} – standardized values of the corresponding independent variables, β_0 = 14.1485; β_1 = 0.1579; β_2 = 0.6625.

Standardized variables were calculated using the ratio:

$$z_i = (x_i - \mu_i)/\sigma_i.$$

The coefficients for the model equation in natural scale are calculated using the following ratios:

$$log(\hat{y}) = \beta_0' + \beta_1' \cdot iv\_as + \beta_2' \cdot sp,$$

$$\beta_1' = \frac{\beta_1}{\sigma_{iv\_as}}, \quad \beta_2' = \frac{\beta_2}{\sigma_{sp}},$$

$$\beta_0' = \beta_0 - \left(\frac{\beta_1 \cdot \mu_{iv\_as}}{\sigma_{iv\_as}} + \frac{\beta_2 \cdot \mu_{sp}}{\sigma_{sp}}\right).$$

Substituting the obtained statistical indicators from the data set:

μ_{iv_as} = 0.0331; σ_{iv_as} = 0.0437;

μ_{sp} = 511.12; σ_{sp} = 598.36, we obtain:

β_0' = 13.4629; β_1' = 3.612; β_2' = 0.001107.

Thus, the model in natural units has the form:

$$log(\hat{y}) = 13.4629 + 3.612 \cdot iv\_as + 0.001107 \cdot sp, \quad (3)$$

or to find ŷ:

$$\hat{y} = exp(13.4629 + 3.612 \cdot iv\_as + 0.001107 \cdot sp) \quad (4).$$

The interpretation of unstandardized coefficients for the model on a natural scale is presented in *Table 4.*

Table 4

Interpretation of non-standardized model coefficients

Variable	Coefficient	Interpretation
Share of investment costs in the company's assets	3.612	A 1% increase in a company's investment spending share of its total assets increases revenue by 3.70%
Number of employees	0.001107	Each additional 100 employees add 11.7% to the company's expected revenue

Source: calculated by the authors based on the model obtained with non-standardized coefficients.

Therefore, according to the results presented in Table 4, we observe a statistically significant relationship between net revenue, investment costs share and the number of employees for pharmaceutical companies that are manufacturers of pharmaceutical products, pharmaceutical preparations and materials.

3. Regression analysis of the relationship between the level of investment, the share of intangible assets, and income

To assess the impact of factors on the revenue of pharmaceutical companies, negative binomial regression was also used in the second model. The following data were included in the final set of independent variables after conducting a certain number of experiments:

- the share of the company's investment costs in the company's assets (iv_as);
- the share of intangible assets in the company's assets (na_as).

As a result of the modeling, estimates of the coefficients of the negative binomial regression model and the free term were obtained. The logarithmic equation of the model has the form:

$$log\,(\hat{y}) = 14.3631 + 0.4631 \cdot iv\_as_{stand} + 0.1730 \cdot na\_as_{stand} \quad (5).$$

To calculate the value of ŷ, the expression must be used:

$$\hat{y} = exp\ (14.3631 + 0.4631 \cdot iv\_as_{stand} + 0.1730 \cdot na\_as_{stand}), \quad (6)$$

where: iv_as_{stand} and na_as_{stand} are standardized values of the variables "share of investment expenses of the company" and "share of intangible assets in assets of the company"; const = 14.3631 is the value of the free term of the model.

The coefficients of the model and their significance are shown in *Table 5*.

Table 5

The coefficients of the model and their significance

Variable	Coefficient	P-values
Free member (constant)	14.3631	<0.001
Share of investment costs in the company's assets	0.4631	<0.001
Share of intangible assets in the company's assets	0.1730	<0.05

Source: the result of modeling using the Python program and a set of generated data (YouControl, n. d.; Opendatabot, n. d.).

The free term and both coefficients for independent variables are statistically significant ($p<0.05$), which confirms the reliability of the model and indicates the presence of a significant relationship between the explanatory variables and the dependent variable. In order to interpret the influence of the coefficients for independent variables on the dependent variable, we will transform the model with standardized variables into a model with natural units.

After mathematical transformations, the model in natural units takes the form:

$$log(\hat{y}) = 13.9610 + 10.7 \cdot iv\_as + 2.94 \cdot na\_as, \quad (7)$$

or to find ŷ:

$$\hat{y} = exp(13.9610 + 10.7 \cdot iv\_as + 2.94 \cdot na\_as) \quad (8).$$

The interpretation of the unstandardized coefficients for the model at natural scale is presented in *Table 6*.

Table 6

Interpretation of the unstandardized coefficients of the model

Variable	Coefficient	Interpretation
Share of investment costs in the company's assets	10.7	A 1% increase in the level of investment costs in the company's assets increases revenue by 11.29%
Share of intangible assets in the company's assets	2.94	A 1% increase in the share of intangible assets in the company's assets increases revenue by 2.98%

Source: calculated by the authors based on the obtained model with unstandardized coefficients.

According to the results presented in *Table 6*, there is a statistically significant relationship between net revenue, the share of investment costs and intangible assets for pharmaceutical enterprises that produce basic pharmaceutical products, preparations and materials.

Thus, it was possible to illustrate the truth of the hypothesis and identify the argumentation for its confirmation based on the data of the formed sample of enterprises.

Conclusions

Geopolitical and technological transformations, increased market competition, regulatory changes in the industry do not reduce the importance of planning the activities of pharmaceutical companies, but on the contrary, make it even more relevant. Revenue planning is a key element of financial management of the enterprise, because this indicator is the main internal source of financing costs, paying taxes, making profits and developing the business.

For domestic pharmaceutical enterprises belonging to section 21 "Manufacture of basic pharmaceutical products and pharmaceutical preparations" according to KVED-2010, the results of calculations based on empirical data revealed confirmation of the formulated hypothesis, which states that a larger volume of enterprise income is generated if the share of investments, intangible assets of the company and the number of personnel increases.

The results of the research can be used in the formation of a strategy for planning the income of pharmaceutical enterprises in particular, to justify the feasibility of attracting additional investments in production facilities, technologies, etc.; for the development of intangible assets (brand, patents, innovative developments, research and development), which form a long-term competitive advantage; for planning an optimal personnel policy focused on increasing labor productivity. The interrelationship of these factors allows the company to plan income more realistically, relying not only on the market situation, but also on internal management decisions.

Further research will be focused on the integration of AI, Big Data and real data into the financial planning of pharmaceutical enterprises.

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DYNAMIC PRICING STRATEGIES TO MAXIMIZE HOTEL REVENUES

This article investigates modern dynamic pricing strategies predominantly employed in the hospitality industry to maximize revenue. The relevance of this topic stems from intensifying competition in the tourism services market, shifts in consumer behavior, and the proliferation of digital booking platforms. The article hypothesizes that implementing adaptive pricing models, based on an analysis of demand, booking lead times, and customer behavioral characteristics, can enhance a hotel's profitability. The research methodology includes comparative analysis, case studies, economic-mathematical modeling, and data visualization. The article analyzes examples of dynamic pricing strategy implementation in leading international hotel chains and develops an adaptive pricing model that integrates the analysis of internal and external data with the automatic generation of optimal prices for various segments and distribution channels. The findings confirm the effectiveness and promise of adaptive pricing strategies as a tool for increasing hotel profitability. Practical recommendations are provided for adapting dynamic pricing to business hotels, recreational complexes, and boutique hotels.

Keywords: dynamic pricing, revenue management, hotel industry, demand, pricing policy, price.

JEL Classification: L83, M21, C51, D40, Z31.

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СТРАТЕГІЇ ДИНАМІЧНОГО ЦІНОУТВОРЕННЯ ДЛЯ МАКСИМІЗАЦІЇ ДОХОДІВ ГОТЕЛІВ

Досліджено сучасні стратегії динамічного ціноутворення, найчастіше застосовувані в готельному бізнесі з метою максимізації доходів. Актуальність теми зумовлена посиленням конкуренції на ринку туристичних послуг, змінами у поведінці споживачів та поширенням цифрових платформ для бронювання номерів. Сформульовано гіпотезу, що впровадження адаптивних моделей ціноутворення, які базуються на аналізі попиту, часу бронювання та поведінкових характеристик клієнтів, здатне підвищити дохідність готельного підприємства. Застосовано методи порівняльного аналізу, кейс-стаді, економіко-математичного моделювання та візуалізації даних. Розглянуто приклади використання стратегій динамічного ціноутворення у провідних міжнародних готельних мережах, а також побудовано модель адаптивного ціноутворення, що поєднує аналіз внутрішніх і зовнішніх даних та автоматичне генерування оптимальних цін для різних сегментів і каналів продажу. Отримані результати підтверджують ефективність та перспективність адаптивних цінових стратегій як інструменту підвищення прибутковості готелів. Обґрунтовано практичні рекомендації щодо адаптації динамічного ціноутворення для бізнес-готелів, рекреаційних комплексів та бутік-готелів.

Ключові слова: динамічне ціноутворення, управління доходами, готельний бізнес, попит, тарифна політика, ціна.

Introduction

In today's conditions of increasing competition, digital transformation and changing consumer demand, hotel companies are faced with a constant need to increase the efficiency of using available resources. One of the key tools for achieving this goal is dynamic pricing, which consists of flexible pricing based on demand forecasting, consumer behavior analysis, market segmentation, and monitoring of competitors' actions. The relevance of the research is due to the need to adapt the hotel business to new market realities with unstable demand, seasonality, high costs of attracting customers and the growing importance of digital sales channels.

The full-scale war in Ukraine has significantly transformed the domestic tourism market and the conditions for the functioning of the hotel business. Migration processes, reduction in international tourism, and relocation of enterprises have led to significant changes in the structure of demand for hotel services. Some hotels have been reoriented to accommodate internally displaced persons, volunteers, humanitarian missions, as well as critical infrastructure workers. In such conditions, traditional approaches to pricing lose their effectiveness. Therefore, new revenue management strategies are needed that will be adapted to conditions of high uncertainty.

Foreign scholars have extensively examined the issues of revenue management and dynamic pricing in the hotel business. In particular, Kahale and Schreiber (2021) investigate algorithmic models of tariff optimization in hotels; Cross et al. (2009) analyzed the implementation of revenue management strategies in hotel chains.

The issue of pricing in the hospitality industry has also been reflected in domestic research. For example, Kish (2024) examined economic mechanisms for regulating prices for tourist services. Kulyk (2023) examines modern approaches to tariff formation in the hotel business, in particular in the context of digitalization. For their part, Gutsalenko et al. (2019) substantiate the feasibility of implementing revenue management systems in Ukrainian hotels as a response to demand variability. However, these studies are mostly focused on general theoretical aspects and only partially cover practical tools of adaptive pricing, taking into account modern digital technologies and data analytics.

Thus, the problem that this research aims to solve is the lack of effective adaptive dynamic pricing strategies that can maximize hotel revenues in an unstable market. The article is devoted to the analysis of existing approaches, assessment of their effectiveness and development of recommendations for the implementation of adaptive solutions in the practice of the hotel business.

The aim of the research is to develop a scientifically based model of adaptive dynamic pricing for hotels of various types, which will allow to

increase the financial performance of enterprises through personalized tariff management in conditions of unstable demand, as well as to develop practical recommendations for its implementation, taking into account digital readiness, behavioral characteristics of visitors and the specifics of the local market.

The hypothesis is formulated that the implementation of adaptive dynamic pricing strategies, which are based on a combination of historical data analysis, demand forecasting and customer segmentation, contributes to the growth of hotel enterprises' revenues even in conditions of uncertainty. To verify it, methods of economic and statistical analysis, demand modeling, cohort analysis of customers and surveys of hotel industry experts were used.

The information base of the research was: operational and financial reports of hotels; data from revenue management systems; analytical online booking platforms (Booking.com, Expedia, Airbnb); results of in-depth interviews with representatives of hotel business management, in particular in Ukraine.

During the research, access to internal data of hotel enterprises was limited, which complicates the quantitative assessment of the effectiveness of strategies in the long term. The hypothesis was tested according to the following algorithm: analysis of the situation before the implementation of the strategy, development and implementation of an adaptive pricing model, assessment of the impact on profitability, correction of the approach based on the results of monitoring.

The main part of the article consists of four substantive sections. The first section considers the theoretical foundations of dynamic pricing and classifies its main types. The second section analyzes international and Ukrainian experience in applying revenue management strategies in the hotel sector. The third section is devoted to the development of the author's adaptive pricing model, the fourth to its empirical testing and formulation of practical recommendations for hotels of various types.

1. Theoretical foundations of dynamic pricing

Dynamic pricing is a strategic revenue management tool for hospitality companies, which consists in changing prices for hotel services depending on the dynamics of the following factors: demand, consumer behavior, competitive environment, sales channels, seasonality, etc. Unlike fixed or uniform pricing, dynamic pricing involves regular price updates in order to maximize revenue through effective demand management.

The theoretical origins of dynamic pricing go back to differential pricing models that developed within microeconomics, in particular the theory of pricing in oligopoly conditions. In the hotel business, the concept

of dynamic pricing is closely related to the concept of revenue management. This approach was first widely used in the aviation industry in the 1980s, and was later adapted for hotels, car rentals, cinemas, rail transport, etc.

According to the definition of Cross et al. (2009), revenue management is a discipline that combines data analysis, behavioral economics and operations management to predict demand and manage pricing to achieve maximum revenue. The research of Bandalouski et al. (2018) has become an important contribution to the theoretical substantiation of dynamic pricing mechanisms in the hotel sector. The work emphasizes that the use of adaptive models allows you to effectively manage the occupancy of the room stock, minimize the risks of under- or overloading and, as a result, increase the overall level of margin of the hotel enterprise. This approach is critically important in the context of high demand variability and the need to respond promptly to market changes.

The key principles of dynamic pricing include:

- price discrimination is the division of consumers into segments with different solvency and willingness to pay for goods or services;
- demand forecasting is the use of historical and current data to model future hotel occupancy;
- availability control involves managing room sales through various channels using restrictions, minimum/maximum length of stay;
- responsiveness is the constant updating of rates in accordance with internal and external factors;
- synchronization with distribution channels involves coordinating prices with the conditions of OTA (Online Travel Agencies), GDS (Global Distribution Systems), CRM systems (Bandalouski et al., 2018).

Using dynamic pricing requires a deep analysis of the market, competitive environment, consumer behavioral characteristics, seasonal trends, events, etc. For this, methods of statistics, machine learning, regression analysis, clustering, as well as customer cohort analysis are used.

Based on the systematization of modern research (Talluri & Van Ryzin, 2021; Vinod, 2021), dynamic pricing in the hotel business can be classified according to the following characteristics: by level of complexity, by source of pricing, by method of price change, by source of control (*Figure 1*).

The use of dynamic pricing has the following advantages: increasing revenue at the same occupancy level; encouraging early booking through price flexibility; reducing dependence on OTAs (Online Travel Agencies) through flexible configuration of sales channels; optimizing the tariff grid, minimizing lost profits or excessive discounts; ensuring the strategic positioning of the hotel in the market, taking into account the behavior of competitors.

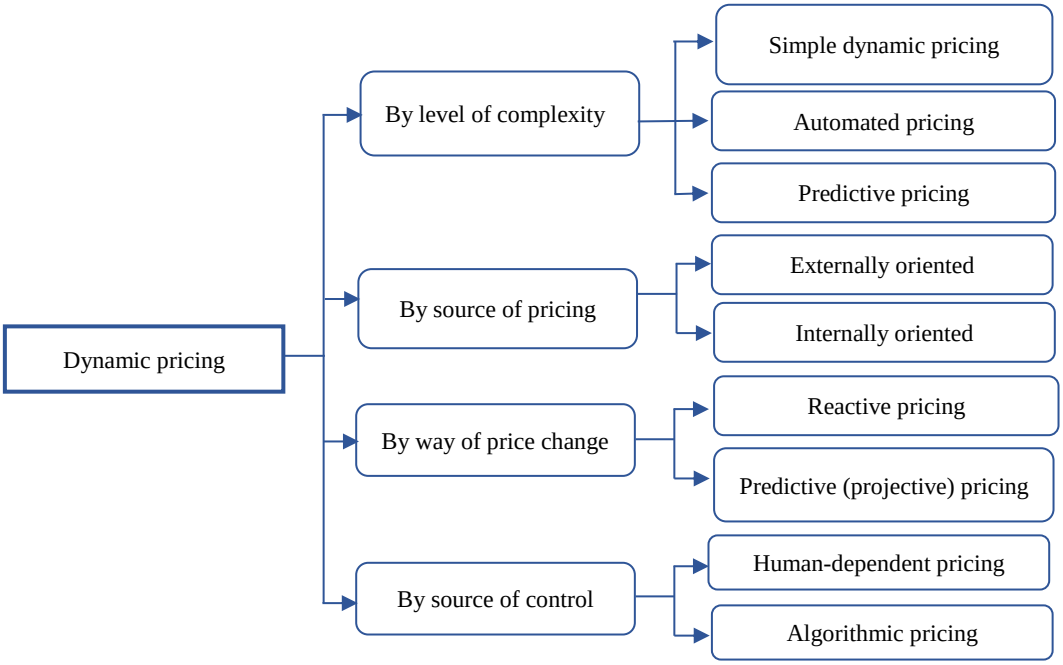

Figure 1. Classification of dynamic pricing types

Source: compiled by the author based on research (Talluri & Van Ryzin, 2021; Vinod, 2021).

At the same time, dynamic pricing also has risks – the possibility of reducing perceived value, negative perception of price fluctuations by customers, the need for investment in technology, and dependence on the accuracy of forecasts.

2. International and domestic experience in implementing dynamic pricing strategies in the hospitality industry

Nowadays, in conditions of significant demand variability and competition, the implementation of dynamic pricing strategies in the hospitality industry is a key factor for ensuring competitiveness. Foreign experience demonstrates many approaches to the implementation of such strategies that are adapted to the specifics of local markets, distribution channels, and different types of customers.

In the USA and Western European countries, dynamic pricing in the hotel business has been used since the early 2000s. The reasons for this are the developed infrastructure of online distribution channels and the wide-spread implementation of analytical CRM and RMS (Revenue Management Systems) systems (Tranter et al., 2019). According to research by Cross et al. (2009), the use of revenue management strategies has allowed RevPAR (revenue per room) to increase by an average of 5–8% compared to hotels that do not use these approaches.

According to research by Cross and Higbie, the use of revenue management strategies has increased revenue per room (RevPAR) by an average of 5–8% compared to hotels that do not use these approaches (Cross et al., 2009).

Large international hotel chains Marriott International, Hilton Hotels & Resorts, Accor Group are quite active in using demand forecasting algorithms and models for optimal pricing in real time. For example, Hilton uses the OnQ RMS (Revenue Management System) system on its own IT platform. This system integrates historical data, segment information, and external market indicators for automated price adjustments (Noone & McGuire, 2013).

In the countries of the Asia-Pacific region, in particular in Singapore, South Korea, Thailand, dynamic pricing is also widespread, but mostly in the mid-range and premium segments. A feature is the flexibility of the system for local events (festivals, conferences, holidays) and a high level of individualization of offers due to the development of mobile applications for booking (Barua & Kaiser, 2024).

In the hotel industry of Ukraine, the use of dynamic pricing strategies has been observed since 2015, which was a consequence of the policy of general digitalization and activation of domestic tourism.

However, the revenue management system is actively used primarily by business-class hotels in large cities (Kyiv, Lviv, Odesa, Dnipro). Yancheva et al. (2019) note that the main obstacle to the full implementation of revenue management systems and, accordingly, the use of dynamic pricing strategies is the lack of specialists, insufficient digitalization of processes, and limited readiness of managers for risk-based pricing.

Ukrainian researchers, in particular Pavlova (2023), point to the need to adapt international practices taking into account domestic specifics: seasonality of demand, high share of direct bookings, unstable macro-economic environment. The study by Kish (2024) proposes a classification of RM strategies for Ukrainian hotels based on the criteria of price flexibility, level of automation, and type of target audience.

However, even taking into account the limitations, some Ukrainian hotels successfully implement dynamic pricing strategies. For example, Premier Palace Hotel in Kyiv uses its own CRM system to differentiate rates by distribution channels and customer segments. The Reikartz Hotel Group hotel chain has implemented a policy of hourly monitoring of competitors' prices and adapting its own rates in real time, which has allowed it to increase the occupancy rate in the off-season (Kish, 2024).

Thus, international experience shows the high potential of dynamic pricing as a revenue optimization tool, and Ukrainian practice demonstrates a systematic but stable development in this direction. To increase the effectiveness of implementation, it is necessary to integrate digital technologies, improve the skills of managers, and adapt strategies to the conditions of the domestic market.

3. Adaptive pricing as a tool for strategic revenue management in the hotel industry

In the modern hotel business, adaptive pricing is considered the main tool for strategic revenue management. It allows you to quickly respond to changes in market conditions, consumer behavior and the competitive environment. Adaptive pricing, unlike traditional fixed tariff approaches, provides a high level of flexibility. This is achieved through the use of demand forecasting algorithms, real-time analytics and segmented price discrimination.

The theoretical model of adaptive pricing involves a combination of three basic components: demand forecasting, room availability management and tariff synchronization with distribution channels. Within the framework of the author's approach, it is proposed to also take into account the behavioral aspects of consumers, the level of price elasticity in different segments and the index of competitive pressure.

A systematic approach was used to build the adaptive pricing model, which includes a comparative analysis of existing models, an assessment of the effectiveness of pricing strategies in a changing environment and scenario modeling based on historical data. The factors taken into account by the adaptive pricing model are schematically presented in *Figure 2*.

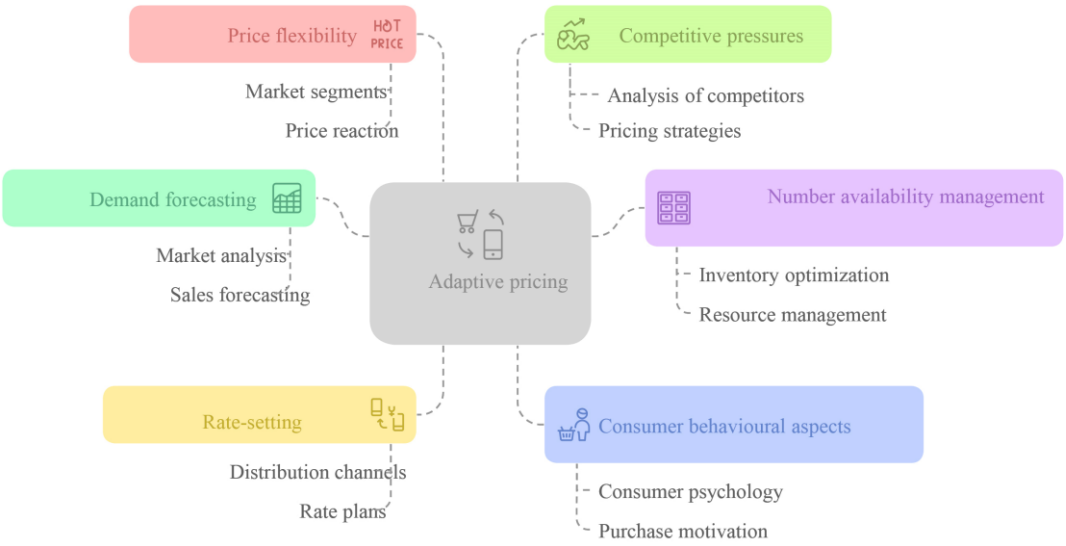

Figure 2. Factor that takes into account the adaptive pricing model (author's approach)

Source: compiled by the author based on research (Matviienko M., 2019).

To better understand the benefits of adaptive pricing, it is advisable to compare it with traditional approaches that are still used in many hotels (*Table 1*).

Table 1

Comparative characteristics of traditional and adaptive pricing approaches

Feature	Level of personalization	Adaptive pricing
Flexibility	Traditional pricing	High
Rate updates	Low	Real-time
Use of analytics	Periodic	Intensive, involving big data
Demand-driven	Minimal	Full
Level of personalization	Limited	Prices depending on the customer segment

Source: compiled by the author based on research (Melnyk, I., & Melnyk, O., 2022).

As can be seen from *Table 1*, the key difference lies in flexibility, speed of response to market changes and levels of data usage. Traditional methods are often based on fixed rates or manual adjustments, while adaptive systems automatically take into account hundreds of factors, which allows for a significant increase in the efficiency of revenue management.

In the conditions of the modern hotel services market, comparative analysis demonstrates a significant advantage of the adaptive approach to pricing. Traditional models, based on periodic revision of rates and limited consideration of changes in demand, are inferior in flexibility, accuracy and ability to quickly respond to behavioral changes of consumers. In contrast, adaptive pricing allows the use of real-time analytics, takes into account Big Data, and also provides a high level of personalization of price offers. This contributes to revenue growth, better occupancy of the room fund and the formation of loyalty among target customer segments. The comparison is another confirmation of the feasibility and necessity of implementing adaptive pricing strategies.

The study proposes an adaptive pricing model that combines components of analytics, forecasting, behavioral personalization, and automatic price management systems (*Figure 3*).

The key advantages of the model are:

- use of internal and external data;
- application of machine learning algorithms to forecast demand, identify peak periods and anomalies;
- generation of optimal prices for each segment and channel, taking into account the maximization of total revenue, not just load;
- adapting prices to the type of customer, sales channel, booking history and probability of purchase (for example, direct customers receive a lower rate in the mobile application than through an online travel agency);
- use of interactive visual panels to analyze key performance indicators and automatic training of the model based on historical data to improve forecasts.

