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Digitalization of control and accounting processes of agricultural enterprises: Risk assessment and management

Natalia Potryvaieva*

Doctor of Economic Sciences, Professor
Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine
<https://orcid.org/0000-0002-9781-6529>

Maryna Dubinina

Doctor of Economic Sciences, Professor
Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine
<https://orcid.org/0000-0002-3993-0622>

Yuliia Cheban

PhD in Economic Sciences, Associate Professor
Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine
<https://orcid.org/0000-0002-8231-2918>

Svitlana Syrtseva

PhD in Economic Sciences, Associate Professor
Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine
<https://orcid.org/0000-0003-4824-3741>

Olha Luhova

PhD in Economic Sciences, Associate Professor
Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine
<https://orcid.org/0000-0003-4432-0295>

► **Abstract.** The digitalization of control and accounting processes is a requirement of the present day due to the wide opportunities to increase competitiveness and efficiency of activities that it provides to enterprises of any industry. The aim of the study was to analyse the effectiveness of digitalization of control and accounting processes to ensure the achievement of the main objectives of agricultural enterprises. The present study used the method of statistical analysis, descriptive and comparative methods, as well as SWOT and PEST-analysis. The study found that the market for software products for agricultural enterprises continues to grow, with a growth rate of 13.5% per year. It was noted that agricultural enterprises can gain significant advantages with the use of new software products, which will increase the speed, accuracy, transparency, and accessibility of control and accounting processes. The paper examined the capabilities of Enterprise Resource Planning systems, which have a wide range of functionality and mostly meet the needs of large agricultural enterprises. The study also covered the consideration of alternative control and accounting tools that may be more suitable for small and medium-sized enterprises due to their simplicity, targeted focus and low implementation costs. Through an assessment of Ukraine's agricultural sector, the paper proves the importance of agriculture for the state, which explains the need for close attention to digitalization processes in the sector. BAS

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*Corresponding author



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AGRO. ERP is considered as an effective system for implementing control and accounting at national agricultural enterprises. As a result of the study, the opportunities and threats, weaknesses and strengths of the digitalization of control and accounting processes in general were noted. It also identified political, economic, social and technological factors that influence these processes in Ukraine

► **Keywords:** agriculture; software products; innovations; Enterprise Resource Planning; financial management; audit

► Introduction

On a global scale, the use of digital products by agricultural enterprises means increasing their ability to meet the more stringent requirements that modern consumers and contractors place on the industry and to meet ever-growing demand. Therefore, the use of certain digital tools to simplify and improve operations is no longer an option, but a requirement for maintaining competitiveness.

The digitalization of control and accounting processes of agricultural enterprises involves the use of certain digital tools to simplify and improve the efficiency of such processes. Big Data (Agostino *et al.*, 2022), Artificial Intelligence (Hasan, 2021), Blockchain (Maiti *et al.*, 2021; Alkan, 2022), Internet of Things (IoT), etc. are actively implemented in the development of such solutions and tools (Kurhan *et al.*, 2023). The software that can be used for these purposes includes various digital platforms, systems (including Enterprise Resource Planning (ERP)), websites, mobile applications, and computer programs (Alam & Hossain, 2021; Gherman *et al.*, 2021). These tools can be involved in planning, optimisation, evaluation, control, monitoring, and other processes, and can also contribute to cost reduction, compliance with legal requirements, and risk management, as noted by M. Bergmann *et al.* (2020) and M.J. Gonçalves *et al.* (2022). In particular, P. Visconti *et al.* (2020), and B. Ramteke & S. Dongre (2022) point out that a single tool can perform both one specific function, such as financial management of an enterprise, and a set of tasks, from accounting to weather forecasting.

Agriculture is one of Ukraine's leading industries and generates a significant share of value added, which in pre-war times exceeded 10% of gross domestic product (GDP) (Semenenko *et al.*, 2021). The war has affected Ukraine's agricultural sector, but agricultural enterprises continue to operate and improve their performance. V. Goi *et al.* (2023) emphasise that the digitalization of control and accounting processes in times of war is of particular importance, as it allows these processes to be implemented remotely and provides access to real-time accounting information from any location. However, this is not the only advantage of digitalization of control and accounting processes, as new technologies can, among other things, increase their speed, accuracy, transparency and efficiency, as noted by I. Lomachynska *et al.* (2023). The analysis shows that the digitalization of control and accounting processes in agricultural enterprises significantly improves their ability to meet modern requirements and meet growing demand. However, further research is needed to fully understand the effectiveness of digitalization in wartime and to identify the most optimal solutions. Therefore, the purpose of this study was to assess the effectiveness of digitalization of control and accounting processes in ensuring the

implementation of the strategic goals of agricultural enterprises. Objectives of the study were outlining the key trends in the market of digital products for the agricultural sector; and describing the use of software solutions to optimise the control and accounting process in Ukraine on the example of BAS AGRO. ERP; conducting a SWOT-analysis and PEST-analysis of the digitalization of control and accounting processes at agricultural enterprises.

► Materials and methods

The study used a comprehensive system of scientific methods that allowed solving the research objectives and, ultimately, achieving its main goal. To describe the key trends in the development of digital products for the agricultural sector, the method of statistical analysis combined with graphical methods was used. This made it possible to assess the current state of the global market for software products for agricultural enterprises, as well as to note the forecast prospects. An indicator that characterises the state of the global market for software products for agricultural enterprises is the size of the market for such software products, expressed in billions of United States dollars (USD). In addition, statistical and graphical methods played a key role in characterising the agricultural sector of Ukraine and other European countries. In particular, their use made it possible to determine Ukraine's place among European countries in terms of the share of value added in agriculture, forestry, and fisheries. For this purpose, the indicators of value added in agriculture, forestry, and fisheries expressed in US dollars and value added in agriculture, forestry, and fisheries expressed as a percentage of GDP were used. The relevant data for the analysis are publicly available on the official website of the Agriculture, forestry, and fishing, value added (current US\$) (n.d.), Agriculture, forestry, and fishing, value added (% of GDP) (n.d.), as well as on the Digital Agro of Ukraine 2024 resource.

