SECTION 2
The impact of digitalization on socio-economic security of Ukraine

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2.1. ANALYSIS OF THE UKRAINIAN LABOR MARKET 2024: KEY INDICATORS, SENTIMENT, AND AI RECOMMENDATIONS

Introduction. The year 2024 marked another stage of challenges and transformations for the Ukrainian labor market. Martial law, economic uncertainty and social challenges have significantly affected employment dynamics, salary policy and expectations of both employers and employees. Despite the difficulties, Ukrainian business demonstrates resilience and readiness to adapt, as evidenced by positive changes in the indicators of recovery of enterprises, income dynamics, and labor market activity.

Summary of the main results of the study. In 2024, Ukrainian business demonstrated further recovery from previous shocks. According to the data, 86 % of companies reported a full recovery in their operations, which is 6 % higher than last year. Another 12 % of companies are operating in a partial mode, but intend to resume full operations in the future.

More than a quarter (28 %) of Ukrainian companies recorded positive revenue dynamics, which is 5 % more than in 2023. Stability of their revenues was reported by 22 % of organizations, which is also a slight increase compared to the previous year.

Among the companies that have faced a decrease in revenues this year, the largest share is accounted for by those whose losses amounted to up to 25 % (12 % of companies). This figure decreased by 3 % compared to 2023. Every tenth company experienced a reduction in revenue of 25–50 %, while last year there were 7 % more such companies. In general, every tenth organization lost more than 50 % of its revenue over the past year, but in 2023, 9 % of companies experienced such significant losses [7].

The vast majority of organizations (88 %) hired staff in 2024, with 59 % of companies recruiting for all areas of their operations. This situation is likely to continue next year: 92 % of companies announced their plans to hire staff in 2025.

The trend in salary payments in 2024 became more stable compared to the previous year. Only 2.6 % of the surveyed companies reported a reduction in compensation. The level of remuneration remained unchanged in 15.8 % of organizations. The companies that increased salaries this year state that the largest share of them was among those who increased payments by 11–20 %. Further salary increases in 2025 are planned by 74 % of organizations [1].

In 2024, Ukrainian businesses were more focused on maintaining what they had achieved than on actively scaling up and finding new markets. In general, the main priorities of companies this year are as follows: maintaining the existing staff in full (68.5 %), maintaining a competitive level of remuneration (65.5 %), and retaining current markets and customers (52 %). The search for new markets or customers was prioritized by 38.2 % of companies, and 14.2 % of organizations made efforts to open new business lines.

Relocation of business abroad or opening of new representative offices in other countries was carried out by 3 % and 5.8 % of companies, respectively.

Thus, the real situation has made adjustments to the plans of many companies, as at the end of last year the number of companies planning changes and growth was much higher. In particular, 53.7 % of companies sought to find new markets or attract new customers. Expansion of business through new lines of business or in other regions was planned by 15.1 % and 13.2 % of companies, respectively.

Despite the economic difficulties and instability, Ukrainian companies have outlined positive intentions for business development for the next year. Among the top five priority areas, the surveyed organizations named the following aspirations: to retain the current team in full (52 %), to find new markets/customers (47 %), to retain existing markets/customers (38 %), to increase employee salaries (34 %), to maintain the level of employee remuneration at the highest possible level (23 %) [3].

The share of employed professionals has increased. While last year 67 % of surveyed professionals reported being employed, in 2024 this figure rose to 81 %. However, the average job search time remained unchanged at 3–6 months. The most common problem faced by professionals when looking for a job is the inability to find an option with a decent level of remuneration, as stated by 45 % of respondents. One in five job seekers (21 %) noted a decrease in the number of vacancies in their specialty.

Compared to the previous year, the number of professionals who fear layoffs in their company over the next six months has increased. This was reported by every fifth specialist (22 %), while last year such fears were shared by 17 % of employees.

Salaries remain one of the key issues for employees. For the vast majority (40.8 %) of surveyed professionals, their salaries have not changed compared to 2023. Salaries were reduced for 12.3 % of employees. Among those who received a salary increase, the largest share was among those whose compensation increased by 11–20 % [7].

Thus, 70 % of job seekers are not ready to lower their salary expectations even in case of employment difficulties. Last year, 62 % of specialists stated this position.

Half of the surveyed professionals are currently actively looking for a job or plan to start looking for a job in the near future. The

average duration of a job search is 3–6 months. The main difficulties faced by Ukrainians in the employment process include the following problems when looking for a job:

– 45 % of respondents cannot find a job with an acceptable level of pay.

– 21 % noted a decrease in the number of available vacancies in their specialty.

– 20 % complain about the lack of responses from recruiters to their job applications.

– 17 % report a lack of feedback after interviews or interviews.

– 12 % have faced discrimination from potential employers based on age [1].

Every tenth respondent said that there are no vacancies in their current place of residence or country of origin that meet their professional interests.

Only 22 % of surveyed professionals did not experience any negative changes in the process of job search and subsequent employment.

Let us consider the main employment problems that have arisen since the beginning of the war in (Table 1).

Table 1

The main problems of employment in the conditions of war (multiple choice)

I can't find a job with a decent salary	45 %
I did not feel any negative changes	22 %
There was a decrease in the number of vacancies in my profession	21 %
Recruiters don't respond to job applications	20 %
Lack of feedback after the interview or interview	17 %
I can't find a job because of age discrimination (50+)	12 %
There is no work that interests me where I live now	11 %
Other	9 %
I am an IDP and I am reluctant to be hired	5 %
I don't know how and where to look for a job	4 %
I am abroad and cannot find a job that interests me	2 %
I am a veteran and they are reluctant to hire me	1 %

Source: based on [1]

Despite the difficult situation in the labor market caused by martial law, a significant part of the surveyed professionals (64 %) expressed overall satisfaction with their current job.

This indicator showed an increase compared to the previous year, when the level of satisfaction was 56 %. At the same time, one in five surveyed professionals expressed some degree of dissatisfaction with their current employment [4].

The value of comfort and safety in the workplace has increased among Ukrainian employees. This factor was ranked third in terms of importance among the motivators and retention factors this year, second only to the level of salary. In addition, employees began to pay more attention to good communication with management.

The top five reasons (other than salary) for keeping employees at their current job include:

– the ability to work remotely (45 %);
– favorable team atmosphere (35 %);
– comfortable and safe working conditions (33 %);
– good relations with the manager (33 %);
– flexible work schedule (32 %) [6].

There is an increase in the attention of Ukrainian employees to such aspects as the company's support of its employees during the war, the availability of interesting projects and tasks and the freedom to implement them, the company's socially responsible position, and shared values in the team.

The importance of these factors for employees is also confirmed by the list of the main demotivators that, in addition to dissatisfaction with the level of salary, can lead to dismissal from the current place of work:

– Lack of friendly atmosphere in the team (32 %).
– Lack of comfortable and safe working conditions (29 %).
– Lack of good relations with the manager (29 %).
– Lack of opportunities for career growth (28 %).
– Lack of opportunities to work remotely (28 %).

The salary situation is of paramount importance in our changing environment [6].

Salary remains a key criterion for employees when choosing an employer. Recognizing this, Ukrainian businesses

have made significant efforts to maintain competitive salaries. According to the surveys, 41 % of employees reported that their compensation level has not changed compared to 2023. The share of those whose incomes increased was 47 %, while 12 % of Ukrainians faced a pay cut.

Amid the difficult economic situation, businesses were cautious about raising wages. Only a limited number of employees experienced a significant increase in monetary compensation of 31 % or more – only 3 % of respondents reported such a significant increase in their income [1].

Despite the challenging economic environment, Ukrainian employees are largely unwilling to make concessions in their salary expectations, even in the event of employment difficulties.

This position was expressed by 70 % of respondents, which is 8 % more than in the previous year. Among those who are still ready to partially concede their salary demands, the largest share is accounted for by those who agree to a reduction of up to 5 % in order to get a job.

Let's look at the data of the survey "Are employees ready to reduce their salary demands and by how much if they face difficulties in finding a new job?" in Table 2.

Table 2

Readiness of employees to reduce their salary expectations

No, I am not ready to (a) lower the bar	70 %
Yes, I am ready to reduce my desired salary by no more than 5 %	15 %
Yes, I am willing to reduce my desired salary by 6–15 %	7 %
Yes, I am willing to reduce my desired salary by 16–25 %	4 %
I'll accept any one they offer	3 %
Yes, I am willing to reduce my desired salary by 26–35 %	1 %

Source: based on [1]

Due to the mismatch between their skills and knowledge and the requirements of employers, an increasing number of Ukrainians

are considering retraining. Compared to the previous year, the share of professionals who are willing to learn a new profession in order to increase their competitiveness in the labor market and increase their salaries has increased by 9 % (from 54 % in 2023 to 63 % in 2024). Currently, every tenth respondent (12 %) is already learning a new profession, and another 9 % of respondents plan to do so in the future [7].

Over the year, the number of those who are not ready to learn new knowledge and skills has decreased, citing significant experience in their current profession as a reason. While last year there were a quarter of such specialists (24 %), in 2024 only 19 % of Ukrainians declared their unwillingness to study and retrain. Table 3 presents data from the employee survey: "Are employees ready to re-profile and learn something new if there are difficulties in finding a job in your profession?".

Table 3

Data from the survey of employees on re-profiling

Yes, I want to get a new profession to be more in demand in the labor market and receive a higher salary	63 %
No, I am not ready to learn something new, I have been in this profession for many years	19 %
I am already learning a new profession	10 %
Yes, I want to get a new profession that I have been dreaming of for a long time	8 %

Source: based on [1]

Let's analyze the current state of the labor market using artificial intelligence, which is a topical issue today.

For the first time in the Labor Market Barometer survey, GRC. UA experts used artificial intelligence to analyze the responses of respondents in both key categories. The responses of employers and employees/candidates to open-ended questions were processed and analyzed using AI. The goal was to obtain visual images reflecting the perception of the current state of the labor market by both target audiences, as well as to compare their responses [1].

The result was a number of interesting images and associations. According to artificial intelligence, employers perceive the current labor market as a "burned-out forest", emphasizing the destruction of the labor market ecosystem and the need to restore it.

Other interesting associations of today's labor market formed by AI include the following components:

– "Tired Tiger" – symbolizes the exhaustion and fatigue of both key market participants: employers and employees/candidates.

– "Water flowing through fingers" – reflects the transience of opportunities or lost chances.

– "The Hunger Games" – based on fierce competition for available resources (personnel, jobs).

– "The Storm" – personifies the turbulence and chaos that prevail in the labor market.

– "Tightrope walker" – conveys a sense of instability and the need to constantly balance existing risks.

– "Squirrel in the wheel" – symbolizes the feeling of fruitless work and lack of progress [1].

In addition, AI suggested the image of "night before dawn", which hints at positive future changes, symbolizing a difficult period preceding a potential improvement in the situation.

Based on the analysis, artificial intelligence formulated recommendations for labor market participants.

Possible ways to solve existing problems on the part of employers:

1. Competitive remuneration: ensuring the level of wages that corresponds to current economic realities.

2. Softening the requirements for candidates: lowering the selection criteria for applicants without work experience or older people.

3. Transparency of communication: providing clear feedback after interviews.

4. Simplification of the hiring procedure: minimizing bureaucratic processes during the hiring process.

5. Inclusive work environment: adaptation of workplaces for veterans, people with disabilities and internally displaced persons [1].

Recommendations for job seekers:

1. Continuous learning and adaptation: use the available time to improve your skills and learn new ones.

2. Active position: focus not only on the level of salary, but also on companies with a healthy corporate culture.

3. Realistic assessment: compare your own skills and experience with the current requirements of the labor market.

Thus, according to AI analysis, the current labor market is in crisis, but retains the potential for recovery and growth. The key challenges are economic instability, discrimination, lack of transparency, and mismatches between employers' and candidates' expectations. To successfully adapt to new challenges, job seekers need to be flexible and willing to learn, and employers need to create attractive conditions that will motivate professionals to stay in the Ukrainian labor market.

Over the past three decades, the Ukrainian labor market has undergone significant transformations and faced a variety of political, economic, and social challenges. During this time, business has demonstrated the ability to respond quickly, adapt and develop several development scenarios. Thus, at the end of 2024, despite the difficult economic situation and the general situation in the country, most employers expressed their intention to strengthen and develop their companies in Ukraine. In 2025, businesses will focus on maintaining their existing teams of employees in full, retaining current markets and customers, actively seeking new ones, and maintaining wages at the highest possible level or, under favorable conditions, increasing them [5].

In addition, a significant number of companies plan to expand their activities both geographically and by developing new business areas next year.

According to the survey, the share of companies planning to relocate abroad is only 3 %. Another 3 % of companies announced their intention to open new offices in other countries.

Most companies demonstrate their intention to actively recruit new employees in the future. Half of the companies (53 %) plan to expand their staff in all areas of their operations. A quarter of employers

(26 %) will focus on hiring in certain specific areas. Every tenth company (13 %) will recruit staff to replace those who have left the company.

The vast majority of companies are optimistic about salaries in 2025. Two-thirds (75 %) of employers plan to increase wages to some extent. 17 % of companies intend to keep salaries at the current level [1; 2].

Almost half (49 %) predict an increase in salaries in their companies, with most of them planning an increase in the range of 11–20 %.

The majority of companies (66 %) plan to leave the bonus system unchanged in 2025. A quarter (28 %) of employers plan to increase the amount of additional payments. Among those who intend to increase bonuses and bonuses, a significant number plan to do so, up to 20 %.

Conclusion. In 2024, the Ukrainian labor market is in a state of complex but dynamic transformation. Despite external challenges, many companies demonstrate resilience, gradual growth, and optimistic plans for the future. The recovery in business activity, stabilization of wages, and positive hiring expectations demonstrate the desire of Ukrainian businesses to retain the domestic market and invest in human capital.