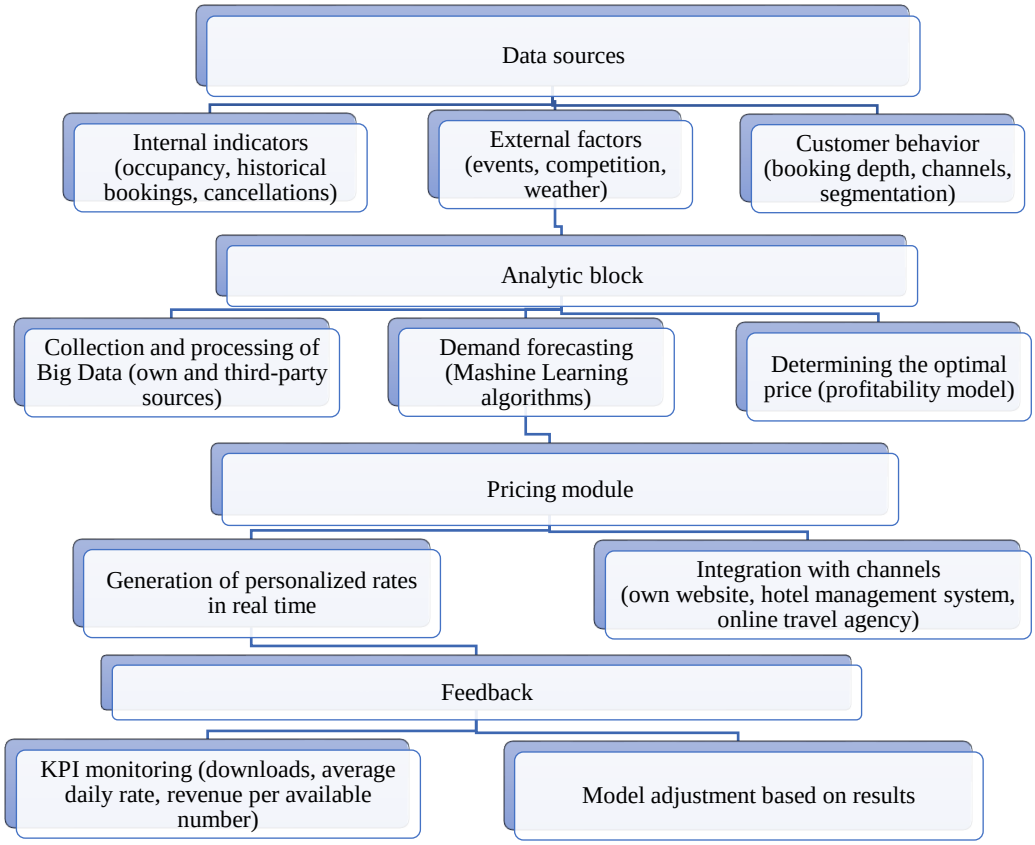

Figure 3. Model of adaptive pricing for hotel enterprises

Source: compiled by the author based on research (Kulyk, 2023).

The proposed adaptive pricing model is not only a tactical tool, but also a strategic means of revenue management. Its implementation changes the very approach to hotel management, shifting the focus from manual management to algorithmic decision-making based on constant revenue optimization. A huge advantage of the model is that it is able to work in conditions of changes in demand (high – low season), crisis phenomena (COVID, war, economic downturns), and high competition in the market (city centers, resort areas).

Based on the test implementation of the model, it is expected:

- an increase in revenue per available room by 12–18%;
- a reduction in manual work of revenue management specialists by 60–70%;
- an increase in the accuracy of demand forecasting by 15–25%;
- a strengthening of the competitive position in the market.

Thus, the proposed author's adaptive pricing model is an effective tool for strategic revenue management in the hotel business. Its implementation allows you to automate the process of making pricing decisions, increase profitability, and adapt to changes in market demand in real time.

3. Empirical evaluation of the effectiveness of adaptive pricing in the hotel business

To test the effectiveness of the author's adaptive pricing model, three hotel establishments in Lutsk were selected, representing different segments of the local market: the Ukraine Hotel (business hotel, city center); the Silver Storks Recreation Complex (resort, country), Patio di Fiori (middle-class boutique hotel).

Testing the model lasted 90 days and included: connection to hotel management systems (PMS), online booking channels (OTA), forecasting systems (RMS); demand analytics based on internal and external data (history of reservations, cancellations, weather conditions, events in the city); dynamic pricing based on the profitability model; KPI monitoring: average room rate (ADR), revenue per room (RevPAR), occupancy level.

All of these hotels demonstrated an increase in revenue indicators after applying the model. Particularly positive results were recorded during periods of increased demand (holidays, business forums, festivals in Lutsk). The dynamics of the indicators of the studied hotels in Lutsk after the introduction of adaptive pricing is presented in *Table 2.*

Table 2

Dynamics of hotel performance in Lutsk after the introduction of adaptive pricing

Hotel	Indicators	Before implementation	After implementation	Changes, %
Hotel "Ukraine"	ADR, UAH	2150	2550	+18.6
	RevPAR, UAH	1590	2120	+33.3
	check-in, %	74	83	+12.2
Recreational complex "Sribni Leleky"	ADR, UAH	1700	1990	+17.1
	RevPAR, UAH	1207	1660	+37.6
	check-in, %	71	83	+16.9
Hotel "Patio di Fiori"	ADR, UAH	1430	1640	+14.7
	RevPAR, UAH	1001	1380	+37.8
	check-in, %	70	84	+20.0

Source: compiled by the author on the basis of analytical calculations (Hotel Noble Boutique Hotel, n. d.; Recreational complex "Sribni Leleky", n. d.; Hotel "Patio di Fiori", n. d.).

The results presented in *Table 2* demonstrate the positive dynamics of the main financial and operational indicators of hotels after the implementation of the adaptive pricing approach. In all three hotels in Lutsk – "Ukraine", "Sribni Leleky" and "Patio di Fiori", a stable growth in average room revenue (ADR) was recorded at the level of 14.7–18.6%, which indicates an increase in the willingness of guests to pay more accurately formed, competitive rates.

The increase in the RevPAR indicator demonstrates the effects of pricing policy and occupancy of the room stock. Such growth was possible thanks to a more accurate forecast of demand and a prompt response to changing market conditions.

The main factors of success were the analytical part of the model, which combined: internal indicators (booking history, occupancy level, seasonality); external factors (in particular, the calendar of local events, such as the Lutsk Jazz Festival or exhibitions in the RC "Adrenaline City", which significantly affect demand in the high season); guest behavioral analytics (booking depth (how many days before arrival they book), selected channels (OTA, own website, phone), average length of stay, room category, etc.). This allowed the adaptive model to generate personalized rates in real time, synchronized with sales channels, which is especially important for hotels with a multi-channel strategy.

In addition to the above results, it is worth noting that the increase in occupancy of the room stock (study *Table 2*) after the implementation of the model indicates a decrease in the number of unoccupied rooms, which in traditional models mostly remain outside the focus of pricing policy.

To increase the efficiency of using adaptive pricing, it is advisable to form recommendations taking into account the type of hotel establishment, its target audience and behavioral characteristics of customers.

For business hotels, such as "Ukraine" or "Svityaz", it is advisable to focus on dynamic adjustment of tariffs on weekdays. After all, it is then that increased business activity is observed. It is important to take into account the city's event calendar, in particular, holding conferences, forums or business events that generate demand among corporate clients. Special attention should be paid to the optimization of corporate contracts – by forming personalized tariffs that take into account the booking history of specific enterprises, their frequency, length of stay and the level of services provided.

Resort recreational complex, such as "Sribni Leleky" or "Restpark", have significant potential for weather-sensitive pricing. For example, during the summer season, it is advisable to increase rates on favorable weather days (sunny weather, weekends), while introducing limited discounts on rainy or cool weather to stimulate demand. In addition, a flexible discount strategy is effective, which involves encouraging early bookings, for example, providing a 10% discount when booking 30 days before the arrival date. Additional activity can be provided through local promotional campaigns for residents of the region, which allows filling the hotel in the off-season.

Boutique hotels such as "Patio di Fiori" or "Noble" should take a more moderate approach to customer segmentation. It is advisable to distinguish between regular guests, guests who come for festive events (for example, weddings, anniversaries), as well as so-called "spontaneous" travelers who book at the last minute. For each category, it is worth forming separate price packages taking into account the expectations and habits of a specific group. Integration with social networks and the hotel's own website is also an effective tool. Regular promotions and personal promotional codes published on Facebook or Instagram help attract a younger audience and provide an

additional sales channel. Such promotions should be updated daily, responding to changes in demand and user behavior in real time.

Therefore, the implementation of adaptive pricing taking into account the specifics of each type of hotel allows not only to increase profitability, but also to improve the customer experience, ensuring high relevance of offers.

Conclusions

Dynamic pricing is a powerful tool for strategic revenue management in the hotel business, providing a flexible response to market changes, consumer behavior and external factors. In today's conditions of high competition and unpredictability of demand, the ability to quickly adapt prices to real-time is becoming a determining factor in the success of a hotel enterprise.

The use of adaptive pricing models based on data on guest behavior, seasonality, events, weather conditions and booking channels allows you to increase the accuracy of tariff policy, optimize room occupancy and maximize key financial indicators – primarily ADR (average rate per room) and RevPAR (revenue from available room stock). This approach not only ensures profit growth but also increases the level of customer satisfaction due to price relevance.

The empirical research conducted confirmed the scientific hypothesis that even in a changing environment, the implementation of adaptive dynamic pricing provides a significant increase in hotel revenues. According to the results of the test implementation of the author's model in hotels in Lutsk, an increase in RevPAR, ADR, as well as a significant increase in the occupancy rate of the room fund was recorded.

In addition, the research found that the success of the implementation of pricing strategies largely depends on organizational support from management, local context (presence of events, seasonal peaks), as well as the digital readiness of the hotel. An unexpected result was also the establishment of the effectiveness of the model for boutique hotels, which have traditionally ignored complex revenue management systems.

The scientific novelty of the research lies in the development and implementation of the author's adaptive pricing model, which integrates demand forecasting based on Machine Learning algorithms, guest behavior analysis, sales channel segmentation and KPI monitoring into a single strategic system for making tariff decisions. Unlike existing approaches, the model is focused on a high degree of personalization and adaptability in conditions of uncertainty.

In addition to developing an adaptive pricing model for hotels of various types and formulating applied recommendations for its implementation in the activities of domestic hotel enterprises, the author also carried out an analytical generalization of approaches to revenue management systems of the above-mentioned business entities.

The practical value of the results obtained lies in the possibility of their direct use by hotel enterprises to increase profitability, improve strategic planning and digitalization of pricing policy. The proposed tools can also become the basis for developing software for small and medium-sized hotel businesses.

Prospects for further research include scaling the model to other regions of Ukraine, integration with CRM systems for in-depth personalization of tariffs, as well as the development of an adaptive pricing system for non-traditional hotel formats, such as hostels, apart-hotels and agro-estate. Thus, adaptive dynamic pricing appears not only as a means of tactical profit optimization, but also as a powerful tool for strategic transformation of hotel management in the era of data analytics, digitalization, and high competition.

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CRISIS MANAGEMENT OF HOSPITALITY ENTERPRISES

Constant economic crises and war escalation in Ukraine create stressful business conditions for economic entities. Counteraction to external negative challenges can no longer be carried out by adaptive mechanisms, because the threat of physical damage (in particular, destruction) is practically impossible to predict and eliminate. This causes the need for hospitality entities not only to conduct foresight research and analyse problems, but also to develop alternative tools and strategies for survival and development. Therefore, the development of innovative anti-crisis business strategies is an urgent scientific task. The main hypothesis is put forward that military crise, in particular the full-scale war in Ukraine, are "black swans", which requires a revision of traditional approaches to anti-crisis management. The development of the hypothesis and the argumentation of the proposed measures for anti-crisis management by hospitality entities are based on the use of theoretical methods (analysis, synthesis, systematization, comparative analysis), as well as systemic approaches (Enterprise Risk Management (ERM), Risk Maturity Model (RMM). The concept of anti-crisis management, the main types of crises and mechanisms for counteracting them (security) are considered. The threats and risks that hospitality entities face in conditions of war crimes are characterized. The international experience of post-war recovery of other countries that have experienced military conflicts is studied, which can be adapted to improve the anti-crisis management methodology. Practical insights into risk management and scenario planning in the hospitality sector against the

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АНТИКРИЗОВЕ УПРАВЛІННЯ СУБ'ЄКТАМИ ГОСТИННОСТІ

Постійні економічні кризи та ескалація війни в Україні створюють стресові умови господарювання для економічних суб'єктів. Протидія зовнішнім негативним викликам вже не може відбуватися адаптаційними механізмами, адже загрози фізичної шкоди, зокрема знищення, спрогнозувати та усунути практично неможливо. Це вимагає від суб'єктів сфери гостинності не просто проводити форсайт-дослідження та аналізувати проблеми, але й розробляти альтернативні інструменти й стратегії для виживання й розвитку. Тому розроблення інноваційних антикризових стратегій бізнесу є актуальним науковим завданням. Висунуто основну гіпотезу, що воєнні кризи, зокрема повномасштабна війна в Україні, є проявом феномену "чорного лебедя", що потребує перегляду традиційних підходів до антикризового управління. Опрацювання гіпотези та аргументація пропонованих заходів антикризового управління суб'єктами гостинності спираються на використання теоретичних методів аналізу, синтезу, систематизації, компаративного аналізу, а також системних підходів (Enterprise Risk Management (ERM), Risk Maturity Model (RMM). Розглянуто поняття антикризового управління, основні типи криз та механізми їхньої протидії (убезпечення). Охарактеризовано загрози і ризики, з якими стикаються суб'єкти гостинності в умовах воєнних криз. Досліджено міжнародний досвід постконфліктного відновлення інших країн, які пережили воєнні конфлікти, що може бути адаптовано для удосконалення методології антикризового управління. Запропоновано практичні інсайти управління ризиками та сценарного

backdrop of unforeseen challenges are offered. Based on the research conducted, a conclusion is drawn about the possible rapid recovery of tourist flows after the war in Ukraine (based on the analysis of similar scenarios) and the readiness of hospitality entities to provide quality services. The authors propose strategic approaches to crisis management in the hospitality sector in turbulent conditions. The results of this research form a theoretical value for both the management of hospitality entities and the scientific community as a discussion field for discussing effective crisis management solutions in wartime.

Keywords: economic security, anti-crisis strategy, cascading crisis, scenario planning, design thinking, innovation.

планування у сфері гостинності на тлі непередбачуваних викликів. На основі проведеного дослідження зроблено висновок про можливе швидке відновлення туристичного потоку після війни в Україні (на основі аналізу подібних сценаріїв) та готовності суб'єктів гостинності надавати якісні послуги. Запропоновано стратегічні підходи до антикризового управління у сфері гостинності в умовах турбулентності. Результати цього дослідження формують теоретичну цінність як для менеджменту суб'єктів гостинності, так і для наукової спільноти як дискусійне поле для обговорення ефективних рішень антикризового управління в умовах війни.

Ключові слова: економічна безпека, антикризова стратегія, каскадна криза, сценарне планування, дизайн-мислення, інновації.

JEL Classification: D81, H12, L22, L83, M10.

Introduction

Ukrainian hospitality entities in modern conditions face unprecedented challenges that threaten their stability and effective functioning. The escalation of military actions territorially and in time, frequent missile and drone attacks on the territory of Ukraine have become the causes of the physical destruction of many hospitality establishments (Sharipov, 2023). The military crisis is a factor of global uncertainty that changes the usual mechanisms of crisis management and forces economic entities to adapt their strategies to high-risk conditions. The impossibility of predicting the economic future creates the phenomenon of the "black swan", changes the landscape of the economic environment and requires the development of new methodological approaches to management in conditions of military threats.

The relevance of this research is due to the need to develop effective mechanisms of anti-crisis management in the hospitality sector in conditions of military conflicts and unpredictable crises. Since this industry is an important component of the Ukrainian economy, its ability to adapt and survive will determine the level of recovery of the post-war economy, the possibilities for receiving foreign and Ukrainian tourists for recreation and rehabilitation. The aim of the research was the behavior of hospitality entities in conditions of crisis phenomena and uncertainty of the external environment, and the subject matter was the theoretical and methodological principles and tools of their anti-crisis management.

The concept of crisis management is always in the focus of scholars and practitioners, as well as government authorities, as it is a matter of business survival and the economic system as a whole. Ukrainian business entities have adapted to cascading crises (Paraskevas, 2021). Global business

operates in a more resilient environment, so global crises have significant negative consequences. In particular, the COVID-19 pandemic has stopped tourist flows and has had a catastrophic impact on the hospitality sector, as evidenced by studies by many scholars. Thus, El-Said et al. (2024) analyze the negative consequences of COVID-19 and the experience of international hotel chains, which focuses on crisis transformations and customer-oriented innovations. Empirical evidence on the practice of managing the recovery of the hospitality sector during the pandemic period in Pakistan is provided by Burhan et al. (2021). The authors investigated the practices of beliefs and psychological factors of stakeholders during the crisis experience of medium and small enterprises and also determined the lack of contingency plans in them, according to which recovery/response methods are predominantly reactive in nature. Similar conclusions are observed among other scholars (Sigala, 2020; Garrido-Moreno et al., 2021). Investigating the paradox of cascading crises, scholars (Broekema et al., 2017; Herbane, 2018; Paraskevas, 2021) indicate that the management of some business entities conducts training and implementation of anti-crisis management, but due to the uniqueness of crises, unpredictability of situations and other factors, cannot take into account the lessons of previous crises.

In the context of the above, the relevance of studying leadership styles (Burton & Dickinger, 2025) and human potential (Molchanova, 2020; Goll & Zieba, 2025) in overcoming crises is argued. The basis of these theoretical aspects is the importance of corporate values and human potential as drivers of rapid and successful adaptation to new and unknown conditions. The authors note that the hidden and unique abilities of employees, if properly managed, can become a significant additional value for the business and increase its competitive advantage and sustainability (Goll & Zieba, 2025).

Finding themselves in a war, the Ukrainian business environment, accustomed to constant crises, must quickly transform and adjust logistical communications in order to survive and withstand unprecedented threats. Therefore, studying the experience of the military economy of countries in overcoming crisis situations in the hospitality sector is extremely important. Understanding the specifics of each type of military crisis and adapting appropriate anti-crisis management strategies is helped by the research of such scholars as Jayasundara-Smits (2020), who studied the impact of a culture of impunity, ongoing militarization, and persistent corruption on business; Parenta (n. d.) – the experience of Yugoslavia in the transformation of the film industry in the post-war period; Kaldor (2020) – the mutual influence of the military sphere and the economy of Vietnam, the stages of technological style in each system; Deineko and Tsyplitska (2022) – the global experience of industrial recovery from the consequences of war; Fulgence (2016) – the experience of the hospitality sector in the context of terrorism in Africa; Ivanov (2024) – the experience of European and East Asian countries with rapid post-war economic growth in the context of its application in Ukraine.

The academic field also includes valuable foresight studies of the development of the hospitality sector in Ukraine in the post-war period, among which it is worth noting the works of Konoplyanyk and Skrob (2024); Korsak et al. (2024); Semyrga et al. (2024). It should also be noted that this article is a continuation of research on crisis resilience (Boiko et al., 2022) and economic security (Bovsh et al., 2023; Bovsh et al., 2024) in the hospitality sector.

The results of the analysis of scientific sources indicate that the issue of crisis management has regional specifics and focuses on management mechanisms and styles. The emergence of new macro challenges and threats, digital innovations and changing values of internal and external consumers actualize the development of this concept. The essence, types of crises and manifestations of cascading crises, as well as their impact on the hospitality sector, require comprehensive research. This will help to understand the properties of each type of crisis and create a toolkit for adapting and counteracting negative impacts on business entities, which forms the scientific and practical value of this study.

The aim of the article is to determine the features of anti-crisis management of hospitality entities in Ukraine in the face of unforeseen challenges caused by military crises, as well as to develop practical recommendations for sustainable development and adaptation of the hospitality sector to modern threats. At the same time, the key tasks are to determine the nature and types of crises, study the experience of other countries in overcoming crisis situations, in particular post-war crises, in the hospitality sector, identify unforeseen challenges faced by business entities, and formulate recommendations for strategic management and ensuring crisis resilience of hospitality entities.

A hypothesis is proposed according to which military crises, in particular a full-scale war in Ukraine, can be considered a "black swan" phenomenon, which requires a revision of classical approaches to the system of anti-crisis management of hospitality entities. The study also emphasizes additional hypotheses: the experience of countries that have experienced military conflicts (Croatia, Israel, Georgia) can be adapted to improve anti-crisis management in the hospitality sector of Ukraine; hospitality entities that implement anti-crisis strategies (environmental, social and management aspects) have better chances of attracting international partners and investments to restore business after the crisis. To confirm the hypotheses, the methodology of processing scientific publications and media information, as well as practical insights of business entities using analytical and scientific research methods, was used. The focus was on practice, because the hospitality sector requires not just an analysis of the problem, but specific tools for survival and development.

The information base of the research is scientific and professional sources on anti-crisis management, hospitality, strategic planning.

During the research, general scientific methods were used, in particular, comparative analysis to determine the definition of "anti-crisis management", the comparison method – to analyze international practices of

overcoming crises. Scenario planning methods were used to interpret different options for the development of events in crisis conditions for strategic prediction and adaptation of business models.

The scientific novelty lies in the development of the concepts of "anti-crisis management" and the systematization of types of crises, as well as modeling the anti-crisis management strategy of hospitality entities, which will allow Ukrainian hospitality entities to navigate in war conditions and create the prerequisites for recovery and sustainable development after the crisis.

The limitations of the research were the lack of formal data on anti-crisis practices in the hospitality sector. To form a foresight vision of the strategic vectors of hospitality entities, public information posted on official and social pages, as well as on media platforms, was used. In the future, it is planned to consider research insights from hospitality entities and test the assumption that the introduction of digital technologies, diversification of services and adaptation of business models to new conditions demonstrate a higher level of resilience and faster business recovery.

The content structure of the main part of the article contains five sections: in the first, theoretical aspects of anti-crisis management in the context of stresses and crises, as well as the typology of crises, are considered; in the second, an empirical analysis of statistical data on the unprofitability of hospitality enterprises and the dynamics of changes in their quantitative composition are presented; in the third, approaches to anti-crisis management are systematized; The fourth section substantiates the challenges caused by the military crisis, which is a "black swan" and requires innovative design thinking; the fifth section models anti-crisis management strategies for hospitality entities and scenarios of different event scenarios aimed at adapting business models and risk management.

1. Identification and characteristics of crises in the hospitality industry

Based on scientific research into the nature and types of crises, business entities receive a reactive toolkit of standard management decisions, which increases the chances of successfully exiting the risk zone. To scientifically substantiate the concept of anti-crisis management, it is worth defining the concept and typology of crises. Previous research (Boiko et al., 2022) interprets a crisis as a depressive process of changing external and internal conditions of activity, as a result of which economic entities are unable to function stably and perform their basic functions, which requires alternative solutions, qualitative transformation to resist the emergence of crisis states. Crises are already aggravated situations that require immediate response. However, there may be situations caused by permanent or temporary challenges that create tension, but do not necessarily lead to a crisis, that is, stresses. Let us examine these two phenomena in interaction (*Figure 1*).

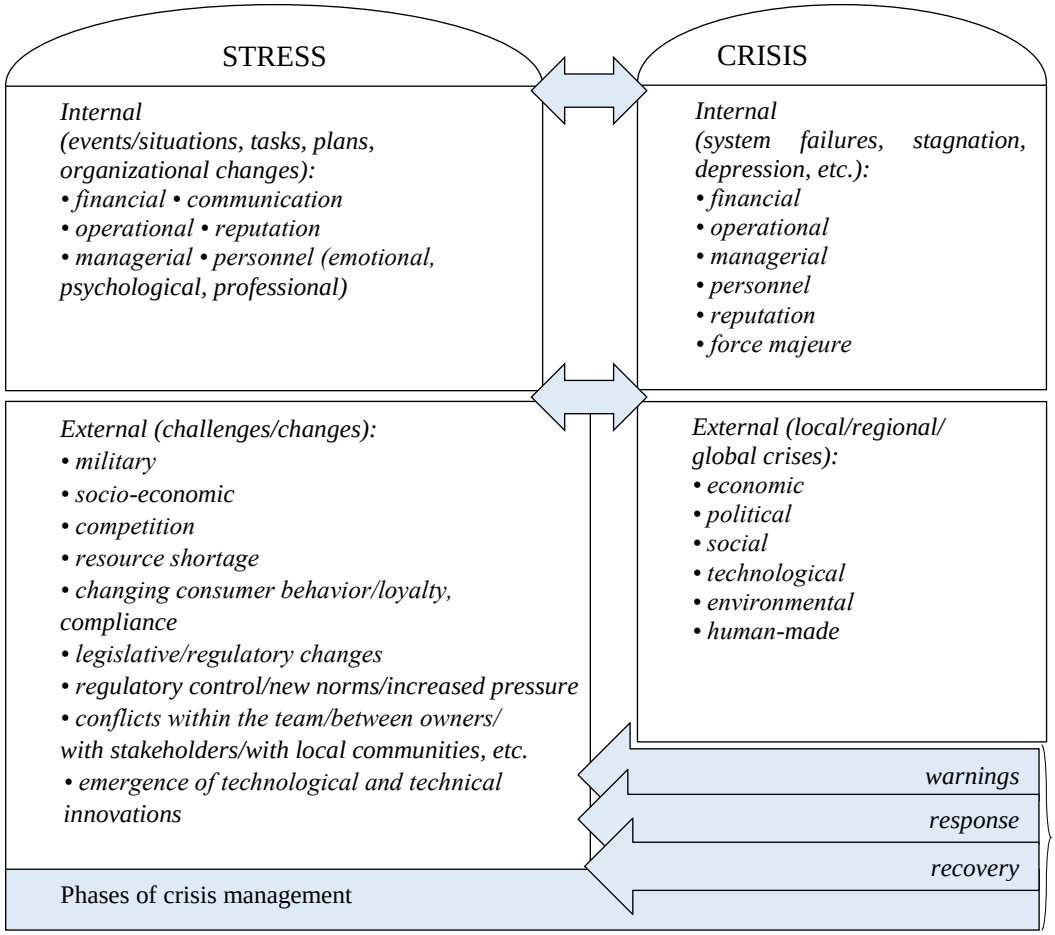

Figure 1. Stresses and crises that form the anti-crisis dynamics of a hospitality entity

Source: compiled by the author.

