

# Digitalization and Adaptive Enterprise Management: Innovative Investment Solutions for Regional Business Development

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## Abstract

The article studies innovative approaches and investment solutions in the system of adaptive management of enterprises of the agro-industrial complex of Ukraine in the digitalization context of the regional business landscape. It is substantiated that the effectiveness of digital transformation is determined not only by the level of technology introduction, but also by the ability of enterprises to integrate them into the process of managerial decision-making, taking into account regional conditions of functioning. Based on the analysis of financial and economic indicators of the activities of enterprises, a methodological approach has been developed and tested, which provides for the use of the Digital Maturity Index (IDZ) and the Adaptability Index (IA) to assess the level of digitalization and managerial flexibility of enterprises. The presence of the positive relationship between digital investments, management adaptability and financial performance has been established, which is manifested in the growth of return on assets, improved liquidity and increased efficiency of resource use. It is proved that the regional business landscape acts as an important determinant of digital transformation, influencing the availability of investment resources, digital infrastructure and institutional capabilities of enterprises. The proposed model allows integrating technological, managerial and regional factors into a single system for forming investment decisions, which ensures an increase in the adaptability and competitiveness of enterprises in an unstable environment.

**Keywords:** Digitalization, Adaptive Management, Digital Maturity Index, Adaptability Index, Investment Decisions, Agro-Industrial Complex, Regional Business Landscape, Financial Efficiency, Digital Investments.

## Introduction

Modern entrepreneurship in Ukraine operates in the context of the transformation of the competitive environment, where the decisive factor is the ability of enterprises to quickly and flexibly adapt. Empirical data confirm the acceleration of these processes: according to the State Statistics Service of Ukraine, in 2023, the volume of the ICT

solutions market for business increased by 34% compared to 2020, and the share of enterprises that implemented at least one digital management tool increased from 23% to 41%. In the subsequent period, against the backdrop of increased digital transformation, the development of electronic services and the spread of cloud technologies, the level of digital maturity of enterprises in 2025 is estimated at the level of 60-70% according to indirect indicators, which indicates the transition from the stage of fragmented implementation of digital solutions to their systematic integration into management processes.

At the same time, Ukrainian business operates in an environment of increased uncertainty caused by the consequences of a full-scale war, structural transformations of the economy, disruption of logistics chains, relocation of enterprises and limited access to investment resources. Under these conditions, at the same time, there is an active formation of the digital economy, which is stimulated both by the internal need of enterprises to increase efficiency and by state initiatives for the development of digital infrastructure and electronic services. As a result, a new regional business landscape is being formed, characterized by uneven digital development, differentiation of investment attractiveness of regions and different levels of adaptability of enterprises.

Under these conditions, traditional management models focused on the stability of the external environment and long-term planning lose their effectiveness. Enterprises increasingly need to move to adaptive management models that involve rapid response to change, integration of digital technologies into business processes, the use of data analytics for decision-making and the implementation of innovative business models. However, the implementation of these approaches is constrained by limited investment resources, a high level of risks, insufficient maturity of financial markets, and uneven access to digital infrastructure in the regional context.

The problem lies in the lack of an integrated approach to the integration of innovative management decisions and investment mechanisms, which could ensure the adaptability of enterprises in the context of digitalization and at the same time take into account the specifics of Ukraine's regional development. The issues of forming

effective investment strategies for the digital transformation of enterprises, assessing the feasibility of innovative projects in conditions of high uncertainty, as well as creating tools for managing the risks of digitalization remain insufficiently developed.

The connection with scientific and practical tasks lies in the need to form theoretical and methodological foundations for adaptive management of enterprises in the digital economy, taking into account Ukrainian realities, to improve approaches to assessing the effectiveness of investments in digital and innovative projects, to develop mechanisms for integrating the state policy of digitalization with regional development and investment activities of enterprises, as well as to create models for increasing resilience and competitiveness business in the context of war and post-war transformations.

The practical significance of solving the outlined problems lies in ensuring the modernization and recovery of the economy of Ukraine, increasing the investment attractiveness of regions, stimulating the development of innovative entrepreneurship and the formation of a competitive digital business environment, which in the strategic perspective will create prerequisites for Ukraine's integration into the European economic and digital space and the transition to a model of sustainable development.

## Literature review

The problems of adaptive management of enterprises in the context of digital transformation are formed at the intersection of theories of innovative development, digital economy and strategic management. A significant contribution to understanding the impact of digitalization on business models was made by Tapscott D. (2015), Brynjolfsson E. et al. (2014), who in the work "The Second Machine Age" substantiated the transition to an economy where digital technologies radically change the productivity and structure of markets. The concept of disruptive Innovation Christensen C. M. (2016) complements this approach by explaining the mechanisms behind the displacement of traditional business models by new digital ecosystems. Also, the concept of organizational flexibility and digital competencies in modern research is considered as a key prerequisite for the adaptability of

enterprises in the digital environment (OECD, 2024).