At the same time, structural problems are becoming more acute: an imbalance between the expectations of candidates and the requirements of employers, a limited number of decent jobs, discriminatory barriers, a lack of transparent communication. Employees increasingly value not only wages, but also security, a team atmosphere, flexibility and support in times of crisis. There is growing interest in retraining as a means of maintaining competitiveness in the labor market.

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2.2. DIGITALIZATION FOR THE SUSTAINABLE DEVELOPMENT OF UKRAINE'S AGRICULTURAL ECONOMY AMID CONTEMPORARY CHALLENGES

Introduction. The article explores the critical issue of the survival and development of Ukraine's agricultural sector in the context of a full-scale war, analyzing the impact of the conflict on agricultural exports and emphasizing the necessity of digitalizing the agricultural economy. The loss of arable land and resource shortages under wartime conditions create an urgent need for innovative approaches to agribusiness management. The authors argue that digital transformation is a key factor in ensuring the resilience and competitiveness of the agricultural sector under the new realities.

Digital farming, as a new concept, offers solutions for optimizing production processes, monitoring field conditions, and controlling seed quality.

The implementation of modern technologies such as drones, geographic information systems (GIS), and Big Data allows farmers to effectively adapt to the challenges of war. The article also discusses the role of digitalization at every stage of agricultural production – from research and development to distribution. The authors emphasize the importance of automating logistics processes, which helps reduce costs and increase efficiency. Furthermore, the training of specialists capable of working with digital technologies is considered a crucial factor in the successful transformation of the agricultural sector. The article highlights that the active implementation of digital solutions in agriculture not only supports the survival of enterprises during wartime but also opens new opportunities for entering international markets. Overall, the research findings confirm the importance of digitalization for the sustainable development of Ukraine's agricultural economy in the face of contemporary challenges.

The purpose of this study is to analyze the challenges facing agricultural exports during the war and to justify the need for digitalization of the economy to overcome these difficulties.

The study objectives include analyzing changes in the structure of sown areas, yields, production volumes, and exports of agricultural products; assessing the war's impact on logistics chains, access to resources, and agricultural product prices; identifying digital technologies that can be effectively applied in Ukrainian agriculture; identifying barriers to the digital transformation of the agricultural sector; developing a roadmap for implementing digital technologies; and evaluating the economic efficiency of digital solutions.

The materials used in this study include:

1) scholarly articles and research dedicated to the digitalization of agriculture, as well as studies conducted in Ukraine and other countries that have faced similar challenges;
2) statistical data;
3) market analysis;

4) examination of the experiences of countries that have successfully implemented digital technologies in agriculture.

The research employed the following scientific methods: system analysis to identify relationships between various elements of the agricultural production system and the role of digital technologies in optimizing them; comparative analysis to compare the state of Ukraine's agricultural sector before and during the war, as well as with other countries; modeling, which enables the creation of a predictive model to assess the impact of different digital technology development scenarios on the agricultural sector.

The scientific article proposes the creation of an integrated platform that would unite all participants in the agri-food chain – from producers to consumers. Such a platform would optimize logistics processes, ensure transparency of all operations, and strengthen trust in Ukrainian products on global markets. The platform would enable real-time tracking of goods, allowing for rapid responses to shifts in market conditions and minimizing risks.

A key aspect of digital transformation is the simplification and automation of customs procedures. Transitioning to electronic document management, implementing electronic certificates, and using modern information technologies would speed up customs clearance, reduce corruption risks, and lower exporters' costs. The development of e-commerce in the agricultural sector is also identified as a promising direction. Creating online platforms for selling agricultural products would help attract new clients globally, increase sales volumes, and diversify exports.

However, digital transformation involves not only technological solutions but also the establishment of a favorable legislative environment. The article highlights the need to develop and implement laws that will encourage investment in digital technologies within the agricultural sector, ensure intellectual property protection, and safeguard against cyberattacks. Cybersecurity is one of the most crucial aspects of digital transformation. Under wartime conditions, the risk of cyberattacks increases significantly, making it essential to take all necessary measures to protect digital systems and data.

Thus, the digital transformation of Ukraine's agricultural sector is a necessary step to ensure its resilience and competitiveness during wartime. The adoption of modern technologies will enable the optimization of production processes, enhance logistics efficiency, simplify customs procedures, and open up new markets for Ukrainian agricultural products.

A promising direction for future research is the optimization of the export potential of Ukraine's agro-industrial complex. Key priorities include improving the efficiency of logistics chains, implementing modern technologies for storage and processing of agricultural products, ensuring high quality and safety standards, and strengthening the global image of Ukrainian agri-food products. Achieving these goals will not only increase export volumes and raise foreign currency inflows to the state budget, but also contribute to job creation and overall economic growth. Reaching these objectives will require a synergy of efforts from government bodies, business entities, and international organizations.

During the war, the export of agricultural products faces significant challenges due to disrupted logistics chains, restricted access to ports, and transportation routes. These conditions threaten not only the country's food security but also its economic stability, which heavily depends on the agricultural sector. Therefore, there is an urgent need to adapt infrastructure and trade processes to the new realities, which requires the implementation of modern digital solutions. The digitalization of the economy could become a key instrument for improving agribusiness management and ensuring uninterrupted export flows. This issue also includes the need for rapid adaptation of the legal framework to support digital initiatives in the agricultural sector. Such an approach can strengthen the country's position on international markets even amidst armed conflict.

The digitalization of business processes continues to evolve rapidly, increasingly integrating into traditional business models. Researchers from various countries are exploring opportunities to transform enterprises through technologies that enable real-time analytics using smart devices and specialized software. This phenomenon spans across all sectors of the economy, including agriculture.

In their work, Ukrainian scholars such as M. V. Hazuda [1], M. V. Rudenko [2], N. M. Horobets [3], I. V. Voronenko [4], S. O. Kostenko [4], S. S. Kiporenko, and N. P. Yurchuk [5], among others, have focused on the applied aspects of digital development in the agricultural sector. International researchers, including M. Bacco, P. Barsocchi, A. Walter, A. Gotta, M. Ruggeri, E. Ferro, and R. Huber [6; 7], have also examined various approaches to implementing digital technologies in agricultural production. However, despite numerous studies, the process of digitalizing agricultural production under martial law remains insufficiently explored, which highlights the relevance of this research.

Future scientific studies are encouraged to focus on opportunities to increase the export volumes of agricultural products, reduce logistics and storage costs, enhance product quality and safety, increase market transparency and trust, boost the competitiveness of Ukraine's agricultural sector in global markets, create new jobs, and strengthen the country's economic stability. Achieving these outcomes will require joint efforts from the state, businesses, and international organizations.

The purpose of this article is to analyze the challenges faced by agricultural exports during wartime and to justify the necessity of economic digitalization as a means to overcome these difficulties. The research objectives include examining existing problems in logistics and trade, as well as identifying digital solutions that can optimize agricultural exports.

Presentation of the Main Research Findings. Despite certain steps toward digitalizing the agricultural sector, many aspects of this process remain underdeveloped. Particular attention must be given to the development of effective mechanisms for digital monitoring and management of agricultural supply chains in times of crisis. The issue of implementing integrated digital platforms for international trade that consider wartime conditions also remains unresolved. Furthermore, cybersecurity in the context of digitalization is insufficiently addressed, which poses risks during trade operations. In addition, the legal framework enabling the full deployment of digital solutions in the agricultural sector requires further research and development.

The international experience of European countries that have suffered significant wartime losses demonstrates that substantial changes in both the economy and society are possible with adequate external financial support. The long-standing successes of these countries show that economic transformation is achievable, though it requires adaptation to local conditions and available resources. While there are no universal solutions for overcoming economic crises, Europe's experience can offer valuable guidance for Ukraine.

Given that Ukraine is one of the world's leading exporters of agricultural products, its potential for economic recovery through the agricultural sector is considerable. For example, Ukraine is the global leader in sunflower oil and meal exports, accounting for half of the world's supply of this product. The country also ranks second in barley and rapeseed exports, and third in rye and sorghum exports. In total, Ukraine supplies about 10 % of the world's grain. Notably, the agricultural sector generates up to 40 % of the country's foreign currency earnings, contributing significantly to the stabilization of the national currency.

However, the war has severely damaged infrastructure, particularly the ports that are vital for exports. The restoration of port infrastructure and improved access to financial resources – especially credit – remain critical for stabilizing the banking system and the broader economy.

Before the full-scale war, agriculture was one of the key sectors of the Ukrainian economy, playing a significant role in international trade.

In the pre-war period, Ukraine supplied major markets with grain, oilseeds, and other agricultural products. Between 2013 and 2021, the share of agricultural exports increased significantly, particularly against the backdrop of declining metallurgical exports. In 2021, the agricultural sector accounted for 41 % of the country's total exports, exceeding USD 27 billion. The primary buyers of Ukrainian products included EU countries, China, India, Egypt, and Turkey – underscoring Ukraine's global importance as a food supplier.

Ukraine is one of the world's leading suppliers of agricultural products, playing a critical role in ensuring food security for many countries. The increase in the share of agricultural exports

to 41 % highlights the significant potential of agriculture within Ukraine's economy. The main buyers of Ukrainian products include the EU, China, and India, underscoring the global importance of Ukrainian agricultural goods. However, the war has posed serious challenges to the country's export capabilities, particularly due to destroyed infrastructure. Despite these difficulties, Ukraine's agricultural sector remains a crucial element of both national and international economic stability.

Table 1

Ukrainian Agricultural Exports in 2021

Product	Volume (million tons)	Value (billion USD)
Sunflower oil	5	6.4
Corn	23	5.9
Wheat	19	5.1
Rapeseed	2.7	1.7
Barley	5.8	1.3

Source: Compiled by the authors based on data from [1]

Ukrainian agriculture has become one of the main targets of Russian aggression, as it underpins economic stability and food security both domestically and globally. Before the war, Ukraine controlled over 32.7 million hectares of arable land, but due to the occupation of significant territories, this figure dropped to 26.5 million hectares. The loss of access to fertile land has severely limited the production of key agricultural commodities, directly affecting the country's export potential. In addition to land seizures, Russia has deliberately blocked Ukraine's Black Sea ports, through which most grain exports traditionally passed. These actions have global repercussions, as Ukrainian grain plays a vital role in feeding countries, particularly in Africa and the Middle East. Russia has also systematically looted agricultural equipment and harvests, deepening the food crisis. These destructive acts are part of a broader strategy aimed at economically weakening Ukraine and undermining its ability to finance the war and supply food to itself and the world.

The situation is further complicated by the fact that, until recently, Ukraine was one of the leading wheat exporters on the Euro-Asian continent. This was possible due to optimal climatic conditions, particularly soil moisture, which contributed to high yields of this crop (Figure 1). International food aid from organizations such as the World Food Programme (WFP) could potentially address food shortages. However, due to the war, these organizations now face difficulties, as Ukraine supplied around 50 % of the wheat used in such aid. Even before the war, rising agricultural prices limited international organizations' purchasing capacity. This highlights that Russia's full-scale invasion of Ukraine has effectively triggered a global food crisis.

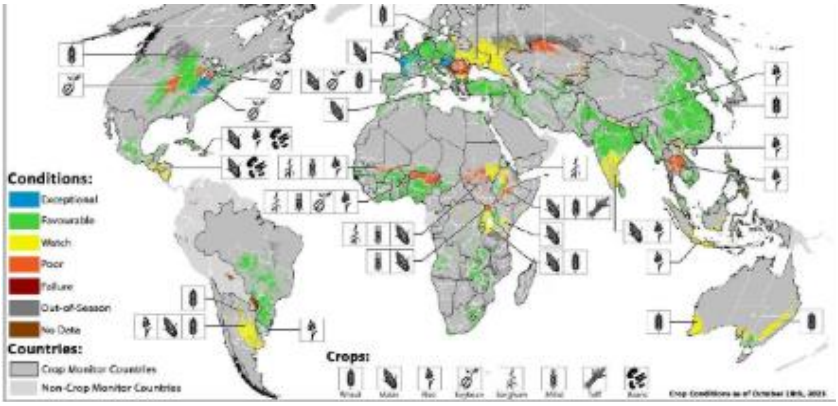

Fig. 1. Map of crop conditions summarizing information for all AMIS member countries across major production areas of wheat, maize, rice, and soybeans

Source: Compiled by the authors based on data from [7]

According to the latest report by the Kyiv School of Economics (KSE) on the Third Rapid Damage and Needs Assessment (RDNA3), as of December 2023, Ukraine's agriculture sector had suffered losses totaling USD 80 billion. This figure includes USD 10.3 billion in damage to or destruction of assets, with agricultural machinery accounting for 56.7 % of these losses. An estimated 181,000 units of equipment were damaged or destroyed, along with 2.8 million tons

of grain, 1.2 million tons of oilseeds, 124,000 tons of fertilizers, and 11.6 million liters of fuel.

Russian attacks also caused major destruction to storage facilities, resulting in the loss of approximately 20 % of Ukraine's storage capacity (excluding occupied territories). Although livestock and aquaculture account for a smaller share of Ukraine's agrarian sector, they also suffered damages of USD 254 million and USD 35 million, respectively. The total income losses in the agricultural sector are estimated at USD 69.8 billion.

In the first year of the war, production of grains and oilseeds fell by 30 %, and producer prices for corn and wheat dropped by 45 %, despite rising global food prices. Total losses due to reduced productivity are estimated at USD 34.3 billion, while losses from falling domestic prices – caused by Russia's export blockade – add another USD 24.1 billion.

Table 2

Key Agricultural Losses in Ukraine, 2023

Type of Loss	Estimated Loss (USD billion)
Asset damage	10.3
Share of losses due to machinery	56.7 % of total asset losses
Loss of grain and oilseeds	2.8 million tons of grain, 1.2 million tons of oilseeds
Reduced production	34.3
Losses due to price drops	24.1
Total income loss	69.8

Source: Compiled by the authors based on data from [3]

This situation represents one of the most severe crises in Ukraine's agricultural sector, requiring significant recovery efforts, as the losses have impacted not only the domestic market but also jeopardized global food security.