Figure 1 shows how internal and external stresses can accumulate and turn into a crisis if not managed effectively. Accordingly, two categories are distinguished:

• external and internal stresses that constantly affect the system can accumulate and lead to a crisis;

• external and internal crises as a result of stressors or unexpected events that require anti-crisis management.

External stresses in wartime for hospitality entities are divided into military (threat of missile strikes, mobilization of personnel), social (reduced population mobility, forced resettlement), economic (inflation of income, increased costs for security and logistics). Causally, they are due to the need to adapt to changes and threats in the external environment. First of all, internal stresses are due to the hospitality entity's own problems. First, they can be the result of making ineffective management decisions, organizational culture or resource constraints. In particular, operational stresses arise due to dysfunction of business processes, supply disruptions, technical failures, etc. Secondly, personnel stresses – under the influence of emotional and

psychological pressure on personnel and work in conditions of constant anxiety. This causes staff turnover and burnout, conflicts in the team, etc. Thirdly, problems in communications (reputational stresses) – loss of trust from clients, partners, negative information background, etc.

Crises arise when accumulated internal and external stresses lead to systemic failures. If internal crises can and should be managed, then it is impossible to influence the emergence and course of external crises, because they are caused by factors beyond the control of the hospitality entity. Today, the Ukrainian economy is experiencing a multi-crisis – when we simultaneously have a negative interaction of political (war, political instability), economic (GDP decline, inflation, asset depreciation), environmental (technological disasters from military operations), social (staff shortage, reduced consumer solvency, socio-psychological and physical injuries of the population, etc.) crises.

A multi-crisis triggers a domino effect (chain reaction), which is difficult to stop if anti-crisis management is not implemented, in particular at the early stages of problem identification. Accordingly, let us consider the typology of crises (*Table 1*).

Table 1

Typology of crises affecting the activities of hospitality entities

Classification feature	Criterion	Type of crisis	Crisis trigger
Source of origin	Internal	Financial	Lack of funds, bankruptcy,
		Operational	cash gap
		Corporate	Insufficient qualification of personnel, failures of management systems
		Reputational	Internal organizational conflicts, change of management
	External	Economic	Inflation, tax increases, economic downturn
		Political	Regulatory changes, corruption risks, sanctions
		Social	Changes in consumer behavior, demographic shifts
		Technological	IT system failures, cyberattacks, obsolete equipment
		Environmental	Natural disasters, man-made disasters, climate change
		Security	Military actions, terrorist acts, pandemics, etc.
By speed of development	Natural/ anthropogenic	Acute (shock)	Terrorist attacks, fires, technological disasters
	Cumulative/stagnant	Chronic	Decrease in demand, financial instability
By scale of impact	Territorial scope of influence	Global	COVID-19, global economic crisis, climate change
		Regional	Military operations, natural disasters
		Sectoral	Decline in demand, reduction in tourist flow, etc.
		Local	Bankruptcy, internal scandals

End of Table 1

Classification feature	Criterion	Type of crisis	Crisis trigger
By predictability	Controlled	Expected	Seasonal decline in demand, update of Service Standards
	Uncontrolled	Unexpected ("black swan" phenomenon)	Military operations, terrorist acts, natural disasters, etc.
By interdependence	Single event	Single	The crisis develops independently of other events
	Ripple effect	Cascading	One crisis triggers a chain reaction (e.g., economic crisis → staff reduction → deterioration in service quality)
	Synergistic effect	Multi-crisis	Several crises develop in parallel, complicating management (economic crisis and war in Ukraine)

Source: systematized by the author according to (Bundy et al., 2017; Coombs, 2019; Watchenko & Sharanov, 2022; Povorozniuk & Budzinski, 2023).

Systematization of crisis types allows developing an appropriate anti-crisis management methodology, guided by crisis criteria and triggers.

2. Empirical indicators of the sustainability of hospitality entities in crisis conditions

In the context of a systemic crisis caused by a full-scale war, hospitality entities in Ukraine faced unprecedented challenges. The escalation of military threats led to a reduction in demand and, accordingly, a deterioration in the financial results of business entities and an increase in the number of unprofitable establishments, which is confirmed by statistical data (*Figure 2*).

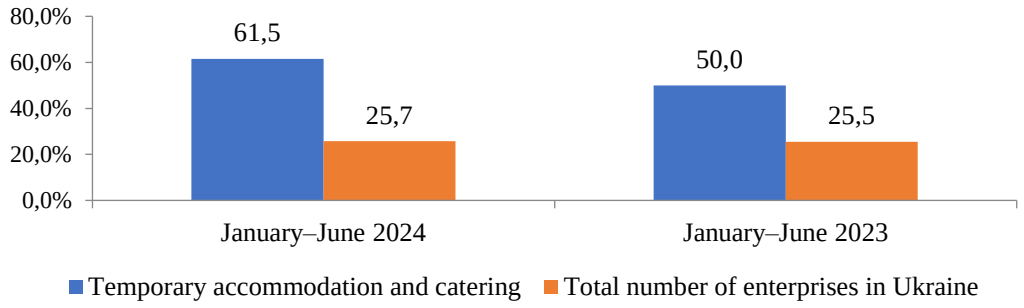

Figure 2. Share of unprofitable medium and large enterprises, 2023–2024

Source: compiled from (State Statistics Service, 2024).

As follows from *Figure 2*, in 2024 the crisis deepened: the share of unprofitable enterprises in temporary accommodation and catering increased by 11.5%. And this is a general economic trend, because we observe an increase in the number of unprofitable enterprises in Ukraine in 2024 compared to 2023 by 0.2%.

Thus, not only the consumer environment has changed, but also the structure of the hotel and restaurant market itself (*Figure 3*).

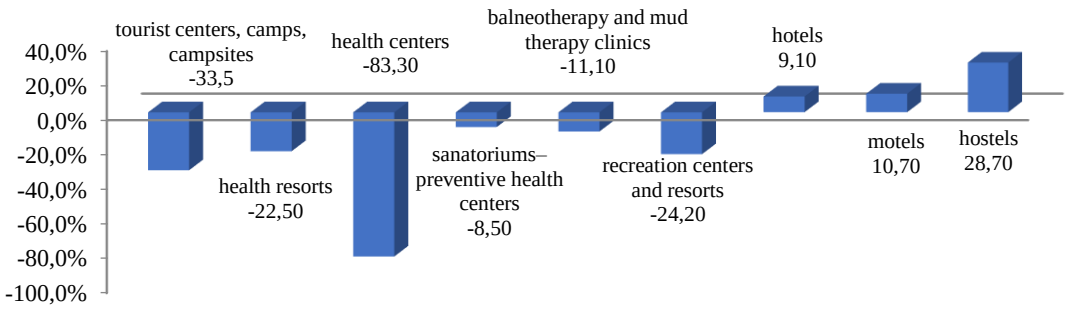

Figure 3. Dynamics of hotel business entities, 2024 compared to 2023

Source: compiled by (Tarasovskyi & Kruchynina, 2024).

Thus, a positive increase in the number of hotel-type establishments (hotels, motels, hostels) is demonstrated, which may indicate the flexibility of their business models, faster adaptation to changes in demand and active use of digital booking channels. This is especially true for small and medium-sized enterprises that were able to reorient services for domestic tourism or temporary accommodation for displaced persons. As for non-hotel-type establishments (medical and health resorts), significant rates of decline in dynamics are observed, which is due to both a decrease in the purchasing power of the population and difficulties in maintaining infrastructure in war conditions. In addition, restrictions on medical tourism and staff shortages have affected the stability of the functioning of these establishments. Such an asymmetry of recovery demonstrates the different resilience of hospitality entities depending on their profile, scale and ability to quickly transform services. As for restaurant establishments, the market in the city of Kyiv, where significant closures are observed every year (*Figure 4*).

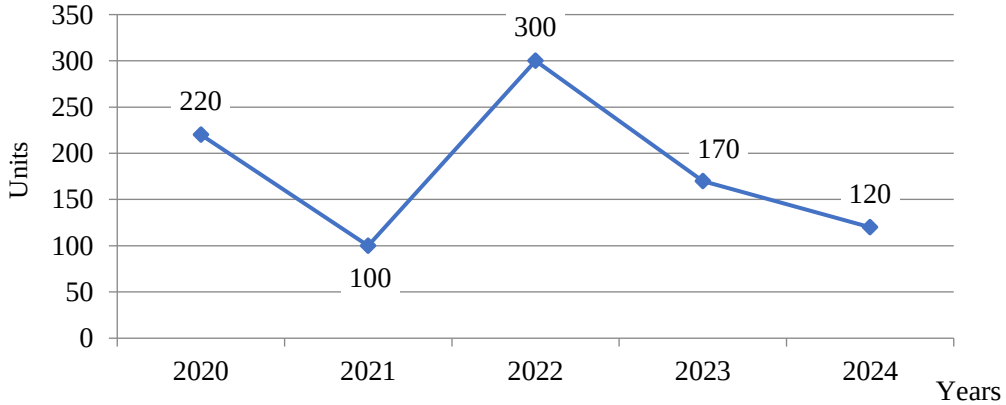

Figure 4. Number of closed restaurant establishments in Kyiv, 2020–2024

Source: compiled by the author according to (Inshe, 2024).

If in 2020–2021 the main reason was the pandemic crisis, then since 2022 the determinants have become problems in maintaining

(assembling) the team – in 46.6% of cases; maintaining stable prices – 32.2%; tax audits – 6.3% and own motivation – 8.4% (Pro-Consulting, 2024). Thus, the full-scale war in Ukraine has caused a critical decline in business activity in the hospitality sector, which was reflected in a reduction in the number of hotel and restaurant establishments, a decrease in consumer demand and an increase in the share of unprofitable entities. In general, the hotel and restaurant market has been experiencing regressive trends since 2022, when a significant part of hospitality establishments has ceased operations due to security risks, destruction of infrastructure, lack of tourist flows and forced migration of personnel. In 2024, we observe a deepening of the crisis due to the uncertainty of the military timeframe, mobilization measures. At the same time, in 2023–2024, a moderate recovery trend is observed, especially in the western regions of Ukraine and in relatively safe centers of domestic tourism. This was facilitated by the adaptation of hotels to wartime conditions (conversion into shelters, hubs for IDPs), the development of "volunteer tourism" and business trips related to humanitarian and IT initiatives, a partial reorientation to long-term accommodation, rental for military or partner organizations, expansion of partnerships with state structures that accommodated IDPs, etc.

It should be noted that the market recovery is not linear: regressive phases are replaced by short recoveries, especially against the background of intensification or weakening of hostilities, which indicates the cyclical nature of anti-crisis adaptation. In the future, this trend will take on the characteristics of a strategic transformation of business models of hotels and restaurants with flexible working conditions and hybrid services. Therefore, it is important to explore the possible tools of anti-crisis management of hospitality entities and a priori effective development strategies.

3. The contextualization of crisis management in the hospitality sector

There are certain methodologies of crisis management in scientific literature, within which types of crises and approaches to their management are discussed. However, such approaches to crisis management have common attributes:

- normative guidelines – legislative and regulatory acts, international concepts of law, standards and provisions of corporate culture, scientific principles, etc.;
- proven and effective tools: approaches and methods by which research is formed, theoretical and applied analysis is carried out, the results of which are implemented in recommendations for business practice;
- an established, defined special thesaurus, thanks to which a conceptual basis is created for analysis, development of strategies and practical application of crisis solutions in the hospitality sector.

Since academic management has worked out typologies of crises inherent in a certain historical period, economic cycle or life cycle of an organization, etc., the task of science is updated each time with

the emergence of new threats or opportunities that create social and economic shocks and innovative breakthroughs. Thus, the concept of anti-crisis management develops from the position of understanding the following aspects:

1) what is the essence and vector of influence of a certain shock (crisis) on business entities and the state (state policy);

2) how the state and business influence the crisis – its overcoming and extinguishing, the development of tactics and strategies of response, ensuring economic security;

3) how specific conditions (in particular, uncertainty) correct the consequences of these mutual influences.

Thus, the concept of crisis management develops scientific approaches and decision-making mechanisms for forecasting and identifying crisis threats, assessing the level of vulnerability of business entities, developing adaptive response strategies, integrating technological and managerial innovations, as well as forming mechanisms for business resilience and recovery in conditions of high uncertainty.

Contextualization of crisis management involves operationalizing the terminological basis. Since there are quite a few interpretations of crisis management today, let us examine the most relevant ones, which will allow us to summarize the main features and characteristics and contribute to its adequate use in this research (*Table 2*).

Table 2

Comparative analysis of crisis management

Author/source	Definition characteristics	Key element
Crisis management, 2025	Actions taken to address an emergency or difficult situation in an organized manner	Organized resolution of an emergency or complex situation
Bundy et al., 2017	This is the process by which an organization deals with a disruptive and unexpected event that threatens to harm the organization or its stakeholders.	The process of countering a disruptive and unexpected event that threatens to harm the organization or its stakeholders
Hryshchuk, 2019; Tkachenko, 2023	A specially organized management system that has a comprehensive systemic approach aimed at the promptest identification of signs of a crisis and the creation of appropriate prerequisites for their timely overcoming in order to ensure the restoration of the vital activity of the business entity, prevent its bankruptcy and prevent a crisis in the future	Ensuring and restoring vital activity, preventing bankruptcy and preventing a crisis in the future
Bolotnov, 2022	Management aimed at avoiding and neutralizing signs of crisis in the economic activities of enterprises, as well as adapting the management system to changes in the external environment, which will contribute to sustainable development	Avoiding and neutralizing signs of crisis. Adapting the management system
Burak, 2023	A system of management measures and decisions related to the diagnosis, prevention, prevention, elimination of crisis phenomena and neutralizing the effects of the crisis in the future	Diagnosis, warning, prevention, crisis management

End of Table 2

Author/source	Definition characteristics	Key element
Vozovyk, 2023	A constantly organized special management, which is based on a system of methods and principles for the development and implementation of specific management decisions that are made by a separate entity in conditions of significant resource and time constraints, increased risk, financial and intellectual costs to restore viability and prevent liquidation	Management decisions. In conditions of resource and time constraints, increased risk, financial and intellectual costs
Thebusinessparadox, 2024	In the face of resource and time constraints, increased risk, financial and intellectual costs, a set of strategies aimed at helping an organization overcome a significant adverse event in a timely and effective manner	A set of strategies

Source: compiled by the author.

The contamination of the above-mentioned scientific views allows us to interpret crisis management as a set of strategies, methods and tools used in the event of threats of financial, reputational or/and property losses, which are aimed at preventing, minimizing the impact, overcoming crisis situations and ensuring business sustainability.

When applying contextuality as a methodological approach in crisis management, it is worth considering:

• the type of threat that causes a certain crisis, its features, intensity and scale of impact;

• the event context (pandemic, war, man-made or financial disaster) as a condition for manifestation;

• available effective tools for combating crises and methods of their application (adaptation);

• prospective research and foresight analytics of crises (local and global).

This will allow us to develop effective strategies for the development of hospitality entities in the face of unforeseen challenges and events.

4. Challenges and the role of innovative design thinking in overcoming the military crisis

The full-scale war in Ukraine caused a shock effect on society and business, described in the scientific literature as the "black swan" phenomenon due to its suddenness, large-scale impact and unpredictability. This theory was proposed by Nassim Nicholas Taleb in the book The Black Swan: The Impact of the Highly Improbable (2007) and is based on the philosophical dogmas of Ancient Greece, which so designated an incredible and rare phenomenon. Taleb (2007) describes events that have key characteristics relevant in the conditions of the war in Ukraine:

• unexpectedness – the event goes beyond the boundaries of usual experience and forecasts;

• significant impact – its consequences are large-scale and radically change the conditions;

• retrospective explainability – after the event, people tried to find a logical explanation for it, although it was almost impossible to predict it.

These findings are confirmed by statistical data (*Figure 5*).

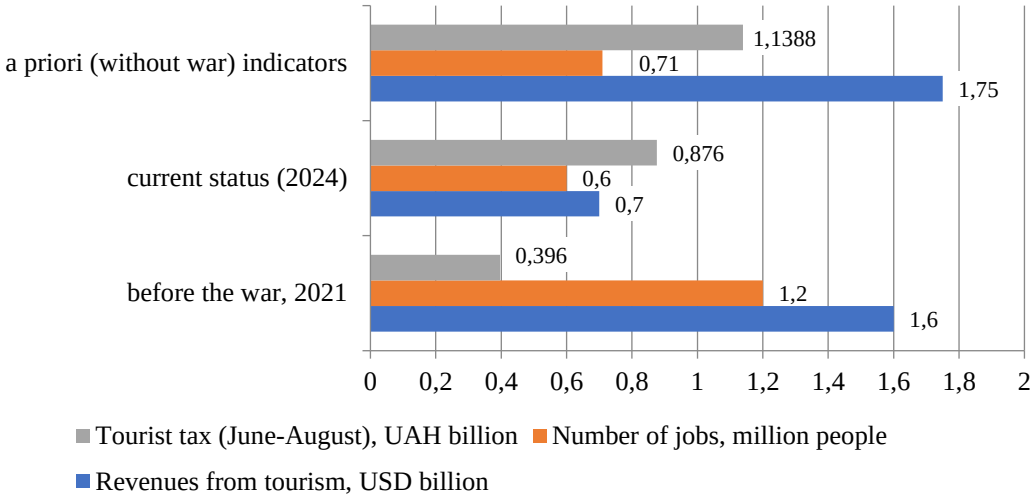

Figure 5. Infographics of the impact of war on the hospitality sector

Source: systematized by the author according to (UHRA, 2024; Lupashko, 2024).

The comparison of data shows negative consequences: a drop in tourism by almost 85% and a reduction in the number of jobs by 710 thousand (UHRA, 2024) – very significant indicators of losses in the hospitality sector and the economy as a whole for three years of full-scale war.

Thus, the war became a "black swan" for the Ukrainian hospitality sector due to a significant impact on infrastructure (physical damage, destruction, frequent alarms), changes in consumer behavior (tourist outflow, shift in demand to safe regions); economy (complication of logistics, increased costs, reduced solvency of the population, financing restrictions, etc.). Therefore, anti-crisis management must take into account the correlations of the above concept and war challenges for the hospitality sector (*Table 3*).

Table 3

Crisis management key aspects of hospitality entities in the context of military challenges in Ukraine

Aspects	Theory of the "black swan"	War challenges for the hospitality industry	Innovative design thinking approaches
Unpredictability of the event	War as an unexpected, rare, but influential factor	Destruction of infrastructure, economic downturn, loss of customers	Flexible rethinking of business models, diversification of services
High destructiveness	Radical changes that destroy familiar business systems	Disruption of communication channels, staff shortage, physical and cybersecurity issues	Rapid testing and implementation of alternative services

End of Table 3

Aspects	Theory of the "black swan"	War challenges for the hospitality industry	Innovative design thinking approaches
Retrospective explanation	Post-crisis understanding of signals and decisions	Business entities were not ready for large-scale risks	Using artificial intelligence and databases to predict crisis scenarios
Case solution for the hotel business	A sharp drop in demand, the need for radical changes	Closing hotels, the need for reprofiling	Shelter hotels, carpet kings, social initiatives, cooperation with humanitarian organizations, etc.
Case solutions for the restaurant business	New challenges force us to look for alternative solutions	Loss of tourists, reduction in purchasing power	Volunteer restaurants, expansion of delivery, social initiatives
Case solutions for creating barrier-free hospitality	Reassessment of spatial and communicative needs of consumers	Increasing need for an inclusive environment for war victims, people with disabilities	Creating a barrier-free space: ramps, adapted rooms, navigation, AI assistants, universal design, adapted restaurant menu, etc.

Source: systematized by the author according to (Taleb, 2007; Boiko, 2022; Korsak et al., 2024; Konoplyanyk & Skrob, 2024).

The concept of the "black swan" directs owners and management of business entities to innovative thinking regarding the use of opportunities that transform the business to new conditions. It should be noted that innovative thinking is design thinking, which is based on a deep understanding of user needs, creative search for solutions and rapid testing of ideas (Bovsh et al., 2024). Thanks to the principles of empathy, ideation, prototyping and testing, design thinking produces innovative approaches to responding to crises not only promptly, but also strategically, turning challenges into opportunities. Therefore, the anti-crisis management system of a hospitality entity should include design thinking approaches to overcoming crises (*Figure 6*).

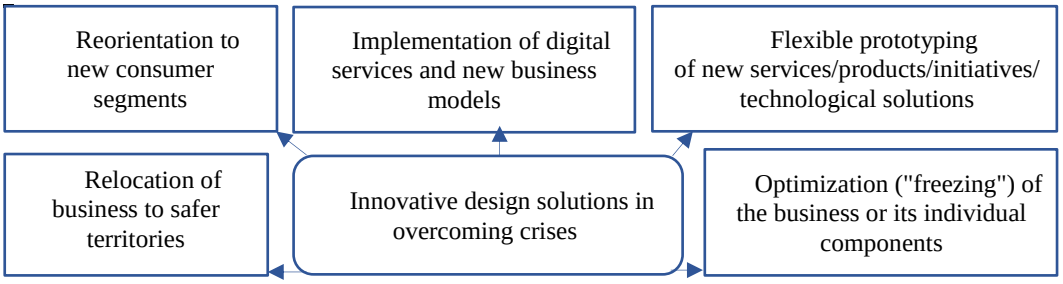

Figure 6. Key innovative design solutions to overcome crises in the hospitality sector

Source: compiled by the author.

Thus, in wartime, the application of design thinking creates powerful tools for crisis management in the hospitality sector.

Let us consider the theoretical insights of design thinking in overcoming the "black swan" in the hospitality sector (*Table 4*).

Table 4

Innovative hospitality solutions based on design thinking in overcoming the "black swan" phenomenon

Challenges	Design thinking tools	Innovative design thinking approach	Crisis management measures	Estimated effect
Unpredictability of the business environment under the influence of war	Flexibility and adaptation	Creating flexible strategies through rapid prototyping and market needs analysis	Transition to hybrid models: online booking, digital customer support, flexible tariff plans, etc.	Timely adaptation to changes, increasing business viability
Customer shortage	Empathy and customer focus	Co-creation with local communities, introduction of new communication channels	Implementation of personalized services for internally displaced persons, military, etc.	Customer loyalty, new target groups
Shortage of personnel	Onboarding, outsourcing, staff mentoring	Process automation, staff training in new competencies	Outsourcing of business processes, automation of certain operational cycles, effective staff motivation	Cost reduction, improvement of service quality
Shortage of financing	Creating an ecosystem of interaction for business sustainability	Integration of alternative sources of financing (partnerships, franchising)	Search for additional sources of income, investment attraction, collaboration and partnerships	Revenue diversification, financial sustainability

Source: compiled by the author after (Taleb, 2007; Fisher et al., 2021; Boiko, 2022; Povorozniuk & Budzinsky, 2023; Konoplyanyk & Skrob, 2024).

Practical recommendations for sustainable development and adaptation of the hospitality sector to modern threats are aimed at finding effective innovative ideas and implementing them. In particular, co-creation is relevant – a process of joint value creation, in which not only hospitality entities participate, but also their customers, partners, employees and other stakeholders. This is an approach when the final product, service or solution is formed through interaction between all participants in the process, which allows you to better take into account their needs and expectations. Thus, hotels implement new room formats and services based on the wishes of guests, restaurants – joint development of menus with chefs and customers (individual master classes or voting for seasonal dishes), marketplaces – use platforms to collect ideas from customers (Airbnb actively uses this approach in its updates).

Therefore, to ensure sustainable development and business adaptation to these threats, it is necessary to implement anti-crisis, innovative, and environmentally responsible approaches that are integrated into the development strategies of hospitality entities and help them not only survive in the face of modern threats, but also lay the foundation for future growth.

5. Anti-crisis strategies for managing hospitality entities

In the context of martial law and economic turbulence in Ukraine, global risks, anti-crisis management includes adaptive planning, strategic flexibility, proactive response to challenges and the use of technological innovations to ensure business sustainability. Institutionalized forms of anti-crisis response should also be taken into account, covering both judicial and pre-trial procedures. Thus, the procedure for preventing insolvency of business entities and mechanisms for their rehabilitation at the institutional level are provided for in the Code of Ukraine on Bankruptcy Procedures (VRU, 2019). Anti-crisis management of hospitality entities in accordance with the specified Code should be adapted in accordance with the specifics of the business, in particular, taking into account seasonality, a high share of variable costs, as well as the need to preserve intangible assets – reputation, customer base, franchise or partnership agreements (*Table 5*).

Table 5

Adaptation of the instruments of the Code of Ukraine on Bankruptcy Procedures (CUB) to the specifics of the activities of hospitality entities

CUB tool	Specifics of the hospitality industry	Suggestions for adaptation/changes
Reorganization before the opening of proceedings	Seasonal nature of income, dependence on tourist flow, emotional and psychological background of consumers	Develop a simplified rehabilitation mechanism for micro, small and medium-sized businesses, taking into account the seasonality of revenues and the risks of unforeseen events
Debt restructuring procedure	High proportion of variable costs, difficulty of long-term planning during war	Provide flexible, quarterly restructuring schedules, with the option of deferring payments in case of force majeure
Liquidation procedure	Significant share of intangible assets (brand, franchises, online rating)	Introduce tools for preserving intangible assets, in particular for franchise entities through license support
Moratorium on satisfaction of creditors' claims	Risks of loss of operating capacity in case of decrease in income	Expand the possibilities of applying a temporary moratorium, taking into account martial law or limited market operation
Analysis of the debtor's solvency	Insufficient forecast data in unstable conditions	Add simplified criteria for assessing solvency for entities operating in front-line or de-occupied zones

Source: compiled by the author according to (VRU, 2019).