Cheng X.-M. et al. (2025); Lin M. et al. (2026) analyze digitalization, servitization strategy and business model innovation of small and medium-sized enterprises, investigate the impact of digital technologies, absorptive capacity and innovative efficiency of hidden champion enterprises. Ramirez E. H. et al. (2026); Li B. et al. (2026); Popelo O. et al. (2025) reveal the features of ensuring the competitiveness of small and medium-sized enterprises, analyze the positive nonlinear impact of digitalization, environmental policy and innovation, and also focus on digitalization and integration of sustainable development of enterprises. Liu H. (2025); Liu M. et al. (2025); Jakubek P. et al. (2023) analyzed the impact of digitalization on the innovative efficiency of enterprises, investigated organizational instability, digital technologies, and green innovations in the activities of modern enterprises.

Xiang D. et al. (2025); Zhang J. et al. (2025); Abramova A. et al. (2021) analyzed whether the digitalization of inclusive finance can promote innovation in small and medium-sized enterprises, and also carried out a quasi-natural experimental approach to study the impact of digitalization on the organizational flexibility of enterprises. Wei J. et al. (2025); Zhou H. et al. (2025) revealed the digitalization policy of enterprise innovation, analyzed the current trends of digitalization, green innovation, and green transformation of energy enterprises in China. Han L. et al. (2025); Zang J. et al. (2025) based on panel data analysis analyzed the impact of digitalization on the efficiency of manufacturing enterprises from the perspective of dual innovations, and investigated whether digitalization of enterprises can promote green technological innovations. Xu Q. et al. (2025); Riaj M. A. J. et al. (2024) considered the mitigating effect of regional digitalization in the context of innovative development of small and medium-sized enterprises, investigated the transformation of digitalization in entrepreneurship and green innovation of enterprises.

Despite a significant amount of scientific developments, a number of key aspects remain insufficiently studied. There is no integrated model that would combine innovative management approaches with investment mechanisms for the digital transformation of enterprises. Methods for

assessing the effectiveness of digital investments in conditions of high uncertainty and risks inherent in the modern economic environment of Ukraine have not been sufficiently developed. The regional differentiation of digital development, which significantly affects the investment attractiveness and adaptability of enterprises, has been taken into account to a limited extent, the features of adaptive management in the context of the war and post-war transformation of the economy, which requires the formation of new approaches to ensuring the sustainability of business models, have not been sufficiently studied.

Thus, the relevance of the study is due to the need to form an integrated approach to the combination of innovative management decisions and investment mechanisms in the system of adaptive management of enterprises, which takes into account the specifics of digitalization, regional development and modern challenges of Ukraine.

The article is aimed at developing a comprehensive theoretical and methodological approach to the formation of innovative and investment solutions in the system of adaptive management of enterprises in the context of digitalization of the regional business landscape of Ukraine, as well as empirical identification of the relationship between the level of digital maturity of enterprises and their financial performance on the basis of data from leading enterprises of the agro-industrial complex, taking into account uncertainty, risks and limited resources.

Achieving this goal involves solving the following tasks: systematization of financial and economic indicators of enterprises; formation and calculation of the Digital Maturity Index of Enterprises (IDZ) based on a set of digital, organizational and technological characteristics; assessing the impact of the regional business landscape as a determinant of digital investment and adaptability of enterprises; as well as verification of the statistical relationship between the digital maturity index and key performance indicators of enterprises using correlation and regression analysis.

## Methodology

The research methodology is based on a combination of systemic, structural-functional and process approaches,

which allows us to consider the enterprise as an open adaptive system sensitive to changes in the digital and regional environment. The paper uses the methods of comparative and factor analysis to identify differences in the levels of development of enterprises, the index method for assessing the dynamics of key indicators, the method of expert assessments for the formation of an integral index of

digital maturity (IDZ), as well as correlation-regression modeling tools for establishing relationships between the level of digitalization and financial efficiency. In addition, the methods of investment analysis are used to assess the feasibility of digital investments and the algorithm of managerial decision-making, which integrates digital and financial parameters into a single analytical model of adaptive management, is formalized.

**Table 1. Methodology for Researching Digitalization, Adaptability and Efficiency of Enterprises**

| Showman                                 | Formalization / indicators                                                                                     | Contents                                                                         |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Region Digital Readiness Index (IDR)    | $IDR = 0,6 \cdot Infra_n + 0,4 \cdot DigitalShare_n$                                                           | Assessment of the level of digital development of the regional environment       |
| Enterprise Digital Maturity Index (IDZ) | $IDZ = 0,20 \cdot ERP + 0,20 \cdot IoT + 0,18 \cdot Cloud + 0,17 \cdot Log + 0,15 \cdot BI + 0,10 \cdot Sales$ | Assessment of the level of digitalization of the enterprise                      |
| Digital Investment ROI                  | $ROI = (Digital\ P / Digital\ I) \times 100\%$                                                                 | Efficiency of digital projects                                                   |
| Return on Assets (ROA)                  | $ROA = (Net\ Profit / Average\ Assets) \times 100\%$                                                           | Financial efficiency of the enterprise                                           |
| Adaptability Index (IA)                 | $IA = 0,35 \cdot IDZ + 0,25 \cdot R\&D_n + 0,15 \cdot ROI_n + 0,15 \cdot CDO + 0,10 \cdot KZ_n$                | The ability of the enterprise to change                                          |
| Military Risk Impact Index (IWR)        | $IWR = 0,30 \cdot Strike_n + 0,25 \cdot Damage_n + 0,25 \cdot Risk_{biz,n} + 0,20 \cdot Migration_n$           | Quantitative assessment of the impact of hostilities on the business environment |
| Influence of the regional environment   | $IDZ = f(Investment, Infrastructure, IDR, IWR)$                                                                | Formation of conditions for the digitalization of enterprises                    |
| Impact on adaptability                  | $IA = f(IDZ, R\&D, ROI, CDO, IWR)$                                                                             | Interaction of digitalization and management                                     |
| Impact on results                       | $Performance = f(IA, IWR)$                                                                                     | Formation of financial efficiency                                                |
| Correlation analysis                    | $r = \Sigma(xi - \bar{x})(yi - \bar{y}) / \sqrt{\Sigma(xi - \bar{x})^2 \times \Sigma(yi - \bar{y})^2}$         | Estimation of relationships between variables                                    |
| Advanced correlation analysis           | $r(IDZ; LENGTH), r(IA; ROI), r(IWR; Performance), r(IDR; IDZ)$                                                 | The impact of digitalization and the military factor                             |
| Normalization of variables              | $x_n = (x - x_{min}) / (x_{max} - x_{min})$ ; applicable for IDZ, IDR, IWR                                     | Bringing heterogeneous indicators to a single scale                              |