The descriptive and comparison methods allowed characterising the capabilities of ERP systems in relation to performing the same actions without implementing ERP. The use of these methods made it possible to describe the main advantages of implementing ERP systems and identify their disadvantages. The identified disadvantages have led to the need to consider and evaluate alternative software products for control and accounting at individual agricultural enterprises. A list of the most popular of these software products is available on the Capterra website (Capterra, n.d.). In the course of reviewing these tools, a comparative analysis was also applied, which allowed us to compare the functions of alternative software products. Among them are Forms On Fire, Granular, Aegro, Kizeo

Forms, Traction, Farmbrite, Agworld, Cropwise Operations, Harvest Profit, EasyKeeper, CropTracker, Conservis, Nax Solutions, fieldmargin, Bushel Farm, OERCA, Farm Service Manager, Work&Track Mobile, AGRIVI, Horse Report System, EasyFarm, MyCrops, TraceX Tech, Blue Skies Accounting, HeavyConnect, +Gestão, Cropolis, Agri360, Farm Matters, EOSDA Crop Monitoring. The descriptive method was additionally used to characterise the features of such a solution as BAS AGRO. ERP, which made it possible to describe the main functions of this system, its cost and suitability for the different needs of agricultural enterprises.

A special place in the study is given to the methods of SWOT-analysis and PEST-analysis. The application of these methods allowed us to summarise and generalise the results obtained using other scientific methods and approaches. Thus, the SWOT-analysis, designed to identify strengths and weaknesses, as well as opportunities and threats of certain phenomena, processes, etc., allowed assessing these aspects in relation to the digitalization of control and accounting processes at agricultural enterprises. PEST-analysis allows for describing the impact of external factors on the activities of the industry as a whole, a particular enterprise, etc. In the context of the study, the PEST-analysis was used to characterise the impact of the

political, economic, social and technological environment on the digitalization of control and accounting processes at agricultural enterprises (on the example of the agricultural sector of Ukraine).

► Results

The global market for digital products for the agricultural sector is actively developing and offering new solutions for agricultural enterprises of all forms of ownership and size. The main technologies involved in this process include artificial intelligence and machine learning, which solve the problem of analysing large amounts of data, as well as the IoT. According to analytical reports, cloud technologies are preferred due to their accessibility, so the share of these technologies, relative to other technologies (local and web-based) will reach 65% over the study period. Comprehensive software solutions for agricultural enterprises, such as ERP systems and other software solutions for managing an agricultural enterprise, are of great importance. In addition to increasing efficiency in the production process, such solutions provide agricultural enterprises with convenient and reliable tools for optimizing control and accounting processes. The market for agricultural software is expected to grow further in the future (Fig. 1).

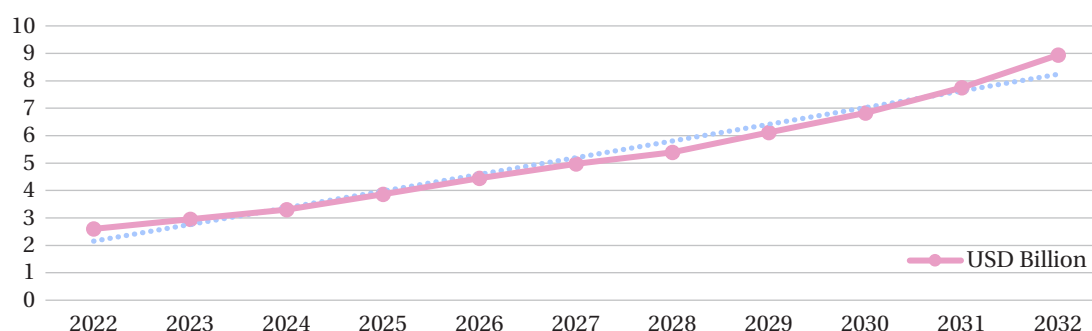


Figure 1. Global market of software products for agricultural enterprises

Source: compiled by the authors

To the data shown in Figure 1, it is worth adding that the market will grow at an average annual rate of 13.5%. The primary driver of growth is the rapid development of technology, but its implementation is not an end in itself, but brings concrete tangible results in the form of simplification and optimization of many processes from finance to production. For example, simplified accounting helps to reduce time and material costs (labour, office space, etc.). Optimisation means more accurate and faster approaches to analysis, evaluation and forecasting, in particular, it improves accuracy in agriculture, providing the basis for more effective decisions to increase yields and maximise profits. At the same time, businesses need to consider potential challenges to technology adoption: high costs, underdeveloped technological infrastructure in rural areas, and a lack of awareness and skills.

Key areas that can be optimised by digital technologies, in particular through the use of specialised applications, encompass: yield monitoring and field inspection,

irrigation, inventory and labour management, field mapping, weather forecasting, and financial management. Often, software providers offer comprehensive solutions, such as ERP systems designed for resource planning and integrating all key business processes into a single ecosystem (Iorgachova & Kovalova, 2023). These systems are able to combine components such as management (personnel, customer, and contractor relations, production, land, inventory, and equipment), data analysis, logistics, and reporting and financial accounting. The latter component deserves special attention in the context of the research topic, so it is advisable to describe in detail the goals of ERP application within this component.

In general, in the context of financial management, ERP systems can optimise the accounting process, improve budgeting, and help to increase the accuracy and minimise errors in reporting. Below is a comparative table of traditional approaches to performing financial transactions and approaches using ERP (Table 1).