In the hospitality sector, the proposed tools can become a stimulus for the development of business entities. It is seen that thanks to such adaptations of legal mechanisms of anti-crisis management to the specifics of the activities of hospitality entities, a toolkit will be formed for their timely response, restoration of solvency and minimization of losses.

The above argues for conducting a systematic analysis of approaches to anti-crisis management taking into account war and economic crises (*Table 6*).

Table 6

Systematic analysis of the conditions for the crisis management implementation in the hospitality industry

The criteria	Ukraine (in times of war)	Global crisis		
		COVID-19 pandemic	Economic and social crises	Military threats, terrorism (Syria, Iran, Georgia, etc.)
Main threats	War, destruction of infrastructure, outflow of tourists, shortage of personnel	Closure of establishments, falling demand, financial risks	Energy crises, migration challenges, inflation	Military conflicts, terrorist threats, destruction of infrastructure
State support	Grants, tax breaks, e-recovery programs, international assistance	Financial support packages, loans to small and medium-sized businesses	Financial (local and regional) recovery funds, subsidies	Special business support programs
Business adaptation strategies	Diversification of services, business relocation, digitalization	Focus on domestic tourism, online services, security protocols	Environmental sustainability, innovations in tourism	Routine response, security protocols
The role of international organizations	Support of the UN, World Bank, EU, international organizations, military support (weapons, equipment)	Cooperation with WHO, international financial institutions	Funding from EU regional funds, World Bank, etc.), Coordination with international structures	Military support, strategic alliances
Use of technologies	Online booking, CRM systems, risk analytics, automated security systems	Artificial intelligence technologies, service automation	Development of smart tourism, eco-innovation	Automated security systems, cyber defense
Effectiveness of measures	Partial recovery, dependence on international assistance	Rapid adaptation, employment support	Relative stability, gradual recovery	High efficiency, loss minimization
Possibility of recovery in the post-crisis period	High in case of long-term support and a quick end to the war	High in case of the development of local tourism	High in case of high consumer trust	High in case of a rapid end of the military conflict

Source: compiled by the author after (Watchenko & Sharanov, 2022; Povorozniuk & Budzinsky, 2023; Zayachkovska et al., 2023; Ivanov, 2024).

By compiling the above aspects and correlations of scientific approaches with the concept of anti-crisis management, we will form the main strategic directions for sustainable development and adaptation of the hospitality sector to modern threats in Ukraine (*Figure 7*).

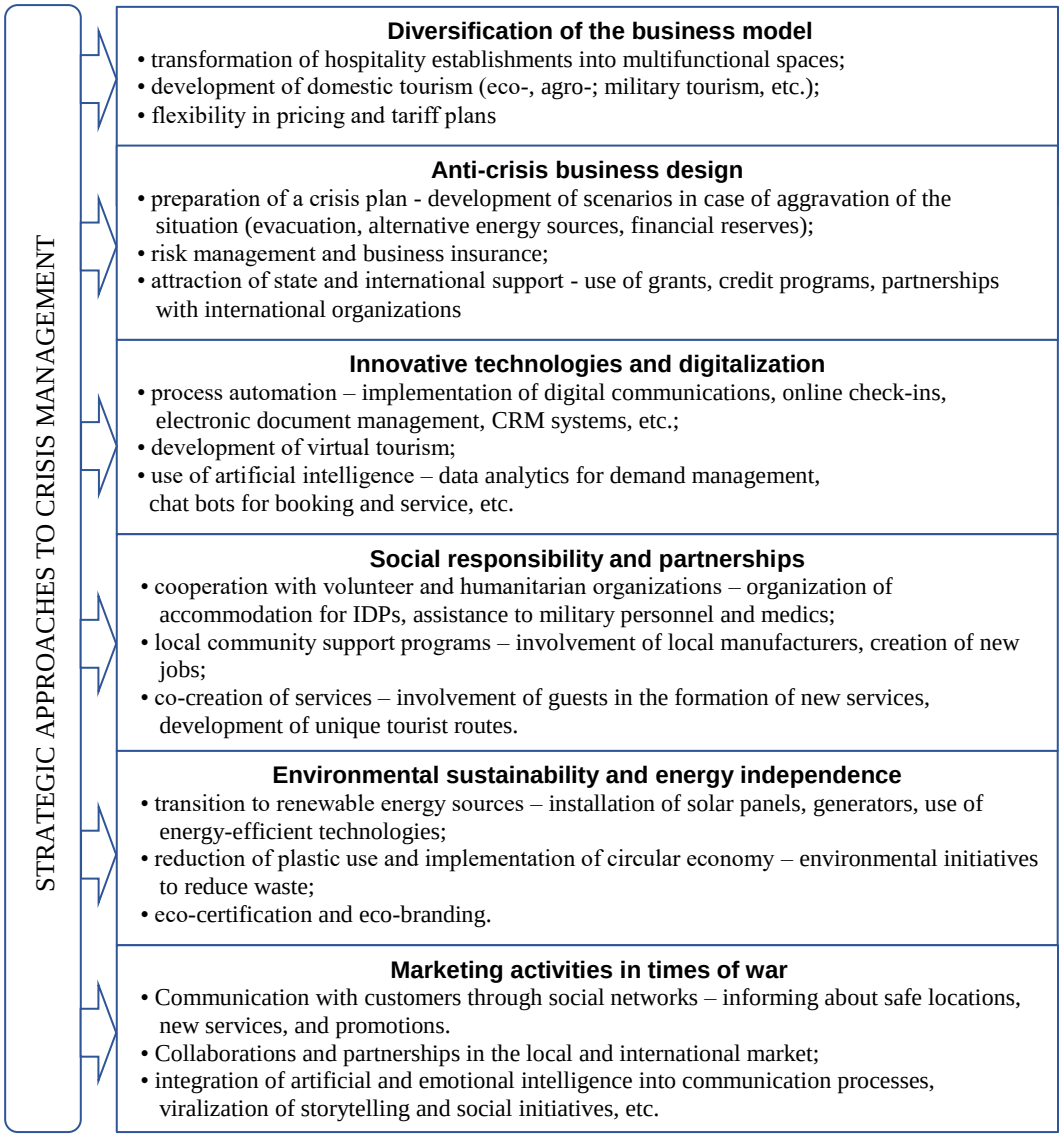

Figure 7. Strategic Approaches to Crisis Management in the Hospitality Sector in Times of Turbulence

Source: compiled by the author.

In view of the considered strategic approaches, it is proposed to use systemic approaches to forecast the development of business in the hospitality sector: Enterprise Risk Management (ERM), Risk Maturity Model (RMM), which allow to optimize risks and increase the predictability of crises (*Table 7*).

Therefore, in the short term, hospitality entities should focus on adaptation, in the medium term – on optimization and expansion of the business, in the long term – on innovations, partnerships and international cooperation. Therefore, the use of ERM and RMM contributes to the timely identification of crisis symptoms, increases predictability and adaptation to crises. Crisis planning and innovations allow you to respond faster to challenges, reducing the impact of uncertainty.

Table 7

Forecasting business development in the post-war period in the hospitality sector of Ukraine using systemic approaches

Methodology	Key aspect	Expected results for business	Forecast		
			short-term (1–3 years)	medium-term (3–5 years)	long-term (more than 5 years)
Enterprise Risk Management (ERM)	Integration of risk management into all business processes	Increasing resilience, adaptation to crises	Operational stabilization, development of crisis strategies, cost optimization	Investment in digitalization and security, flexible personnel management	Diversification of business models, entry into international markets
Risk Maturity Model (RMM)	Assessment of risk management maturity, development of risk culture	Increasing predictability of crises, strategic adaptation	Assessment of business weaknesses, implementation of basic risk management mechanisms	Strengthening corporate risk management culture, automation of risk monitoring	Formation of a long-term risk management strategy based on analytics and artificial intelligence
Strategic risk analysis (PESTLE, SWOT)	Assessment of the Impact of Macroeconomic, Political, Social and Technological Factors	Flexible planning, adaptation to market changes and consumer preferences	Identification of key risks, short-term solutions to support business	Formation of strategic vision, search for partnerships for recovery	Entering new market segments, strengthening international cooperation
Crisis planning (Business Continuity Management – BCM)	Development of Action Plans in Case of Force Majeure	Minimization of losses, rapid response to crisis situations	Development of crisis response scenarios, testing of business resilience	Automation of crisis management, preparation of alternative business models	Institutionalization of anti-crisis management, implementation of flexible operating models
Digital Transformation and Innovation	Investments in technology, automation, artificial intelligence	Cost optimization, increasing competitiveness	Implementation of online bookings, CRM, chatbots for customers	Using Big Data for demand forecasting, intelligent management systems	Full-fledged service automation, integration with global platforms
Human Capital Management	Flexible work models, staff retraining	Increasing employee productivity and loyalty	Training staff to work in a crisis, minimizing layoffs	Flexible contracts, strengthening the role of soft skills	Automated HR management systems, hybrid work models

Source: compiled by the author according to (Taleb, 2007; Fisher et al., 2021; Boiko, 2022; Povorozniuk & Budzinsky, 2023; Konoplyanyk & Skrob, 2024).

Therefore, in the short term, hospitality entities should focus on adaptation, in the medium term – on optimization and expansion of the business, in the long term – on innovations, partnerships and international cooperation. Therefore, the use of ERM and RMM contributes to the timely

identification of crisis symptoms, increases predictability and adaptation to crises. Crisis planning and innovations allow you to respond faster to challenges, reducing the impact of uncertainty.

Most international hotel operators use an ERM strategy for risk management. The ERM methodology involves the following steps:

1. Risk identification, which includes the following agendas:
   - analysis of global and local risk factors through PESTLE;
   - collection of data on events that have affected operations in the past;
   - identification of specific threats for each region.
2. Assessment and prioritization, which includes the following implementation results:
   - risk assessment model based on probability, impact and mitigation options;
   - response scenarios for different types of crises (e.g. pandemic, terrorist attacks).
3. Development of response strategies, which includes the implementtation of:
   - financial hedging of risks to reduce losses;
   - cybersecurity systems to protect guest data;
   - physical security systems against military threats;
   - investments in post-COVID-19 sanitation protocols and contactless technologies, etc.
4. Monitoring and adjusting the strategy, ensuring:
   - using Big Data and AI for real-time risk analysis;
   - internal audits and regular review of strategies.

An example of the application of crisis management through ERM is demonstrated by the InterContinental Hotels Group chain (InterContinental and Holiday Inn hotels), which minimized financial losses during the pandemic by 30% compared to competitors thanks to crisis management strategies, and is constantly strengthening the brand reputation through security declarations and environmental initiatives. Holiday Inn suffered from a massive missile attack in December 2024 (AIN, 2024), so it is currently strategizing to support loyalty and prospects for recovery on its social pages (Holiday Inn Kyiv, n. d.).

At the same time, the RMM methodology is also used in strategic planning by both hotels and restaurants. This methodology primarily includes an assessment of the current state of risk management through self-assessment in the following key areas: strategic alignment, culture and responsibility, risk management capabilities, risk management and analytics. A striking example of the application of RMM is the Hyatt hotel chain (n. d.), which pursues an open policy and demonstrates corporate goals on the official website, strengthening the positive reputation of the brand.

Thus, the approaches proposed for review demonstrate the capabilities of hotels to adapt their anti-crisis strategies to unforeseen challenges. The prospects for the recovery and sustainable development of hospitality entities in the post-war period are positive, most hotels demonstrate successful anti-crisis management practices: they introduce energy efficiency practices, open new establishments, reorient services to domestic tourism and provide services for internally displaced persons and military personnel. In addition, according to experts, the hospitality market will need an additional 30–40% of hotel rooms (Lupashko, 2024).

Thus, the war in Ukraine has become a "black swan" event for business, especially in the hospitality sector, due to its suddenness, large-scale impact and unpredictability. However, hospitality entities are successsfully overcoming unprecedented challenges, which indicates the effecttiveness of the application of anti-crisis strategies and tactics.

Conclusions

The results of the analysis of scientific and media sources showed the relevance of the issues of anti-crisis management in the hospitality sector in conditions of uncertainty. In particular, before the full-scale war in Ukraine, the scientific focus covered financial stability, competitiveness and internal efficiency. In conditions of martial law, priorities shifted: management was forced to abandon long-term strategic plans in favor of flexible operational management. After all, an instant response to shelling, evacuations, logistics restrictions, etc. was required. Hospitality entities began to close or preserve individual facilities, launch personnel outsourcing, share premises with partners, and more actively implement digital services (QR menus, online booking, flexible service packages, etc.). The integration of crisis management with security functions has also intensified, which began to cover not only financial and organizational aspects, but also security protocols: organizing shelters in hotels and restaurants; training personnel in actions during an air raid; purchasing generators, Starlink, autonomous power systems, etc. Accordingly, the hypothesis put forward regarding military crises as a manifestation of the "black swan" phenomenon, which requires the transformation of traditional approaches to crisis management, has been theoretically confirmed.

The scientific value of this research lies in improving the definition of anti-crisis management as a set of strategies and solutions to counteract financial, reputational and property risks. The types of crises are systematized, including the phenomenon of the "black swan" – sudden events with a significant impact. A strategic management model is proposed that takes into account the unpredictable conditions of war. From the development of the theory, including additional hypotheses, the following conclusions were obtained: even predicted crises change dynamically, requiring adaptability. And the experience of countries with military conflicts (Syria, Iran, Georgia) can be partially adapted in Ukraine. Hospitality entities that implement

anti-crisis strategies have more chances to attract partners and investors during the reconstruction period. This requires further market research in the post-war period.

Practical results include the implementation of decision-making tools in a state of uncertainty: diversification of services, digitalization, social responsibility, energy independence, sustainable management. The use of design thinking as a method of adaptation, rapid prototyping, and co-creation of solutions was recognized as particularly important. This can help reduce the negative effects of unforeseen crises.

At the same time, the results of the comprehensive analysis showed that business activities are under the pressure of multi-crisis (a combination of several types of crises), which complicates planning and requires the implementation of modern ERM and RMM methodologies. Their effectiveness is proven by examples of international hotel chains in Ukraine. It is also important to take into account global challenges, in particular environmental ones, which may cause new crises in the future. Thus, for the long-term adaptation of the hospitality industry in Ukraine, it is important to combine risk-oriented thinking with innovative approaches that ensure a balance between economic efficiency and social responsibility. This is seen as a promising area of scientific research with further analysis of the experience gained in anti-crisis management in wartime and post-war revival, taking into account the goals of sustainable business development.

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MODELING OF UKRAINE'S DAIRY PRODUCTION

Ukraine's dairy industry, being in a state of crisis, has faced an aggravation of existing problems due to the full-scale invasion of the russian federation. One of the most substantial factors negatively affecting milk production volumes is the constant reduction in the number of cows, which was especially accelerated due to the entry into force of legislative requirements for the safety and quality of dairy products in 2019. Even though the established norms were supposed to harmonize Ukrainian production standards with European ones, most of the raw milk still does not meet the criteria of extra-quality, remaining unsuitable for export to EU markets. Given the partial lack of statistical data from 2010 to 2023, the research aim is to analyze and forecast resource and technological indicators, as well as behavioral and technological characteristics of households, which affect the increase in milk production volumes and high-quality milk. A hypothesis concerning a statistically significant relationship between the indicators that determine the conditions of dairy industry and the number of cows has been put forward. To test it, linear regression models were constructed. In addition, time series analysis methods (Holt, Brown, ARIMA models) were used to obtain forecast values. Based on the confirmed relationships, the reduction in the number of livestock leads to a decline in the feed base and material and technical equipment, the pace of modernization of which is insufficient to meet the needs of the growing herd without losing its productivity. In particular, milking installations and machines cannot fully service the number of

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МОДЕЛЮВАННЯ МОЛОЧНОГО ВИРОБНИЦТВА В УКРАЇНІ

Молочна галузь України, перебуваючи у кризовому стані внаслідок повномасштабного вторгнення рф, зіткнулась із загостренням існуючих проблем. Одним з найголовніших факторів, що негативно впливає на обсяги виробництва молока, є постійне скорочення кількості корів, яке особливо прискорилось через набуття чинності законодавчих вимог до безпечності та якості молочної продукції у 2019 р. Попри те, що встановлені норми мали гармонізувати українські стандарти виробництва з європейськими, більшість молока все ще не задовольняє критерії екстраякості, залишаючись непридатним для експорту на ринки країн ЄС. З огляду на часткову відсутність статистичних даних у 2010–2023 рр., метою статті є аналіз та прогнозування ресурсних і технологічних показників, а також поведінково-технологічних характеристик домогосподарств, що впливають на збільшення обсягів виробництва молока високої якості. У ході дослідження висунуто гіпотезу, що між показниками, які визначають умови ведення молочного скотарства, та поголів'ям корів є наявний статистично значущий взаємозв'язок. Для перевірки гіпотези побудовано лінійні регресійні моделі. Окрім цього, для отримання прогнозних значень використано методи аналізу часових рядів (моделі Хольта, Брауна, ARIMA). На основі підтверджених взаємозв'язків встановлено, що зменшення поголів'я призводить до скорочення кормової бази та матеріально-технічного оснащення, темпів модернізації якого недостатньо для забезпечення потреб зростаючого стада без втрати його продуктивності. Зокрема, доїльні установки та апарати не можуть повністю

cows at the enterprises, which will expand by 1 thousand heads. In contrast, the number of milk purifier-coolers grew due to the enterprises' need to meet quality and safety requirements. Households are characterized by technological degradation: according to the forecast, only 1 in 10 households will have a milk separator in 2023. In addition, they will most likely need to make savings for 2–3 years to purchase a separator and a milk quality analyzer. The results obtained can be used to forecast the development of the dairy industry and design a state agricultural policy with a justified priority of state support measures.

Keywords: dairy industry, economic security, the number of cows, forecasting, regression analysis, time series models.

обслуговувати на підприємствах поголів'я корів, що збільшиться на 1 тис. голів. На противагу цьому кількість очищувачів-охолоджувачів молока зростає внаслідок прагнення підприємств відповідати вимогам якості та безпечності. Для домогосподарств характерна технологічна деградація: у 2023 р. молочні сепаратори наявні лише в 1 з 10 домогосподарств. Окрім цього, для придбання сепаратора та аналізатора якості молока домогосподарствам, найімовірніше, знадобиться заощаджувати протягом 2–3 років. Отримані результати можуть бути використані для прогнозування розвитку молочної галузі та розробки державної аграрної політики з обґрунтованою пріоритетністю заходів державної підтримки.

Ключові слова: молочна галузь, економічна безпека, кількість корів, прогнозування, регресійний аналіз, моделі часових рядів.

JEL Classification: C53, O13, Q18.

Introduction

Dairy production is one of the areas of agriculture that plays an essential role in ensuring Ukraine's economic security, entering its production and food components in the form of separate indicators. However, despite the intensification of production systems in livestock farming due to the expansion in demand for dairy products observed on the world market, negative trends are observed in dairy cattle breeding in Ukraine. This situation is associated with a stable drop in the number of cows. Possessing favorable natural and climatic conditions for the development of dairy agribusiness, milk production in Ukraine is constantly decreasing, and most of it does not meet the requirements of extra-quality, suitable for export to world markets.

Kyenko and Symchuk (2019), comparing European and Ukrainian milk quality standards, concluded that the main reason for the low quality of raw milk in Ukraine is the failure to cool it immediately after milking, high bacterial contamination, and the number of somatic cells, which exceed the European thresholds by 4 and 1.6 times, respectively. In addition, the study indicated that Ukrainian milk was considered unsuitable for processing at European enterprises due to its low-fat content (3.4% in Ukraine compared to 4.2% in the EU) and protein content (while the norm is set at 3.4% in Europe, in Ukraine its actual content was 3.0%). It weakens the country's foreign economic security, increasing the gap between actual and potential foreign exchange earnings that could be received in the case of the sector's prosperity.

According to Cherednichenko and Pashchenko (2018), whose article focused on pinpointing the indicators that have the most significant impact on dairy production and the level of population provision, the constant reduction in livestock is one of the most important factors that has negative consequences. In turn, Hladiy and Prosovych (2022), who had a similar goal and studied the development trends of the dairy industry, additionally

highlighted among the difficulties the insufficient amount of financial resources that would allow producers to cover current costs, the dominant share of households in the structure of milk produced, and the inability of products to meet the requirements and standards of EU member states, which is currently the chief market due to the russian invasion. In addition to the fact that the position of livestock is significantly worse than that of crop farming, the authors emphasized that dairy farming is its most problematic direction.

Tsvihun and Tsvihun (2023) also focused on the aggravation of the crisis in the dairy sector due to armed aggression, noting that the loss of considerable breeding stock is one of the issues that must be eliminated to ensure the country's food security. Under these conditions, according to the authors, the optimal way to increase production is such an intensive factor as cows' milk productivity. A similar thesis about herd productivity as an intensive factor of gross milk production in the regions was noticed in the study by Boltianska (2021). However, the author detailed that it is also influenced by the fullness of feeding, housing conditions, and both environmental and extensive production indicators. Despite the contribution of the research, the authors focused on the regional analysis of the dynamics of milk production volumes, cow population, and average annual milk yield, not sufficiently assessing the state of the resource and technical securement, which are crucial circumstances for manufacturing high-quality dairy products.

Kolosha (2018), defining the economic efficiency of milk production as the volume of gross output per head, also supported the view that it is much more necessary to analyze the factors that impact the achieved level of cows' productivity or production efficiency. According to the author, low productivity of cows is considered the result of underdevelopment and imbalance of the feed base, which is often used not for milk formation but to support the basic life of the herd, most likely due to a lack of financial and material resources. However, the study did not detail the sources of feed supply formation or its quantitative parameters – the area of hayfields and pastures or the harvest volumes of crops, which limits the possibility of analyzing the state of the feed base as an indicator of milk production in Ukraine.

Bondarenko and Li (2025), studying the problems of the dairy industry development as a result of the war in Ukraine, which complicated the situation and added new obstacles, also identified the growth in the cost of feed due to the increase in the price level of grain and oilseed crops as an indicator in dairy agribusiness. Bednarski and Kupczyński (2024) believed that improving feeding, its composition, or proportions of components can increase milk productivity quite quickly. However, when studying the factors that affect the cows' productivity, according to the authors, technological indicators, in particular hygiene and efficiency of milking cows, as well as ensuring further milk processing, are no less important than nutrition and housing conditions.

The results of the study by Sokoliuk et al. (2022) proved that organizational and technological measures (comfortable housing conditions, proper feeding, and efficient milking of cows) are promising since increasing production volumes, quality, and safety of dairy raw materials. Kulish (2020),

analyzing the impact of macroenvironmental factors on the dairy products market, also focused on both scientific and technical elements, identifying the low level of producers' technological equipment as a threat to the dairy industry. In this context, assessing the dynamics and relationship between the number of cows and the level of producers' provision with milking installations, machines, separators, milk coolers, and feed dispensers for cattle and manure belt and chain conveyors is a reasonable approach to analyzing technological facilities.

The need to estimate the condition and availability of technological tools is reinforced by the analytical monitoring of Uzhva (2024), in which the author emphasized the need for re-equipment with modern milking machines, separators, and milk quality analyzers. Although her conclusion did not consider the necessity for cattle feed dispensers and manure removal conveyors, which not only create high-quality housing conditions but also contribute to compliance with sanitary and hygienic standards, the author rightly noted the importance of these facilities for achieving compliance of Ukrainian products with accepted European quality and safety standards.

The quality of Ukrainian dairy products is an indicator that determines the dairy industry's development, as it affects its competitiveness and sales markets. According to Voliak and Galitska (2018), the low quality of raw milk, which is produced by households in non-sterile conditions with a lingering collection and transportation process, is also one of the biggest challenges. Although the authors justified this situation by low average sales prices, which do not motivate households to modernize and ensure high-quality dairy products, their study did not present behavioral and technological characteristics, in particular, the use of separators by households, sanitary control of milk quality, veterinary inspection or treatment of livestock premises, which would allow for a more comprehensive understanding of the root causes for the low-quality raw milk.

In this context, it is worth noting that new requirements for the safety and quality of milk and dairy products came into force in Ukraine on July 12, 2019, which was aimed at harmonizing Ukrainian and European standards (Government Office for the Coordination of European and Euro-Atlantic Integration, 2019). Since it concerned all market operators, the approved requirements excluded the possibility of second-grade milk, produced mainly by households, entering processing plants. Therefore, the analysis of resource and technological indicators of dairy production, necessary to ensure the competitiveness of Ukrainian dairy products on the global market, takes on particular importance.

Thus, since the studies above did not focus on the relationships between individual sources of cattle feed base, types of technological equipment, behavioral and technological characteristics of households, and the number of cows, the decrease of which directly affects the reduction in milk volumes, further empirical assessments and modeling of factors that potentially affect milk volumes are necessary.

However, despite the outlined scientific need, conducting a full-fledged analysis considering the consequences of a full-scale invasion is

complicated by the partial lack of up-to-date statistical data starting from 2022. According to Derzhstat (2023), business entities during the martial law period and within three months after its end have the right not to submit statistical or financial reporting to protect their interests. Given this, the State Statistics Service of Ukraine has also suspended the publication of individual statistical information. In addition, to reduce the reporting workload, starting in 2020, statistical observation of the agricultural machinery availability has a low frequency, and respondents are required to report only once every five years (State Statistics Service of Ukraine, 2022a). It necessitates the utilization of models to restore data and make forecast estimates based on the identified relationships.

The hypothesis assumed that factors affecting the development of dairy production in Ukraine and the volume of high-quality milk are statistically dependent on the number of cows kept in households, agricultural enterprises, or the country in general.

The research aim is to model resource and technological factors that potentially influenced the development of dairy production in Ukraine in 2010–2023 and to restore absent statistical data by building time series or regression models, which estimate the dependence of indicators on the number of cows.