The destruction of the Kakhovka Dam by Russia on June 6, 2023, led to a large-scale disaster, flooding over 620 km² of territory. This caused massive humanitarian, environmental, and economic damage

to Ukraine, with the agricultural sector suffering the most. According to the joint Post-Disaster Needs Assessment (PDNA) report by the Government of Ukraine and the United Nations, damage to the agricultural sector reached USD 406.6 million, primarily due to the loss of irrigation systems.

Before its destruction, the Kakhovka Dam supplied water to one of the largest and most critical irrigation networks in Ukraine, covering up to 800,000 hectares of fertile land. Following the disaster, over 300,000 hectares were left without irrigation and are now dependent solely on rainfall, which could reduce crop yields by up to 70 %. This event delivered yet another heavy blow to Ukraine's agricultural sector, which was already suffering massive losses due to the war.

In 2023, Ukraine's agriculture faced serious challenges caused by Russian aggression, which resulted in extensive damage. Despite the hardships, recovery efforts and grain export operations continued. Important indicators of progress included data on grain, legume, and flour exports, reflecting a partial recovery in agricultural output. However, in 2024, the situation remained unstable due to ongoing issues such as damaged infrastructure, limited market access, and port blockades.

According to Ukraine's State Customs Service, grain and flour exports in 2024 increased compared to 2023. Nevertheless, despite the rise in volume, concerns remain regarding the quality and competitiveness of Ukrainian products. Wheat, barley, and corn remain the main export crops. Export volumes (Table 3) highlight the need for new strategies to adapt to wartime conditions. The following table presents a comparison of grain and flour exports from Ukraine in 2023 and 2024, reflecting changes in the country's agricultural sector.

Analysis of grain and flour exports from Ukraine in 2023 and 2024 reveals significant changes in the agricultural sector.

Comparative data indicate a substantial increase in export volumes in 2024, reflecting a partial recovery in agricultural production. In particular, wheat exports increased by 80 %, signaling a rebound in its production. However, despite positive trends, issues related to product quality and market access persist. A 145 % growth in barley exports indicates its competitiveness on the global market.

Table 3

Comparison of Grain and Flour Exports from Ukraine in 2023 and 2024

Category	2024/2025 MP		2023/2024 MP	
	Total	including: in October 2024	Total as of 16.10.23	including: as of 16.10.23
Total grains and legumes (kt)	12,483	2,035	7,690	937
– Wheat	7,081	983	3,927	593
– Barley	1,588	265	650	28
– Rye	10,6	3,1	0,8	0,0
– Corn	3,543	779	2,995	310
Wheat flour (kt)	20,1	2,7	38,0	3,4
Other flour (kt)	2,0	0,5	1,3	0,2
Total flour (grain equivalent)	22,1	3,2	39,3	4,8
Total exports (grain + flour)	12,512	2,039	7,742	942

Source: Compiled by the authors based on data from [5]

Conversely, the decline in flour exports suggests a need for adaptation to new conditions. The situation is further complicated by infrastructure damage and port blockades that hinder logistics. This underscores the urgency of developing new strategies to support exports. The volume of Ukrainian grain exports remains critical to global food security, especially as many countries face food shortages. In conclusion, 2024 should become a year of new opportunities for Ukraine's agricultural sector despite the challenges it brings.

Turning to digitalization processes in agriculture, the digital transformation of agricultural exports during wartime in Ukraine has become crucial for sustaining the sector.

Key strategic initiatives among major agro-companies include business process automation and implementation of electronic document flow – both of which enhance management efficiency and reduce costs. The introduction of Customer Relationship Management

(CRM) systems and market analysis tools helps producers better understand consumer needs. For example, the agroholding "KERNEL" launched a multifunctional platform called "Open Agribusiness", which facilitates communication among agricultural producers. This platform provides services such as a Forward Program to finance production modernization. Thanks to a GNSS correction service, farmers can operate automated machinery in the fields with high precision. The "Agrotechnologies" service offers insights into cutting-edge agricultural practices implemented by the company. These innovations foster partnerships and information exchange within the agri-business community, promoting growth in Ukraine's agricultural economy. Thus, digitalization becomes a key factor in the survival and recovery of the Ukrainian agricultural sector during wartime.

Due to the war, many Ukrainian farmers face severe challenges during the planting season, including the loss of farmland, landmines, and fuel shortages for machinery. This highlights the need for broad adoption of digital technologies in agribusiness. One innovative solution is the use of drones for pesticide application, which can help compensate for fuel shortages. The readiness of Ukrainian farmers for digitalization is a vital factor, as digital farming integrates financial and field data for effective farm management. It relies on precision and smart agriculture methods, along with web platforms and Big Data analysis. Digital farming can be implemented through smart devices connected to the Internet (Internet of Things, IoT) or through Software as a Service (SaaS) models within the AgTech sector. When equipment transmits data over a global network, it becomes part of the IoT ecosystem, enabling solutions across industries. IoT leverages intelligent devices and the Internet to automate processes, assisting in areas like traffic control, security, agriculture, energy efficiency, and healthcare. In recent years, many IoT projects have emerged, especially in the U.S., Europe, and the Asia-Pacific region (see Figure 2).

Thus, these projects demonstrate the vast potential of digitalization and automation across various sectors. As such, IoT can significantly enhance the efficiency and productivity of agriculture.

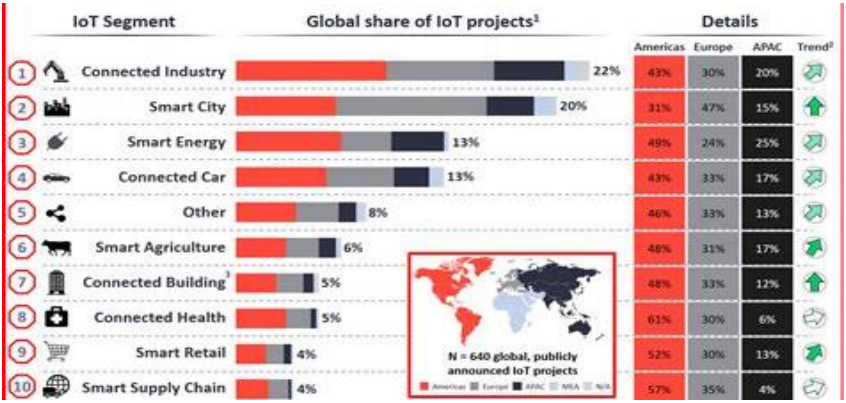

Fig. 2. Global Distribution of IoT Projects in the USA, Europe, and APAC Countries

Source: Compiled by the authors based on data from [8]

In agriculture, IoT enables the effective use of modern technologies such as sensors, drones, robots, and cameras to collect and store data, which is later subjected to advanced analytics. In addition to monitoring field conditions, IoT plays a crucial role in managing overall farm operations, allowing for the development of accurate financial forecasts. Thanks to advancements in satellite imagery, machine learning, and cloud technologies, predictive analytics software is becoming increasingly accessible and scalable. These tools allow agricultural producers not only to respond to current conditions but also to plan future production stages based on the insights gained.

The key stages of seed production and the opportunities enabled by digitalization are illustrated in Figure 3.

Thus, the integration of IoT into agriculture can significantly enhance the efficiency and profitability of agricultural production.

As illustrated in Figure 3, digital farming plays a crucial role in shaping the seed value chain. Implementing digitalization at all stages of seed companies' business processes – from research and development to final sales – is key to improving agricultural productivity. At the research stage, close monitoring and selection

of seed material allows for the digitalization of trial data from field stations. This enables researchers to thoroughly analyze the performance of various seed varieties.

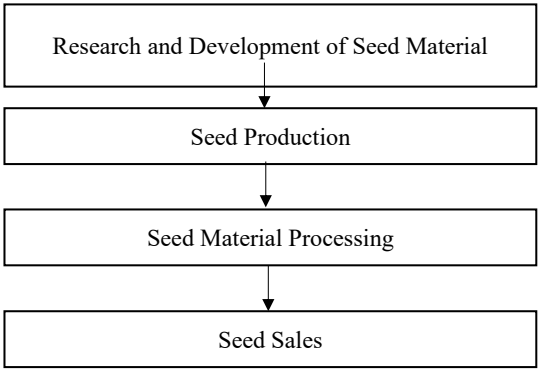

Fig. 3. Stages of Seed Production Activities in Digital Farming

Source: Compiled by the authors based on data from [1]

During the seed production stage, digital technologies support the selection of the best seed material based on previous findings, facilitating its expansion over larger agricultural areas. After harvesting, seed processing becomes critical for detecting poor quality or counterfeit seeds, requiring close monitoring of their origin. The use of QR codes on packaging allows consumers to trace the origin and quality of the seed material. In the sales stage, digitalization also considers climate conditions, enabling agri-companies to adapt their sales strategies effectively to weather fluctuations, while information platforms serve as vital tools for communication among farmers to share seeding optimization recommendations [2, pp. 82–83].

The digitalization of the agricultural sector necessitates the adoption of modern technologies such as satellite imagery, drones, and geoinformation services that enhance the monitoring of farmland. To achieve high performance, it's also important to improve management components, including the digitalization of decision-making metrics. The use of Big Data technologies and

economic-mathematical models ensures effective data analysis, supporting process optimization in the agri-sector. Furthermore, training managerial staff in IT competencies is essential for the successful application of digital tools.

Conclusions. Thus, digitalization of the economy in Ukraine has become critically important in wartime conditions, particularly in the agricultural sector. The loss of arable land and limitations in resources necessitate new approaches to agribusiness. Digital farming, as an innovative method of agricultural management, offers solutions for monitoring, controlling, and optimizing production processes. The use of technologies such as drones, geographic information systems, and Big Data enables farmers to adapt effectively to emerging challenges.

Agri-companies can leverage digitalization opportunities at all stages of the seed value chain – from research and development to sales. This includes productivity monitoring, seed selection, and quality control through digital tools such as QR codes. Digitalization also enhances logistics by automating warehousing and transportation processes, helping to reduce costs and improve efficiency.

Moreover, the implementation of information platforms ensures communication between farmers and facilitates the sharing of best practices to improve crop yields. An essential aspect is the training of specialists capable of working with digital technologies, which strengthens the competitiveness of agricultural enterprises. The systematic use of digital tools enables businesses to explore new markets, expand their customer base, and attract international investment for the recovery of the agricultural sector.

In conclusion, to ensure the sustainable development of agribusiness in Ukraine during the war, it is necessary to actively implement digital solutions. This will not only improve production efficiency but also help the country access new international markets, safeguard food security, and drive economic development. Research findings confirm that digitalization in the agri-sector is a key factor not only for survival but also for prosperity amid modern challenges.

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2.3. THE UKRAINIAN LABOR MARKET IN THE CONTEXT OF DIGITALIZATION AND MARTIAL LAW

Introduction. Ukraine's current labor market is undergoing a profound transformation caused by two parallel challenges: the digitalization of the economy and the impact of martial law. These factors lead to radical changes in the structure of labor supply and demand, forms of labor organization, and require adaptation by the state, business, and citizens.

In the context of the study of the modern labor market of Ukraine under the influence of digitalization and martial law, a number of Ukrainian scholars who analyze these problems can be mentioned: V. Hrynevych and O. Shubina study the transformation of the labor market under the influence of digitalization and martial law [3]; Libanova E. M. and Makarova O. V. analyze migration processes, labor loss and labor market adaptation during the war [4]; Kulikov O. Yu, Bondar T. P. consider the impact of technological changes on employment and the need for retraining [5]; Mishchenko V. I., Onyshchenko A. M. study remote employment, gig economy and regulatory changes under martial law [6]; Kinakh A. V., Savchuk V. S. analyze employment policy, support for IDPs and integration of digital technologies into government programs [7].

The work of these scholars covers key aspects of employment transformation, migration, technological change, and regulatory challenges.

Summary of the main results of the study. Ukraine's current labor market is undergoing profound structural changes caused by full-scale Russian aggression and global transformations in employment. The war has not only destabilized traditional employment models, but also accelerated the processes of digitalization, changes in the professional structure and migration of labor resources. Under these conditions, there is a need for a systematic analysis of the key factors shaping the new reality of the Ukrainian labor market.

This article examines the main determinants of its transformation, in particular, the impact of martial law on employment, the role of digital technologies in the adaptation of businesses and employees, and the effectiveness of government regulatory mechanisms. The findings allow us to assess the prospects for further development of the labor market in the face of current challenges.

Let's analyze the main factors of transformation of the Ukrainian labor market during the war:

1. Impact of martial law on the labor market:
– reduction of the number of jobs;
– increase in unemployment;
– mass migration and mobilization;

– destruction or evacuation of enterprises;
– change of business profile for military needs;
– state employment programs (e.g., "Army of Recovery") [2].

2. Digitalization as a key factor of adaptation:
– development of digital services (public services, education, medicine);
– growth of remote work and online learning;
– development of freelancing and IT-sphere [7].

3. Transformation of employment forms:
– development of the gig economy, freelancing, self-employment;
– reduction of traditional forms of labor due to migration and infrastructure destruction;
– demand for new professions (logisticians, UAV operators, cybersecurity specialists, crisis psychologists) [10].

4. Social challenges for the labor market:
– shortage of labor in the areas of active hostilities;
– return of refugees to work;
– insufficient level of digital literacy in certain groups of the population [11].

5. State initiatives to support the labor market:
– introduction of digital tools ("Diia", electronic certificates);
– retraining programs (IT areas, courses for the unemployed);
– support for small businesses and startups [1; 2; 3; 7].

These factors affect Ukraine's current labor market, creating new conditions for businesses, employees, and government policy.

Thus, Ukraine's current labor market is undergoing a profound transformation caused by two key factors: a full-scale war with Russia and the accelerated digitalization of the economy [1]. Martial law has also led to serious structural changes: job losses, mass migration, mobilization, and the reorientation of businesses to military needs. The government has responded to these challenges with employment and business support programs, but the shortage of personnel in some regions remains critical.