Source: systematized by the authors

The methodological tools presented in Table 1 for the study of digitalization, adaptive management and efficiency of investments of enterprises are built as an integral multi-level system, demonstrating a consistent transition from theoretical approaches to formalized assessment models. The methodology is based on a combination of systemic, structural-functional and adaptive approaches, which allows considering the enterprise not as an isolated unit, but

as an element of a complex system, where financial results are formed under the simultaneous influence of internal management decisions and external regional conditions. Unlike traditional economic and mathematical models, this approach significantly expands the composition of factors of influence through the integration of the military-risk component, which is critically important for the modern Ukrainian environment.



The key technological indicator in the model is the Digital Maturity Index (IDZ), which aggregates the level of implementation of ERP systems, IoT, cloud technologies, Big Data and digital sales channels, reflecting the real level of innovation of the enterprise. However, within the framework of this methodology, digitalization is considered in close relationship with the external environment through the introduction of the region's Military Risk Impact Index (IWR). This tool allows you to formalize and quantify the impact of hostilities, destruction of infrastructure and security risks, which were previously mostly described only qualitatively. By applying the normalization procedure to convert heterogeneous indicators into a relative scale, the model ensures the correct integration of financial and technological parameters with security factors.

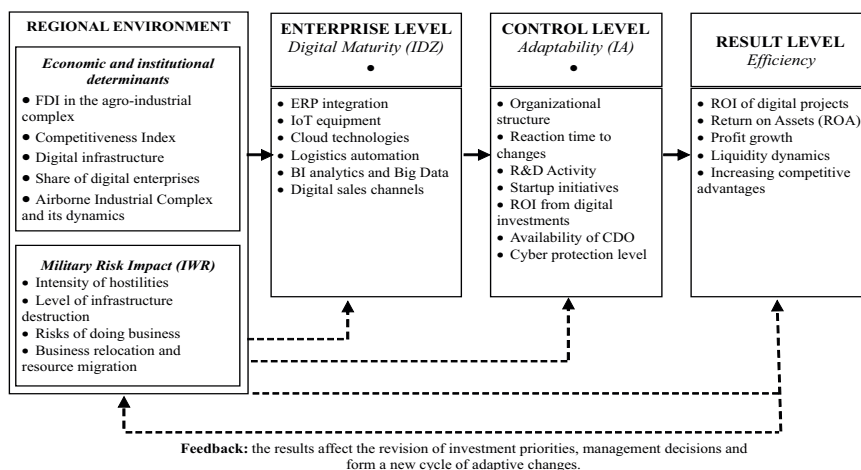
The central analytical element of this system is the Adaptability Index (IA), which synthesizes the level of digital maturity, R&D costs, the availability of a digital management center and the level of cyber protection taking into account the IWR indicator. This design allows you to assess not only the flexibility of the enterprise, but also its ability to function in conditions of increased uncertainty, explaining situations when entities with a similar technological level demonstrate different managerial efficiency due to differences in external risks. Investment performance in this model is evaluated through the ratio of return on digital projects (ROI) and overall asset performance (ROA), which allows you to move from a simplified linear relationship to a more realistic analysis of

economic returns. The methodology also includes an extended correlation analysis, where the IWR acts as a separate variable that allows quantifying the strength of the influence of the military factor as a limiting factor for digital investments.

Taken together, this integrated approach provides a transition from classical models of analysis to an adequate reflection of the real conditions for the functioning of domestic agricultural enterprises, creating a scientific basis for making effective investment decisions in the environment of military challenges.

Figure 1 reflects the logic of relationships between the environment, enterprise, management and results and the sequence of application of methodological research tools, where each block corresponds to a specific stage of analytical data processing and calculation of integral indicators. The model is proposed as a multi-level system of cause-and-effect relationships, in which the regional business landscape is adjusted for the security factor, forms external conditions for the development of enterprises. In this model, the level of digital maturity determines the technological potential of an economic entity, but it is the military-risk impact index that acts as a critical filter that determines the limits of the realization of this potential. Adaptability of management, in turn, provides a mechanism for transforming available resources into sustainable management decisions capable of counteracting external shocks, and financial indicators reflect the final effectiveness of digital investments, taking into account risks environment.