Statistical yearbooks that have been published by the State Statistics Service of Ukraine served as an information base. It contained data on the social and economic state of agriculture in Ukraine and its resource indicators. Modeling of resource and technological indicators, the time series of which is not covered by disseminated data, was carried out using single-factor regression models 1:

$$y = \beta_0 + \beta_1 x + \varepsilon, \quad (1)$$

where: y – the value of a dependent resource or technological indicator;
x – the number of cows;
β_0, β_1 – estimated parameters of the linear regression model;
ε – random error.

Due to the detected sharp jumps in the dynamics of the number of milk coolers and feed dispensers for cattle, a dummy variable ($Dummy$) was included in the models starting in 2018, which considered the effect of external circumstances and took on the value 1, if $t \geq 2018$. Otherwise, $Dummy = 0$, which is presented in formula 2:

$$y = \beta_0 + \beta_1 x + \beta_2 Dummy + \varepsilon, \quad (2)$$

where: β_2 – estimated structural gap parameter.

The criterion for an acceptable model reliability level was the value of the coefficient of determination (R^2), based on which the model has moderate ($R^2 > 0.5$), high ($R^2 > 0.7$), or very high ($R^2 > 0.9$) explanatory power and the F-test, the values of which confirm the statistical significance of the constructed dependence ($Sig.F < 0.05$). Interpretations of the explanatory

power of the constructed models were carried out according to the Chaddock scale, presented in the study by Mitryasova et al. (2021). The criterion for an acceptable model accuracy level was the mean percentage error ($MAPE$), which should not exceed 5% to ensure high forecast accuracy, but $MAPE < 10\%$ was also considered satisfactory. In addition, statistical characteristics were the standard error of the model estimate (Std. error), which shows how much the actual values are scattered around the regression line on average and is used for constructing confidence intervals (95%), and the maximum percentage error ($MaxAPE$), which is an indicator of marginal accuracy.

If at least one of the established conditions was not satisfied ($R^2 < 0.5$, $Sig.F > 0.05$ or $MAPE > 10\%$), time series models were built using IBM SPSS 25, namely Brown (exponential smoothing that considers the trend), Holt (modification of exponential smoothing that considers both the level and the trend components) and low-order ARIMA models to achieve greater explanatory power and accuracy compared to regression models with the number of cows as an independent factor.

If none of the models were acceptable, an alternative way to build a forecast was a univariate regression model with time t as the independent variable, which was used to forecast the share of households using veterinary inspection (Model 20.2).

Given the large number of models and the auxiliary nature of the forecast, a limitation of the approach is the lack of autocorrelation analysis of residuals, which, however, should be eliminated in further studies that will focus on modeling the relationships between several factors and the volume of extra-quality or higher-grade milk in 2010–2023.

The main part of the study consists of four interconnected sections. The first section forecasts dairy production indicators based on regression models in which the number of cows is the independent variable. It also provided an economic interpretation of the coefficients obtained. The second section contains models that confirmed the statistical dependence of production indicators of enterprises on livestock size, considering the structural gap. The third section covered the indicators of enterprises' dairy production, but the forecast of their dynamics is based on time series models. However, their relationships with the number of cows are non-random and statistically significant. The fourth section analyzes the behavioral and technological characteristics of dairy production in households, for which the hypothesis of statistical dependence on livestock size was partially confirmed.

1. Assessment of the dependence of resource and technological indicators of dairy production on the number of cows: forecasting based on regression models

As a result of the forecasting of indicators that have a potential impact on the development of dairy production in Ukraine, the hypothesis of a high level of dependence of indicators on the total number of cows or their number kept at enterprises and households was confirmed. The single-factor

regression models presented in *Table 1* are characterized by moderate (Models 5–7), high (Models 3–4), and very high (Models 1–2, 8–9) explanatory power since the variation in the number of cows explains from 57% to 97% of the variation in the corresponding dependent variables. It indicates the decisive role of livestock in studied agricultural processes.

Table 1

Statistical characteristics of single-factor regression models that confirmed the dependence on the number of cows and have high forecast accuracy

Model No.	Dependent variable, y	Independent variable, x_i	R^2	Std. Error	F	Sig.F*
1	Average annual milk yield per cow at enterprises (kg)	The number of cows at enterprises, x_1 (thousands of heads)	0.96	180.09	256.40	0.000
2	The value of feed costs of enterprises for agricultural production (million UAH)		0.97	2 798.48	303.87	0.000
3	Milking installation and machines (units)		0.71	313.39	19.25	0.002
4	Average annual milk yield per cow in households (kg)	The number of cows in households, x_1 (thousands of heads)	0.81	60.49	41.59	0.000
5	The amount of fodder spent on feeding cows and breeding bulls of the dairy herd (thousand centners of fodder units)	Total number of cows in the country, x_1 (thousands of heads)	0.64	1 148.73	16.21	0.003
6	Gross harvest of feed corn (thousand tons)		0.60	720.31	16.32	0.002
7	Gross harvest of annual and perennial grasses for hay (thousand tons)		0.57	286.45	14.42	0.003
8	Gross harvest of annual and perennial grasses for green fodder, hay, silage (thousand tons)		0.93	332.93	149.35	0.000
9	Gross harvest of hayfield (thousand tons)		0.93	88.74	138.10	0.000

* – p-value of the parameters of one-factor regression models is equal to their Sig.F.

Source: calculated by the author based on (State Statistics Service of Ukraine, 2023).

Since the constructed Models 1–9 are statistically significant, based on the minimum values of $Sig.F \in [0.000; 0.002]$, and the $MAPE$ on average is 4.07%, not exceeding 6.81%, the established relationships are non-random. For these reasons, these models can be used for further economic interpretation, providing mainly high forecast accuracy (*Table 2*). Even though Model 8 has satisfactory accuracy ($MAPE = 6.81\% < 10\%$), its explanatory power is interpreted as very high ($R^2 = 0.93 > 0.90$), which makes it acceptable for achieving the set purpose.

Table 2

Forecast values of milk production indicators depending on the number of cows in regression models with high forecast accuracy

Model No.	Equation	*MAPE* (%)	*MaxAPE* (%)	Forecast period	Forecast value	Lower limit (95%)	Upper limit (95%)
1	$y = 12\,598.17 - 13.64x_1$	1.93	6.14	2011	4 561.67	4 169.29	4 954.05
2	$y = 169\,431.93 - 259.08x_1$	4.47	14.79	2021	59 607.07	53 509.71	65 704.42
				2022	59 425.71	53 328.36	65 523.06
				2023	67 301.80	61 204.45	73 399.16
3	$y = 5\,999.81 + 8.37x_1$	2.42	5.48	2020	9 670	8 987	10 353
				2021	9 547	8 864	10 230
				2022	9 553	8 870	10 236
				2023	9 298	8 615	9 981
4	$y = 5\,022.67 - 0.336x_1$	0.94	2.08	2011	4 336.53	4 204.73	4 468.32
5	$y = 18\,119.65 + 4.56x_1$	3.47	5.06	2021	25 743.51	23 240.63	28 246.38
				2022	25 155.65	22 625.78	27 658.53
				2023	24 284.36	21 781.48	26 787.23
6	$y = 2\,603.70 + 2.14x_1$	6.34	17.50	2023	5 504.10	3 934.67	7 073.53
7	$y = 2\,374.04 + 0.80x_1$	5.00	15.31	2023	3 457.64	2 833.52	4 081.76
8	$y = -2\,709.93 + 3.00x_1$	6.81	16.48	2023	1 344.41	619.02	2 069.80
9	$y = -311.24 + 0.77x_1$	5.23	23.01	2023	727.71	534.37	921.05

Source: calculated by the author based on (State Statistics Service of Ukraine, 2023).

Based on the values of the model parameters, the average annual milk yield at enterprises demonstrates a negative relationship: with a growth in the number of cows by 1 thousand, the studied indicator decreases by 13.64 kg, probably due to the limited resources required to care for cattle. It can be the amount of resources, in particular investment or qualified workers, the lack of which leads to a lowering in individual care, or infrastructure (equipment, veterinary services) that is unable to handle such a load without loss of productivity.

This conclusion correlates with the opinion of Boltianska (2021), who emphasized that increasing the livestock population is a capital-intensive process, as it requires investments in technological equipment, updating the herd, and expanding the feed base. However, the author's conclusion about growth in average annual milk yield by 1 000 kg in the case of a reduction in the livestock by 1.7 thousand heads in 2016–2020 contradicts the results of the current study, raising some doubts given the lack of a confirmed statistical

relationship between the indicators in its article. Given that the calculation was based on a comparison of absolute increases in 2020 compared to 2016, without considering cause-and-effect connections in the intermediate periods, and the relationship between the change in the number of cows and their average annual yield appears arithmetically disproportionate, the author's results require a more substantiated method of quantitative data processing.

Although somewhat smaller, the number of cows in households has a similar effect on their average annual milk yield: with an increase in the number per 1 thousand heads, the yield declines by only 0.34 kg. It may be due to the fact that in the family model of care, cows are kept mainly in small groups (1–2), the number of which is determined by the family size that serves them, relying exclusively on their own resources.

If the number of cows at the enterprises grows by 1 thousand heads, the number of milking installations and machines (Model 3) rises by 8.37 units. It is consistent with economic logic and the need for more equipment to ensure regular milking. However, this growth rate may not be sufficient for the high-quality service of the new livestock and scaling up production.

Considering the above technical features, a milking machine can serve up to 18 cows per hour (DaMilk Dairy Assistance, n. d.), and a milking installation on average – up to 53 (Tavria State Agrotechnological University, Dmytro Motornyi, n. d.). Assuming a milking session at the enterprise lasts about three hours, then one machine serves 54 cows and one milking installation – about 159. Although under an optimistic forecast, growth in the number of installations of 8.37 units makes it possible to serve almost 1 331 cows, under the pessimistic forecast (with an increase in relatively less powerful milking machines by the same number) – only about 452 cows. Since the production process most likely involves a mix of milking machines and installations, their combination in a 1:1 ratio will allow serving the herd size of 891 heads if the equipment is not damaged or downtime.

Thus, based on the calculated value averaged between the optimistic and pessimistic forecast, it is possible to conclude that the pace of re-equipment of enterprises is insufficient in the case of an enlargement in the number of cows by 1 thousand heads. The results coincide with the conclusions about the limited capabilities of the infrastructure to serve the increased herd size, as evidenced by the reduction in their average annual milk yield due to the need to milk some of the cows manually. The lack of agricultural machinery was also highlighted by Kushnir (2019), who analyzed the impact of technical, energy capacities, and labor resources on the efficiency of farming enterprises' production. In addition, the study noted that even existing machinery does not guarantee high production volumes due to its physical and moral wear and tear.

In the case of an increase in the number of cows at enterprises by 1 thousand heads (Model 2), the value of feed costs of enterprises for

agricultural production decreased by UAH 259.08 million. It may point to economies of scale – optimization of the average cost curve due to more favorable contracts with suppliers or the introduction of an automated feeding system. The risk of reducing the volume of feed per cow is unlikely since, according to Model 5, with an increase in the livestock, the amount of fodder spent on feeding cows and breeding bulls of the dairy herd expands by 4560 thousand centners of fodder units. However, it does not mean that fodder volume is sufficient to ensure high-quality feeding and care.

Models 6–9 confirm the positive impact of livestock on the expansion of the feed base: in the case of an increase in the livestock by 1 thousand, the gross harvest of feed corn growths by 2 140 t, annual and perennial grasses for green fodder, hay, silage – by 3 000 t, annual and perennial grasses for hay – by 800 t, hayfield – by 770 t. The obtained non-negative parameters of the regression models are logical given the growing needs of the herd since corn is one of the main feed components, and green fodder, silage, and hay are considered vital elements of ensuring balanced nutrition, especially in the winter period. The relatively lesser volumes of hay and hayfield are explained by the fact that these parts of the fodder base are dry feeds, which have much lower moisture content than corn or green fodder and, therefore, a smaller tonnage even with the same nutritive value.

The obtained forecast values of average annual milk yields at enterprises (Model 1) and in households (Model 4) are consistent with the statement of Tsvihun & Tsvihun (2023) that the cows' productivity at enterprises is significantly higher, which, according to the authors, was due to their better opportunities to purchase highly productive cows, and high-quality feed, and ensure proper conditions for keeping livestock. In addition, according to the study by Bal-Prylypko et al. (2023), the cows' productivity in households is not only lower but also had a relatively small growth rate in 2010–2022, which was only 1% compared to 5.1% calculated for enterprises.

2. Assessment of the dependence of resource and technological indicators of enterprises' dairy production on the number of cows: forecasting based on regression models considering structural gaps or more economically justified parameters

As a result of the forecasting, the models presented in *Table 3* are characterized by high (Model 11.2) and very high (Model 12.2) explanatory power with R^2 values exceeding 0.80. However, the hypothesis of a statistically significant dependence of milk purifier-coolers and cattle feed dispensers on the number of cows at the enterprises was confirmed only after considering the structural gap observed in the dynamics of these indicators of dairy production.

Table 3

Statistical characteristics of models that confirm the dependence on the number of cows, but require consideration of structural gaps or justified factors to ensure high forecast reliability

Model No.	Dependent variable, y	Independent variable, x_i	R^2	Std. Error	F	Sig.F
10.1	The value of fixed assets put into operation in agriculture (UAH million)	The number of cows at enterprises, x_1 (thousands of heads)	0.87	6 575.46	45.06	0.000
10.2		Capital investments in agriculture, x_1 (UAH million)	0.95	3 995.47	133.99	0.000
11.1	Milk purifier-coolers (units)	The number of cows at enterprises, x_1 (thousands of heads)	0.05	142.20	1.493	0.257
11.2		The number of cows at enterprises, x_1 (thousands of heads)	0.85	64.15	19.83	0.001
		Structural gap, x_2				
12.1	Cattle feed dispensers (units)	The number of cows at enterprises, x_1 (thousands of heads)	0.02	693.98	0.06	0.808
12.2		The number of cows at enterprises, x_1 (thousands of heads)	0.91	219.65	36.75	0.000
		Structural gap, x_2				

Note: p-value of the parameters of one-factor regression models is equal to their Sig.F.

Source: calculated by the author based on (State Statistics Service of Ukraine, 2023).

Demonstrating a relatively stable trend in 2010–2017, there were sharp jumps in 2018, which were inconsistent with previous tendencies in the number of cattle feed dispensers and milk purifier-coolers. It may suggest a transformation of the methodology for collecting statistical information or instructions for maintaining economic accounting. In light of this assumption, an argument is that, according to the State Statistics Service of Ukraine (2022a), a new form of report on agricultural machinery availability was approved in 2018 with a frequency of once every two years instead of its annual submission. In addition, as an improvement part of the statistical accounting system, the list of agricultural machinery was clarified, the composition and content of indicators were revised in particular, and certain methodological and organizational approaches to information generation were updated. The inclusion of a dummy variable, which in the period 2018–2023 equals 1, allowed for the consideration of structural changes and obtaining F-significant models ($Sig.F < 0.05$) with high accuracy ($< 5\%$).

Despite the reliability of the confirmed dependence of the value of fixed assets put into operation in agriculture on the number of cows at the enterprise, $MAPE = 13.67\% > 10\%$ demonstrates the unsuitability of Model 10.1 for making forecasts of acceptable accuracy (*Table 4*). For these reasons, in the constructed Model 10.2, the independent regression parameter is the volume of capital investments in agriculture, the variation of which explains 95% of

the variation of the dependent variable, showing a more reliable relationship ($F = 133.99 > 45.06$), with a satisfactory $MAPE$, which has decreased almost by half.

Table 4

Forecast values of milk production indicators depending on the number of cows in regression models, but demonstrate high forecast accuracy considering structural gaps or more justified factors

Model No.	Equation	$MAPE$ (%)	$MaxAPE$ (%)	Forecast period	Forecast value	Lower limit (95%)	Upper limit (95%)
10.1	$y = 183\,111.08 - 294.14x$	13.67	31.86	–	–	–	–
10.2	$y = -685.74 + 0.82x_1$	7.01	15.23	2010	8 742.18	36.79	17 447.56
				2011	13 201.04	4 495.66	21 906.43
				2012	15 134.22	6 428.84	23 839.61
				2022	41 237.04	32 531.66	49 942.43
				2023	52 641.42	43 936.03	61 346.80
11.1	–	4.06	7.11	–	–	–	–
11.2	$y = 3\,330.39 - 0.86x_1 - 380.76x_2$	1.47	4.03	2020	2 573	2 433	2 713
				2021	2 586	2 446	2 726
				2022	2 585	2 445	2 725
				2023	2 611	2 471	2 751
12.1	–	13.59	26.40	–	–	–	–
12.2	$y = -1\,006.06 + 8.79x_1\ 1\,957.71x_2$	3.50	11.26	2020	4 806	4 327	5 285
				2021	4 676	4 197	5 155
				2022	4 683	4 204	5 162
				2023	4 415	3 936	4 894

Source: calculated by the author based on (State Statistics Service of Ukraine, 2023).

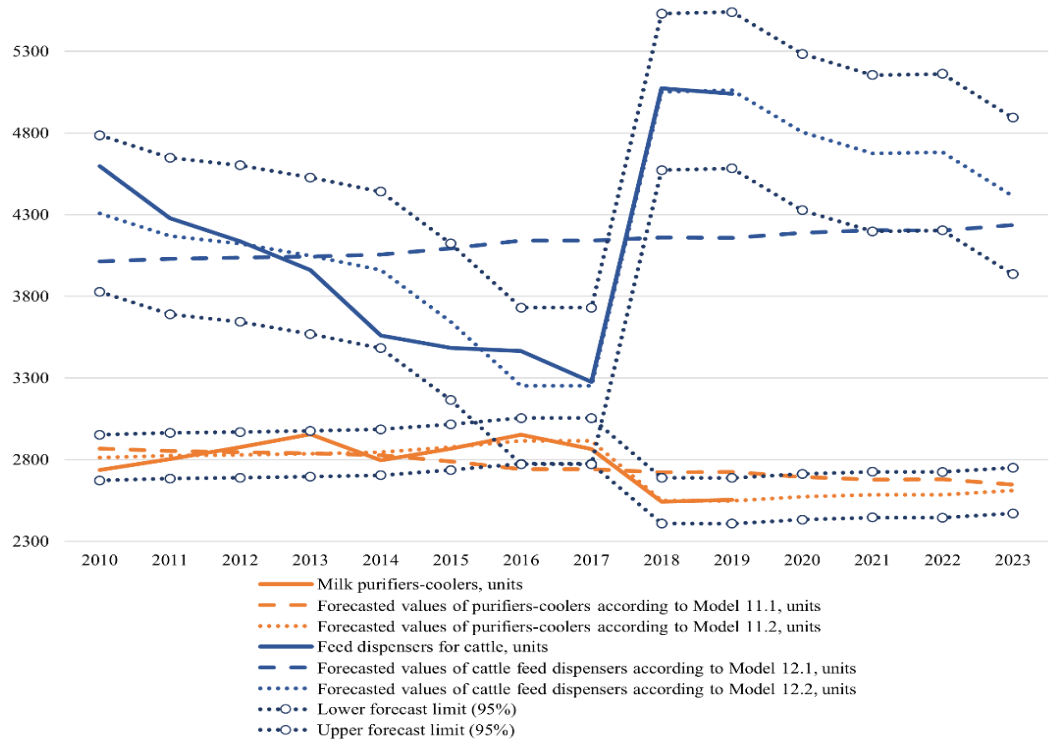
Based on the values of the model parameters, the value of fixed assets put into operation in agriculture declines by UAH 294.14 million in the case of an enlargement in the number of cows by 1 thousand heads. Such results are explained by the reverse trend of the analyzed indicators: against the annual reduction in the number of cows at enterprises in 2010–2023, the value of fixed assets put into operation, on the contrary, increased. Since its notedly rapid upsurge was observed starting from 2014, the probable cause for the obtained coefficient of Model 10.1 obtained was the currency factor, namely the devaluation of the hryvnia, which enormously raised the value of imported machinery, equipment, and materials regardless of the dynamics of the number of cows at enterprises. On the other hand, according to Model 10.2, the dependent variable increases by UAH 0.82 million in the case of growth in capital investments in the industry by UAH 1 million, i.e., not all capital investments were directed at the financing of new fixed assets.

According to Model 11.2, the number of milk purifier-coolers increases by 0.86 units, even if the livestock population decreases by 1 thousand cows. It means that despite the drop in the number of cows, the need for the production

of extra-grade milk suitable for export to the world market is growing, especially in the context of new requirements for the safety and quality of milk and dairy products, which establish the immediate cooling of milk to a temperature of 6–8 °C (in various cases) immediately after milking. Even though the milk purifier-coolers reduced by an average of 380.76 units due to improvements in the statistical accounting methodology in 2018, with a confidence level of 95%, a gradual increase in their number to 2 611 units is expected in 2023.

Cattle feed dispensers are characterized by a positive dependence on the number of cows. If they expand by 1 thousand heads, the amount of equipment that provides animal feeding increases by 8.79 units, which increased rapidly by an average of 1 957.71 units in 2018 after a structural gap. Their positive impact was confirmed by the analysis of modern animal feeding equipment presented in the article by Smoliar et al. (n. d.), according to the results of which it was established that feed dispensers ensure uniformity of their distribution at a level of almost 91% to over 95% and demonstrate efficiency, minimizing fodder losses. Thus, the expansion of technical provision with this equipment is an economically justified enterprise's response to the growing livestock.

However, despite its substantial increase of 54.88% in 2018 compared to the previous period, according to the forecast, a steady decrease in their number will continue, reaching a value of 4 415 units in 2023 (*Figure*), as the number of cows at enterprises showed a lowering of 73.60 thousand heads in 2023 compared to 2018.



Actual and forecasted amount of equipment required for dairy production, considering the structural gap observed since 2018

Source: calculated by the author based on (State Statistics Service of Ukraine, 2023).

If, when modeling the dynamics of this equipment, the structural gap observed since 2018 is ignored, the forecast trajectories of the indicators deviate significantly from the actual values, which is especially noticeable in 2016–2020. While all the de facto values fall into the confidence intervals of statistically reliable Models 11.2 and 12.2 with a probability of 95%, the values excluding the gap go beyond the lower and upper limits of the forecasts. The underrated factual number of cattle feed dispensers and, conversely, the overrated number of milk purifier-coolers will further distort the estimations of the parameters of the multiple regression models, which are aimed at scrutinizing the impact of factors in 2010–2023 that contribute to an increase in the volume of extra-grade milk suitable for export to foreign markets.

3. Assessment of the dependence of resource and technological indicators of enterprises' dairy production on the number of cows: forecasting based on time series models

Table 5 presents Models 13–17, which confirmed the hypothesis of a statistically significant relationship between the number of cows and resource and technological indicators of the dairy industry, the explanatory power of which varies from 0.44 to 0.89. However, the use of time series models leads to an improvement in the R^2 values and their transition on the interpretation scale of the coefficient to higher quality levels: Model 13, 15 (weak → moderate), Model 14 (moderate → high), Model 17 (high → very high). Although Model 17.1 is characterized by acceptable explanatory power, $MAPE = 6.09\%$, which does not suggest its high accuracy. In Model 17.2, built using the Holt method, $MAPE$ is lower, at 2.79%, and $MaxAPE$ has more than halved to 5.83%, which, together with other time series models used (Holt, Brown, ARIMA), provides highly accurate forecasts, which are especially important in the context of restoring absent statistical data.

Table 5

Statistical characteristics of single-factor regression models that confirm the dependence on the number of cows but have higher forecast accuracy using time series models

Model No.	Dependent variable, y	Independent variable, x_i / Time series model	R^2	Std. Error	F	Sig.F
13.1	Hay mowing area (thousand hectares)	The number of cows at enterprises, x_1 (thousands of heads)	0.44	37.90	6.97	0.027
13.2		Brown	0.54	–	–	–
14.1	Pasture area (thousand hectares)	The number of cows at enterprises, x_1 (thousands of heads)	0.59	51.60	13.08	0.006
14.2		ARIMA (0,1,0)	0.71	–	–	–
15.1	Hay mowers (units)	The number of cows at enterprises, x_1 (thousands of heads)	0.47	411.11	7.19	0.028
15.2		Holt	0.51	–	–	–

End of Table 5

Model No.	Dependent variable, y	Independent variable, x_i / Time series model	R^2	Std. Error	F	Sig.F
16.1	Milk separators (units)	The number of cows at enterprises, x_1 (thousands of heads)	0.76	15.36	25.88	0.001
16.2		Holt	0.83	–	–	–
17.1	Conveyors for cleaning manure (units)	The number of cows at enterprises, x_1 (thousands of heads)	0.89	1 388.73	64.87	0.000
17.2		Holt	0.98	–	–	–

Note: p-value of the parameters of one-factor regression models is equal to their Sig.F.

Source: calculated by the author based on (State Statistics Service of Ukraine, 2023).

At the same time, regression models remain a source for interpreting reliable and robust relationships between variables. Based on the values of the model parameters (*Table 6*), the hay mowing area increases by 530 hectares if the number of cows expansions by 1 thousand heads, which is natural given the greater need for meadow vegetation, which is necessary for the formation of the feed base – the preparation of hay and green fodder.