It is worth noting that digital technologies have become a key tool for the economy's survival, enabling remote work, online education,

and public services. The IT sector has demonstrated resilience and even growth, becoming one of the drivers of the economy, and new forms of employment (gig economy, freelance, self-employment) are gaining popularity, while traditional labor models are losing relevance. At the same time, there is a demand for new professions related to war and technology.

Social challenges, such as staff shortages, refugee returns, and low digital literacy, require comprehensive solutions from the government and businesses.

It should be noted that government policy is aimed at digitalizing services, supporting employment, and developing new skills among the population. However, long-term strategies are needed to stabilize the labor market, including investment in education, infrastructure, and support for small businesses.

Going forward, Ukraine's economic recovery will depend on its ability to adapt to new conditions, integrate digital technologies, and ensure social stability. The labor market will not return to its pre-war state, so the key challenge is to create a flexible, sustainable and innovative employment model.

Against the backdrop of these catastrophic changes, the Ukrainian labor market has demonstrated an impressive ability to adapt, forming new mechanisms of functioning. While at the beginning of the full-scale invasion we observed chaotic processes – mass layoffs, shutdowns of production facilities and forced migration of millions of citizens – a year and a half later, holistic transformation trends have emerged.

Thus, from the initial chaos and destruction, the Ukrainian labor market has moved on to form a new model that combines:

– flexible forms of employment;
– technological solutions;
– social adaptation;
– strategic planning.

This transformation was made possible by both the internal resilience of businesses and citizens and systemic support from the government. Overcoming the consequences of the war for the labor market is still ongoing, but today we can talk about the formation of a fundamentally new employment paradigm in Ukraine.

As of January 1, 2024, more than 30 % of the working-age population lost their jobs or were forced to change their place of residence. Many businesses have ceased or reduced their operations. According to the International Labor Organization, the number of jobs in Ukraine has decreased by more than 4.8 million compared to the pre-war period.

About 8 million Ukrainian citizens were forced to leave the country, seeking safety and employment abroad. Many of them joined foreign labor markets, which led to the loss of qualified personnel. At the same time, a large number of men were mobilized, which also created a staff shortage in certain industries.

The largest losses were in the industrial, construction, transportation, and tourism sectors. At the same time, there is a growing need for logistics, healthcare, IT, and social services. New professions related to humanitarian aid, reconstruction, cyber warfare, and information security are emerging. These data demonstrate the depth of the crisis caused by the war, as well as the key areas of labor market transformation. They are directly related to the factors discussed earlier (martial law, digitalization, new forms of employment) and reveal their specific consequences [13]:

1. Scale of impact: destruction of traditional employment:

– job losses and reduced business activity confirm the need for government support programs (such as the "Army of Recovery");

– figures show that it will take years to restore pre-war employment levels – even if the fighting stops.

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– job losses and declining business activity confirm the need for government support programs (such as the "Army of Recovery");

– figures show that it will take years to restore pre-war employment levels – even if the fighting stops.

3. Sectoral consequences: economic restructuring:

– the decline of some industries (industry, tourism) and the rise of others (IT, logistics, cybersecurity) show how the war accelerates the redistribution of labor;

– the emergence of new professions confirms the trend towards flexibility and lifelong learning.

4. Challenges for the labor market: systemic problems:

– shadow employment and social protection: The need to legalize work and expand social guarantees;

– psychological aspects: employee exhaustion requires the inclusion of psychological support in employment programs;

– gap between education and the market: the need to synchronize curricula with the needs of the economy (e.g., through public-private partnerships);

– digital divide: without developing infrastructure and skills in the regions, inclusive recovery is impossible;

– IT emigration: the loss of IT specialists is a direct signal to improve conditions.

We can see that this data not only illustrates the problems, but also shows the relationship between destruction, adaptation, and future reforms. For example:

– migration → staff shortage → emphasis on automation and remote work;

– growth of the IT sector → need to bridge the digital divide;

– new professions → require an updated education system.

Thus, overcoming the consequences of the war for the labor market is impossible without a comprehensive approach that combines economic stimulus, investment in infrastructure, social protection, and educational innovations. It is this comprehensiveness that will form the basis for sustainable recovery.

In parallel with the military challenges, Ukraine is facing digitalization processes that are changing the requirements for employee qualifications and creating new forms of employment. Studies by Sumy State University emphasize that digital transformations have a contradictory impact on the labor market, causing both the loss of traditional jobs and the emergence of new ones related to digital technologies. Digitalization is a global process that is rapidly changing the structure of employment, work formats, and professional requirements. In Ukraine, this process has intensified under the influence

of the COVID-19 pandemic, and in the context of martial law, it has become especially relevant as a means of supporting the economy, ensuring access to services and preserving jobs [9].

According to studies by Hrynevych V. V. and Shubina O. O. [3], digitalization has become a key factor in the adaptation of the Ukrainian labor market to wartime conditions, contributing to the:

1. Digital transformation in the economy is a driver of new opportunities:

– the emergence of new professions (cybersecurity, data analytics) compensates for the loss of jobs in traditional sectors;

– the transformation of "old" professions (e.g., teachers are switching to online education) confirms that digital skills are now a requirement for most specialties.

2. New forms of employment are a response to the challenges of war:

– remote work has allowed millions of people, including IDPs and residents of frontline areas, to maintain employment;

– freelance platforms have become a lifeline for those who have lost their jobs, providing access to international markets;

– this emphasizes the globalization of the Ukrainian workforce and the need to support such formats (for example, through taxation or training).

3. Automation and AI are a challenge and a prospect at the same time:

– the disappearance of routine professions (e.g., call center operators) forces a review of the vocational education system;

– the need for analysts and creatives emphasizes the importance of soft skills (critical thinking, project management);

– without mass retraining (as in the Diia.Digital Education program), these changes will lead to an increase in unemployment among low-skilled workers.

4. Digital education is the basis for future competitiveness:

– training in IT skills (even basic ones) helps older people avoid exclusion from the labor market;

– integration of digital tools into school and university education is key to training new personnel.

Let's analyze how this relates to other challenges:

– migration and staff shortages: Remote work allows attracting Ukrainians who have left;

– industry changes: The IT sector is growing, compensating for losses in industry;

– social problems: The digital divide between urban and rural areas could deepen inequality if left unaddressed.

Thus, digital transformations are not just a "trend" but a strategic way to restore the labor market. We can see that they:

– create new jobs;

– allow you to work in war conditions.Allow you to work in war conditions;

– require rapid training and support from the state.

Without digital adaptation, overcoming the consequences of the war will be impossible. Therefore, the priorities should be:

1. Mass digital education (including regions).
2. Incentives for the IT sector (tax benefits, protection from mobilization).
3. Infrastructure (fast internet, coworking spaces).

This will help turn threats into opportunities and create a sustainable model of the labor market of the future. Digitalization opens up new horizons for economic development, innovation, and increased competitiveness of employees. Improving digital skills, adapting to flexible forms of employment, and supporting digital entrepreneurship are key tasks for the state.

Digitalization is not only a challenge but also a powerful opportunity for labor market modernization. Its effective implementation requires the synergy of public policy, business, and civil society [4; 5].

To compare the labor market indicators of pre-war and wartime, see Table 1.

Table 1 shows that by 2022 (stable development):

– digitalization was gradually being introduced into business (e-commerce, online banking), but the scale was limited;

– remote work was only gaining momentum (the COVID-19 pandemic accelerated the process);

– the IT sector was growing, but was not the main driver of the economy;

– government digital services (Diia) had just started [6].

Table 1

Digitalization and the Ukrainian labor market: a comparative analysis (2020–2024)

Indicator	2020–2021 (pre-war period)	2022–2024 (martial law period)
Number of IT specialists	~285,000 (2021)	~320,000 (2023) (+12 %)
Remote work	~15 % of employees	~35–40 % (2023)
Freelancers	~500,000 (2021)	~1.5 million (2023)
Unemployment	~500,000 (2021)	18–25 % (2022–2023)
Job losses	–	4.8 million (according to ILO)
IT services export	$6.8 billion (2021)	$7.3 billion (2023)

Source: developed by the authors based on [6]

After 2022 (accelerated transformation):

– massive transition to online: banks, education, medical services have switched to remote formats;

– IT as an "anti-crisis shield": the sector showed growth (+7 % of exports in 2023), despite the war;

– freelancing explosion: the number of remote workers has increased 3 times due to migration and destruction of offices;

– state in digital: "Diya" and e-services have become critical to the functioning of the state [7].

Let's look at the problems that have arisen due to the war and digitalization:

1. Staff shortages in critical industries, namely:

– outflow of IT specialists abroad (up to 100 thousand in 2022–2023);

– mobilization of qualified specialists (engineers, doctors).

2. Digital divide:

– 30 % of the population (especially the elderly) lack basic digital skills;

– lack of Internet infrastructure in villages and frontline areas.

3. Shadow employment: up to 40 % of workers (especially in the service sector) work unofficially.

4. Imbalance between education and the labor market: some universities or some educational programs are based on "pre-war" programs.

5. Psychological challenges: burnout due to constant stress and instability.

Based on the problems that have emerged since the start of the full-scale invasion, the following recommendations for the state should be taken into account:

– create "digital war bonds" – tax breaks for IT companies that invest in training and infrastructure;

– scale up Diia.Digital Education to include mandatory courses for the unemployed;

– legalize freelancing – simplify taxation for the self-employed.

For business:

– develop hybrid models of work – a combination of offline and online formats;

– invest in retraining – corporate training centers (for example, together with UNIT.City).

For citizens:

– learn a minimum of digital skills – even for "non-digital" professions (e.g., Excel basics for accountants);

– use state support – grants for training (e.g., from the Ministry of Digital Transformation).

Thus, the war has accelerated digital transformation, but it has not become a panacea. Without systemic solutions (education, infrastructure, social protection), the risks will increase, including

– inequality between "digital" and "non-digital" citizens;

– loss of competitiveness due to the outflow of personnel.

Now is a critical moment for the formation of a sustainable labor market model, where digitalization complements (but does not replace) social guarantees. Ukraine's labor market is undergoing profound and ambiguous transformations in the context of digitalization and martial law. On the one hand, the war has had devastating effects on employment, social security, and migration dynamics. On the other

hand, digitalization is creating new employment opportunities and shaping a more flexible and adaptive labor market model. Successful overcoming of the consequences is possible only if the government, business, and educational institutions consolidate their efforts. Particular attention should be paid to the development of digital skills, support for the IT sector, and reintegration measures for internally displaced persons. In the future, this may contribute to a more innovative, mobile, and sustainable economy.

Conclusions. Ukraine's labor market has undergone profound transformations under the influence of digitalization and martial law. On the one hand, the war caused large-scale job losses, changes in the employment structure, and massive labor migration. On the other hand, digital technologies have become a powerful tool for adaptation: the role of remote work, online learning, and process automation in the private and public sectors has increased. Governments, businesses, and society are increasingly integrating IT solutions to support employment, retraining, and retention of human resources. This creates the basis for a new, flexible, and technology-oriented labor market that can withstand the challenges of instability.

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2.4. MARKETING STRATEGIES OF BUSINESS ASSOCIATIONS IN THE CONTEXT OF ECONOMIC DIGITALIZATION

Introduction. The modern conditions of societal development, in which the economy is being digitalized, are also accompanied by the transformation of joint economic structures – such as holdings, clusters, and corporations – rather than just individual enterprises. Marketing strategies thus require new adaptability and flexibility, focusing on customer experience data and new technologies. Digitalization has already become a prerequisite for the survival and effective functioning of joint business entities.

Holdings, clusters, corporations, and financial-industrial groups face the need to establish a unified digital system, harmonize integrated business processes, consolidate marketing approaches, and unify information systems.

Main findings. Modern marketing is moving away from traditional formats and gradually transitioning too digital. Traditional marketing focuses on all types of target audiences, including uninterested ones, while digital marketing prioritizes audiences genuinely interested in the business, its goods, and services. This is achieved through communication and promotion via social networks, online channels, and search engines [1].

Digital marketing in business allows for clear evaluation of what works and what doesn't, by measuring the success of campaigns. It optimizes campaigns for better results and enables direct communication with clients, allowing for feedback and improvement – essentially, digital direct marketing.

Modern direct marketing encompasses all marketing activities aimed at business or social enterprise development, based on identifying or even forming demand and satisfying it through direct communication, which enables a highly personalized approach to each segment of the target audience.

Paradoxically, digital transformation allows for such direct customer interactions not only through internal efforts but also via outsourcing [2].

In Ukraine, the main types of business associations include associations, corporations, consortia, concerns, holdings, conglomerates, financial-industrial groups, and franchises [3]. Companies merge to gain economic, organizational, and strategic benefits that are difficult or impossible to achieve independently. These benefits include:

– Reduced unit costs of production and distribution.
– Creation of a stronger market player.
– Centralized logistics and marketing for business associations.
– Access to international markets.
– Expansion of operations in the sector, etc. [4].

In recent years, especially since the start of the full-scale Russian-Ukrainian war, Ukrainian businesses have demonstrated high adaptability focused on development and recovery of the national economy. New management approaches are being implemented, particularly in customer relations and marketing management. With growing awareness of the

potential for individualized and personalized customer relations through modern technologies, marketing is becoming increasingly automated – either in-house or outsourced – to meet the demands of target market segments and ensure economic efficiency.

Modern AI programs are rapidly developing and, in marketing, can enhance customer experience, optimize marketers' time, segment and cluster audiences, and improve budget efficiency. Some AI technologies still require ethical guidelines and cautious use but should not be ignored – they're an objective reality. Skilled use of automation opens new horizons for business efficiency. Companies can choose between developing their own tools or outsourcing – each option must be assessed in terms of customer focus and cost-effectiveness.