**Figure 1. Model of Formation of Investment Decisions in the Context of Digitalization, Taking into Account the Military-Risk Impact**



Source: compiled by the authors

The presented methodology reflects a holistic framework of the study, combining institutional, technological, financial, economic and security dimensions. This approach allows us to consider the digital transformation of Ukrainian enterprises not as a linear process, but as a complex strategy for survival and development in conditions of increased uncertainty, where security resilience is a basic prerequisite for economic efficiency.

## Results

The empirical basis of the study is a sample of five enterprises of the agro-industrial complex of Ukraine, representing different regions and scales of production: PJSC "Myronivskyi Hliboproduct" (MHP, Kyiv region) – market leader; LLC "Agro Elite" (Kharkiv region) – medium-sized enterprise; PJSC "Ukrzernoprom-LAN" (Odesa region) – a large grain trader; LLC "Agrofirma Zoria" (Dnipropetrovsk region) – diversified agricultural holding; "Agrocomplex Karpaty" (Lviv region) is a small regional enterprise.

The choice of these enterprises within the framework of the study is determined by the need to ensure the representativeness of the analysis of adaptive management and digital transformation in the agro-industrial complex of Ukraine, which is one of the key sectors of the national economy and at the same time demonstrates high sensitivity to external risks, in particular military, logistics, and energy.

The selected enterprises form different types of economic agents within the agro-industrial complex: from a large vertically integrated agricultural holding, which is a systemic player with a high level of capitalization and developed digital infrastructure, to medium and small enterprises of the regional level, operating in conditions of limited resources and greater dependence on the regional business landscape. This sampling structure allows us to trace the differentiation of adaptive capabilities of enterprises depending on the scale of activities and the level of digital maturity.

The geographical coverage of enterprises ensures that the regional asymmetry of Ukraine's development is taken into account, which is an important factor in the context of digitalization of the business environment. Regions differ significantly in the level of infrastructure support, access to investment resources, logistics opportunities and security conditions, which directly affects the pace of digital transformation and investment activity of enterprises.

Thus, the formed sample ensures the comprehensiveness of the study, allows combining macro- and micro-level analysis and creates an empirical basis for assessing the impact of digitalization on the financial performance and adaptability of enterprises in the unstable regional business landscape of Ukraine.

**Table 2. Financial and economic indicators of the activities of agricultural enterprises of Ukraine for 2021–2024, thousand USD**

| Showman                         | 2021    | 2022    | 2023    | 2024    | Change 2024 to, % |       |
|---------------------------------|---------|---------|---------|---------|-------------------|-------|
|                                 |         |         |         |         | 2023              | 2021  |
| PJSC "Myronivskyi Hliboproduct" |         |         |         |         |                   |       |
| Income                          | 1686531 | 1277512 | 1373600 | 1112823 | -19,0             | -34,0 |
| Net profit                      | -58847  | 13937   | -3268   | -34696  | -961,7            | +41,0 |
| Profitability, %                | -3,49   | 0,11    | -0,24   | -3,12   | -1200             | +10,6 |
| LENGTH, %                       | -2,8    | 0,4     | -0,3    | -2,6    | -766,7            | +7,1  |
| Liquidity                       | 1,52    | 1,61    | 1,68    | 1,55    | -7,7              | +2,0  |
| Agro Elite                      |         |         |         |         |                   |       |
| Income                          | 1708    | 1436    | 1489    | 1158    | -22,2             | -32,2 |
| Net profit                      | 204     | 101     | 100     | 66      | -34,0             | -67,6 |
| Profitability, %                | 11,95   | 7,06    | 6,70    | 5,67    | -15,4             | -52,6 |
| LENGTH, %                       | 10,8    | 8,1     | 7,4     | 6,2     | -16,2             | -42,6 |
| Liquidity                       | 1,42    | 1,47    | 1,50    | 1,45    | -3,3              | +2,1  |

| Showman                        | 2021  | 2022   | 2023  | 2024  | Change 2024 to, % |         |
|--------------------------------|-------|--------|-------|-------|-------------------|---------|
|                                |       |        |       |       | 2023              | 2021    |
| Ukrzernoprom-LAN               |       |        |       |       |                   |         |
| Income                         | 832   | 426    | 342   | 649   | +89,8             | -22.0   |
| Net profit                     | 306   | -131   | 74    | 135   | +82,4             | -55.9   |
| Profitability, %               | 36,75 | -30,83 | 21,73 | 20,77 | -4,4              | -43,5   |
| LENGTH, %                      | 18,2  | -9,4   | 12,6  | 14,1  | +11,9             | -22,5   |
| Liquidity                      | 1,30  | 1,18   | 1,42  | 1,55  | +9,2              | +19,2   |
| AF Zorya                       |       |        |       |       |                   |         |
| Income                         | 104   | 17     | 101   | 64    | -36,6             | -38.5   |
| Net profit                     | 5     | 3      | 36    | 21    | -41,7             | +320.0  |
| Profitability, %               | 4,47  | 16,40  | 35,90 | 33,21 | -7,5              | +642,3  |
| LENGTH, %                      | 5,1   | 7,8    | 14,2  | 12,9  | -9,2              | +152,9  |
| Liquidity                      | 1,25  | 1,33   | 1,48  | 1,52  | +2,7              | +21,6   |
| Agrocomplex of the Carpathians |       |        |       |       |                   |         |
| Income                         | 487   | 347    | 534   | 605   | +13,3             | +24.2   |
| Net profit                     | 5     | 1      | 22    | 127   | +477,3            | +2440.0 |
| Profitability, %               | 1,05  | 0,28   | 4,20  | 20,98 | +399,5            | +1898   |
| LENGTH, %                      | 3,2   | 2,1    | 6,8   | 15,4  | +126,5            | +381,3  |
| Liquidity                      | 1,10  | 1,12   | 1,35  | 1,60  | +18,5             | +45,5   |