Table 6

Forecast values of milk production indicators in Ukraine, calculated using time series models, but demonstrating a statistically significant dependence on the number of cows in regression model

Model No.	One-factor regression equation / Time series model	$MAPE$ (%)	$MaxAPE$ (%)	Forecast period	Forecast value	Lower limit (95%)	Upper limit (95%)
13.1	$y = 2\,106.00 + 0.53x_1$	1.15	2.62	–	–	–	–
13.2	Brown	0.47	4.49	2021	2 249.90	2 177.10	2 322.70
				2022	2 216.70	2 107.70	2 325.70
				2023	2 183.40	2 033.00	2 333.90
14.1	$y = 4\,894.06 + 0.99x_1$	0.69	1.49	–	–	–	–
14.2	ARIMA (0,1,0)	0.46	2.18	2021	5 226.40	5 132.80	5 319.90
				2022	5 202.40	5 070.00	5 334.80
				2023	5 178.50	5 016.40	5 340.60
15.1	$y = 7\,342.16 + 6.71x_1$	3.05	6.12	–	–	–	–
15.2	Holt	2.81	5.35	2020	10 197	9 283	11 111
				2021	10 070	9 156	10 984
				2022	9 943	9 029	10 857
				2023	9 816	8 903	10 730
16.1	$y = 51.09 + 0.48x_1$	3.85	9.22	–	–	–	–
16.2	Holt	3.08	7.17	2020	257	227	287
				2021	248	218	278
				2022	239	208	269
				2023	230	199	260

End of Table 6

Model No.	One-factor regression equation / Time series model	$MAPE$ (%)	$MaxAPE$ (%)	Forecast period	Forecast value	Lower limit (95%)	Upper limit (95%)
17.1	$y = -18\,979.32 + 68.08x_1$	6.09	13.80	–	–	–	–
17.2	Holt	2.79	5.83	2020	10 368	9 003	11 733
				2021	9 073	7 682	10 465
				2022	7 779	6 361	9 197
				2023	6 484	5 040	7 928

Source: calculated by the author based on (State Statistics Service of Ukraine, 2023).

For similar reasons, pasture areas are also subject to a statistically significant impact, which rises by 990 hectares, as they are used by animals as fodder in the spring and summer. The conclusion obtained is consistent with Moschovas et al. (2023), who, studying the factors affecting milk quality, emphasized the importance of pastures not only for ensuring the natural behavior of cows but also in the context of reducing the prevalence of diseases compared to keeping them in specialized premises.

As with the sources of feed base, the equipment is characterized by a positive dependence on the number of cows: in the case of their enlargement by 1 thousand heads, the number of hay mowers increases by almost 7 units, and manure conveyors – by 68 units. While hay mowers provide the growing need for mechanized mowing of juicy fodder, the manure conveyor system maintains cleanliness and optimal humidity in the premises where animals are kept, ensuring better care and reducing the labor intensity of this production process. Compared to Models 15.1 and 17.1, the number of milk separators, although positive, is only 0.48 units. Although the upsurge in the number of cows drives larger milk volumes for processing and cleaning, enterprises are most likely to use high-capacity separators with a long service life. In addition, depending on the level of technological equipment, separation can be part of an automated line of installations, not a separately built-in element. Based on this, a slight increase in the number of separators when the herd grows by 1 thousand heads is justified from a technological point of view.

The reliability of the forecasts obtained based on time series models is enhanced by the fact that all values from *Table 6* are characterized by a stable negative trend in 2021–2023, which is consistent with Ukraine's general trend toward a reduction in the number of cows in both at enterprises and in households. Similar dynamics are also present in the study by Tkachuk (2019), which noted a significant reduction in the level of enterprise provision in almost all categories of technological equipment necessary for agricultural production.

Thus, the smaller the herd size, the smaller the need for both hay mowing and pasture areas, hay mowers, manure conveyors, and milk separators, given the positive values of the coefficients of the independent variable in one-factor linear regression models.

4. Assessment of the dependence of milk production indicators in households on the number of cows: forecasting behavioral and technological characteristics

Although the share of milk received by processing enterprises from households was only 10.98% in 2023, they keep most cows (958.6 thousand heads), which in the total livestock structure of Ukraine is over 70%. Thus, while maintaining their crucial role in ensuring domestic consumption through local markets, their awareness, technological equipment, and compliance with veterinary and sanitary standards affect the overall dairy high-quality production in the country. Since households do not produce extra-grade milk, and more than 81.67% of milk received by processing enterprises from the population in 2023 was of grade I, the competitiveness of Ukrainian dairy products and their export potential significantly depends on the functioning of family-type farms.

According to Shevchenko and Tabachuk (2019), the concentration of raw milk production in households that do not provide proper conditions for keeping cows and violate sanitary and hygienic standards or milking technology without immediately cooling the milk, as a result, causes high bacterial contamination with undesirable microflora and low milk quality. At the same time, despite the validity of their conclusions, the authors did not analyze and forecast the behavioral and technological aspects of household production activities, which are presented in *Table 7*.

Table 7

Dependence of household functioning on the number of cows: statistical characteristics of one-factor regression and time series models

Model No.	Dependent variable, y	Independent variable – x_i or t / Time series model	R^2	Std. Error	F	Sig.F
18.1	Share of households with a separator (%)	The number of cows in households, x_1 (thousands of heads)	0.64	1.66	8.92	0.031
18.2		Holt	0.89	–	–	–
19.1	Share of households carrying out sanitary control of milk quality (%)	The number of cows in households, x_1 (thousands of heads)	0.58	0.90	6.88	0.047
19.2		Holt	0.65	–	–	–
20.1	Share of households using veterinary inspection (%)	The number of cows in households, x_1 (thousands of heads)	0.31	0.96	2.27	0.192
20.2		Time, t	0.86	0.49	12.03	0.020
21.1	Share of households carrying out sanitary treatment of livestock premises (%)	The number of cows in households, x_1 (thousands of heads)	0.28	1.47	1.97	0.219
21.2		ARIMA (0,2,0)	0.94	–	–	–

* – p-value of the parameters of one-factor regression models is equal to their Sig.F.

Source: calculated by the author based on (State Statistics Service of Ukraine, 2023).

Since the 2010–2015 time series is short due to the cessation of data collection and processing by statistical authorities after 2015 and does not satisfy the requirement for the minimum permissible number of observations (n) for building reliable models, the original data set was expanded by adding observations from 2009 so that $n = 7$. Given the riskiness of the long-term forecast until 2023 and the entry into force of new requirements for the safety and quality of milk and dairy products in 2019, which could outcome in meaningful structural transformations of production processes, the upper limit of the forecast horizon was 2018.

The statistical characteristics of Models 18–21 only partially confirmed the hypothesis of the dependence of household milk production indicators on the number of cows kept. Despite the substantial impact of livestock on the share of households with a separator and the share of households carrying out sanitary control of milk quality in regression models, their explanatory power is interpreted as moderate ($R^2 \in [0.5;\ 0.7]$). At the same time, the independent variable is not statistically significant for veterinary inspection (Model 20.1) and sanitary treatment of livestock premises (Model 21.1). Time series models (Holt, ARIMA) and a simple regression model using time t as an independent variable provide mainly high R^2 values and better accuracy based on $MAPE \leq 5\%$, which indicates the feasibility of using these approaches for medium-term forecasting.

Based on the values of the model parameters (*Table 8*), with an expansion in the number of cows in households by 1 thousand heads, the share of households that have a separator or carry out sanitary control of milk quality increases by 0.01%.

Table 8

Forecast values of household characteristics that affect the development of dairy production in Ukraine and calculated using time series models

Model No.	One-factor regression equation / Time series model	*MAPE* (%)	*MaxAPE* (%)	Forecast period	Forecast value	Lower limit (95%)	Upper limit (95%)
18.1	$y = -6.08 + 0.01x_1$	5.21	14.03	–	–	–	–
18.2	Holt	5.09	8.98	2016	15.90	12.30	19.50
				2017	14.90	11.20	18.50
				2018	13.90	10.20	17.50
19.1	$y = 9.76 + 0.01x_1$	2.41	6.55	–	–	–	–
19.2	Holt	2.50	5.43	2016	20.40	18.30	22.50
				2017	19.90	17.80	22.00
				2018	19.40	17.30	21.50
20.2	$y = 48.40 + 1.48t - 0.22t^2$	0.63	1.00	2016	46.38	45.32	47.44
				2017	44.17	43.11	45.23
				2018	41.53	40.47	42.59
21.2	ARIMA (0,2,0)	0.61	1.22	2016	52.10	50.80	53.40
				2017	48.30	45.30	51.30
				2018	43.80	38.80	48.80

Source: calculated by the author based on (State Statistics Service of Ukraine, 2023).

Regression Models 20.1 and 21.1 demonstrate statistical unimportance, i.e., the number of cows in households is not a key factor affecting the share of households that use a veterinary inspection or carry out sanitary treatment of livestock premises.

According to the forecast for 2016–2018, there is a further reduction in households that perform the necessary procedures to ensure milk quality: the share of households with a separator decreased to 13.90% in 2018, i.e., by 2.60 pp compared to 2015, the share of households that carry out sanitary control of milk quality – by 1 pp (19.40%), the share of households that use veterinary inspection – by 6.6 pp (41.50%), the share of households that carry out sanitary treatment of livestock premises – by 11.40 pp, amounting to 43.80% in 2018. These changes are of concern given the growing public interest in cow welfare as a component determining the quality of dairy products. The results of the study by Castellini et al. (2023) showed that consumers equate low-quality milk with the lack of medical treatment and proper veterinary inspection, considering animal welfare as a condition for product acceptability. Given the forecasted lowering in households carrying out veterinary inspection and sanitation of premises, thus neglecting the cows' welfare, some consumers are likely to refuse such products, which in turn may lead to an even more critical situation for individual peasant farms, which are already in a vulnerable economic position.

Against the background of the reduction in the number of cows in households, which was observed throughout the study period, it indicates the departure of not only uncompetitive producers but also those who had the necessary equipment and carried out basic processes to ensure milk quality but probably faced economic barriers: a low purchase price for milk, which does not contribute to a quick return on investment, the lack of infrastructure and processors necessary for the sale of extra-grade milk, limited financial resources for modernization in conditions of economic instability. Bondarenko and Omelianenko (2024), who studied the threats and prospects of the milk market in Ukraine, also highlighted the lack of sufficient funding for investment and innovation projects among the factors that negatively affect its development. In turn, Cwalina et al. (2020) noted that for family farms, the purchase price of milk is the most essential aspect that affects their desire to engage in production activities.

The analysis of the situation with the level of household provision with separators requires special attention since the additional regression model, which examines the relationship between the number of separators and the share of households that possess them (considering their restored values in 2016–2018 using the Holt model), demonstrates extremely high statistical characteristics of reliability and validity. Built on data for 2010–2018, it is statistically significant with $R^2 = 99.85\%$, $F = 5\,216.77$, $MAPE = 0.48\%$. Based on the values of the model parameters, each new separator is associated with an increase in the share of households that own them

by 0.11%. Considering the steady negative absolute growth in the number of separators in 2010–2023, the share of households using them in 2023 is forecasted to be only 8.8%, not exceeding the value of 9.1%, which is the upper limit of the confidence interval. It indicates a technological decline of family-type farms since less than 1 in 10 households use a milk separator, which is incompatible with the growth of extra-grade or higher-quality milk. For these reasons, state support measures aimed at improving the technological provision of households with pivotal equipment for primary milk processing, such as milk separators and milk quality analyzers, are of great importance. Tsvihun and Tsvihun (2023), when agreeing that the development of dairy farming in households requires state support, proposed interest-free loans and tax breaks as possible ways to revive the industry.

An additional argument in favor of the implementation of efficacious tools is the negligible positive coefficients β_1 in regression Models 18.1 and 19.1, which may indicate the lack of incentives for modernization, one of which is the low-income level. Since the monthly cash income of rural households averaged UAH 11 889.69, and cash expenses were recorded at UAH 9 245.44 (State Statistics Service of Ukraine, 2022b) in 2021, the average residual of resources after satisfying various types of needs equals UAH 2 644.25. At the same time, income from entrepreneurial activity, self-employment, and the sale of agricultural products, which in the structure of their total resources was only 12.3% in 2021, equaling UAH 1 462.43 per month. Based on this data, it is possible to determine the terms of accumulation of funds by households on two created scenarios (*Table 9*):

1) optimistic scenario – involves directing 100% of the income received from agricultural activities (UAH 1 462.43) to the needs of dairy production modernization;

2) realistic scenario – involves setting aside a third of the average residual resources (UAH 8 72.60).

Table 9

Determining the terms of accumulation of funds by households for the modernization of dairy production under two scenarios

The goal of accumulation	Model with a statistically significant factor	Average cost of equipment, UAH	Optimistic scenario (100% of income from agricultural activities), month	Realistic scenario (33% of residual income), month
Milk separator	18.1	6 929.2*	4.74	7.94
Milk quality analyzer	19.1	25 200**	17.23	28.88

* – calculated for Ukrainian-made equipment of Motor Sich as of April 21, 2025, and averaged according to data (ProTek, n. d.), (Byrenka.com.ua, n. d.), ** calculated for Ukrainian-made equipment of IKF Agroservice as of April 21, 2025, and averaged according to data (IKF Agro, n. d.).

Source: calculated by the author based on (State Statistics Service of Ukraine, 2022b).

Thus, households in rural areas planning to purchase both a milk separator and a milk quality analyzer will need from 1 year and 10 months if they accumulate 100% of their income from agricultural activities to over 3 years if they save 33% of their average monthly residual budgets in 2021. While purchasing a separator is a relatively achievable goal in the short term for households, a milk quality analyzer, which is a principal condition for producing premium milk, is scarcely available.

By ensuring control of somatic cell counts, fat, protein content, and compliance with requirements for the absence of traces of antibiotics or bacterial contamination, households should sell high-quality products at higher prices (Bal-Prylypko et al., 2023). However, according to the study by Voliak and Galitska (2018), the payment of extra-quality, premium, and first-grade milk in previous years had minimal differences within 2–3%, which does not contribute to a quick return to households of funds spent on the purchase of separators or milk quality analyzers. For these reasons, investment by households in these types of technical equipment is not only inaccessible due to limited financial capabilities but also unlikely, given the lack of economic incentives for the modernization of production processes.

Even though the scenario modeling is based on household incomes in rural areas in 2021, since it is the latest data published by state statistics bodies, according to the study by the United Nations in Ukraine (2023), 65% of households reported a decrease in income since February 2022. Based on this, it is unlikely that the difference between the actual income and expenditure in 2022–2023 will exceed the value in 2021, especially in the context of a slow growth in state social standards due to a full-scale invasion.

Therefore, the conclusions about the need to accumulate for 2–3 years for households to purchase this equipment can be considered reliable. If the state seeks to boost the volume of export-oriented extra-grade milk, programs for partial compensation of costs for separators and milk quality analyzers can positively affect the development of dairy production in Ukrainian households. At the same time, Shpychak et al. (2022), justifying ways to overcome problems in dairy production, on the contrary, advocated the introduction by the state of incentives for the reorganization of production and concentration of cow herds on the farm.

Given the results of the study, to increase the volume of high-quality dairy products, the government should introduce additional state support measures within the framework of the budget program "Financial support for agricultural producers", under which expenditures of UAH 1 205 million are planned in 2025 (Pavlenko, 2025). In this context, a special tax-free investment account, similar to the Canadian AgriInvest program, to which dairy producers would contribute their funds in the form of a set percentage (for example, % of income from the sale of milk and dairy products), is promising. By adding another 50% or the full amount to this contribution, the state would help stimulate targeted investments, which are allowed to be directed only to the purchase of high-cost equipment or modernization, which is critically necessary to produce extra-quality milk. In addition, within the

framework of the budget program "Support for farms and other producers of agricultural products", to which about UAH 4 726 million should be allocated in 2025, it is possible to develop a system of additional payments for households for high and extra-quality milk. Providing for the availability of basic equipment as a prerequisite for receiving compensation for 2–3 years would encourage family farms to improve their technical equipment. To modernize their material and technical base, households may show greater interest in obtaining interest-free loans under the budget program "Provision of loans to farms".

The practical value of the proposed measures lies in shifting the focus from direct support of producer incomes to reducing their dependence on subsidies, which in turn will reduce the budget burden.

In any case, increasing the production of high-quality raw milk in Ukraine requires effective state policy that will help the industry overcome the crisis during the post-war recovery period and strengthen food sovereignty, which is especially important given the reduction in the level of population provision with milk and dairy products (from 107.71% in 2017 to 95.21% in 2021) and the increase in the share of their imports in consumption (from 1.55 to 9.37% in the same periods), as was determined in the article by Ivanov and Hurtovyi (2023).

Conclusions

The results of a comprehensive analysis of the constructed regression and time series models allowed for the restoration of the absent data, confirming the main study hypothesis about the presence of a statistically significant relationship between the number of cows and resource and technological indicators of dairy production both at enterprises and in households. The negative relationship between the number of cows and the average annual yield at enterprises indicates a probable limitation of resources and infrastructure capability to provide proper care for the growing livestock without losing productivity. It is confirmed by insufficient technical modernization since the combination of milking machines and installations, according to the average scenario, will allow servicing the size of the herd, which includes 891 heads but not 1,000 cows, without considering damage and downtime of equipment.

The number of cows positively impacts the expansion of the fodder base. Nonetheless, given the nationwide reduction in the number of cows in 2010–2023, their decline is expected by 2023 with a probability of 95%. Compared to 2022, in 2023, the gross harvest of feed corn is expected to decrease by 7.25%, hayfields by 24.68%, and annual and perennial grasses for green fodder, hay, and silage by 27.84%. Compared to 2019, the number of hay mowers in 2023 will fall by 3.73%, milking machines by 7.81%, cattle feed dispensers by 12.40%, and milk separators by 13.86%.

However, unlike other equipment, despite the drop in the number of cows, the number of milk purifier-coolers is forecasted to increase by 2.19% – from 2 555 units in 2019 to 2,611 in 2023. It hints at a certain level of enterprise modernization and their focus on compliance with the requirements for the quality and safety of milk and dairy products, which establishes the immediate cooling of milk to an established temperature immediately after milking.

The technological degradation of dairy production in households is of great concern: in 2016–2018, there was a further decline in households that carried out the necessary procedures to ensure milk quality, veterinary inspection, and sanitation of premises. According to the forecast, the share of households using a separator in 2023 will be no more than 9.1%. It indicates the unavailability of primary equipment for family-type farms since only 1 in 10 households uses a milk separator. In the case of saving a third of the monthly residual income and even assuming the accumulation of entire income from agricultural activities, it will take 2 to 3 years for rural households planning to purchase a milk separator and a quality analyzer.

Given the limited households' possibilities for purchasing milk separators and quality analyzers in the short term and the need to increase the volume of high-quality milk, urgent state support measures are needed for producers within the framework of which technical re-equipment is partially compensated by the government. One of the ways may be the mechanism of the Canadian state support model, in which producer funds in a tax-free savings account (in a defined %) are supplemented by state contributions that can be directed only to investments.

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SEMANTIC AND SENTIMENT ANALYSIS OF BRAND REPUTATION

The formation of a modern marketing strategy in the digital environment involves the use of various data that make it possible to assess the current situation and identify development prospects. The hypothesis is formulated that sentiment and semantic analysis using machine learning algorithms allows businesses to objectively assess the attitude of the target audience to the activities of brands on the Internet and identify popular thematic content. Conducting the research, general scientific methods of analysis and synthesis were used to characterize the basic principles of using sentiment and semantic analysis in the process of assessing brand reputation; empirical methods, graphic representation, and system-structural analysis. The feasibility of using text information and emoticons as a valuable source of data for developing effective management decisions in the field of marketing is proven. The implementation of sentiment and semantic analysis based on text and emoji is justified. A structural and logical scheme of the differences between sentiment and semantic analysis is presented. The features of building information support when implementing the two

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СЕМАНТИЧНИЙ ТА СЕНТИМЕНТНИЙ АНАЛІЗ РЕПУТАЦІЇ БРЕНДУ

Формування сучасної маркетингової стратегії в цифровому середовищі передбачає використання різноманітних даних, що дають можливість оцінювати поточну ситуацію та ідентифікувати перспективи розвитку. Сформульовано гіпотезу, що сентиментний та семантичний аналіз із застосуванням алгоритмів машинного навчання дозволяє об'єктивно оцінювати відношення цільової аудиторії до активностей брендів в Інтернеті та ідентифікувати популярний тематичний контент. При проведенні дослідження використано загальнонаукові методи аналізу та синтезу для характеристики основних принципів застосуванням сентиментного та семантичного аналізу у процесі оцінювання репутації бренду; емпіричні методи, графічне зображення та системно-структурний аналіз. Доведено доцільність використання текстової інформації та емотіконів як цінного джерела даних для розробки ефективних управлінських рішень у сфері маркетингу. Обґрунтовано реалізацію сентиментного та семантичного аналізу на основі тексту та емодзі. Представлено структурно-логічну схему відмінностей між сентиментним та семантичним аналізом.

approaches under study are investigated. The necessity of using social media for assembling text content and emoticons is proven, which is associated with the significant activity of generations Y, Z, and Alpha on such platforms as YouTube, Instagram, TikTok, etc. The feasibility of using sentiment and semantic analysis for retail chains that sell consumer electronics on the Internet is proven. Machine learning algorithms are used to assess user sentiment and interests, which allows for effective processing of text content.

Keywords: brand, content, emoticon, marketing, machine learning, semantic and sentiment analysis, social media, text.

Досліджено особливості побудови інформаційного забезпечення при реалізації двох досліджуваних підходів. Доведено необхідність використання соціальних медіа для збору текстового контенту та емотіконів, що пов'язано зі значною активністю поколінь Y, Z та Альфа на таких платформах, як YouTube, Instagram, TikTok тощо. Обґрунтовано доцільність використання сентиментного та семантичного аналізу для торговельних мереж, які реалізують споживчу електроніку в Інтернеті. Для оцінювання настроїв та інтересів користувачів використано алгоритми машинного навчання, які дозволяють ефективно обробляти текстовий контент.

Ключові слова: бренд, контент, емотікон, маркетинг, машинне навчання, семантичний та сентиментний аналіз, соціальні мережі, текст.

JEL Classification: C55, C81, D83, M31, M37.

Introduction

The Internet acts as a global information environment that allows a large number of users to interact on a continuous basis. The purpose of interaction can be business interests, education, leisure, social communications, etc. For modern companies, the Internet is an important environment that allows companies to maximize the reach of the target audience and accelerate the process of promoting goods and services. Optimization of marketing strategy in the global network involves the use of effective digital tools. Information support is the basis for making effective management decisions in the marketing field. The digital environment is characterized by a high level of data collection efficiency, since, thanks to the use of modern approaches, it is possible to accumulate relevant information continuously in real time. The main methods of data collection on the Internet include web analytics, parsing, API queries, collection from open data, etc.

For brands in conditions of high competition, it is important to identify the interests of the target audience and assess the level of loyalty to their products. The digital environment is structured in such a way that a large number of users publicly post information about their attitudes towards certain companies, goods, and services. The presented public information can be used by all market participants to assess their competitive positions, identify the advantages and weaknesses of other companies, as well as determine areas for strengthening interaction with the target audience. Many companies in Ukraine do not pay due attention to assessing the mood of the target audience based on comments on the Internet and processing the relevant information using machine learning algorithms, which prompted this study to solve the outlined scientific problem.

First of all, social media should be used to assess user judgments, since the overwhelming majority of modern generations Y, Z, and Alpha show interest in social interaction on specialized online platforms (Instagram, TikTok, YouTube, Facebook, etc.). Expression of one's attitude towards

relevant brands can be carried out by posting comments, emoticons, photos, and video content etc. To assess heterogeneous information about users' attitudes towards relevant brands and their products, it is advisable to use semantic and sentiment analysis, which are implemented thanks to high-performance machine learning algorithms. The advantages of using the presented approaches based on mathematical models are the processing of big data in a digital environment characterized by dynamic changes in user behavior.

Scientific works indicate the relevance of using semantic and sentiment analysis in marketing. An important area of research is the adaptation of machine learning algorithms to process heterogeneous information containing information about users' attitudes, brands, and their products. The issue of using semantic and sentiment analysis to identify the context and emotional coloring of statements on the Internet is addressed in the works of many scientists. Scientists are investigating areas of comprehensive analysis of text content, emoticons, and visualized materials used by the audience to demonstrate their attitude toward certain issues.

Abbasi-Moud et al. (2021) investigate the specifics of collecting data from social media and its use in the process of forming relevant recommendations for consumers using the example of the tourism sector. The feasibility of using semantic clustering of comments and a comprehensive analysis of their sentiments to identify preferences is proven.

Song et al. (2021) prove the feasibility of conducting a tonality analysis of texts that can be collected in a digital environment. The feasibility of using the semantics perception and refinement network (SPRN), which allows analyzing tonality based on aspects, is justified. The advantages of the presented approach are the possibility of using multichannel convolution, which significantly improves the quality of assessing the content load in the text.

Lu et al. (2022) proposed a novel graph convolutional network with sentiment interaction and multi-graph perception for aspect-based sentiment analysis. The advantage of implementing the presented approach is the ability to simultaneously take into account semantic relationships and tonality of text content.

Chandra and Kulkarni (2022) focus on the study of text translation problems that can lead to distortion of tone and content. They substantiate the feasibility of using bidirectional encoder representations from transformers (BERT) for building modern language models.

Khan et al. (2023) investigate the features of semantic analysis of unstructured data, which constitutes a significant portion of information on the Internet and can serve as a valuable source for forming effective management decisions. They propose to use a hybrid DNN model that allows taking into account tone and context based on the attention mechanism.

Iswari et al. (2024) investigate methods to improve sentiment analysis based on online travel product reviews through semantic similarity search. The implementation of the presented approach involves the use of a keyword library that is collected according to the frequency of mentions in customer comments.

Mercha et al. (2024) presented multilingual sentiment analysis (MSA–GCN), which involves the use of a graph convolutional network to identify short- and long-range semantics in complex text messages. It is assumed that a unified heterogeneous text graph will be used, which allows achieving effective results in the analysis of multilingual text content in a digital environment.

Cao et al. (2025) investigate the problems of the polarity of individual terms' tonality in sentences. The authors propose to use Aspect-Level Sentiment Analysis with Semantic and Emotional Modeling (ALSEM) in text processing. They manage to establish a structure that identifies the relationship between semantic information and evaluative words.

Deng and Liu (2025) assessed the emotions of society groups and their requirements using high-performance mathematical algorithms. Data from microblogs and social media comments were comprehensively processed using Python. The feasibility of using the RoBERTa–BiLSTM–Attention model for evaluating the semantics of text content was established.