Modern marketing strategies include: loyalty cards; guerrilla marketing; branding tools; discount coupons; and promotional gadgets (USBs, pens, keychains, etc.). For instance, "membership cards" for loyal customers can offer access to special discounts or unique offers. Guerrilla marketing – common for budget-conscious businesses – uses unconventional, affordable campaigns (e.g., outdoor installations, stickers, contextual ads). Branded apparel can also serve as promotional gifts for loyal customers or top employees. Targeted discount coupons or bundled products with promotional gadgets can encourage trials and reviews [2].

Retention strategies focus on maintaining existing customers and increasing their loyalty. These involve tools like email marketing, loyalty programs, personalized discounts, and special offers – aimed at repeat purchases. Repeat sales are highly profitable, generating more revenue from less investment and engaging a more loyal audience. However, relying solely on current clients is risky – their number may decline – so continuous outreach to new audiences is essential.

To objectively assess marketing effectiveness in business associations, it is necessary to analyze promotion channels, identify problems in customer interaction, assess customer feedback and brand perception, and evaluate associations and emotions triggered by the brand.

It is also advisable to monitor metrics like profitability ratios and comprehensive analytics. Evaluation should consider types of marketing effectiveness indicators, systematic assessment methods, synergies, the specifics of digital marketing performance, research to enhance decision-making, and marketing risks.

Understanding and analyzing competitors is key in forming and implementing marketing strategies for business associations. Without deep market insight, the strategy may fail. Benchmarking is a tool for comprehensive competitor analysis. To stay ahead, businesses must study others' experiences, avoid ineffective practices, and adopt efficient tools.

Benchmarking allows a comparative analysis to understand one's market position and evaluate average industry performance. These methods help assess effectiveness, market trends, advantages, and the influence of business associations on the market [4].

Digital transformations affect all areas of life. Marketing is no exception – it adopts digital solutions to foster interactivity, product awareness, and customer communication. While data volumes grow, so do threats. For example, at the end of 2024, Russian hackers attacked Ukrainian state registries, which remained non-operational for over a month, disrupting business processes. Such incidents underline the need for better cybersecurity.

Outsourced marketing services in Ukraine are provided by agencies like eSputnik, HIGHWAYTOTOP, Jumator, Mnews.agency, Netpeak, and others. Proper communication channel management significantly boosts conversions. Centralizing channel management and optimizing it with the right tools is essential.

For instance, eSputnik offers automation for personalized marketing messages without needing technical experts. Urgent news can be delivered via mobile marketing – push notifications, SMS, messengers. Scenario-based distribution prioritizes budget-friendly channels while ensuring effectiveness. Loyalty programs and CRM data enable personalized messaging. Online behavior helps tailor recommendations for physical stores. Each business must evaluate the pros and cons based on its own context.

Current marketing trends in Ukraine and globally are shaped by the challenges of the Russian-Ukrainian war and digital transformation. AI programs are powerful assistants capable of analyzing vast data and making accurate forecasts. However, even the most advanced technology cannot yet generate the emotional appeal of brands. Specialists must master all AI tools, ideally within a single platform, to save time and focus on strategic planning for business associations [5].

An example of a successful integrated business marketing strategy is the partnership between Carrefour and Google. Carrefour was the first French retailer to work with Google on a new grocery shopping interface, launched in 2019 via Google Assistant and Google Shopping.

Carrefour opened an innovation lab in Paris in partnership with Google Cloud, where Carrefour engineers collaborated with Google AI experts to develop new customer experiences. Google supported Carrefour's digital transformation by implementing G Suite and collaboration tools across the group.

Their partnership included: Carrefour's presence on Google Shopping and Assistant in France; the Carrefour-Google innovation lab; and accelerated digitalization of the Carrefour Group.

Through this partnership, Google contributed AI, cloud, and retail interface technologies, while Carrefour provided product and logistics expertise. Their joint goal: deliver innovative shopping experiences across stores, online platforms, smartphones, and voice assistants.

Table 1

Carrefour's Financial Indicators Before Partnership with Google (2017)

Indicator	Value
Net Sales	€78.9 million
EBITDA	€3.6 million
Net Profit	€531.0 million
Operating Profit	€700.0 million
EBITDA Margin	4.6 %
Operating Profit Margin	2.5 %

Source: [6]

Carrefour's Financial Indicators After Partnership with Google (2024).

Table 2

Carrefour's Financial Indicators After Partnership with Google (as of 2024)

Indicator	Change
Sales Growth	+9.9 % (like-for-like)
E-commerce GMV Growth	+18 %
Operating Profit Growth	+1.4 % (excluding FX)
Company Valuation	€9.22 billion
Increase in Ordinary Dividends	+6 %

Source: [7]

The partnership marked a stage in Carrefour's digital transformation, with 9.9 % sales growth, cost optimization, 18 % e-commerce growth, and the adoption of Big Data and AI technologies. Following the partnership, Carrefour automated logistics, expanded online sales, and integrated e-commerce (Table 3).

Table 3

Comparative Metrics Before and After Carrefour-Google Partnership

Metric	**2017**	**2024**
Total Sales (€ bn)	78.9	86.8
Operating Profit (€ bn)	0.7	1.2
Mobile App Downloads (m)	5.0	33.0

Source: [8]

AI reduced costs in demand forecasting and inventory management. Figure 1 illustrates profit growth.

Digitalization has already reshaped the marketing "rules of the game". Business process automation, data analytics, and communication channels are evolving rapidly. Digital transformation is key to forming effective marketing strategies for business

associations. CRM systems, Big Data analysis, and BI platforms enable deeper market interaction, improved marketing efficiency, and stronger competitive positioning.

Marketing strategies for business associations now include:

– Business Intelligence support for decisions.
– Big Data segmentation and personalization.
– Integrated CRM database management.

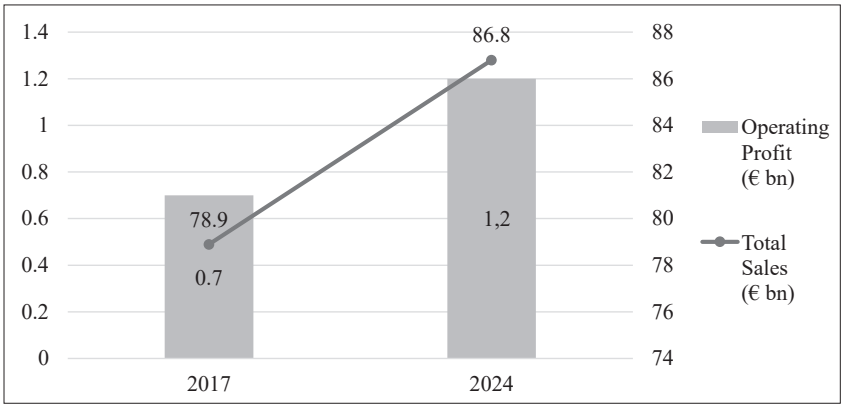

Fig. 1. Carrefour's Total Sales and Operating Profit Growth

Sources: [6–8]

These strategies ensure seamless multichannel customer interaction. By synchronizing real and digital marketing efforts and integrating CDP platforms, integrated businesses deliver unified customer experiences, build loyalty, and optimize communication across complex networks.

Merged companies can develop a unified communication platform to synchronize messaging across social networks, offline stores, and mobile apps while promoting Customer Data Platforms (CDPs).

Conclusion. In today's increasingly digital economy, mergers are no longer just about capital accumulation or market share – they're strategic responses to digital transformation, changing consumer behavior, and global competition.

Marketing strategies during mergers play a decisive role in successful integration, value creation, adaptation to digital channels, and enhanced market interaction. These strategies must be flexible, data-driven, customer-oriented, and technologically adaptive.

Thus, an effective marketing strategy in business consolidation not only ensures synergy of resources and competencies but also acts as a growth engine, fostering innovation and sustainable development in the digital era.

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2.5. TRANSFORMATION OF MARKETING COMMUNICATION STRATEGY

Introduction. In the modern business environment, marketing communications are undergoing constant changes due to digital transformation, the development of artificial intelligence and changing consumer behavior. Modern companies are forced to adapt their strategies, implementing new technologies and approaches for effective interaction with the audience. It has been proven that an effective marketing communication policy plays a key role in the development of companies, it provides the principle of information in marketing, audience engagement, motivates interaction with the brand and influences the speed of decision-making on the purchase of a product. Since the number of communication channels is constantly increasing, marketers are constantly searching for the most effective of them, and therefore in finding ways to transform the marketing communication strategy.

Presentation of the main research results. The current stages of transformation of marketing communication policy should be based on the following components: systematic communications management, a comprehensive approach to communication channels, targeting the target audience and forming hooks for attention management, forming a sales funnel, and retention marketing (Fig. 1).

Research proves that the list of marketing communications tools can be expanded now, and most likely it will expand in the future. Old

forms are developing, new ways of transmitting marketing messages appear, it has been proven that this process is dynamic and constantly improving. It is worth noting that all marketing communications tools are closely interconnected and have a common goal – to accelerate the promotion of goods in target markets, to encourage buyers to take active actions (purchase or make repeat purchases, distribute reviews and recommendations), to inform. However, they help to achieve a common goal in different ways and play a different role in the implementation of marketing tasks [1].

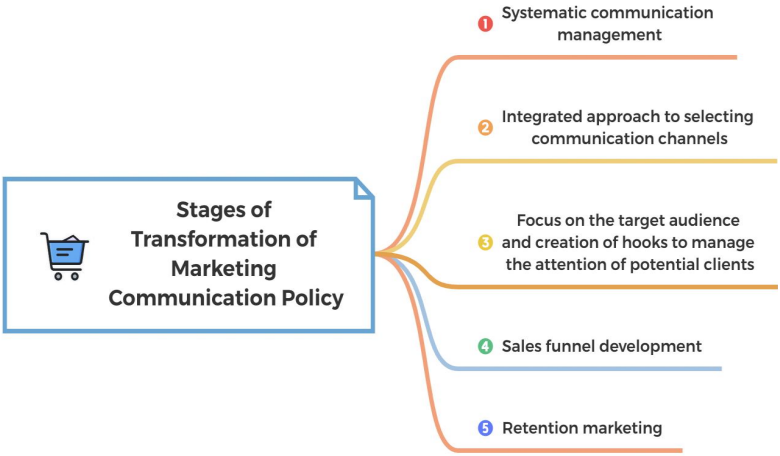

Fig. 1. Stages of transformation of marketing communication policy

Source: own development

To achieve the effect of implementing a communication policy, it is necessary to manage it and follow certain stages. The stages of managing a communication policy are presented in Fig. 2.

Analyzing Fig. 2, it should be noted that communication policy management today involves not only the choice of communication channels, but also compliance with the sequence of stages: determining communication goals; determining the target audience; developing an appeal; choosing communication channels, their optimal complex;

Fig. 2. Stages of managing marketing communication policy (off-, online)

Source: own development

determining the communications budget; assessing the effectiveness of communications and operational management, adjustments, if communication did not provide the expected result, in conditions of rapid changes in trends and consumer behavior, an important component of marketing communication policy management is the constant analysis and adaptation of strategies. The use of analytical tools, which helps to assess the effectiveness of advertising campaigns, identify the strengths and weaknesses of communication policy and make the necessary adjustments in a timely manne.

In a period of high competition and overly demanding attitude of customers to the offer of companies, there is a need for communication channels that allow companies not only to improve interaction with the target audience, introduce customizations, but also increase the level of trust and loyalty of customers. One of the main areas of improvement is the digitalization of marketing communications. Modern technologies open up new opportunities for a personalized approach to customers. The use of social networks, chatbots, email marketing and mobile applications allows companies to quickly and effectively convey information to consumers, adjusting the content to their needs and interests.

But practice shows that replacing one channel with another does not lead to the efficiency of marketing business processes, so marketing communication policy should be improved by integrating multi-channel communication and creating an omnichannel strategy.

Multi-channel marketing communication integration is a strategy that ensures the use of various channels of interaction with customers, such as: social networks, email, mobile applications, websites, physical stores, etc. The combination of online and offline communication channels allows you to create a holistic perception of the brand, which is positive for the modern customer.

The next stage of the transformation of marketing communication policy is focusing on the target audience and forming hooks to manage the attention of potential customers, taking into account that consumer behavior is becoming increasingly difficult to track, because sometimes the client ignores advertising, sometimes he is

able to make spontaneous decisions and buy little-known products from an advertisement, at a certain period the consumer forms a basket and carefully studies the properties of the product, pricing policy, functionality, etc., sometimes, on the contrary, he is bought by offers and headlines that form triggers or indicate benefits.

The target audience of a brand is potential customers who can become potential buyers of a product promoted through various communication channels. In order to define your target audience as accurately as possible, it should be divided into several segments based on general characteristics: gender, age, geographical, financial and professional characteristics, etc.

It has been proven that the target audience of a business cannot be absolutely all people who live, for example, in one region, city or country. Each individual product has its own unique characteristics, which determines the formation of an equally unique target audience. For the purpose of effective communication at the initial stages of its formation, a portrait of the target audience of the product (company) is determined [2].

Given the significant number of competitors in the Internet space and, as a result, a significant information load, a potential client evaluates Internet advertising instantly. Given these marketing research results, there is a need to form hooks to keep the client's attention and increase the rate of response to advertisements, which is measured by the click-through rate (CTR).

CTR (Click-Through Rate) reflects the percentage of users who clicked on a link after viewing an ad. One of the methods of increasing the response to an ad is through properly formed communication. In practical activities, there is a concept of a formula for successful advertising (Fig. 3).

Offer (target audience or problem) + Deadline + Call to action, (1)

where, Offer is a strong proposition, advantage, appeal to the target audience, or problem addressed by the advertised product.

Fig. 3. Formula for successful advertising

Source: own development

Deadline – a time limit (size, quantity) creates a feeling of a lost opportunity, of not receiving a benefit, and motivates an urgent decision to purchase a product or order a service;

Call to action – an incentive to action, a mandatory component of an advertising message that shows the client the way to make a purchase [3].