Table 1. Comparative table of traditional approaches to financial operations and approaches using ERP

Name of the operation	Traditional design	Execution using ERP
Cost control	Manual data entry, which can increase the risk of errors	Improving input accuracy with automatic recording
Generating reports	Requires a high time investment	Generating accurate reports without time-consuming expenses, access to data at any time
Accounts receivable and payable management	May be accompanied by time delays, tracking issues	Cash flow optimization, automatic notifications
Calculation of profitability	Probability of errors in calculations	Accuracy, support for management decision-making
Risk management	A reactive approach – by determining mistakes that have already been made that can affect efficiency and lead to additional problems	Proactive approach – automatic verification and early detection of inaccuracies

Source: compiled by the authors based on data by J. Schrijvers (n.d.)

Thus, the main advantages of using ERP in the control and accounting process include increased accuracy and transparency, minimization of errors, acceleration of processes, cost reduction, and provision of information for making sound management decisions in a convenient form. At the same time, the implementation of full-fledged ERP systems faces numerous barriers. Firstly, it is worth noting that these systems are more suitable for medium and large agricultural enterprises, given the need to manage complex multi-stage processes. In addition, such enterprises have better financial capabilities and can therefore afford to implement ERP systems, which are expensive. Also, one of the significant barriers is the complexity of implementing ERP systems, which involves the involvement of a third party, high time costs, and the need for extensive training and adaptation of staff. The need to integrate with existing systems and customise them to meet the specific goals of a particular enterprise can also be a significant problem due to a lack of flexibility. At the

same time, it is important to ensure reliable storage and transfer of data in the system, as improper use and configuration can lead to data loss.

As an alternative to complex ERP systems, simpler and less expensive software solutions can be considered. These software products are designed primarily to solve specific tasks, but can also be comprehensive. As a rule, these solutions have a narrower functionality, in particular, for analysing and reporting, but they can fully meet the needs of individual enterprises, especially small and medium-sized ones. The main advantages of such tools include ease of use, focus on specific tasks and goals, low cost, ease, and speed of implementation, greater flexibility and, as a rule, no need for integration with other systems.

Table 2 shows a list of popular software solutions for solving certain tasks of agricultural enterprises, in particular, for optimising control and accounting processes. These are the top 30 most popular applications with a rating of at least 4.5 according to Capterra (n.d.).

Table 2. Comparison of the functionality of popular software solutions for managing an agricultural enterprise

Programme	Forms On Fire	Granular	Aegro	Kizeo Forms	Traction	Farmbrite
Rating	4.7	4.7	4.5	4.6	4.9	4.8
Built-in Accounting	—	Yes	—	—	Yes	Yes
Financial management	—	—	Yes	—	Yes	Yes
Production tracking	Yes	Yes	Yes	Yes	Yes	Yes
Crop/livestock management	Yes	Yes	YesWw	Yes	Yes	Yes
Inventory management	Yes	Yes	Yes	Yes	Yes	Yes
Traceability	Yes	Yes	—	Yes	Yes	Yes
Field mapping	Yes	Yes	Yes	Yes	Yes	Yes
Labour management	Yes	Yes	Yes	Yes	Yes	Yes
Weather records	Yes	—	—	—	—	Yes
Programme	Agworld	Cropwise Operations	Harvest Profit	EasyKeeper	CropTracker	Conservis
Rating	4.5	4.5	4.8	5	4.5	4.5
Built-in Accounting	Yes	—	—	—	—	Yes
Financial management	Yes	—	—	—	—	Yes
Production tracking	Yes	—	Yes	Yes	Yes	Yes

Table 2, Continued

Crop/livestock management	Yes	Yes	Yes	Yes	Yes	Yes
Inventory management	Yes	—	—	—	Yes	Yes
Traceability	Yes	Yes	—	Yes	Yes	Yes
Field mapping	Yes	—	—	—	Yes	Yes
Labour management	Yes	Yes	—	—	Yes	Yes
Weather records	Yes	—	—	—	Yes	Yes
Programme	Nax Solutions	fieldmargin	Bushel Farm	OERCA	Farm Service Manager	Work&Track Mobile
Rating	4.5	4.9	4.8	4.5	4.8	4.6
Built-in Accounting	—	—	—	—	—	—
Financial management	—	—	Yes	—	—	—
Production tracking	Yes	Yes	Yes	—	Yes	—
Crop/livestock management	Yes	Yes	Yes	—	—	—
Inventory management	Yes	—	Yes	Yes	Yes	—
Traceability	—	Yes	Yes	—	Yes	—
Field mapping	Yes	Yes	Yes	—	—	Yes
Labour management	—	Yes	Yes	—	Yes	—
Weather records	Yes	Yes	Yes	Yes	—	—
Programme	AGRIVI	Horse Report System	EasyFarm	MyCrops	TraceX Tech	Blue Skies Accounting
Rating	4.7	5	4.6	5	5	4.8
Built-in Accounting	Yes	—	Yes	Yes	—	Yes
Financial management	Yes	—	—	Yes	—	—
Production tracking	Yes	—	Yes	Yes	—	—
Crop/livestock management	—	Yes	Yes	Yes	—	Yes
Inventory management	Yes	Yes	Yes	Yes	Yes	—
Traceability	Yes	—	Yes	Yes	—	—
Field mapping	Yes	—	—	Yes	—	—
Labour management	Yes	—	Yes	Yes	—	Yes
Weather records	Yes	—	Yes	—	—	—
Programme	Heavy Connect	+Gestão	Cropolis	Agri360	Farm Matters	EOSDA Crop Monitoring
Rating	5	4.6	5	5	4.8	5
Built-in Accounting	—	Yes	Yes	—	—	—
Financial management	—	Yes	—	—	—	—
Production tracking	—	Yes	Yes	Yes	—	—
Crop/livestock management	—	Yes	Yes	Yes	Yes	Yes
Inventory management	—	Yes	Yes	Yes	Yes	—
Traceability	Yes	Yes	Yes	Yes	Yes	—
Field mapping	—	Yes	—	—	—	Yes
Labour management	Yes	—	—	Yes	—	—
Weather records	—	—	—	—	—	Yes

Source: compiled by the authors

As can be seen from Table 2, most of the proposed software solutions are capable of performing more than one task in the field of agricultural enterprise management. These solutions take advantage of the advances in Big Data, Blockchain IoT, Artificial Intelligence and other modern technologies. Many of these applications can solve the tasks of reporting and financial management. At the same time, the cost of using software products is minimal, for example, Farmbrite, which can perform all the

tasks listed in the table, costs USD 39 per month with the possibility of free use during a certain trial period.