Source: calculated by the authors based on enterprise's reporting

The analysis of the indicators given in Table 2 shows a significant differentiation of financial and economic results both in terms of the scale of activity and the dynamics of enterprise development. This reflects the heterogeneity of the industry environment and the different level of adaptability of enterprises to the conditions of digitalization and military-economic uncertainty. MHP, despite its status as a market leader with revenues in the range of USD 1.1–1.7 billion., demonstrates unstable financial dynamics: after a drop in income from USD 1686.5 million. in 2021 to USD 1277.5 million. in 2022 and partial recovery to USD 1373.6 million. In 2023, the company recorded a further decline in 2024 to USD 1112.8 million. Particular attention is drawn to the company's unprofitability in 2021 and 2024 (net loss – USD 58.8 million). and – USD 34.7 million. respectively) against the background of a single profitable 2022 (USD 1.4 million.), which indicates a significant impact of external shocks on the financial stability of even the largest enterprises in the industry. The ROA ranged from –2.8% to +0.4%, reflecting volatility in asset utilisation, although liquidity remained in the acceptable range of 1.52–1.68.

Agro Elite LLC, much smaller in scale (revenues of USD 1.2–1.7 million), demonstrates the opposite trend of deterioration of efficiency with relative stability of

turnover. Profitability steadily declined from 11.95% in 2021 to 5.67% in 2024 – a reduction of more than half, and net profit decreased by 50.4% in four years.

Ukrzernoprom-LAN demonstrates the most volatile dynamics among the entire sample: after a sharp drop in income from USD 832 thousand in 2021 to USD 342 thousand. In 2023, the company showed a rapid recovery to 649 thousand USD. in 2024 (+89.8% in USD terms to the level of 2023). A similar trajectory has a net profit — loss in 2022 (–USD 131 thousand.) was replaced by an increase to 135 thousand USD. In 2024, it is significant that the liquidity of the enterprise has been steadily improving – from 1.30 to 1.55, which indicates a gradual strengthening of the financial base despite operational fluctuations.

AF Zorya has the most dynamic efficiency growth among the entire sample, with profitability increasing from 4.47% in 2021 to a peak of 35.90% in 2023 and slightly decreasing to 33.21% in 2024, while ROA increased from 5.1% to 12.9%. Net profit for four years increased from USD 5 thousand to USD 21 thousand, which in terms of relative indicators is the best result in the sample and may indicate the successful implementation of local management and technological solutions.

"Agrocomplex Karpaty" demonstrates stable positive

dynamics in all key indicators: income increased from UAH 487 thousand. USD. to 605 thousand. USD. (+24.2%), net profit increased from USD 5 thousand to USD 127 thousand, profitability increased from 1.05% to 20.98%, and ROA increased from 3.2% to 15.4%. However, it should be borne in mind that these growth rates are largely due to the low base effect of 2021-2022, when the company was at the initial stage of increasing production capacity. Therefore, the interpretation of these indicators requires caution: the relative growth rates of a small enterprise are structurally incomparable with the dynamics of large and medium-sized sample subjects, which is a limitation of the comparative analysis of large-scale enterprises.

Summarizing the analysis of the indicators in Table 2, it is worth noting that it reveals a paradoxical pattern: the largest

enterprise in the sample (MHP) demonstrates the worst profitability and profitability indicators in 2024, while the smallest enterprises ("AF Zorya", "Agrocomplex Karpaty") demonstrate the highest relative efficiency. This confirms the hypothesis that in the context of digitalization and instability, scale alone does not guarantee financial stability – management flexibility, adaptation speed, and quality of investment decisions are decisive.

The results of the calculation of the Digital Maturity Index (Table 3) indicate a significant differentiation between enterprises in terms of the level of digitalization. The leader of the sample is MHP with IDZ = 0.79, which characterizes it as an enterprise with a high level of integration of digital technologies into production, logistics and management processes and brings it closer to the limit of "advanced digital transformation".