In building an effective communication policy, a properly formulated appeal encourages potential customers to make a decision to purchase a product. The process of making decisions by customers about purchasing a product is complex and multi-stage. It includes several key stages, at each of which companies can influence consumers, directing them to make a purchase (Fig. 4).

Thus, understanding the stages of customer decision-making allows companies to more effectively build their marketing strategies, increase consumer trust and increase sales. By influencing each stage of this process, a business can shape a positive customer experience and strengthen its competitive position in the market. A modern marketing tool – a sales funnel – can help build effective communication with a customer for the long term and motivate them to make a purchase.

The sales funnel is considered one of the effective business tools that demonstrates the features of the client's movement from the moment of interest in the product to its purchase. The model works regardless of the sales sphere – online (on the Internet) or offline.

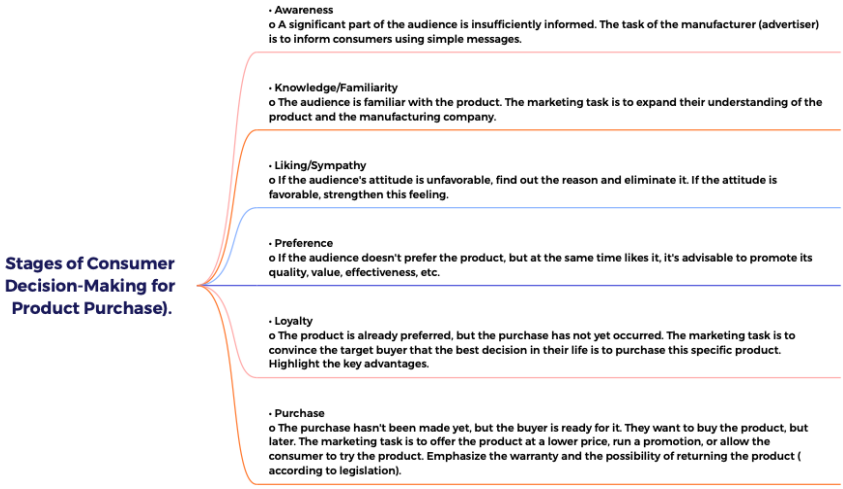

Fig. 4. Stages of a consumer's decision to purchase a product

The owner of the site (business) must clearly imagine and understand all the features of the consumer's path to purchasing the product.

The funnel begins to be built on the business premises when a potential customer enters the site (enters the store).

The essence of the sales funnel is to find out at what stage customers can leave the business area. The main goal of its construction is to return potential customers to the business area (for example, the website) and bring them to the final point, that is, to purchase a product or order a service (motivate to buy). The sales funnel will allow you to analyze the quality of marketing management, identify problems and eliminate them in a timely manner.

Using a sales funnel system, you can define separate phases for customer management and sales process automation.

The sales funnel shows the business owner at which stage the client most often leaves the business area (leaves the site). Thus, the entrepreneur is guided by the stages of the sales funnel and can offer potential clients who were interested in his business (products), but

for certain reasons did not reach the final point of sale, to conclude a cooperation agreement. The main point of building a sales funnel is the mandatory registration of potential clients when entering the business area (website). After registration, having email or mobile phone details, the business owner can make contacts with interested parties and, if they leave the site, will have the opportunity to inform and send them advantageous offers in order to return clients and bring them to the final point of the funnel. The sales funnel provides indicators (analytics), which are very important in online promotion for building an effective business and tracking certain business processes [1–3].

For a modern enterprise, a sales funnel may look like this (Fig. 5).

Fig. 5. Sales funnel

Source: created by the author

By controlling the stages at which a potential customer left the site (business territory) using the first stage of the funnel (registration), the business owner can reconcile all issues and resolve problems that were bothersome or unacceptable to the potential customer through direct sales.

At each stage of the funnel, the business owner's task is to motivate a potential customer to return or continue moving through the funnel to the final point, that is, to purchase a product or order a service. To do this, it is necessary to formulate offers in advance that will stimulate the consumer to buy the product, namely:

1. Login to the site (registration) – an offer to register in order to obtain contacts for further informing the client.
2. Site review – at this stage, you need to provide a user-friendly interface and simple functionality so that the client can easily service themselves on the site.
3. Interest in the product (search and study of the product) – if the client is interested in the product, but for some reason left the site, you can offer them discounts, point out the benefits, provide information about prices in other stores, compare the product's functions with similar ones, justify the profitability, warn about the limited stock, create an artificial shortage, etc.
4. Adding a product to the cart – if the customer added the product to the cart and left the funnel, it is advisable to offer a discount for a new (regular) customer, free shipping (or on favorable terms), service, the possibility of returning the product, a guarantee, or simply remind that adding the product to the cart does not guarantee its reservation and the product remains on free sale until the price is paid.
5. Sales – at this stage it is important to retain the client and motivate him for further cooperation, to build partnership relationships. Relationships, provide discounts on subsequent products, assign the status of a regular customer, offer gift certificates, bonuses, etc. [1–5].

In the presented figure, the funnel has a double arrow stage, which also means that the task of modern marketing communication policy should be based on the return of a client who has purchased the company's product at least once – which indicates that the product being promoted meets certain needs or solves the client's problems and he is likely to systematically buy it. It should be noted that the strategy of returning a client and "binding" him to the company is a cheaper business process than finding and winning the attention of a new client who is not familiar with the product, therefore it is necessary to form strategies for returning

regular customers and establishing long-term cooperation with them: form bonus systems, promotional codes for subsequent orders, certificates, cashback, etc. Such a strategy is called Retention marketing, relevant offers effectively form and launch through remarketing (retargeting), which is focused on an audience that has previously collaborated with the business page and is interested in its product.

Conclusions. Therefore, the proposed ways of transforming the marketing communication strategy have practical significance and can be implemented in the marketing policy of modern companies. InImproving marketing communication policy is an important step towards achieving success in marketing. Companies that actively implement digital technologies, experiment with a comprehensive approach to the formation of marketing communication policy are able to win over competitors and manage customer attention. In the conditions of rapid development of marketing tools, only constant improvement of communication strategy allows companies to remain relevant and attractive to their audience.

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2.6. INTERCONNECTION OF ECONOMIC DIGITALIZATION AND NATIONAL SECURITY OF UKRAINE

Introduction. In today's environment, where the external environment is changing and digitalization processes are intensifying,

information is a key resource, and digital technologies are improving all spheres of society. It should be noted that the digitalization of the economy is a key factor in the transformation of Ukraine's economic system in the face of hybrid threats and increased competition. At the same time, there is a need to protect information and strengthen cybersecurity. At the same time, national security encompasses economic, information, energy, and cybersecurity components, which are undoubtedly interconnected with digitalization processes.

Digitalization processes cover many areas where various digital technologies are used, such as the economy, social and military spheres, and many others. Digitalization helps to shape and strengthen the national security of the state. Theoretical and practical approaches to the essence of the concept of "digitalization" have been defined by the following scholars: Li X., Ratti C. [1], Li X., Zhang C., Li W., Ricard R., Meng Q., Zhang W. [2], Mitchell R. L. [3], Pope D. G., Sydnor J. R. [4], Regeda Y. O., Regeda V. O. [5], Shakir A., Staegemann D., Volk M., Jamous N., Turowski K. [6], Haustova V. E., Kriachko E. M., Bondarenko D. V. [7], Yang J. [8], Cherep A. V., Sarbey L. S. [9], Cherep A., Dashko I., Ohrenych Yu. [10], Cherep A., Cherep O., Ohrenych Yu. Kurchenko M. [11], Cherep O. H., Oleinikova L. H., Bekhter L. A., Veremieienko O. O. [12], Haustova M. G. [13], Melnichenko B., Figel N. [15]. Thus, digitalization affects the level of national security of countries, which confirms the relevance of the study.

Summary of the main results of the study. The rapid development of information and communication technologies opens up many opportunities to improve the efficiency of public administration, strengthen defense capabilities, stimulate economic growth, ensure environmental safety, and improve the quality of life in society. Despite the many positive aspects, there are several important drawbacks: the growing level of cyberattacks, disinformation companies, technological dependence, and digital inequality.

In this context, the study of the role of digitalization as a tool for shaping the national security of the state is extremely relevant. Understanding the potential of digital technologies, identifying the

risks associated with them, and developing effective strategies for their use are key tasks to ensure the sovereignty, stability and sustainable development of the state in the context of digital transformation.

It should be noted that the digitalization of Ukraine's economy and national security are closely interconnected: cybersecurity is a component of national security, as the growth of digital operations increases the number of cyberattacks and the need to protect the information system; digital data transparency ensures increased economic security through the introduction of an electronic administration system that allows for greater control over public finances, the use of big data analytics, which avoids economic costs; the introduction of digital technologies allows to ensure the continuity of business processes, the stability of public administration; digitalization has a positive impact on information security, as the introduction of digital mechanisms allows to verify data, inform the society; the development of artificial intelligence, the introduction of digital platforms, blockchain solutions are a prerequisite for ensuring digital security.

Thus, the role of digitalization is to deeply penetrate digital technologies into all spheres of society, the economy, and the state. This is not just digitization or automation of processes, but a rather qualitative transformation of the way we interact, do business, provide services, and make decisions using digital tools and data.

In general, digitalization involves the transformation of information and processes into digital ones, i.e. digitization of documents, transfer of communication to an online format, use of electronic signatures, etc. Digital technologies are introduced to optimize and create new processes, including the use of artificial intelligence, cloud technologies, the creation of new technologies and services based on digital capabilities, the development of fast mobile communications, the Internet, and data exchange platforms. Digitalization requires new skills, adaptability, and readiness to use digital tools from citizens and employees

At the same time, it is important to distinguish between the following concepts: digitization – converting information from a conventional form to a digital one, the first step towards digitalization; digitalization – using digitized information and digital technologies to improve existing processes and operations; digital transformation – a deeper and more

strategic change that involves fundamental rethinking of business models, creation of new values and change of organizational culture under the influence of digital technologies [14; 16].

In national security, digitalization is a powerful tool that covers all three levels: from digitization of intelligence data to the introduction of digital command and control systems and strategic digital transformation of the defense sector to counter modern threats.

It should be noted that "national security of Ukraine is the protection of state sovereignty, territorial integrity, democratic constitutional order and other national interests of Ukraine from real and potential threats" [17]. Let us analyze the existing approaches to understanding the essence of national security:

1. The realist approach assumes that the state is the main actor in international relations, and national security is the main goal of the state. The main emphasis is placed on the protection of sovereignty, territorial integrity and political independence [14; 16].

2. The liberal approach develops the understanding of national security not only in terms of military character, but also covers economic, environmental, social, and political aspects. At the same time, the emphasis is placed on the interconnection of the state, international institutions, democracy and human rights, which are factors of stability and security of the state [14; 16].

3. Human-centered approaches assume that human security is the main object. Also, threats are considered not only from the state, but also from structural inequality, poverty, discrimination and other social problems [14; 16].

4. The comprehensive approach emphasizes the importance of understanding the different aspects of national security and trying to integrate elements of different approaches. National security is a multifaceted concept that includes military, political, economic, social, informational, environmental aspects [14; 16].

Having considered the existing approaches to understanding the essence of national security, it is advisable to determine the relationship between digitalization and national security through a set of approaches:

1. Realistic approach: digitalization is seen as an important factor in building up the military and economic power of the state. The development of cyberwarfare and artificial intelligence systems for defense purposes, high-tech production based on digital technologies, contributes to strengthening military capabilities and economic competitiveness, which are key elements of national security in a realistic sense [14; 16].

2. Liberal approach: digitalization is a prerequisite for economic growth, introduction of innovations, innovative development, improvement of living standards, automation of business processes at enterprises, which are important prerequisites for national stability and security. Liberals see digital technologies as a tool for promoting democratic values, freedom of speech and access to information, which contributes to a more sustainable and secure society. The liberal approach emphasizes the importance of international cooperation in combating transnational cyber threats such as cybercrime and cyberterrorism, which requires joint efforts and the creation of international norms and institutions [14; 16].

3. Human-centered approach (critical approach): Critical theories can emphasize the risks of deepening social inequalities as a result of digital transformation. Unequal access to digital technologies and skills can create new forms of social vulnerability and marginalization, undermining the overall security of society. Critical approaches also draw attention to the potential of digital technologies to increase state control and surveillance of citizens, which can violate human rights and freedoms, which are important elements of security [14; 16].

4. Comprehensive approach: recognizes that digitalization affects national security simultaneously in many dimensions (military, economic, social, information). An effective national security policy in the digital era should take into account all these aspects and coordinate the efforts of various government agencies, business and civil society [14; 16].

Conclusions. It should be summarized that the digitalization of Ukraine's economy is a direction of ensuring efficiency, innovative development, increasing competitiveness, entering international markets, and a fundamental tool for strengthening national security. At the same

time, an important role is played by the effective integration of digital technologies into all spheres of state life, which will allow to identify and respond in a timely manner to threats and risks of the external environment, to ensure the country's economic growth in the face of constant challenges. Among the areas of improving national security through digitalization processes are the following: strengthening control over economic processes, increasing transparency of financial data through the introduction of artificial intelligence technologies, establishing data integration between government agencies, improving the system of digital monitoring of finances; development of the cybersecurity system by establishing cooperation with international partners, exchanging data on cyber threats, and training civil servants and business representatives on the main aspects of digital security; development of digital infrastructure by attracting investments in software development and cyber defense; improving information security by supporting information literacy of the population, countering disinformation; training of personnel in digital security. Thus, the integration of digitalization of the economy and national security will increase the competitiveness of the country's economy.

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2.7. THE IMPACT OF INDUSTRY 4.0 ON THE FINANCIAL SUSTAINABILITY OF MACHINE-BUILDING ENTERPRISES

Introduction. Industry 4.0, known as the fourth industrial revolution, is characterized by the introduction of modern digital technologies that integrate physical and virtual production systems. This concept involves the use of the Internet of Things (IoT), big data, artificial intelligence, and other innovations to create smart factories [11]. For machine-building enterprises, the implementation of Industry 4.0 principles is a key factor in achieving financial sustainability and sustainable development [8].