Optimization of processes in Ukraine's agricultural sector is critical for the country's economy as a whole, as agriculture is becoming one of the priority sectors of the economy for developing countries. Comparing the results of Ukraine and other European countries in terms of value added in agriculture, forestry and fisheries, it is worth noting that Ukraine ranks sixth in Europe by this indicator (Fig. 2).

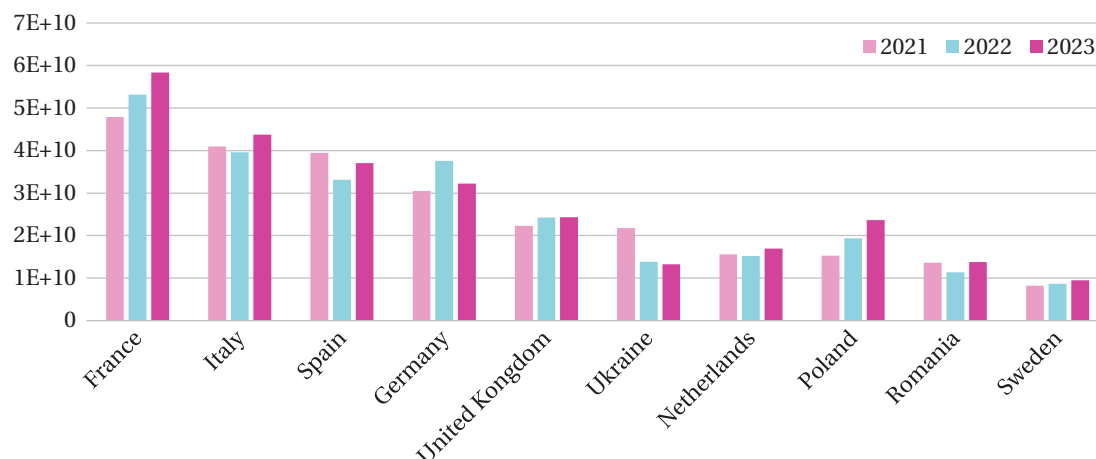


Figure 2. Value added in agriculture, forestry, and fisheries (USD)

Source: compiled by the authors based on the Agriculture, forestry, and fishing, value added (current US\$) (n.d.)

As can be seen in Figure 2, over the last three years (2021-2023), Ukraine's score was highest in 2021 and almost reached the level of the UK. However, the war in Ukraine has had a significant impact on the agricultural sector, and in 2022-2023, the indicator dropped significantly. Thus, in 2021, the value added was more than

USD 21.7 billion, in 2022 – about USD 13.89 billion, and in 2023 – about USD 13.24 billion.

When examining the value added in agriculture, forestry, and fisheries as a percentage of GDP, it should be noted that Ukraine ranks second among European countries (Fig. 3).

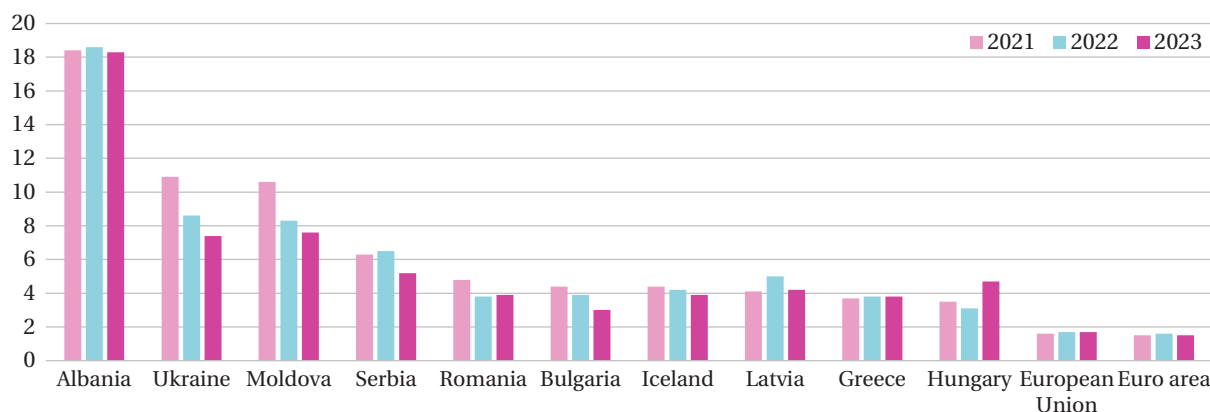


Figure 3. Value added in agriculture, forestry, and fisheries (% of GDP)

Source: compiled by the authors based on the Agriculture, forestry, and fishing, value added (% of GDP) (n.d.)

Figure 3 shows that the value added in agriculture, forestry, and fisheries as a percentage of Ukraine's GDP declined by about 3.5 per cent over the three years under review. However, it is still significantly higher than the European average and the European Union average, which are 1.5 and 1.7 per cent, respectively. The above data confirms the importance of Ukrainian agriculture not only for the country itself, but also for ensuring food security in Europe and the world as a whole. Therefore, the issue of increasing efficiency in the agricultural sector should be high on the agenda of Ukraine and its partners. Digitalization plays a pivotal role in this process.