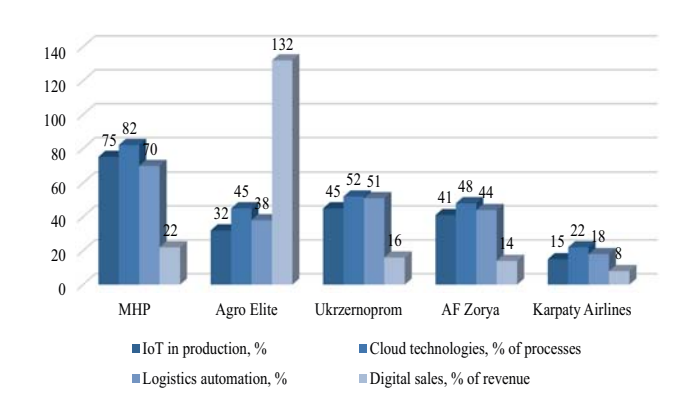
**Table 3. Digital Maturity Indicators of Enterprises, 2021–2024**

| Digitalization indicator            | MHP   | Agro Elite | Ukrzernoprom | AF Zorya | Karpaty Airlines |
|-------------------------------------|-------|------------|--------------|----------|------------------|
| ERP Systems (1–10)                  | 9     | 6          | 7            | 6        | 4                |
| IoT in production, %                | 75    | 32         | 45           | 41       | 15               |
| Cloud technologies, % of processes  | 82    | 45         | 52           | 48       | 22               |
| Logistics automation, %             | 70    | 38         | 51           | 44       | 18               |
| BI / Big Data (1–10)                | 8     | 5          | 6            | 5        | 3                |
| Digital sales, % of revenue         | 22    | 12         | 16           | 14       | 8                |
| Digital Maturity Index (IDZ)        | 0,79  | 0,47       | 0,56         | 0,51     | 0,29             |
| IDZ growth from 2021 to 2024 (p.p.) | +0,31 | +0,18      | +0,21        | +0,19    | +0,10            |

*Source: calculated by the authors based on enterprise's reporting*

The average level of digital maturity is demonstrated by Ukrzernoprom-LAN (0.56), Agro Elit (0.47) and Agrofirma Zorya (0.51), which indicates partial digital integration with the predominance of individual digital solutions over system transformation. These enterprises are characterized by fragmentation of digitalization, when the introduction of technologies is not accompanied by a complete restructuring of management processes. The lowest level of IDZ is in the Karpaty Agrocomplex (0.29), which indicates the initial stage of digital transformation and limited investment opportunities for the implementation of complex digital solutions (Figure 2).

**Figure 2. Main Digitalization Indicators of Enterprises**



*Source: calculated by the authors based on enterprise's reporting*



In general, all enterprises demonstrate positive IDZ growth dynamics in 2021-2024, which confirms the gradual transition of the agro-industrial sector of Ukraine from targeted digitalization to more systematic integration of digital technologies. At the same time, the persistence of a significant gap between the leader and other enterprises of the sample indicates the presence of structural digital asymmetry in the industry.

The indicators of Table 4 reflect the comparative characteristics of the parameters of adaptive management and the efficiency of digital investments in the enterprises of the agro-industrial complex of Ukraine for the period 2021–2024, combining organizational, innovative, technological, financial and managerial indicators, which allows assessing the level of their adaptability in the context of digital transformation.

**Table 4. Parameters of adaptive management and efficiency of digital investments, 2021–2024**

| Criterion                  | MHP        | Agro Elite | Ukrzernoprom      | AF Zorya          | Karpaty Airlines |
|----------------------------|------------|------------|-------------------|-------------------|------------------|
| Organizational structure   | Divisional | matrix     | linear-functional | linear-functional | linear           |
| Market reaction time, days | 3–5        | 6–9        | 8–12              | 9–13              | 14–20            |
| R&D in costs, %            | 4,2        | 2,8        | 2,1               | 1,9               | 0,8              |
| Startup pilots (pcs)       | 14         | 6          | 4                 | 3                 | 1                |
| Digital Investment ROI, %  | 31         | 22         | 18                | 17                | 13               |
| Availability of CDO        | 1          | 1          | 0,5               | 0                 | 0                |
| Cyber Defense (1-10)       | 8          | 6          | 6                 | 5                 | 4                |
| Adaptability Index (IA)    | 0,84       | 0,62       | 0,55              | 0,49              | 0,32             |

*Source: calculated by the authors based on enterprise's reporting*

The data obtained indicate a clearly expressed differentiation of enterprises by the level of organizational flexibility. MHP has the most complex and at the same time adaptive structure, which operates on the basis of a divisional management model, which provides a higher level of autonomy of business units and a faster response to changes in the market environment. As the scale and level of digitalization of enterprises decreases, there is a transition to less flexible organizational forms: from matrix in Agro Elite to linear-functional and linear in medium and small enterprises, which directly reflects a decrease in the level of managerial adaptability.

The indicator of reaction time to market changes demonstrates a systemic dependence on the level of digital maturity and organizational structure. In MHP, this figure is 3-5 days, which is a consequence of the high level of digitalization of management processes and decentralization of decision-making. At the same time, enterprises with linear structures, in particular AK Karpaty, increase the response time to 14-20 days, which confirms the presence of management delays and lower flexibility of business processes.

Innovation activity, measured by the share of R&D spending and the number of startup pilots, also differs

significantly between businesses. MHP demonstrates the highest values (4.2% of R&D and 14 pilot projects), which exceeds the industry benchmark of 3.0% and indicates a systematic approach to innovative development. At the same time, enterprises with a lower level of digitalization have much lower values of these indicators, which reflects the limited innovation resources and weaker integration of research activities into business processes.