The introduction of Industry 4.0 technologies helps to optimize production processes, which leads to lower costs and increased efficiency. Automation and digitalization minimize the human factor, reducing the number of errors and equipment downtime. This, in turn, improves product quality and increases the company's competitiveness in the market.

In addition, the use of big data and analytics allows businesses to make informed financial decisions, forecast demand, and manage

resources more efficiently [56]. This ensures the stability of cash flows and increases the financial stability of the enterprise.

The purpose of the article is to analyze the role of Industry 4.0 in ensuring the financial sustainability and sustainable development of machine-building enterprises. The main focus is on the impact of digital technologies on the efficiency of production processes, increasing competitiveness and optimizing management decisions.

The topic of implementing Industry 4.0 and its impact on the financial sustainability and sustainable development of machine-building enterprises is the subject of research by many scholars, in particular:

– V. M. Osipov and O. S. Kovalevska: in their article "Strategy of the machine-building enterprise in the context of the declarative paradigm "Industry 4.0"" they investigated the conceptual foundations of the emergence and development of Industry 4.0, as well as determined the place of Ukraine in this process [7];

– L. Vdovenko: in the article "Instruments of State Financial Support for the Agricultural Sector under Martial Law" she considered financial mechanisms that can be used to support the financial stability of enterprises, including machine-building ones, in crisis situations;

– S. V. Hlibka: in the monograph "Industry 4.0 Concept: Problems of Implementation and Certain Legal Aspects of its Implementation in Ukraine", he studied the issues of formation of Industry 4.0 in Ukraine and certain legal aspects of its implementation, focusing on economic and legal factors that affect the development of economic activity in the digital economy [10];

– The Association of Industrial Automation Enterprises of Ukraine (AIAEU) has developed the "Strategy for the Development of Industry 4.0 in Ukraine", which focuses on the main priorities and initiatives in this area [1];

– I. Dashko, who actively studies digitalization in various aspects of the economy and governance, namely: in the article "Dynamics of Digital Public Services Development in the Context of Ukraine and EU Member States" together with L. Mykhailichenko. Mykhailichenko analyzes the development of digital public services in Ukraine and the

EU and examines Ukraine's place in the digital well-being ranking and proposes a strategy for the digital transformation of public services in Ukraine [6]; in the article "Digitalization of the Economy in the Context of the COVID-19 Pandemic as a Strategic Platform for the Development of the State's Economy" the impact of the pandemic on the world economy, the role of digital technologies during this period and the prospects for digital transformation in Ukraine are studied; in the work with E. Loseva: "Digitalization as a Modern Trend in the Development of Human Resources Management" examines the impact of digitalization on human resources management, analyzes current trends and challenges in this area [3]; the article "Advantages and Challenges of Digitalization of the Ukrainian Economy" explores the basic principles of digitalization of the Ukrainian economy and analyzes the advantages and challenges associated with this process [9].

These researchers and organizations have made a significant contribution to the study of the impact of Industry 4.0 on the financial sustainability and sustainable development of machine-building enterprises, analyzing both theoretical aspects and practical approaches to the introduction of the latest technologies into production processes.

The topic of Industry 4.0 implementation and its impact on the financial sustainability and sustainable development of machine-building enterprises is also the subject of research by many foreign scholars. They analyze how digitalization, automation and integration of modern technologies affect the efficiency, competitiveness and environmental responsibility of enterprises:

– K. Schwab is the author of the book "The Fourth Industrial Revolution", where he analyzes the impact of Industry 4.0 on various industries, including mechanical engineering, and discusses the challenges and opportunities it brings to business and society;

– G. Luks examines the impact of digital technologies on production processes and financial sustainability of enterprises, in particular in the machine-building industry;

– E. Schmidt examines the impact of artificial intelligence and big data on business processes and development strategies of enterprises, including machine-building companies;

– M. Porter analyzes how Industry 4.0 changes the competitive environment and affects the sustainability of enterprises;

– S. Essen studies the strategies for implementing Industry 4.0 in industrial enterprises and sustainable development.

These researchers and their work make a significant contribution to understanding how Industry 4.0 is transforming the machine building industry, affecting the financial sustainability and sustainable development of enterprises.

At the same time, new questions arise in relation to this research, which requires more detailed research to identify areas for improvement.

Summary of the main results of the study. Sustainable development involves a balance between the economic, environmental and social aspects of an enterprise, and Industry 4.0 contributes to this through:

– environmental responsibility: through precise monitoring and management of resources, businesses can reduce energy and material consumption, which reduces their environmental footprint [2];

– social aspect: automation of routine processes allows employees to focus on more creative and strategic tasks, increasing their job satisfaction and stimulating professional development [4];

– economic efficiency: increasing productivity and product quality opens up new markets and opportunities for growth, ensuring the long-term stability of the enterprise [1].

The study determined that Industry 4.0 is a key factor in ensuring the financial stability and sustainable development of machine-building enterprises. The main results of the study can be summarized as follows:

1. Digital technologies contribute to the financial sustainability of enterprises:

– automation and digitalization of production can optimize costs, increasing productivity by reducing downtime and product defects [8];

– the use of big data and artificial intelligence (AI) allows forecasting production needs and efficiently managing resources, which helps stabilize the financial flows of enterprises [5];

– the introduction of cyber-physical systems (CPS) and the Internet of Things (IoT) in mechanical engineering allows monitoring production processes in real time, which has a positive impact on their economic efficiency [2].

1. Industry 4.0 contributes to the sustainable development of machine-building enterprises:

– environmental sustainability: digitalization of production helps to reduce energy and raw material consumption, reducing CO_2 emissions and other environmental pollution [4];

– social aspect: automation of routine processes allows employees to engage in more creative and strategic tasks, which increases their job satisfaction and motivation for professional development;

– economic efficiency: digital tools allow machine-building enterprises to adapt to market changes faster, create innovative products and strengthen their competitive position [1].

1. The main challenges of implementing Industry 4.0 in mechanical engineering:

– high initial costs of digital transformation, which makes it less affordable for small and medium-sized businesses [8];

– insufficient level of digital infrastructure in Ukraine, which complicates the integration of Industry 4.0 into production processes [2];

– lack of qualified specialists capable of working with new technologies, which requires significant investment in staff training [4].

1. Strategies for overcoming challenges and recommendations:

– government support and stimulation of investments in the implementation of Industry 4.0 technologies through tax incentives, grant programs and international partnerships [1];

– development of digital infrastructure, in particular the introduction of high-speed Internet and 5G technologies in industry [2];

– educational initiatives and cooperation with universities to train specialists in the field of digital economy and production automation [4].

Challenges of implementing Industry 4.0 in Ukraine.

Despite the obvious advantages, Ukrainian machine-building enterprises face a number of challenges in implementing Industry 4.0:

– financial constraints: high initial investments in new technologies may be unaffordable for many enterprises [8];

– insufficient infrastructure: lack of the necessary digital infrastructure slows down the implementation process;

– lack of qualified personnel: the need for specialists capable of working with the latest technologies requires investment in training and retraining.

Let's analyze the data for 2022–2024, which illustrate the impact of Industry 4.0 on the financial sustainability of Ukrainian machine-building enterprises (Table 1).

Table 1

Statistical data for 2022–2024: Impact of Industry 4.0 on the financial sustainability of machine-building enterprises

№	Indicator	Years		
		2022	2023	2024
1	Production volume, thousand units.	10.0	11.2	12.0
2	Unit cost, UAH.	1000.0	920.0	850.0
3	Net profit, UAH million.	1.8	2.9	4.2
4	Profitability, %	12.0	16.0	19.4
5	Share of defects, %	8.0	4.0	2.0
6	Maintenance costs, UAH million.	2.5	2.2	2.0
7	Energy costs, UAH million.	1.5	1.3	1.1
8	Downtime, %	15.0	10.0	5.0

Source: developed by the author

Table 1 shows the key financial and production indicators of the machine-building enterprise for 2022–2024. These tables illustrate the dynamics of changes under the influence of the introduction of Industry 4.0 technologies, namely:

1. The volume of production (thousand units) increased from 10.0 thousand in 2022 to 12.0 thousand in 2024, which indicates an increase in production efficiency.

2. The unit cost (UAH) decreased from 1000 UAH to 850 UAH, which is the result of automation, resource control and loss reduction.

3. Net profit (UAH million). It shows an increase in profitability: from UAH 1.8 million in 2022 to UAH 4.2 million in 2024, which is more than a twofold increase.

4. Profitability (%). Increased from 12 % to 19.4 %, which demonstrates an improvement in the financial return on production activities.

5. Share of defects (%). Decreased by 4 times – from 8 % to 2 %, thanks to the implementation of real-time quality control systems.

6. Maintenance costs (UAH million). Decreased from UAH 2.5 million to UAH 2.0 million, which indicates a shift to IoT-based preventive maintenance.

7. Energy costs (UAH million). Reduced from UAH 1.5 million to UAH 1.1 million as a result of increased energy efficiency.

8. Downtime (%). Significant reduction from 15 % to 5 % due to digital monitoring of equipment condition.

Thus, Table 1 clearly demonstrates the positive impact of Industry 4.0 on the production productivity, profitability, and cost structure of enterprises. These dynamics indicate a strengthening of financial stability and an increase in the competitiveness of the machine-building business.

The implementation of the Industry 4.0 concept in Ukraine, especially in the machine building sector, is accompanied by a number of significant challenges that hinder the dynamics of digital transformation:

1. Insufficient digital infrastructure. Many companies face limited access to high-speed internet and modern IT solutions, which makes it difficult to integrate the latest technologies into production processes.

2. Lack of financial resources. Investments in the modernization of production and the introduction of Industry 4.0 technologies require significant funds, which are often unavailable to Ukrainian machine-building enterprises.

3. Insufficient staff qualifications. The lack of specialists with the necessary skills to work with the latest technologies is a significant obstacle to digital transformation.

4. Political and economic instability. An unstable situation in the country can scare away potential investors and slow down the modernization process.

5. Lack of a clear state strategy. Uncertainty in government policy to support Industry 4.0 leads to insufficient coordination of efforts between different sectors of the economy.

6. Cybersecurity issues. The growth of digitalization increases the risk of cyberattacks, which many businesses are not prepared for.

7. Resistance to change on the part of management. Unwillingness or fear of large-scale changes can slow down the process of implementing the latest technologies.

To overcome these challenges, a comprehensive strategy is needed, including infrastructure development, training, investment attraction, and active support from the state – a comprehensive strategy for implementing Industry 4.0 in Ukrainian machine building:

1. Institutional support and legislative framework:

– development and approval of the state program for digital transformation of industry;

– definition of clear standards, technical requirements and regulations for Industry 4.0;

– creation of a centralized body to coordinate digital initiatives.

2. Investments and financial support:

– introduction of preferential loans, grants and subsidies for modernizing enterprises;

– partnership with international institutions to obtain financing;

– encouraging venture capital to support startups in the field of mechanical engineering.

3. digital infrastructure:

– development of high-speed Internet and data centers;

– creation of regional hubs for digital transformation;

– integration of enterprise IT systems at the national level.

4. Training and professional development:

– introduction of educational programs in universities in the areas of IoT, Big Data, Smart Manufacturing;

– regular trainings for enterprise personnel;

– creation of certification programs according to Industry 4.0 standards.

5. Innovations and R&D:
– creation of digital modeling, testing and prototyping laboratories;
– stimulating cooperation between scientific institutions and enterprises;
– financing innovative projects in the field of artificial intelligence, robotics and automation.
6. Cybersecurity:
– development of a national strategy for industrial cybersecurity;
– introduction of mandatory audits of IT systems;
– training of cybersecurity specialists.
7. Monitoring and performance evaluation:
– introduction of KPI systems to assess the level of digitalization of enterprises;
– annual update of analytical reports on progress;
– formation of open registers on the state of implementation of Industry 4.0.

The application of this strategy will significantly increase the financial sustainability of machine-building enterprises through increased efficiency, competitiveness and adaptation to global trends.

Challenges of implementing Industry 4.0 in Europe:

1. Uneven level of digitalization among EU countries. The level of implementation of Industry 4.0 differs significantly between developed and less developed member states, which creates a gap in competitiveness.
2. Limited funding for digital transformation. Despite the availability of EU funds, some countries face problems in accessing investments in digital modernization.
3. Lack of skilled labor. Industry 4.0 requires specialists with knowledge in IT, data analytics, and artificial intelligence, which are in short supply in the labor market.
4. Cybersecurity and digital threats. Increasing automation and network connectivity increases the risk of cyber threats.
5. Resistance to change and lack of a culture of innovation. Some managers and staff resist digitalization out of fear of losing control or position.

6. Lack of a unified European coordination policy.

Each country has its own digitalization strategy, which complicates synergy at the EU level.

To overcome these challenges, we recommend a comprehensive strategy for overcoming the challenges of Industry 4.0 in Europe:

1. Unification of the EU digital policy:
– to create a pan-European digital platform;
– to develop common standards and criteria for digital transformation for all EU countries;
– to ensure coordinated action within the Digital Europe program.
2. Financial support for innovation:
– use of Horizon Europe and Digital Europe Program funds;
– expanding access to finance for SMEs (small and medium-sized enterprises);
– partnership with the private sector through public-private partnership schemes.
3. Human capital development:
– reform of the education system with an emphasis on STEM and digital skills;
– creation of the EU Skills Agenda platform for retraining workers;
– support for the mobility of students and professionals between EU countries.
4. Investments in infrastructure and digital technologies:
– construction of pan-European 5G networks and data centers;
– development of smart factory and the Internet of Things at enterprises;
– introduction of Industry 4.0 innovation centers in the regions.
5. Digital security:
– implementation of ENISA cybersecurity standards;
– raising awareness of cyber threats among businesses and citizens;
– formation of national incident response centers (CSIRT).
6. Support for innovation culture:
– encouraging enterprises to experiment through pilot project support programs;

– establishing communication between universities, startups and businesses;

– holding hackathons, competitions, business forums on digital solutions.