Increasing the competitiveness of the industry relies heavily on the introduction of innovative technologies, both in the production process (e.g., the use of the latest systems to track fertiliser application levels) and in the optimization of other areas of activity (e.g., accounting automation). Among the most popular innovations in the agricultural sector in Ukraine are autopilots, sectional nozzle

shutdown technologies for protection, drone application and telematics. More than half of innovative agricultural enterprises also use online document management, and about 40 per cent use outdated accounting software (or similar). Only about 19 per cent of agricultural enterprises use software solutions such as those described in Table 2.

Application of software solutions to optimise the control and accounting process in Ukraine on the example of BAS AGRO. ERP. Given the importance of agriculture for Ukraine and the large number of large and medium-sized agricultural enterprises, it is advisable to consider in more detail the possibilities of implementing ERP systems at such enterprises. As noted above, such systems are complex and integrate numerous tasks into a single ecosystem. An important component of such systems is analytics and reporting modules. One of the most popular in Ukraine is the BAS AGRO. ERP system, which contains a powerful arsenal for controlling and accounting for the financial and economic activities of agricultural enterprises.

BAS AGRO. ERP provides opportunities for automating all types of accounting at agricultural enterprises, as well as for planning and optimising business processes. This solution meets the needs of large and medium-sized agricultural enterprises. The main functions of the system include: automation of business processes; business planning; budgeting; determination of material requirements; detailed operational accounting; automation of accounting (land and settlements, services and works, expenses); analysis and planning of divisions; cost analysis, etc.

The cost of BAS AGRO. ERP costs UAH 259,200, but there are also some industry-specific solutions available. For example, the cost of "BAS AGRO. Integrated Enterprise Management. Crop production" equals UAH 39,000. There are also solutions for the livestock industry, as well as separate offers for grain storage facilities, mills, and feed mills. A separate solution, "BAS AGRO. Accounting", costs UAH 14,440. The example of BAS AGRO shows that solutions for the digitalization of agricultural enterprises in general and control and accounting processes in par-

ticular can be very flexible and adapt to the specific capabilities and needs of enterprises. The main task of managers before making a decision to implement a particular system or software product is to define clear goals and the future implementation process, taking into account the needs and problems that may arise in this process.

The evaluation of the effectiveness of digitalization of control and accounting processes in ensuring the implementation of strategic goals of agrarian enterprises by means of SWOT-analysis and PEST-analysis. The assessment of the effectiveness of digitalization of control and accounting processes in ensuring the implementation of strategic goals of agricultural enterprises was carried out by conducting a SWOT-analysis. This allowed characterizing the strengths and weaknesses of the introduction of digital technologies, as well as the relevant opportunities and threats. The results of the analysis are general, i.e., they adequately describe the aspects of digitalization of control and accounting processes in the agricultural sector both in Ukraine and in other countries (Table 3).

Table 3. SWOT-analysis of digitalization of control and accounting processes in ensuring the implementation of strategic goals of agricultural enterprises in Ukraine and other countries

Strengths	Weaknesses
Optimization of control and accounting processes by speeding them up, increasing accuracy, saving resources, and minimising errors. Real-time access to data and monitoring, which allows for timely management decisions Greater control capabilities by tracking transactions, activities, and products. Reduced labour and office costs. Promotion of digitalization by the state.	Depending on the software product chosen, there may be high upfront costs for implementation, training, and integration. Insufficient funding. Lack of highly skilled workers with relevant knowledge in agriculture and information technology. The need to ensure the security of data and information due to the possibility of data leakage or hacker attacks. Underdeveloped technological infrastructure, especially in remote areas.
Opportunities	Threats
Thanks to the automation of a number of routine tasks, employees of agricultural enterprises can have additional time to solve more important tasks. The ability to work remotely can solve problems related to quarantine restrictions, military operations, and other negative phenomena. The use of systems such as ERP allows for greater opportunities for integration with new technologies that provide additional benefits to businesses, ensuring high competitiveness and innovation. In particular, blockchain can increase transparency of operations, and the IoT can be used to optimise resource management. Accurate reporting and real-time access to information enables better risk management. The use of digital tools allows adapting more efficiently and quickly to changes in the legal framework and the market.	Economic instability, the presence of political and/or military conflicts in the country may slow down the digitalization process and reduce the investment attractiveness of agricultural enterprises. The need to meet the demands of rapidly evolving technology and competition can affect the performance of less resilient businesses. Cybersecurity breaches, which can lead to data leaks and significant material losses, as well as damage to reputation and customer confidence.

Source: compiled by the authors

The SWOT-analysis suggests that digitalization itself is mostly beneficial, except for the risk of cyberattacks. Most of the factors identified as weaknesses and threats to digitalization are related to insufficient capabilities of the enterprises themselves or the environment in which they operate. Regarding the environment, it is relevant to note that the state plays a leading role in the digitalization process, providing appropriate legislative and financial support, promoting infrastructure development and improving educational programmes in the field of information

and communication technologies. A general assessment of the environment should be carried out using a PEST-analysis, which will allow describing the political, economic, social and technological factors influencing the digitalization of control and accounting processes at agricultural enterprises. In the context of the study, this type of analysis covers a narrower scale than the SWOT-analysis, the results of which are suitable for many countries. In turn, the PEST-analysis focuses on Ukrainian conditions in order to take into account national peculiarities (Table 4).