Machine learning algorithms have proven effective in the process of analyzing heterogeneous data, but the possibilities of improving the quality of sentiment identification are being studied. The configuration of complex mathematical models is focused on identifying real user judgments, since in many cases human behavior involves the use of indirect manifestations of emotions (sarcasm, jokes, irony). In the process of selecting and configuring machine learning algorithms, the specifics of the brand's activities and the characteristics of its target audience are taken into account, since certain groups of consumers may be characterized by a certain slang, especially for representatives of generations Z and Alpha. An important area of scientific research in the field of semantic and sentiment analysis is the adaptation of models to a multilingual environment, since, in the conditions of globalization, a large number of users may use various languages or constructs specific to their culture, despite the use of another language.

The aim of the research is to substantiate the areas of integration of semantic and sentiment analysis based on machine learning algorithms into the process of assessing brand reputation in the digital environment.

Following the presented aim, the hypothesis is formulated that the use of sentiment and semantic analysis based on machine learning algorithms makes it possible to reliably assess consumer perception of brands on the Internet and determine relevant content according to the interests of the target audience.

Creating an effective information system in a digital environment based on server technologies allows for the continuous accumulation of information from various sources regarding the discussion and evaluation of the brand and its products by users. Along with this, cloud computing is adapted for the implementation of high-performance machine learning algorithms that are used to process big data in structured, semi-structured, and unstructured formats.

The research involves the use of the following scientific research methods: analysis and synthesis to characterize the main approaches to the application of sentiment and semantic analysis in assessing brand reputation; empirical methods, graphical representation, and system-structural analysis.

In the context of active digitalization, semantic and sentiment analysis approaches are important for companies, as they allow using text and visualized information to assess the mood of the target audience in real time. The risks of using the approaches presented by brands include the formation of ineffective marketing strategies based on the misinterpretation of the mood of the target audience.

The three sections of the main part of the article present key approaches to sentiment and semantic analysis for processing text content. The feasibility of using emoticons to assess user sentiment is proven, and the main approaches to transforming emojis into mathematical form are characterized by the possibility of implementing machine learning algorithms. A diagram of the characteristic differences between semantic and sentiment analysis in the process of analyzing text content and emoticons is presented. A system for providing information for sentiment and semantic analysis in the digital environment is presented. The research used data from the Comfy YouTube channel: comments under videos for January–July 2025. The results of assessing the content topic and target audience sentiment based on machine learning algorithms are presented, which allows optimizing the brand's marketing strategy in the digital environment, including thanks to a modern content plan.

1. Semantic and sentiment analysis: concepts, goals, and role in digital marketing

The functioning of companies in a highly competitive digital environment involves using opportunities to gain advantages over other participants in the relevant market. On the Internet, a large number of users discuss different topics on various resources every day. Posted reactions in the form of text messages and visualized content (emoticons, GIFs, pictures, etc.) can serve as a valuable resource for analyzing the popularity and current attitude of the target audience to the corresponding company, as well as identifying changes in user behavior. It is advisable to complete the set tasks through the use of semantic and sentiment analysis, which have gained considerable popularity in the field of marketing.

Semantic analysis is used in the study of text content presented in the form of natural language (words, phrases, and full-fledged texts) to identify the essence and context laid down by the target audience. The implementation of specialized algorithms allows software to understand the real content of texts posted by users on the Internet. When implementing semantic analysis, two main approaches are used:

Text classification. This direction involves dividing users into certain groups (by emotions, interests), attributing text content to a specific category (goods for young people, financial sector, online education), etc.

Text extraction. A comprehensive audit is used to determine the hidden value of the corresponding text content and use the identified features as a basis for optimizing marketing strategies in the digital environment (Thieshen, 2024, November 5).

The process of processing text data is possible through the use of traditional analysis; however, the significant growth of verbal information on the Internet leads to the need to use various artificial intelligence algorithms, including Natural Language Processing (NLP). High-performance mathematical models based on server technologies allow companies to quickly process big data presented in a structured, semi-structured, and unstructured form. To implement machine learning algorithms, it is necessary to transform the text data array in a certain way, which includes the following stages:

• first: *lexical analysis*. The purpose of this stage is to bring text content into a structured form suitable for processing by a computer. The collected text information is divided into individual words or tokens, that is, individual lexical elements are isolated;

• second: *grammatical analysis*. Identification of speech parts (nouns, verbs, adjectives) and the grammatical structure of a sentence allows algorithms to be provided with information about the syntactic connections between words. This stage allows building a structured model for the text that was collected on the Internet;

• third: *syntactical analysis*. A comprehensive analysis of the syntax of text content is carried out to identify the principles of combining words into sentences. The transformation of sentence construction logic into a mathematical form significantly simplifies text processing by machine learning algorithms. Converting text into a form acceptable to artificial intelligence involves breaking each sentence into components by the grammatical rules' characteristic of a particular language;

• fourth: *semantic analysis*. The presented stage acts as a generalizing one, since it involves combining the results obtained in the three previous stages. The qualitative implementation of lexical, grammatical, and syntactical analysis allows for the determination of the essence and meaningful relationships in the studied text as accurately as possible. The key goal of this stage is to provide conditions for the interpretation of text content by mathematical algorithms in accordance with human understanding and meaningful subtext.

Sentiment analysis is used as a separate approach, but in many cases is part of semantic analysis. The presented approach is used to determine the tone of text generated by users on the Internet. Lexical analysis is implemented according to the selected set of words and involves determining the mood of users on certain web resources (social media, sites, forums, etc.).

Along with text content, emojis (emoticons) are often used in the implementation of semantic analysis. For the most active in the digital environment, generations Y, Z, and Alpha, it is natural to use thematic emoticons in the process of discussing various issues and expressing certain

emotions. Visualized content in combination with text is used mainly in the implementation of AI sentiment analysis.

To ensure high-quality sentiment analysis based on the emoticons used, they are grouped according to the identified emotional reactions. The process of preparing emojis for the implementation of certain approaches involves manual marking in accordance with a specific emotional state.

To use artificial intelligence algorithms, it is necessary to transform emoticons into digital form. The most popular transformation methods include:

One-Hot Encoding. Emoticons receive certain indices containing a binary vector (0 and 1). For example:

☺ – [1, 0, 0]

😊 – [0, 1, 0]

😎 – [0, 0, 1]

Count-Based Features. Statistical analysis of emoticons in text content is used: total number of emoticons in a message or comment; density of emoticons in the text; distribution of emojis by emotion. *Figure 1* presents three groups of emoticons according to the main emotions.

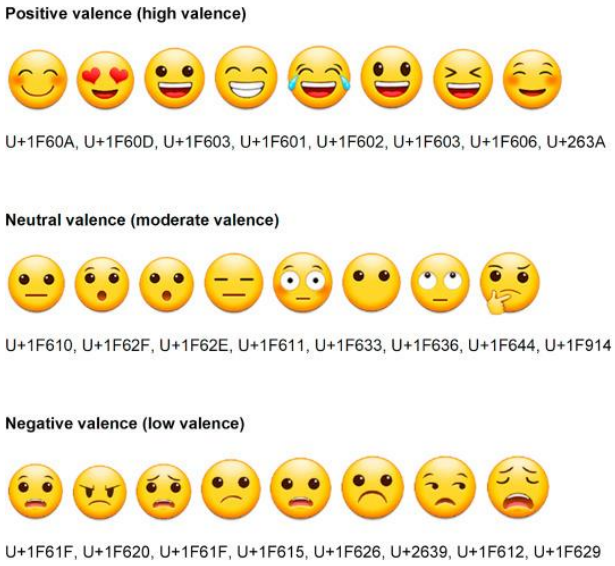

Figure 1. Emoticon groups according to basic emotions

Source: (Kaye et al., 2022).

Embeddings. This approach is very effective because it allows companies to qualitatively prepare data for processing by machine learning algorithms. Emoticons are converted into high-dimensional numerical vectors, the distance between which serves as a characteristic of specific reactions. The main methods include Pre-trained Models, Custom Embeddings; Contextual Embeddings.

Hybrid Approaches. In the practice of machine learning, ensemble models have become widespread, which allow companies to combine several approaches at the same time to obtain the optimal result. The use of hybrid

models for processing emoticons is based on the multiplicative effect, which allows analytics to use the strengths of each of the algorithms in a common mathematical model.

For a comprehensive assessment of brand reputation in the digital environment, semantic and sentiment analysis are often used together. However, the development and implementation of an effective marketing strategy involve understanding the main differences between the presented approaches (*Figure 2*).

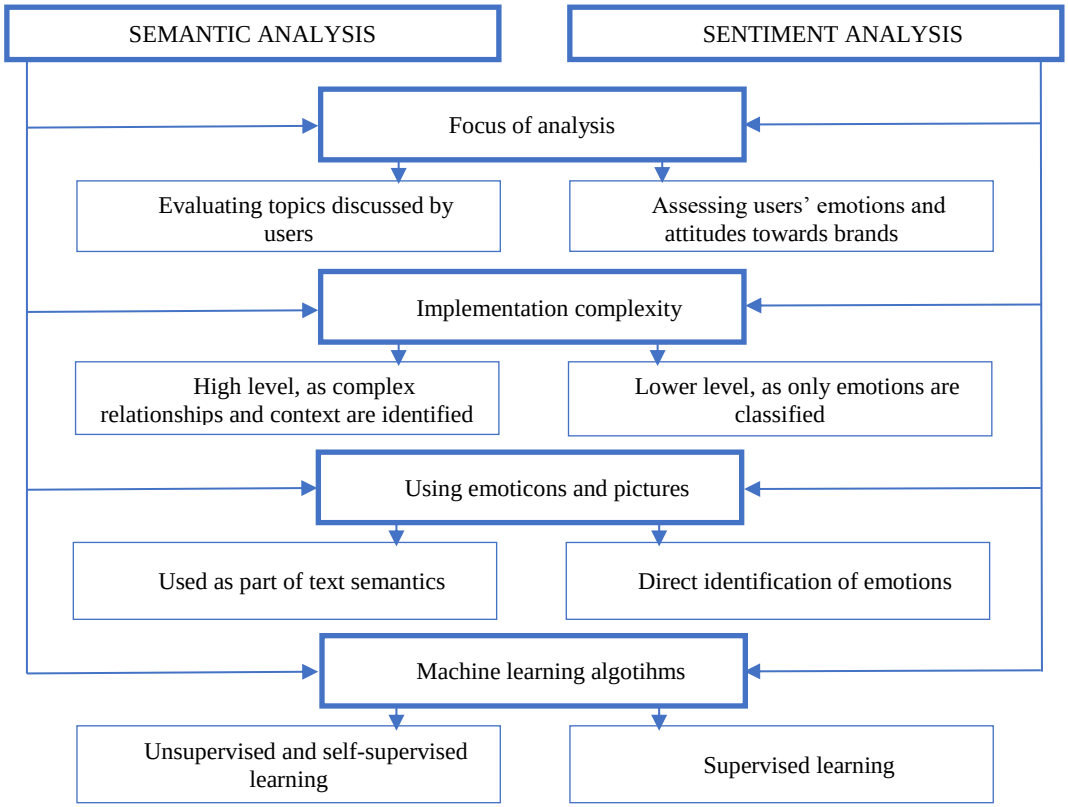

Figure 2. Differences between semantic and sentiment analysis

Source: compiled and supplemented by the authors from (Williams, 2025, January 7).

Despite the simpler procedure for implementing sentiment analysis, the presented approach is widely used in the practice of marketing analytics in the digital environment. The availability of limited resources and the need to obtain quick results in a highly competitive environment make the presented approach effective and allow companies to achieve optimal results in the process of establishing communications with a demanding target audience, which easily switches from one brand to another.

The ability to choose between semantic and sentiment analysis, or to combine the two presented approaches, allows companies to effectively process large amounts of text information, emoticons, and other visualized content in the process of identifying the mood of the target audience and key trends in the markets of operation.

2. Information support for sentiment and semantic analysis

The digital environment allows for the collection of large amounts of textual and visual information for sentiment and semantic analysis. At this stage of development, the assessment of topics and user sentiments on the Internet is carried out through the use of emoticons and images. However, the evolution of machine learning algorithms leads to the testing of approaches that involve the processing of audio and video content. The formation of effective information support for sentiment and semantic analysis involves the use of specific methods of data collection on various resources on the Internet (*Figure 3*).

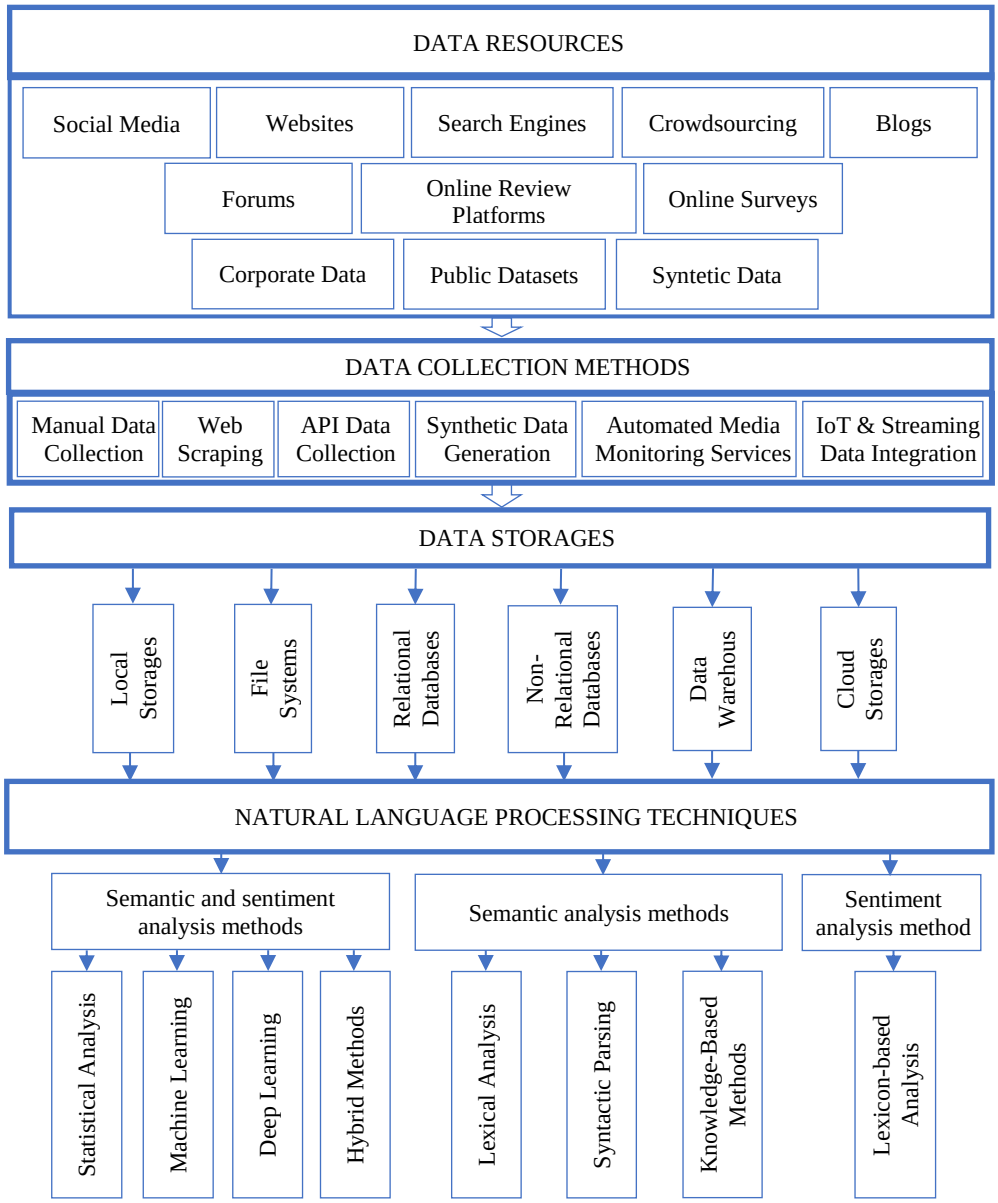

Figure 3. Information system of semantic and sentiment analysis

Source: compiled and supplemented by the authors from (Watchers, 2025, March 6).

The consumer electronics market was chosen to conduct sentimental and semantic analysis, as users consistently generate high demand for innovative products. Interest in modern electronics among representatives of generations Y, Z and Alpha implies active use of digital communication channels by companies to promote products and establish close communications. On the Internet, the leaders in consumer electronics sales in Ukraine in 2025 are Rozetka, Allo, Comfy, Foxtrot, and Moyo (Vtop-Shop, 2025, August 10; Similarweb, 2025, August 10). The activity of the presented brands in the digital environment and interaction on various web resources, primarily in social media, allows the collection of large amounts of text information in combination with emoticons. According to the presented information support scheme on the Internet, data was collected on the consumer electronics market for the Comfy retail chain. The sources of information for conducting sentimental and semantic analysis of the brand were popular on social media (*Table 1*).

Table 1

Characteristics of Comfy social media accounts, July 2025

Social Media	Posts/Videos	Readers/followers
X	632	1779
Instagram	3401	275k
YouTube	557	11.3k
TikTok	42	15.3k
Facebook	≈ 500	490k

Source: (Comfy X, n. d.; Comfy_ua, n. d.; COMFYchannel, n. d.; comfy_media, n. d.; COMFY, n. d.).

The intensive activity of the Comfy retail chain in interacting with the target audience on social media allows it to attract a large number of potential users. Along with this, the target audience is stimulated to leave feedback and wishes regarding certain activities of the company. A detailed analysis of posts and videos made it possible to establish that modern users do not have a particular desire to leave comments for most of the posted content in all the above media. Along with this, the target audience actively participates in various promotions that involve active communication in text format. On Instagram, the company constantly holds various draws that attract the attention of thousands of users and stimulate posting comments according to the specifics of the posted content. During the UKRAINEPRIDE events, Comfy posted a post on its own social media accounts with the text: "Be yourself. Speak out loud. Stand up for equality". A large number of users in the comments joined the discussion of this issue, expressing their position.

Social media in Ukraine, popular among generations Y, Z, and Alpha, are characterized by a larger number of comments that can be collected for sentimental and semantic analysis. Along with this, the X network, which is characterized by significant popularity in the world and is considered a valuable resource for collecting text content and reactions in the form of emoticons, does not allow collecting large amounts of information about the company under study in Ukraine.

3. Semantic and sentiment analysis of Comfy's brand reputation in social media

The Comfy brand YouTube channel was used to conduct semantic and sentiment analysis. When studying this resource, 7046 comments were collected from 60 video clips published during January-July 2025. Analysis of the topics of publications posted by the brand indicates the effectiveness of using a marketing strategy in building communications with the target audience. The topics of the content posted on the Comfy channel clearly show an orientation towards providing commercial and educational functions. Videos can be divided into the following areas: consumer electronics reviews; gaming and entertainment; gift selections, and life hacks; tips for ensuring energy saving.

The process of processing text content and emoticons in the formed database was carried out in the following stages:

- Tokenization and removal of stop words using the Natural Language Toolkit, which allowed us to isolate words valuable for analysis.
- Text translation using googletrans, using API queries. To further assess user sentiment and interests, it was advisable to translate text comments from Ukrainian to English.
- Sentiment analysis using the VADER library (Valence Aware Dictionary for sEntiment Reasoning) (Chiny et. al., 2021).
- Text vectorization using the TF-IDF (Term Frequency – Inverse Document Frequency) method, which allows analytics to transform the text into a digital format and implement various machine learning algorithms.

When implementing sentiment and semantic analysis, a word cloud is widely used, which allows companies to visually assess the presence of the most common words in the studied text array. The formation of text popularity was carried out on the basis of nouns, adverbs, and adjectives (*Figure 4*). The most popular thematic words for the Comfy brand include machine (315 words or 1.03%), kitchen (296 words or 0.97%), vacuum (288 words or 0.94%).

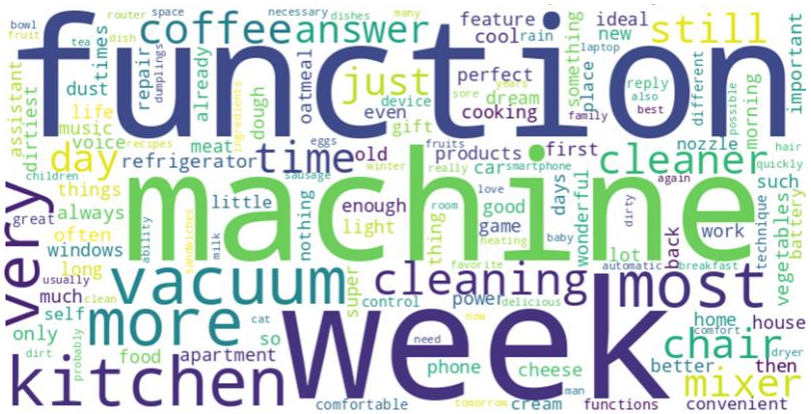

Figure 4. Word Cloud of Comments (Nouns, Adverbs, Adjectives) of Comfy YouTube Channel from January to July 2025

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

The next step is to use the t-SNE Visualization of Comments graph, which displays the results of sentiment analysis of comments in a two-dimensional space (*Figure 5*). The presented graph contains three mood categories (positive, neutral, and negative), as well as intensity zones for each state. The analysis of mood dynamics indicates the prevalence of positive reviews at the beginning of 2025, the peak of which is noted in March-April of the studied period. Subsequently, a partial shift in user moods is noted due to an increase in the share of negative comments.

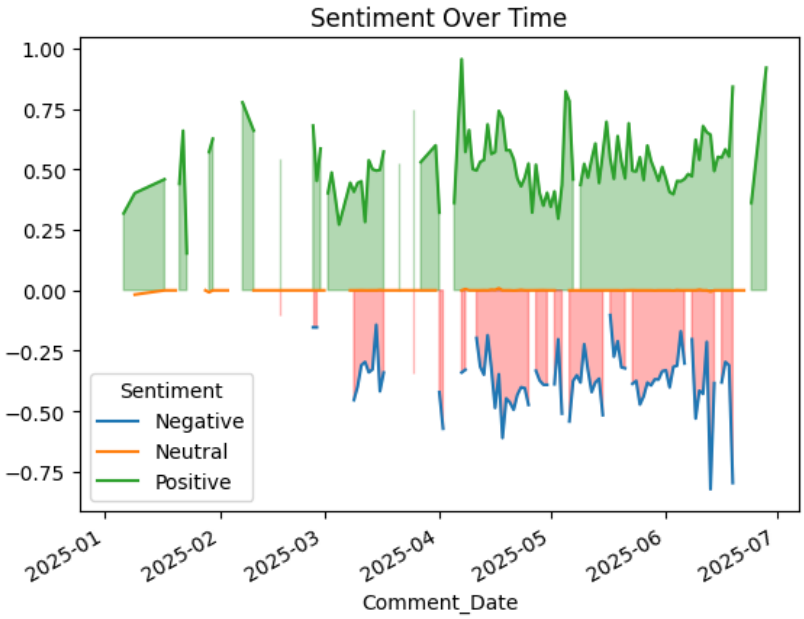

Figure 5. Sentiment analysis of Comfy's YouTube channel from January to July 2025

Source: calculated by the authors based on (COMFY channel, n. d.).

In the next step, we will use the t-SNE Visualization of Comments graph, which demonstrates the results of sentiment analysis of comments in a two-dimensional space (*Figure 6*). The study of semantics shows that local structures are identified for reviews of the Comfy brand on YouTube, and the density of the cluster of points in the center of the graph is noted. Accordingly, there are key topics that stimulate users to actively participate in the discussion, leaving emotionally similar comments in the content. Negative reviews in this segment are mainly associated with user dissatisfaction with the quality of Comfy services, and neutral reviews are associated with the discussion of products in the corresponding video reviews.

The concentration of neutral and negative reviews mainly in the center requires the brand to isolate this segment and conduct additional surveys to identify relative amorphousness and dissatisfaction. Identifying problems will allow Comfy to minimize negativity and ensure increased loyalty of the target audience.

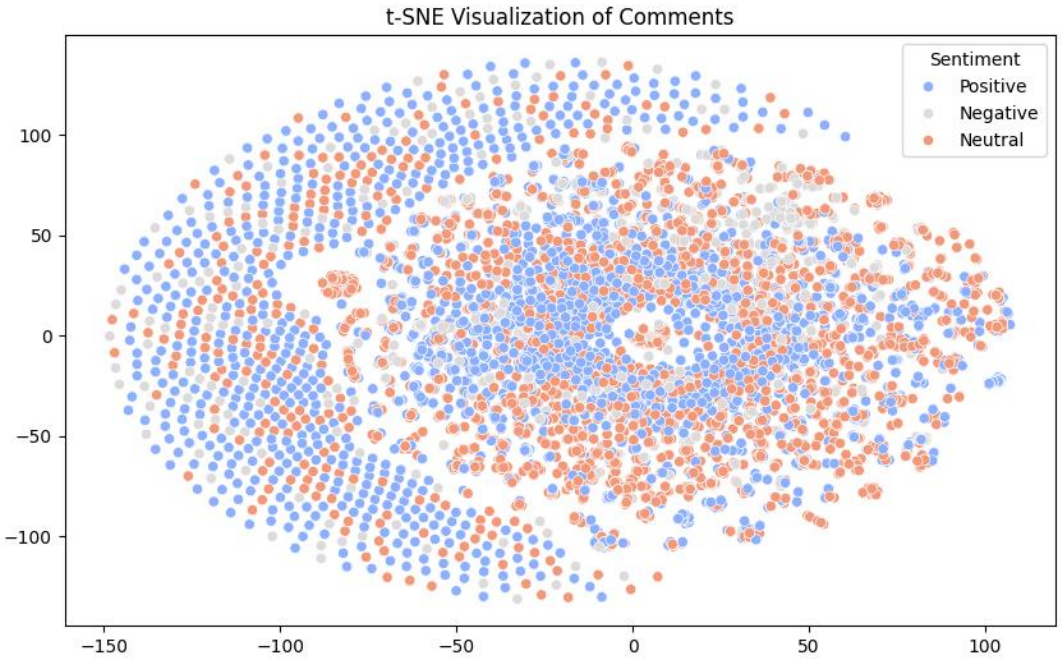

Figure 6. t-SNE Visualization of comments on Comfy's YouTube channel from January to July 2025

Source: calculated by the authors based on (COMFY channel, n. d.).