The effectiveness of digital investments, estimated through the ROI of digital projects, also shows a clear gradation: from 31% in MHP to 13% in AK Karpaty. This confirms the provision that the effectiveness of digitalization is determined not only by the volume of investments, but primarily by the quality of their management support and the level of integration of digital solutions into the strategic management of the enterprise, it is enterprises with a more developed organizational structure and digital competencies that demonstrate a higher return on investment, even with a much larger scale of investments.

The institutional aspect of digital transformation is important, reflected in the Chief Digital Officer (CDO) indicator. Its presence in MHP and partly in Agro Elite indicates the formalization of the digital function in the management system, while in most other enterprises this element is either absent or is at the initial level of

implementation. The level of cyber protection also demonstrates a direct dependence on the scale and digital maturity of enterprises: MHP is the most protected (8 points), while small enterprises have lower values (4-5 points), which creates additional risks for their digital transformation.

The Integral Adaptability Index (IA), which summarizes all of the above parameters, reflects the overall ability of enterprises to quickly respond to changes in the environment, introduce innovations and effectively use digital investments. Its maximum value has MHP (0.84) corresponding to the highest level of adaptive control, while the lowest values in the Karpaty AK (0.31) indicate a limited capacity for structural transformation.

In general, the results of the analysis confirm that the adaptability of enterprises in the agro-industrial complex of Ukraine is determined not only by the volume of digital investments, but by a complex of interrelated factors, including organizational structure, level of innovation activity, institutionalization of digital functions and risk management. It is these factors that form different levels of efficiency of digital transformation and explain the existing differentiation between enterprises in the industry.

The indicators of Table 5 reflect the comparative characteristics of the regional business landscape of Ukraine, combining economic, digital and military-risk parameters that form the environment for the functioning of enterprises of the agro-industrial complex.

**Table 5. Analysis of the regional business landscape taking into account digitalization and military-risk impact**

| Indicator                                                          | Kyiv region | Kharkiv region | Odessa region | Dnipropetrovsk region | Lviv region |
|--------------------------------------------------------------------|-------------|----------------|---------------|-----------------------|-------------|
| Economic indicators                                                |             |                |               |                       |             |
| Volume of investments in the agro -industrial complex, million USD | 1240        | 620            | 580           | 710                   | 310         |
| Regional Competitiveness Index                                     | 0,68        | 0,59           | 0,61          | 0,63                  | 0,57        |
| Airborne Industrial Complex, USD million                           | 1627        | 814            | 994           | 1180                  | 445         |
| Dynamics of GVA 2020 –2023, %                                      | +38         | +27            | +31           | +35                   | +22         |
| Digitalization indicators                                          |             |                |               |                       |             |
| Digital Infrastructure Accessibility (1-10)                        | 8,2         | 6,8            | 7,1           | 7,3                   | 6,4         |
| Share of digital enterprises, %                                    | 34          | 22             | 25            | 28                    | 16          |
| Region Digital Readiness Index (IDR)                               | 0,83        | 0,64           | 0,69          | 0,72                  | 0,58        |
| Military risk indicators                                           |             |                |               |                       |             |
| Intensity of hostilities (1-10)                                    | 5           | 9              | 6             | 7                     | 3           |
| Level of infrastructure destruction, %                             | 12          | 38             | 18            | 22                    | 8           |
| Business Risk (1-10)                                               | 6           | 9              | 7             | 7                     | 4           |
| Business relocation, %                                             | 15          | 42             | 18            | 25                    | 12          |
| Military Risk Impact Index (IWR)                                   | 0,42        | 0,83           | 0,54          | 0,63                  | 0,31        |

Source: calculated by the authors based on enterprise's reporting

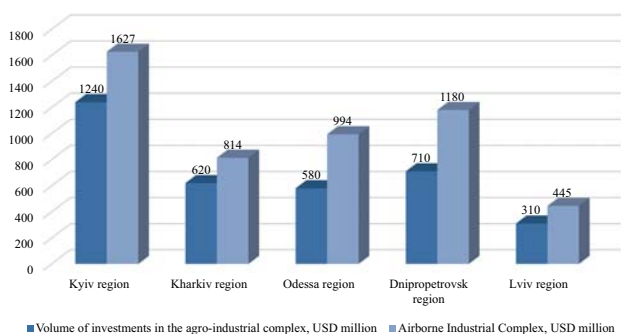
The economic block of Table 5, Figure 3 demonstrates the unevenness of investment activity and the scale of production between regions. Kyiv region concentrates the largest volumes of direct investments in the agro-industrial complex and forms the highest level of gross value added, which indicates its leading role as a financial and economic center. Dnipropetrovsk and Odesa regions occupy intermediate positions, combining a sufficient level of investment with relatively stable growth dynamics. On the

other hand, the Lviv region is characterized by a lower scale of economic activity, which limits its investment potential, despite relatively favorable security conditions.