Table 4. PEST-analysis of digitalization of control and accounting processes in ensuring the implementation of strategic goals of agricultural enterprises in Ukraine

Political factors	Economic factors
The government's efforts to ensure digitalization in various areas are increasing, providing financial and legislative support for this process. Given the rapid development of technology, regulations may not take into account certain aspects of regulation or may lag significantly behind changes in the technological environment. European integration processes in Ukraine, on the one hand, increase the burden on the political, economic, and other activities in the country due to the need to meet new standards and high requirements. On the other hand, this stimulates the introduction of the latest technologies, which contributes to improving product quality and raising living standards in general. Moreover, Ukraine and individual enterprises have the opportunity to access financing and grants, as well as to exchange experience with advanced countries. The war in Ukraine has significantly slowed down the process of digitalization and affected the investment attractiveness of businesses, especially those located in the areas of hostilities. The recovery from the war, which is still taking place in the country, may be lengthy.	Economic instability caused by the war and other factors is impeding access to financial resources. The investment climate in Ukraine has also been severely affected by the war, which is depriving the country and its agricultural enterprises of additional opportunities for development. Sustainable economic development cannot be imagined without technological innovations, so the digitalization of control and accounting processes is in line with the Sustainable Development Goals, such as Sustainable Development Goal 9 – industry, innovation and infrastructure, and Goal 8 – decent work and economic growth.
Social factors	Technological factors
Ukraine has a strong potential in terms of the number and qualifications of information and communications professionals. However, many workers are moving abroad, including due to the war, so the lack of qualified personnel may affect the efficiency of digitalization processes. The development of technology can lead to a reduction in the number of jobs due to automation, so professionals in the sector need to make efforts to develop new skills. The perception of innovations plays an important role, as the resistance of employees to change can be an obstacle to an effective digitalization process.	Rapid technological development makes digitalization not an option but an objective necessity. The availability of adequate technological infrastructure, such as Internet access, is critical. Such infrastructure may be underdeveloped in Ukraine, especially in remote areas. The agricultural sector is quite receptive to innovations to improve yields, determine fertiliser levels, etc., which provides fertile ground for their introduction into all areas of agricultural business.

Source: created by the authors

In conformity with the results of the PEST-analysis, Ukraine currently lacks the capacity to successfully implement the digitalization process, primarily due to the war. However, even in difficult circumstances, the digitalization process cannot be completely stopped. It is now necessary to intensify work on legislative support for the digitalization process, creating favourable conditions for Ukrainian specialists in the field of information and communication technologies, expanding access to the Internet, developing digital literacy of Ukrainians, etc.

► Discussion

The study fills the identified gaps in scientific works on the digitalization of control and accounting processes at agricultural enterprises. In particular, the study identified not only the advantages and opportunities, but also the risks, threats, and weaknesses of the digitalization of control and accounting processes. These barriers and shortcomings relate primarily to the limited capabilities of agricultural enterprises (financial, human, etc.) and the limitations of the operating environment (underdeveloped infrastructure, legislative framework, etc.). The study focused not only on digitalization at large and medium-sized agricultural enterprises, but also sought to assess digital solutions for small businesses. The

solutions considered in the study are comprehensive and use a wide range of new technologies, including Artificial Intelligence, Big Data, Blockchain IoT, etc.

In order to maximise the disclosure of all the above aspects, the article outlines the main trends in the market of digital products for agricultural enterprises, reveals the advantages of ERP systems and alternative software solutions for control and accounting, provides an assessment of the agricultural sector of Ukraine, and conducts a SWOT-analysis and PEST-analysis of the digitalization of control and accounting processes at agricultural enterprises. The results obtained should be compared with the conclusions of scientists to define potential opportunities for improvement and further research.

The optimisation of control and accounting processes at agricultural enterprises is an essential topic in recent research by Ukrainian scientists (Dubiniina *et al.*, 2022; Potryvaieva & Palieiev, 2023; Verbiivska *et al.*, 2023). The author of this study took into account the results of the work of S. Ihnatenko & I. Tomashuk (2024), who outlined the functionality of popular technologies and information systems used in the agricultural sector today. Similarly to M. Petchenko *et al.* (2023), the researchers identified the most influential trends in digitalization and automation, which include the integration of

ERP systems, accounting automation, and the use of the IoT, Big Data, and analytics. The researchers identify the key benefits of digitalization in the accounting of agricultural enterprises, including improved management, increased productivity, and reduced costs and risks. At the same time, the problems of implementing digital technologies in the field of research are not sufficiently addressed in the work of scientists. S. Ihnatenko & I. Tomashuk limit themselves to remarks on high initial costs, the need for staff training and problems with the integration of new technologies. In the author's opinion, in the course of studying the digitalization of control and accounting processes at an agricultural enterprise, it is advisable to pay more attention to the advantages and opportunities, as well as the problems and risks of this phenomenon.

The work of I. Shepel (2023), which the author relied on in the course of his own research, reveals the capabilities of the ERP system for agricultural enterprises BAS AGRO. ERP. This paper contains an in-depth assessment of this system, including a detailed description of various variations and modules of the system. At the same time, the paper does not consider alternatives to the BAS AGRO. ERP, which leaves out the digitalization of control and accounting processes at small enterprises. T. Hnatieva *et al.* (2023) devoted their work to a detailed assessment of the capabilities of artificial intelligence when used by agricultural enterprises. In the field of control and accounting, artificial intelligence can be used to automate cost accounting, monitor financial status, calculate taxes, manage payments, analyse financial indicators, automate accounting of operations, reporting and auditing, etc. (Novykova *et al.*, 2023). The present study focuses exclusively on aspects of artificial intelligence, but it is not the only technology that can benefit the optimization of control and accounting processes at an agricultural enterprise. Therefore, in the context of the topic of this study, it is advisable to consider solutions that also use Big Data, Blockchain IoT, etc.