The impact of Industry 4.0 on the financial sustainability of machine-building enterprises (2022–2024).

The introduction of Industry 4.0 technologies significantly affects the financial sustainability of machine-building enterprises:

1. Increase in productivity and efficiency: the use of automation, robotics and IoT allows to optimize production processes, which leads to lower costs and higher profitability.

2. Reduced operating costs: intelligent monitoring and data analytics systems help identify inefficiencies and reduce unproductive costs.

3. Improved product quality: Industry 4.0 technologies provide more precise quality control, which reduces the number of defects and returns, positively affecting financial performance.

4. Production flexibility: the ability to quickly adapt to changes in demand provides companies with a competitive advantage and stable revenues.

5. Investment in technology: Although the introduction of new technologies requires significant initial investment, the long-term benefits in terms of increased efficiency and cost savings offset these costs.

6. Cybersecurity risks: Increased digitalization increases the risk of cyberattacks, which can lead to financial losses. Investments in cybersecurity are needed to protect data and systems.

7. The need for staff retraining: the introduction of new technologies requires new skills from employees. Investing in staff training and development is critical for a successful transformation.

In general, Industry 4.0 has the potential to significantly increase the financial sustainability of machine-building enterprises, provided that it is implemented strategically and managed.

Based on the above, let's consider the steps to implement Industry 4.0 to strengthen financial sustainability:

1. Audit of the enterprise's readiness for Industry 4.0:

– to analyze digital maturity;

– to assess the financial condition and potential for investment;

– to identify bottlenecks in production that can be automated.

2. Develop a digital strategy:

– define specific goals (e.g., reducing costs by 20 % in 2 years);

– create a digitalization roadmap with a phased implementation of IT solutions.

3. Investing in technology:

– install IoT sensors to monitor equipment;

– implement ERP/MES systems for real-time production control;

– apply AI/ML to predict failures and optimize inventory.

4. Financial optimization:

– reduce losses through automated quality control;

– use IoT data to reduce energy consumption;

– increase logistics efficiency through digital planning.

5. Personnel development:

– to train employees in robotics, data analytics, digital engineering;

– to launch a retraining program or cooperate with technical universities.

6. Cybersecurity:

– implement basic IT infrastructure protection;

– audit cybersecurity systems and update access policies.

7. Performance evaluation:

– implement KPIs: operating costs, downtime, profitability;

– audit the results achieved every 6 months.

Let's look at an example of expected results based on the recommended steps for implementing Industry 4.0 (Table 2).

Table 2

Example of expected results (2022–2024):

№	Indicator	Before implementation	After 2 years
1	Product profitability	8–12 %	18–22 %
2	Equipment downtime	15 %	5 %
3	Maintenance costs	–	−20 %
4	Volume of defects	8 %	2 %
5	Energy efficiency	–	+25 %

Source: developed by the author

Based on the results of Table 2, the following conclusions can be drawn:

1. Increase in product profitability: profitability increases from 8–12 % to 18–22 %, which indicates a significant improvement in financial results due to optimization of production processes and cost reduction.

2. Reduction of equipment downtime: a decrease from 15 % to 5 % means an increase in the efficiency of the use of enterprise assets through the introduction of digital monitoring and predictive maintenance.

3. Reduced maintenance costs: an expected 20 % reduction confirms the effectiveness of IoT-based systems and analytics that avoid unscheduled repairs.

4. Significant reduction in rejects: the reduction of rejects from 8 % to 2 % indicates an improvement in product quality due to automatic control and real-time data analytics.

5. Improved energy efficiency: a 25 % increase shows that Industry 4.0 implementation contributes to more efficient use of resources, reduced energy costs, and increased environmental sustainability.

In general, the results of Table 2 clearly demonstrate that Industry 4.0 has the potential to significantly improve the financial sustainability of an engineering enterprise, while ensuring increased profitability, reduced risks, and increased efficiency.

Conclusions. The study results confirmed that Industry 4.0 plays a key role in ensuring the financial sustainability and sustainable development of machine-building enterprises. Digital technologies can improve production efficiency, reduce costs and enhance the environmental responsibility of businesses. However, to fully implement Industry 4.0, a number of barriers need to be overcome, which is possible through strategic cooperation between the government, business, and research institutions.

Thus, Industry 4.0 is a key element for ensuring the financial sustainability and sustainable development of machine-building enterprises. The introduction of modern technologies can increase efficiency, reduce costs, and improve product quality. However, to realize this potential, it is necessary to overcome the existing challenges through joint efforts of the state, business, and educational institutions.

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2.8. DIGITALIZATION AS A TOOL FOR ENSURING NATIONAL SECURITY

Introduction. In today's world, national security increasingly depends not only on military strength or political stability, but also on the ability of the state to effectively use digital technologies. In the

21st century, new threats, including cybercrime, information warfare, and attacks on critical infrastructure, require new methods of defense from the state.

Domestic and foreign scholars have studied digitalization processes that cover all spheres of life – economy, education, healthcare, public administration and, most importantly, the security sector, namely: Korotun N. V. [1], Mitchell R. L. [2], Pope D. G., Sydnor J. R. [3], Regeda Y. O., Regeda V. O. [4], Shakir A., Staegemann D., Volk M., Jamous N., Turowski K. [5], Haustova V. E., Kriachko E. M., Bondarenko D. V. [6], Cherep A. V., Voronkova V. G., Cherep O. H. [7], Cherep A. V., Ohrenych Yu., Oleinikova L. H., Vasylenko D. O. [8], Cherep O. H., Oleinikova L. H., Bekhter L. A., Veremieienko O. O. [9], Yang J. [10].

Summary of the main results of the study. Digitalization is the process of large-scale implementation of digital technologies in all spheres of public and government life to increase the efficiency, transparency and accessibility of services, management and communications. It is not just the automation of existing processes, but a profound transformation of the way the state, citizens, and businesses interact.

As defined by the Ministry of Digital Transformation of Ukraine, digitalization involves the use of digital tools to create convenient electronic services, optimize processes, and ensure better interaction between the government and the public.

Digitalization covers the following key areas:

– implementation of e-government;
– development of digital infrastructure;
– use of big data and analytics;
– creating platforms for online interaction;
– development of digital skills among the population.

In the context of security, digitalization is becoming not only a management tool, but also a means of responding to new types of threats, in particular in cyberspace, the information field and critical infrastructure.

National security is a state of protection of vital interests of an individual, society and the state from internal and external

threats. It covers a wide range of areas that together ensure the state's resilience to the challenges of the modern world.

According to the Law of Ukraine "On National Security", the main components of national security include [11]:

– Political security – ensuring the stability of the political system, state sovereignty, independence and territorial integrity.

– Economic security – stable economic development, energy independence, financial stability and protection of critical infrastructure.

– Military security – the ability of the state to defend itself against armed aggression, support for the combat capability of the Armed Forces and other security agencies.

– Cybersecurity – protection of state information systems, communication networks and data from cyberattacks, malware and hacker threats.

– Information security – protection of society from information influence, propaganda, disinformation and preservation of information sovereignty.

– Environmental safety – preventing environmental disasters, monitoring the environment, and rational use of natural resources.

– Social and humanitarian security – ensuring the rights and freedoms of citizens, access to quality education, healthcare and social protection.

– Defense and industrial security – development of the national military-industrial complex and preservation of strategic potential.

In today's environment, digitalization is becoming an integral part of the national security system. It not only transforms traditional governance and communication mechanisms, but also creates new tools for detecting, preventing and neutralizing threats.

Digital technologies allow you to:

– Quickly process and analyze large amounts of information, which increases the effectiveness of decision-making in a crisis or threat.

– Ensure transparency of governance – e-governance reduces corruption, promotes government accountability and strengthens public trust.

– To increase the cyber resilience of the state – the creation of reliable cyber defense systems allows to prevent interference in the internal processes of the state, as well as to ensure the smooth operation of critical infrastructure.

– Develop a system of national monitoring and response – digital tools allow tracking potential threats in real time [12].

– Counteract information attacks – analytical platforms can detect the spread of fake information, and digital campaigns can inform the public and counteract disinformation [13].

It is especially important that digitalization helps to strengthen interagency cooperation: data exchange between law enforcement agencies, local governments, emergency services, and other institutions becomes fast and efficient [14].

Cybersecurity is a set of measures, strategies, technologies and institutional mechanisms aimed at protecting information systems, digital infrastructure, personal and state data from unauthorized access, attacks, destruction or manipulation. In the context of digitalization, cybersecurity is becoming a key element of national security [15].

The main areas of state cyber defense include:

– Protection of critical infrastructure. Critical infrastructure is the facilities on which the stability of the state depends (power plants, transportation, communications, financial institutions). Their cyber defense is of paramount importance.

– Developing early detection systems for cyber threats. This includes monitoring of the digital space, risk analysis, and the creation of a cyber response center that can quickly detect attacks and coordinate defensive actions.

– Ensure the security of state information resources. All government databases, registries, and portals (including Diia) must be securely protected. This is achieved through encryption, user authentication, backup and multi-level access control.

– Training and awareness raising in the field of cyber hygiene. The human factor is often the weakest link in a security system. That is why it is important to train both civil servants and citizens in the

basics of cybersecurity, such as using secure passwords, detecting phishing attacks, etc.

– International cooperation in the field of cybersecurity. Cyber threats are often transnational in nature. Participation in international initiatives, information exchange with partners, and integration into global cyber defense systems help strengthen national positions [16].

– Legal regulation and regulatory framework. Effective cybersecurity is impossible without modern legislation that regulates liability for cybercrime, sets security standards and incident response procedures.

In today's digital world, cyber threats have become a real challenge to the national security of any country. They are constantly evolving and include both technical attacks on infrastructure and information and psychological influence on society. For Ukraine, which is in the midst of a hybrid war, the issue of cyber defense is particularly relevant.

The most common types of cyber threats to the state are:

– Cyber attacks on critical infrastructure. These are attacks on energy, transportation, finance, and communications facilities. They can cause paralysis of important systems, for example, stopping power supply or banking operations.

– DDoS attacks (distributed denial of service attacks). The purpose of such attacks is to disable the websites of government agencies, e-government services or information resources.

– Malicious software (viruses, trojans, spyware). Used to steal confidential data, track user activity, lock down systems, or demand ransom (e.g., ransomware).

– Phishing attacks. Aimed at deceiving users to gain access to logins, passwords, or financial information. Often used against government officials and journalists.

– Hacking into government accounts or IT systems. Could lead to the leakage of classified information, manipulation of data, or undermine trust in the government.

– Cyberintelligence and espionage. Carried out by foreign intelligence services or hacker groups to obtain strategically important information about defense, politics, and the economy.

– Information and psychological operations (IPO). They are carried out through social networks, news platforms, bots to destabilize society, influence public opinion, create panic or distrust of the authorities.

– Data manipulation and fake information campaigns. This includes the dissemination of fakes, hacked documents, fake news, which can affect elections, the reputation of government agencies, the course of military or diplomatic operations [17; 18].

Cyber incidents that have occurred in Ukraine and abroad clearly demonstrate the growing level of threats to national security in the digital age. These incidents have a significant impact on government agencies, businesses, and society as a whole. Several vivid examples of such incidents illustrate the scale and diversity of cyber threats.

Examples of cyber incidents in Ukraine [18; 19]:

– Attack on the power grid (2015). One of the largest cyber attacks on critical infrastructure in Ukraine occurred in December 2015, when hackers attacked the energy system, causing massive power outages in Kyiv and other regions. The attack was carried out using malware that damaged the control systems of power plants. This was the first ever attack that led to real physical consequences – power outages.

– WannaCry (2017). Ukraine became one of the countries that was severely affected by the global cyberattack with the WannaCry ransomware. The attack affected tens of thousands of computers around the world, including government agencies and critical infrastructures in Ukraine, resulting in significant financial and organizational losses.

– Attack on the PrivatBank system (2016). In 2016, Ukraine's largest bank, PrivatBank, suffered a massive DDoS attack that disrupted its online services, including banking operations. This became a vivid example of how cyber threats can affect the financial stability of a country.

– Espionage attacks (2017). Numerous cases of cyber surveillance by foreign government agencies have been recorded in Ukraine. In particular, groups of hackers attacked government agencies to steal confidential data, including documentation on defense and military issues.

– Examples of cyber incidents in the world.

– Stuxnet attack (2010). One of the most famous cyber incidents in the world is the Stuxnet attack that hit nuclear facilities in Iran. The malicious program, created to sabotage Iran's nuclear program, damaged centrifuges used for uranium enrichment. This incident was the first time cyber weapons were used in the international arena.

– Attack on Sony Pictures (2014). In 2014, hackers from a group linked to North Korea carried out a cyberattack on Sony Pictures. They hacked into the company's servers and stole a large amount of confidential data, including emails and unreleased movies. This attack was considered an act of cyber terrorism.

– WannaCry attack on medical institutions (2017). The WannaCry ransomware attack, which spread to more than 150 countries, caused serious disruptions in the work of medical institutions, including in the UK. More than 70,000 NHS (National Health Service of Great Britain) computers were infected, leading to the cancellation of operations and interruptions in the provision of medical services.

– SolarWinds attack (2020). In 2020, one of the largest and most complex cyber incidents in history was detected – an attack on SolarWinds. Hackers, likely working on behalf of the state, hacked into SolarWinds software updates, which led to the compromise of many government and private organizations in the United States, including the Department of Defense, the State Department, and others.

Conclusions. Thus, digitalization acts as a multifunctional security tool that covers both the prevention of external threats and ensuring internal stability. Without proper digital development, it is impossible to imagine modern national security, especially in the context of hybrid warfare and dynamic technological changes.

Therefore, in the context of globalization and hybrid conflicts, digital tools are becoming an important element of national resilience. The development of e-governance, cyber defense systems, digital defense infrastructure and information security opens up new opportunities to strengthen the country's sovereignty.

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