The digital block, represented by indicators of the availability of digital infrastructure and the share of active enterprises, is complemented by the integral index of digital readiness of the region (IDR), which summarizes the ability of the regional environment to support the digital

transformation of business. The highest IDR values are typical for the Kyiv region, which reflects the concentration of technological resources, developed infrastructure and a high level of penetration of digital practices in the business environment. Dnipropetrovsk and Odesa regions demonstrate an average level of digital readiness, while Lviv and especially Kharkiv regions lag behind in this indicator, which is partly explained by restrictions on access to resources and infrastructure.

**Figure 3. Volume of investments in the agro-industrial complex and the Airborne Industrial Complex in Ukraine's regions**



The military-risk block, represented by the IWR index, allows you to quantify the impact of security factors on economic activity. The results indicate a significant asymmetry: the Kharkiv region is characterized by the highest IWR value, reflecting the high intensity of hostilities, significant destruction of infrastructure and increased risks of doing business. Dnipropetrovsk and Odesa regions are in the medium risk zone, while Kyiv region demonstrates a moderate level of military influence. The lowest IWR value was recorded for the Lviv region, which confirms its relatively stable security environment.

The integral analysis shows that there is an inverse relationship between the Digital Readiness Indices (IDR) and the Military Risk Impact (IWR): high-risk regions tend to have limited opportunities for the development of digital infrastructure and the adoption of digital technologies. At the same time, the Kyiv region demonstrates the ability to partially compensate for war risks due to a high concentration of capital and technological resources, which ensures a relatively high level of digital readiness even in the presence of external threats.

The results obtained confirm that the regional business landscape in modern conditions is formed under the simultaneous influence of economic, technological and security factors, and the latter act as a significant limitation on the effectiveness of investments in digitalization. This justifies the need to take into account the index of military risk impact along with indicators of digital readiness when forming investment strategies of enterprises, since ignoring this aspect leads to an overestimation of the potential effectiveness of digital transformations.

Conclusions. Generalization of the results obtained indicates that the study made it possible to form a holistic analytical model of the relationship between digitalization, adaptability of management and financial performance of enterprises of the agro-industrial complex of Ukraine, taking into account regional specifics and military-risk environment. In contrast to traditional approaches, the paper substantiates the need to integrate digital, economic and security factors into a single system for adopting managerial and investment decisions.

The analysis of the financial and economic indicators of enterprises for 2021–2024 confirmed the presence of a significant differentiation in their performance, which cannot be explained solely by the scale of activities or industry specifics. It has been found that enterprises with a higher level of digital maturity demonstrate more stable income dynamics, better profitability indicators and higher liquidity even in conditions of instability. This confirms the hypothesis of the systemic impact of digitalization on the financial efficiency of business.

The developed and tested Digital Maturity Index (IDZ) made it possible to formalize the level of digital technology adoption at enterprises and ensure their correct comparison. The obtained IDZ values showed the existence of a significant gap between the leading enterprises and the majority of agricultural entities that are at the initial stages of digital transformation. This indicates the uneven digital development of the industry and the limited diffusion of innovations.

The key result of the study was the confirmation of the close relationship between digitalization and management adaptability. The formed Adaptability Index (IA) has demonstrated that enterprises with a higher level of digital

integration, developed analytical tools and the presence of specialized digital units are characterized by a much faster response to changes in the market environment and higher efficiency of management decisions. At the same time, it has been established that the volume of investments in digitalization is not a determining factor in itself – the quality of their integration into the management system is crucial.

The inclusion of the Military Risk Impact Index (IWR) in the analytical model made it possible to quantify the impact of security factors on the economic activities of enterprises. The results obtained showed that the military factor acts as a systemic constraint on the effectiveness of digital investments, reducing their return and complicating the implementation of long-term strategies. It has been established that even with a high level of digital readiness of the region, the negative impact of high IWR values can significantly neutralize the potential effects of digitalization.

Additionally, the role of the region's Digital Readiness Index (IDR) as a determinant of investment activity of enterprises in the field of digital technologies is substantiated. It has been proven that regions with a developed digital infrastructure and a high share of digital enterprises create favorable conditions for the introduction of innovations, which has a positive effect on the level of digital maturity of business. At the same time, an inverse relationship between IWR and IDR has been revealed, which confirms the destructive impact of war risks on the digital development of regions.

As a result, a generalized cause-and-effect model has been formed, according to which regional conditions (IDR) and military risk factor (IWR) determine the level of digitalization of the enterprise (IDZ), which, in turn, affects the adaptability of management (IA) and financial performance. This approach allows you to move from fragmentary analysis to a systematic understanding of business transformation processes in the context of digitalization and instability.

The practical significance of the results obtained lies in the possible use of the proposed model to justify investment decisions in the field of digitalization, taking into account regional and security restrictions. The proposed indices can

be used as tools for diagnosing the level of digital maturity of enterprises, assessing their adaptability, and predicting the effectiveness of investments in digital projects.

Prospects for further research are related to the deepening of quantitative analysis of the relationship between digitalization and financial results by expanding the sample of enterprises and using more complex econometric models. A relevant area is also the study of time lags between investments in digitalization and the economic effects obtained, as well as the development of scenario models for the development of enterprises, taking into account different levels of military-risk load. Special attention should be paid to the study of mechanisms for increasing the sustainability of digital business models in the post-war period and the formation of tools for integrating the state policy of economic recovery with the processes of digital transformation of enterprises.

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