Many works by researchers from other countries also note the wide potential of modern technologies to improve control and accounting, such as automation capabilities (Syrtseva *et al.*, 2021; Stender *et al.*, 2024). Particular attention is paid to blockchain technology in the works of M. Bellucci *et al.* (2022), T. Garanina *et al.* (2022), E. Pimentel & E. Boulianne (2020). Scientists concentrate on the practical aspects of the technology and highlight its advantages over traditional approaches. R. Spanò *et al.* (2020) and O. Desplebin *et al.* (2021), also focusing on blockchain, address the future prospects of its use, in particular, in combination with other technologies (e.g., virtual reality). The possibilities of the blockchain in combination with the potential of artificial intelligence are revealed in the works by Y. Zhang *et al.* (2020), A. Qasim & F.F. Kharbat (2020) and H. Han *et al.* (2023). Among other things, scientists study the impact of these technologies on the accounting profession and note the need to change approaches to training professionals. H. Damerji & A. Salimi (2021) linked the effectiveness of the introduction of artificial intelligence technology in accounting to the peculiarities of the perception of new technologies. E. Martaseli & M. Maragita (2023), O.H. Cho (2024) and

C. Estep *et al.* (2024) assess the impact of artificial intelligence on the accounting industry. In general, scientists conclude that the new technology can maximise the efficiency of accounting, but note certain barriers to its implementation, in particular, lack of knowledge (Oklander *et al.*, 2024). G. Rocha *et al.* (2021) noted the broad prospects for the use of blockchain technologies in agricultural enterprises. The researchers noted the use of blockchain by agribusinesses, among other things, for financial purposes. M. Lei *et al.* (2022) focus on the possibilities of tracking agricultural products provided by the blockchain and offer their own view on solving existing problems. A. Rață *et al.* (2022) proposed a framework that combines blockchain capabilities with digital signatures and artificial intelligence to optimise accounting and auditing at agricultural enterprises. The researchers point out that this approach allows for more transparent auditing and accounting through secure transaction documentation, asset control, and product tracking. In addition, the researchers revealed how artificial intelligence can help automate routine audit activities, speeding up the process and minimizing possible manual errors. The researchers do not ignore the possible problems of introducing new technologies (the possibility of bias, high implementation costs, and regulatory requirements). In contrast to these studies, the author's work notes the capabilities of individual technologies rather briefly, as the focus is on integrated software solutions that operate on the basis of one or more of these technologies.

The benefits of using software platforms, individual software tools or a combination of them are outlined in the works by M. Bradford *et al.* (2020), M.M. Thottoli *et al.* (2022) and C. Zhang *et al.* (2022). The main benefits include increased efficiency, reduced time spent on routine tasks, and improved information quality. In the studies by J. Mökander *et al.* (2021) and T.P. Nugrahanti & A.S. Pratiwi (2023), the authors additionally highlight how such solutions can address ethical issues and ensure compliance with standards in the accounting profession.

V. Saiz-Rubio & F. Rovira-Más (2020) investigated the possibilities of the latest software solutions to increase efficiency in the agricultural sector. As in the author's work, the researchers focus on outlining the capabilities of software products to improve the performance of agricultural enterprises, in particular, in the area of control and accounting. This inspired the author to consider more recent ratings of software products for the agricultural sector, which allowed us to provide a list and describe the main functionality of the tools that are most popular today. In addition, the researchers note that the beginning of the 21st century is a very favourable period for the digital transformation of the agricultural sector and the transition to Agriculture 5.0. In this context, the paper notes that the transition to Agriculture 5.0 is a priority for large agricultural producers. Agreeing with the above, it is worth adding that digitalization, as the author of this paper has shown, does not bypass small agricultural enterprises. Due to their flexibility and adaptability, small enterprises are one of the important drivers of digitalization and economic growth (Trusova *et al.*, 2020; Dovgal *et al.*, 2024). Therefore, the inclusion of aspects related to small businesses is a crucial focus of the author's article.

S.A. Shukor *et al.* (2020) do not ignore small and medium-sized enterprises in the context of studying digitalization in the agricultural sector. The authors examine the process of digitalization of the agricultural sector in Malaysia, with a focus on the use and adaptation of ERP systems. The researchers, like the author of this article, discuss the problems of implementing ERP systems at small and medium-sized businesses. However, the works differ in that S.A. Shukor *et al.* (2020) propose an approach to the adaptation of ERP systems by small and medium-sized agricultural enterprises, while the author's work contains alternatives that can be used by such enterprises to replace ERP. A similar approach is considered in the work by V.S. Han *et al.* (2020). The researchers noted that complex ERP systems such as SAP and ORACLE may not be an appropriate solution for SMEs due to their cost, resource requirements, and technical expertise. Instead, SMEs may consider implementing certain local platforms that are open-source and free of charge. At the same time, the solution considered in the study also contains several modules that provide a comprehensive solution for solving various business tasks, including financial management. T. Krassowska *et al.* (2022), also focusing on small and medium-sized enterprises, propose an approach to the selection by such business units of a system for finance and accounting that is appropriate to their tasks. The advantage of this work is the development of a special ranking procedure that makes it possible to model the decision-making situation, on the basis of which managers receive a solid basis for choosing a particular system. E. Trichkova-Kashamova & E. Paunova-Hubanova (2021) presented their own approach to the selection of farm management software, in which the researchers analyse 8 such platforms according to 12 main functions. As in the author's work, the approach takes into account the rating of software users, but contains more specific guidelines for choosing a particular program.

Despite the fact that the author's research focuses on control and accounting in the agricultural sector, it highlights the benefits of an integrated approach. This approach emphasises the importance of integrating digital solutions in the field of control and accounting with other areas of agricultural enterprises' activities. This opinion is supported by the work of J. Munz *et al.* (2020), who studied the process of digitalization in German agricultural enterprises. The researchers focused on answering the question of which functions of agricultural enterprise management information systems are most often used in Germany. The researchers found that most farmers use such systems to maintain documentation, as well as to plan and monitor management processes at agricultural enterprises. A smaller proportion of enterprises use a wider range of digitalization tools, combining software with sensors, hardware, etc. (Sokil *et al.*, 2020). Scientists are confident that understanding digitalization as a simple increase in the use of desktop applications is not yet a transition to smart agriculture. They emphasise the importance of using universal data standards and see an increase in the efficiency of the agricultural sector in moving away from individual applications in favour of developing integrated systems of related products. This

approach may be useful for solving the problem of the need to integrate software products noted in the author's work.