Continuous interaction with users on social media will allow Comfy to meet the expectations of generations Y, Z, and Alpha in Ukraine. The digital marketing strategy of this brand involves the formation of a positive consumer experience based on identified trends, which will contribute to the expansion of the segment of positive comments. Along with this, it is necessary to use other effective digital marketing tools to obtain a multiplicative effect (Iankovets, 2025).

Conclusions

Ensuring the effectiveness of marketing strategies of companies is important, as it is a key element of a high level of competitiveness. In the conditions of digitalization, brands get the opportunity to receive diverse information and use it to make effective management decisions in the process of ensuring long-term communications with the target audience. Comments contain text responses and visualized reactions in the form of emoticons that users leave on the Internet. The best sources for assessing the reaction of modern generations (Y, Z, and Alpha) include social media, which allow brands to constantly post thematic content and collect comments from users. The most effective approaches to text and emoji processing include sentiment and semantic analysis, which allow assessing the thematic areas of the issues discussed in the comments and assessing the attitude of users to brands and their activity in implementing marketing strategies.

The development of e-commerce and high demand for consumer electronics in Ukraine in modern conditions necessitated conducting research in this area. Comfy was chosen as the brand under research, as one of the market leaders that actively uses various digital marketing tools to interact with the target audience. Comments and emojis for sentiment and semantic analysis were collected on the company's YouTube channel for January-July 2025. The specified social media was chosen due to the ability to quickly collect a large number of text reactions from users regarding the assessment of the Comfy brand.

The results obtained in the research process confirm the effectiveness of using machine learning algorithms for sentiment and semantic analysis. Studying user sentiment and assessing user interests allows companies to quickly adapt to existing demand and form a positive brand image in the digital environment. The practical significance of the presented study lies in the fact that, using the example of the Comfy retail chain, users' attitudes towards its activity on YouTube were assessed and popular video content topics in Ukraine were identified in the context of digitalization and military operations. The effectiveness of using videos describing the characteristics of various consumer electronics to attract the attention of representatives of modern generations and encourage them to express themselves in comments was proven. Video content in the field of gaming and entertainment is mainly interesting for representatives of generations Z and Alpha. Also, stimulation of interest and active posting of comments is observed for videos related to Comfy contests and the drawing of valuable prizes. It should be noted that consumers are more active in posting comments to participate in contests on Instagram. The importance of the research conducted lies in substantiating the need for Ukrainian companies to use high-performance machine learning algorithms when conducting semantic and sentiment analysis to assess brand reputation based on text content and emoticons.

Further research will focus on expanding the sources of information from the digital environment to implement sentiment and semantic analysis. The use of modern and high-performance machine learning algorithms will allow optimizing the interaction process between brands and consumers, contributing to increasing the loyalty of the target audience.

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THE IMPACT OF SOCIAL MEDIA ON CONSUMER CHOICE

The rapid digitalization of society has radically transformed the behavior of the modern consumer, as social networks are not only a communication tool, but also a full-fledged channel that influences the process of consumer decision-making. This necessitated the need for an interdisciplinary study of the dynamics of consumer decision-making in a digital environment in which social platforms act as leading sources of information, shapers of consumer preferences, and channels of emotional engagement. The aim of the research is to identify the mechanisms of influence of social networks on consumer decision-making in the digital environment in the context of changing their behavior and forming digital trust in interaction with brands. The research is based on the hypothesis that brands use social media to influence consumers at every stage of their digital journey in order to increase awareness and create a socially responsible image. The hypothesis was tested using the following research methods: systems analysis, interdisciplinary synthesis, content analysis of visual and text materials, and comparative analysis of business cases. An analysis of digital trust

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ВПЛИВ СОЦІАЛЬНИХ МЕРЕЖ НА СПОЖИВЧИЙ ВИБІР

Стрімка цифровізація суспільства докорінно трансформувала поведінку сучасного споживача, зробивши соціальні мережі не лише інструментом комунікації, а й повноцінним каналом впливу на процес прийняття споживчих рішень. Це обумовило необхідність проведення міждисциплінарного дослідження динаміки ухвалення рішень споживачами в умовах цифрового середовища, в якому соціальні платформи виступають як провідні джерела інформації, формувачі споживчих уподобань та каналів емоційної залученості. Метою статті є виявлення механізмів впливу соціальних мереж на ухвалення рішень споживачами у цифровому середовищі в контексті зміни їх поведінки та формування цифрової довіри у взаємодії з брендами. В основу дослідження покладено гіпотезу, що бренди використовують соціальні мережі для впливу на споживачів на кожному етапі їх цифрового шляху з метою посилення впізнаваності й формування соціально-відповідального іміджу. Гіпотезу перевірено через такі методи дослідження: системний аналіз, міждисциплінарний синтез, контент-аналіз візуальних і текстових

factors was conducted, including user-generated content (UGC), quantitative metrics (likes, shares, subscriptions), interactive reviews, and the role of influencers as digital thought leaders was identified. It examines how social media influences each phase of the consumer's digital journey: need identification, search for alternatives, evaluation, purchase decisions, and post-sales behavior. Particular attention is paid to the analysis of current trends in the use of social platforms by various demographic groups, in particular in Ukraine, which is experiencing transformational challenges caused by the war, market adaptation to new technologies, and the formation of a new culture of digital consumption. The results of surveys, statistical data from international analytical centers (GWI, DataReportal, Statista, Nielsen) are presented, and cases of brands that have successfully applied marketing strategies in the social media ecosystem are considered. The conclusions emphasize the need to build long-term relationships between the brand and the consumer through personalization mechanisms, emotional engagement, and the use of neuromarketing technologies. Practical recommendations are offered for the effective use of social networks as a tool for digital interaction and the formation of consumer loyalty.

Keywords: social media, digital behavior, decision-making, influencer marketing, digital trust, UGC content, personalization, neuromarketing, brand–consumer interaction, marketing strategies, Ukraine, digital transformation, behavioral marketing.

матеріалів, порівняльний аналіз бізнес-кейсів. Розглянуто фактори цифрової довіри, зокрема контент, створений користувачами (UGC), кількісні метрики (уподобання, поширення, підписки), інтерактивні огляди. Визначено роль інфлюенсерів як цифрових лідерів думок. У ході дослідження проаналізовано, що соціальні мережі впливають на кожну фазу цифрового шляху споживача: виявлення потреби, пошук альтернатив, оцінка, рішення про покупку та постпродажна поведінка. Особливу увагу приділено аналізу сучасних трендів використання соціальних платформ представниками різних демографічних груп, зокрема в Україні, яка переживає трансформаційні виклики, спричинені війною, адаптацією ринку до нових технологій та формуванням нової культури цифрового споживання. Наведено результати опитувань, статистичні дані міжнародних аналітичних центрів (GWI, DataReportal, Statista, Nielsen), а також розглянуто кейси брендів, які успішно застосували маркетингові стратегії в екосистемі соціальних медіа. У висновках акцентовано на необхідності побудови довготривалих відносин між брендом і споживачем через механізми персоналізації, емоційного залучення та використання нейромаркетингових технологій. Запропоновано практичні рекомендації щодо ефективного використання соціальних мереж як інструменту цифрової взаємодії та формування споживчої лояльності.

Ключові слова: соціальні мережі, цифрова поведінка, прийняття рішень, маркетинг впливу, інфлюенсери, цифрова довіра, *UGC*-контент, персоналізація, нейромаркетинг, взаємодія бренд–споживач, маркетингові стратегії, Україна, цифрова трансформація, поведінковий маркетинг.

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Introduction

The digital transformation of society and the economy has led to significant changes in communication processes and consumer behavior. Social networks, as a key element of the digital space, have opened up new mechanisms for influencing consumer decision-making, transforming traditional sources of information into interactive environments for monetization, sharing experiences, broadcasting emotions, and collectively creating ideas about goods and services.

Therefore, digital interaction has become dominant in the process of choice, purchase, and post-purchase behavior. According to GWI (2024), more than 76% of users under the age of 35 admit that they have made a purchase under the influence of content on social networks. This emphasizes

a large-scale shift in the consumption paradigm: from autonomous rational analysis to emotional reactions to influencer recommendations, reviews, and visual content. In such an environment, consumers gain access to a huge amount of information, build digital trust, and interact with brands on a personal level through stories, live broadcasts, comments, and recommend-dations. This forms a new communications architecture in which advertising, emotional influence, and social confirmation are combined into a complex decision-making system. Neuromarketing is also considered a tool for psychological influence on the consumer (Skrigun & Meteyko, 2018).

Comprehensive research of the impact of social networks on consumer decisions in the digital environment is based on an interdisciplinary source base that combines analytical reports, scientific articles, marketing reviews and practical cases. The structure of the materials used traces three interconnected vectors such as empirical, conceptual-theoretical and applied.

The empirical basis is the annual reports of the world's leading platforms: Digital 2024: Global Overview Report (DataReportal, 2024, January 31), Social Media Trends 2024 (GWI, 2024), Digital 2024 Statshot (We Are Social, 2024, October 23), as well as the statistical indices Statista (2024) and Lariba (2024). They provide up-to-date data on the structure of social network use, sources of product information search, level of trust in UGC content and digital behavior by age groups. Their significance lies in reflecting the dynamics of global changes and the specifics of the omnichannel consumer experience.

The conceptual and theoretical block is represented by publications that substantiate the transformation of consumer behavior due to the action of digital communication channels. One of the authors of this article substantiated the role of social media marketing in business interaction (Zaitseva et al., 2023), and in a previous study by the second author (Povod & Zhosan, 2025) the significance of neuromarketing for forming loyalty in the segment of knowledge-intensive products was proven. The works of Kukharska (2024), Zincio and Stasyuk (2022), Savchenko, Sukach et al are of particular analytical value. Savchenko, Ablyazova et al. (2021) highlight the methods, tools and issues of digital trust and cognitive influence on the consumer in the conditions of a visualized media field.

The applied block of sources covers the results of industry surveys, benchmarking studies (Sprout Social, 2023, Influencer Marketing Hub, n. d., Nielsen, 2020), as well as non-public internal reports of arbitrarily selected Ukrainian brands, which became the basis for the formation of business cases in the fourth chapter. In particular, the article by Burdyak et al. (2024) analyzes the effectiveness of nano-influencers, and the analytics of the Ukrainian Marketing Association (n. d.) examines business marketing practices in wartime.

Thus, the source base of the research is representative, multi-level and relevant to the stated issues. Its structure allows for an in-depth analysis of the phenomenon of digital consumer behavior, combining macro-analytical observations with micro-marketing practices. Despite the presence of a significant amount of empirical data and examples of the use of social networks in marketing, the mechanisms of influence of social networks on consumer behavior in the Ukrainian digital context require further clarification. In particular, the question remains open as to which factors: type of content, level of trust, participation of influencers or visual component have a decisive impact on buyer behavior. Even with the availability of a large number of international studies, the mechanisms of influence of individual factors in social networks remain insufficiently detailed in Ukrainian realities, which necessitates the need for further research.

The aim of the research is to identify the key mechanisms of influence of social networks on consumer decision-making in the digital environment in the context of transforming their behavior and forming digital trust in interaction with brands.

The research is based on the hypothesis that brands use social media to influence consumers at every stage of their digital journey and touchpoints in order to increase awareness and build a socially responsible image.

The hypothesis was tested using the following general scientific research methods: system analysis, interdisciplinary synthesis, content analysis of visual and text materials, as well as comparative analysis of cases on the Ukrainian market. The information base of the study is made up of analytical reports, sociological surveys, marketing research, scientific publications and empirical data obtained from the YouTube, TikTok, Instagram, Facebook platforms.

The article analyzes the evolution of the formation and development of consumer behavior models under the influence of social networks, identifies the role of influencers in the formation of trust, presents practical examples from the Ukrainian market and formulates marketing implications for brands that seek to function effectively in the digital environment. The first section analyzes the transformation of consumer behavior in the context of digitalization: it reveals how the stages of decision-making have changed under the influence of digital technologies and social networks and also highlights the phenomenon of the consumer’s emotional reaction, which replaces rational analysis in the choice process. The second section is devoted to the characteristics of social networks as channels of influence on the consumer: it examines their role in creating an information space, behavioral patterns of users in TikTok, Instagram, Facebook, YouTube, etc.; substantiates the effect of "social confirmation", personalization mechanisms and algorithmic formation of the information feed. The third section examines

influence marketing as a new logic of authority in the digital environment: analyzes the nature of digital trust, delimits its components, presents empirical indicators of the effectiveness of influence marketing and provides examples of successful campaigns using micro- and nano-influencers. The fourth section contains an applied analysis of marketing cases from the Ukrainian market: summarizes the effects that companies have received from active interaction with the audience on social networks, describes statistical data on changes in conversion rates, reach, and brand awareness. Based on this, strategic implications for enterprises regarding the use of social networks as a tool for forming long-term brand value are formulated.

1. Transformation of consumer behavior in the context of digitalization

The spread of mobile technologies, the active use of social networks, personalized platforms and artificial intelligence have significantly transformed not only the channels of interaction with brands, but also the logic of decision-making itself. The consumer is moving from autonomous analysis to collective interaction, dominated by emotional, situational and social factors. In the traditional model of decision-making, which involves five consecutive stages: awareness of the need, search for information, evaluation of alternatives, decision-making and post-purchase behavior, it was believed that the consumer acts rationally and logically. However, the digital environment has significantly complicated and fragmented this process. Currently, consumers discover new products and services through feeds, stories and recommendations. Platforms such as Instagram and TikTok set the tone by demonstrating what opinion leaders and celebrities buy and use. Unlike traditional advertising, influencers and UGC (user-generated content) are perceived as more reliable and honest sources of information, and their recommendations are similar to advice from acquaintances. In this context, brands act as external triggers through social networks, which stimulates the emergence of new needs, forms emotional impulses and accelerates the digital path to purchase. This is confirmed by the data of the DataReportal study (2024), which proves that 62.3% of the world's population (5.04 billion people) actively use social networks and this creates an unprecedented density of information pressure on the consumer (DataReportal, 2024, January 31).

In the digital environment, the difference between information search and evaluation is blurred – comments, likes, video reviews and algorithmically selected recommendations form a fast-paced information background, in which emotional reactions prevail over rational analysis. More than 76% of users aged 18–35 report that they have made a spontaneous

purchase at least once under the influence of content seen on social networks (GWI, 2024).

Table 1 demonstrates the key differences between the classical decision-making model and the digital scenario of consumer behavior in the social media environment:

Table 1

The comparison of traditional and digital models of consumer decision-making

Decision-making stage	Traditional model	Digital environment (social networks)
Need awareness	Personal experience, advertising	Post, influencer recommendation, UGC, paid advertising on social networks
Information search	Catalogs, advice from experts and friends	Reviews, comments, bloggers, reviews via video/story/gamification, integration with GoogleMaps
Evaluation of alternatives	Comparison of characteristics	Algorithmically selected offers, videos, ratings, push notifications
Decision making	Weighed, rational	Under the influence of emotions, trends, offers of bonuses and discounts for activity, "social confirmation"
Post-purchase behavior	Personal experience, discussion with friends	Publishing reviews, stories, sharing experiences online, uniting by values in consumer communities

Source: authors' research.

Thus, brands are influencing consumers' digital behavior through the increasing volume of interactive content, the use of social proof, and the effect of instant mass influence. At the center of decision-making is now not only individual logic, but also collective digital culture – a community that shapes trends, meanings, and expectations.

2. Social networks as channels of influence on consumers

Social networks have become the leading communication channels that have a direct and multifaceted impact on consumer behavior. They not only inform, but also shape needs, emotions, expectations, trust and even values. The consumer is no longer a passive recipient of information – he becomes an active participant in digital interaction, which covers the processes of search, selection, purchase and post-purchase behavior.

Modern social platforms Instagram, TikTok, Facebook, YouTube provide a constant stream of content, personalized through recommendation algorithms based on user behavioral analysis. According to the We Are Social report (2024, October 23), 46.1% of users in the world use social networks to search for information about brands, products and services, which makes this channel key in the consumer journey.

Content analysis by Bondarenko et al. (2022) showed that social networks demonstrated the best performance in attracting funds for influencing consumers, compared to promotion through traditional media. The most popular social platforms for product research (by age of users, global data 2023) are presented in *Table 2*.

Table 2

The most popular social platforms for researching products
(by user age, global data for 2023)

Age group, years	Share of social network, %			
	TikTok	Instagram	YouTube	Facebook
16–24	67	64	59	21
25–34	48	61	66	34
35–44	32	49	62	41
45+	18	33	54	55

Source: (Statista, 2024).

The behavioral mechanism of interaction with social networks can be described using the S-O-R (Stimulus – Organism – Response) model, in which the stimulus is the content on the social network (video review, post, stories), the organism is the consumer with his emotional and cognitive filter, and the reaction is a specific action (click, save, purchase).

Particular attention should be paid to the phenomenon of visual content, which dominates social networks such as TikTok and Instagram. Short videos lasting 15–60 seconds have a higher level of attention retention and influence on the purchase decision compared to text or banner messages. Thus, according to Statista, more than 57% of young users aged 16–24 choose video reviews as the main source of information about new products (Statista, 2025, July 1).

In addition to material brands, an important source of influence is the feedback of other consumers, which is often perceived as objective and reliable. Among users who read reviews on social networks before making a purchase, 84% consider them a "decisive factor" in making a decision (Lariba, 2024). The use of neuromarketing tools on social networks helps to increase the effectiveness of promotion by activating emotional engagement and subconscious reactions of consumers (Lozovska & Značek, 2024).

The digital environment forms the so-called "loop of influence": the more a user interacts with brand content (through comments, sharing or liking), the more similar content he receives in his feed. This mechanism, enhanced by machine learning algorithms, forms a zone of information resonance in which the consumer is in constant interaction with brands, which significantly affects his behavior. At the same time, legal principles related to state stimulation of knowledge-intensive products should also be taken into account (Chubenko, 2018).

So, brands are using social media not only to communicate information to consumers, but also to build trust, actualize needs, increase awareness and a sense of "social belonging," and build consumer communities around the brand. This opens up new opportunities for marketing activities but also requires an ethical and strategic approach to content management.

3. Influencers and digital transparency: the new logo of authority

In an oversaturated information space, traditional sources of authority such as advertising and expert opinion are gradually losing their leading positions. They are being replaced by influencers - digital opinion leaders who build trust with the audience through systematic, personalized and, most importantly, authentic communication. It is through influencers that the modern consumer increasingly forms an idea of a product, its value and the feasibility of buying.

Influencers function as micromedia, combining the features of a communicator, analyst and friend. According to the research by Sprout Social, 49% of users make a purchase at least once a month under the influence of an influencer's publication. This figure is even higher among Generation Z – 64% (Sprout Social, 2023).

Digital trust, which is formed between a subscriber and an influencer, has a different nature than in traditional advertising relationships. It is based on the following components:

- Regularity of interaction. Influencers publish content daily, actively comment, respond to subscribers, creating the effect of constant presence.
- Authenticity. Successful influencers demonstrate "real life", without hiding emotions, failures and the process of making their own decisions.
- Social closeness. The audience perceives influencers as "their" informal advisors, and not carriers of the corporate message.

It is these factors that determine the emergence of the so-called digital trust – a new form of social capital that has high marketing value (*Table 3*). Digital trust turns into a convertible asset: its presence increases the effectiveness of an advertising campaign, reduces the cost of explaining the value of the product and stimulates the organic dissemination of information.

Table 3

Comparing the effectiveness of traditional advertising and influencer marketing

Indicator	Traditional advertising	Influencer marketing
Source Trust, %	32	63
Engagement Rate, %	0.9	3.6
Conversion Rate, %	1.4	4.2
Average Customer Acquisition Cost, USD	1.15	0.73

Source: (Nielsen, 2020; Influencer Marketing Hub, 2025).

In the context of the Ukrainian market, it is worth noting the growing popularity of nano-influencers (less than 10 thousand subscribers), who have a localized and deeply engaged audience. According to the data of the LOOQME platform, campaigns with the participation of nano-influencers in

the fashion and FMCG sectors demonstrate an increase in organic reach by 18–27% and an increase in conversions to the brand's website by up to 34% (LOOQME, n.d.). One of the applied methods is eye tracking, which is actively used for testing web pages (Moskalenko & Zozulyov, 2018).

Influence marketing also shifts the focus from short-term effects to long-term interaction with the client. A positive mention from an opinion leader not only increases the likelihood of purchase, but also creates a loyalty effect, which affects repeat consumption, the formation of a community around the brand, and increasing its reputational stability in times of crisis.

Thus, influencers are becoming new intermediaries between the brand and the consumer, focused not only on broadcasting advertising messages, but also on creating value through trust as the emotional currency of the digital age. As a result of the analysis, several main factors that determine consumer behavior in the digital environment can be identified. Video content, short clips and UGC formats stimulate emotional reactions and spontaneous purchases. For example, TikTok and Instagram demonstrate a high level of attention retention through short videos that create the effect of instant interest. Consumers tend to trust UGC and other users' reviews more than traditional advertising. Research by Lariba, C. (2024) confirms that 84% of users consider reviews to be a decisive factor when choosing a product. Influencers act as opinion leaders, building social trust through authenticity and regular interaction. Nano-influencer campaigns in Ukraine (LOOQME, n. d.) prove their effectiveness for localized audiences. Visual content on social networks (especially video reviews) is the main trigger of behavior among young audiences. Over 57% of users aged 16–24 choose video as the main source of information about new products (Statista, 2024).

4. Practical case studies and marketing implications

The integration of social media into the marketing activities of enterprises in Ukraine and the world demonstrates not only the increase in the effectiveness of advertising campaigns, but also a rethinking of the very approach to customer interaction. As noted, social networks are no longer just a channel for promotion, they are turning into a digital platform for co-creation of value, dialogue and building trust.

In Ukraine, despite the challenges of war, the share of businesses actively using SMM (social media marketing) increased from 54% in 2021 to 68% in 2023 (Ukrainian Marketing Association, (2022). Companies focused on visual and video content, which allows you to achieve an emotional connection with the audience, proved to be particularly effective. For example, the Ukrainian natural cosmetics brand YAKA conducted a series of collaborations with micro-influencers on Instagram, thanks to which, within 3 months, the campaign recorded:

- an increase in website traffic by 31%;
- an increase in conversion by 24%;
- an increase in organic sector by 46%.

A similar case demonstrates the power of the so-called proximity effect: users trust local faces who have "live" contact with the audience.

Another example is the Aroma Kava coffee shop chain, which in 2022–2023 systematically used TikTok to attract a young audience. Thanks to simple videos with challenges, memes and short surveys, the company achieved:

- an increase in subscribers by +142 thousand in 6 months;
- over 5 million organic views;
- an increase in seasonal menu sales by +37% during the campaign period.

These data indicate that marketing strategies adapted to the specifics of social networks provide not only a short-term increase in sales, but also create sustainable competitive advantages in terms of:

- increasing brand awareness;
- forming a community around the brand;
- increasing emotional engagement and customer loyalty;
- adaptability to crises and communication challenges (*Table 4*).

Table 4

The impact of companies on social media on marketing indicators (data from Ukrainian cases)

Company	Platform	Indicator	Changes (%)
YAKA Cosmetics	Instagram	Conversion	+24
Aroma Kava	TikTok	Seasonal menu sales	+37
Duna Brand	Facebook	Number of followers	+29
Lviv Croissants	Instagram	Brand awareness	+33

Source: (Ukrainian Marketing Association, 2022; internal company reports).

In addition, marketing on social networks stimulates real-time feedback, which allows companies to respond faster to customer needs, adapt positioning, test new products and evaluate the audience's reaction to a change in tone of voice.

Thus, social networks create a new culture of interaction, where the consumer is not only the target audience, but also an active participant in the formation of brand identity and image.

Conclusions

In the course of this research, the authors found that social networks in the digital economy have transformed from a regular communication channel into a powerful tool for influencing consumer behavior, contributing to the formation of trust and personalized interaction with the brand. The decisive role in this transformation is played by the platforms Instagram,

TikTok, YouTube and Facebook, which have created a favorable environment for the formation of a new logic of consumer choice through visuality, emotionality, quick feedback and the effect of social proof.

The results of the analysis of empirical data and practical cases confirm that influencers are intermediaries of digital trust, who not only accumulate reputational capital and increase brand recognition, but also actively transform the mechanisms of consumer decision-making. Micro- and nano-influencers are of particular value, demonstrating a high level of authenticity and relevance for narrow target audiences.

The marketing implications of active use of social networks require deeper personalization of content, adaptation to the specifics of each platform, the use of neuromarketing technologies and the development of long-term strategies for working with digital opinion leaders. At the same time, digital consumer behavior is becoming increasingly fragmented, nonlinear and contextually sensitive. Modern research confirms that neuromarketing allows for a deeper understanding of consumer cognitive reactions and management of their behavior (Karpenko & Ostapchuk, 2022).

The effectiveness of a brand's presence on social media depends on its ability to adapt to new formats of interaction and ensure transparency of communication, as well as the active involvement of communities and the strategic integration of influencer marketing into the overall consumer experience management system. Thus, the hypothesis that brands use these networks at each stage of the consumer's digital journey is proven.

The results obtained confirm the hypothesis about the multifactorial impact of social networks on all stages of the consumer's digital journey. In particular, it is shown that the type of content, the level of trust, the participation of influencers and the visual component act in an interconnected manner, forming a complex system of consumer behavior. This requires brands to strategically manage digital trust, content personalization and long-term interaction with the audience.

A prospective direction for further research will be the development of integrated models for building digital trust, taking into account cognitive, social, and cultural factors of user behavior in the virtual environment.

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