Comparison of the author's work with the conclusions of other researchers allowed confirming the validity of the research results, and identifying its advantages and unexplored aspects. This makes it possible to suggest areas for further research, in particular, a critical area for further work should be the formation of a multi-criteria approach to the selection of a software solution on the example of a particular agricultural enterprise, taking into account internal and external factors of activity. Moreover, some works (Poppe *et al.*, 2023) note the direction of using digitalization in control and accounting processes, which is not disclosed in the article, namely the collection of data for external reporting on sustainable development. In the context of growing concerns about balancing the economic, social and environmental needs of society, this area may be quite relevant for further research.

► Conclusions

The digitalization of control and accounting processes at agricultural enterprises contributes to increasing the accuracy, transparency, speed, and overall efficiency of such processes. The analysis conducted in this study shows that the market for software products for agricultural enterprises has broad prospects. The growth rate of this sector is 13.5% per annum, and the main trends are the introduction of technologies based on artificial intelligence and machine learning for analysing big data, as well as the IoT.

The paper notes that ERP systems can improve the accuracy of input through automatic recording, generate more accurate and timely reporting, optimise cash flow, provide more thorough support for management decisions, and identify problems in advance. At the same time, alternative software products that are simpler and more affordable than complex ERP systems may be a more appropriate solution for small and medium-sized enterprises. These include Forms on Fire, Granular, Aegro, Kizeo Forms, Traction, etc. For Ukraine, the agricultural sector is an important element of the economy, with a value added of more than 7% of GDP even in wartime.

The SWOT-analysis summarised numerous opportunities and benefits of digitalization in the control and accounting activities of agricultural enterprises. At the same time, the results of the analysis made it possible to determine that the main threats and weaknesses of the digitalization process are mainly related to the limited capabilities of the enterprises themselves and their operating environment. The PEST-analysis made it possible to emphasise that the main problems associated with the introduction of digitalization in the control and accounting processes of agricultural enterprises in Ukraine are related to military restrictions and risks, as well as imperfect legislative framework and insufficient infrastructure development in certain regions. The limitation of the study is that the data of Ukrainian agricultural enterprises in general were used for the analysis. This allowed us to expand our coverage, but an analysis of the digitalization of control and accounting processes at a particular enterprise could reveal more specific problems and benefits.

A promising area for further research is the development of a multi-criteria approach to the selection of

digital tools for an agricultural enterprise, taking into account the impact of internal and external factors, as well as the analysis of digitalization opportunities for collecting data for sustainable development reporting in Ukraine.

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►Conflict of interest

The authors of this study declare no conflict of interest.

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Цифровізація контрольно-облікових процесів аграрних підприємств: оцінка та управління ризиками

Наталя Потриваєва

Доктор економічних наук, професор
Миколаївський національний аграрний університет
54008, вул. Георгія Гонгадзе, 9, м. Миколаїв, Україна
<https://orcid.org/0000-0002-9781-6529>

Марина Дубініна

Доктор економічних наук, професор
Миколаївський національний аграрний університет
54008, вул. Георгія Гонгадзе, 9, м. Миколаїв, Україна
<https://orcid.org/0000-0002-3993-0622>

Юлія Чебан

Кандидат економічних наук, доцент
Миколаївський національний аграрний університет
54008, вул. Георгія Гонгадзе, 9, м. Миколаїв, Україна
<https://orcid.org/0000-0002-8231-2918>

Світлана Сирцева

Кандидат економічних наук, доцент
Миколаївський національний аграрний університет
54008, вул. Георгія Гонгадзе, 9, м. Миколаїв, Україна
<https://orcid.org/0000-0003-4824-3741>

Ольга Лугова

Кандидат економічних наук, доцент
Миколаївський національний аграрний університет
4008, вул. Георгія Гонгадзе, 9, м. Миколаїв, Україна
<https://orcid.org/0000-0003-4432-0295>

► **Анотація.** Цифровізація контрольно-облікових процесів є вимогою сьогодення через широкі можливості із підвищення конкурентоспроможності та ефективності діяльності, які вона надає підприємствам будь-якої галузі. Метою роботи був аналіз ефективності цифровізації контрольно-облікових процесів для забезпечення досягнення основних цілей діяльності підприємств сфери сільського господарства. В роботі застосовано метод статистичного аналізу, описовий та порівняльний методи, а також методи SWOT- та PEST-аналізу. В результаті проведеного дослідження було виявлено, що ринок програмних продуктів для аграрних підприємств продовжує зростати, при чому темп зростання становить 13,5 % на рік. Зазначено, що аграрні підприємства можуть отримати суттєві переваги із застосуванням нових програмних продуктів, що дозволить збільшити швидкість, точність, прозорість та доступність контрольно-облікових процесів. У роботі розглянуто можливості систем Enterprise Resource Planning, які мають широкий функціонал та здебільшого відповідають потребам великих аграрних підприємств. Також, дослідження охоплює розгляд альтернативних інструментів для контролю та обліку, які можуть більше підходити для малих та середніх підприємств завдяки їхній простоті, цільовому спрямуванню та невисоким витратам на впровадження. Через оцінку агросфери України у роботі доведено важливість сільського господарства для держави, що пояснює необхідність пильної уваги до процесів цифровізації в галузі. В якості ефективної системи для реалізації контролю та обліку на національних агропідприємствах, розглянуто BAS АГРО. ERP. У підсумку дослідження відзначено можливості та загрози, слабкі та сильні сторони цифровізації контрольно-облікових процесів загалом. Також, визначено політичні, економічні, соціальні та технологічні фактори, що впливають на ці процеси в Україні

► **Ключові слова:** сільське господарство; програмні продукти; інновації; Enterprise Resource Planning; фінансовий менеджмент; аудит