CHAPTER 3

Transforming information support for technology and innovation management in the context of digitalization

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Abstract

This section presents the results of a comprehensive study of the theoretical, methodological, and applied foundations for transforming information support for technology and innovation management in the context of digitalization. It has been proven that in the modern business environment, the classical accounting paradigm, which historically functioned as a closed cybernetic "black box", is not capable of fully satisfying the information needs of stakeholders. The necessity of a conceptual transition to a proactive "data-driven innovation" paradigm is substantiated, involving the formation of a transparent, flexible, and SDG-oriented digital system. The evolution of the functional role of an accounting specialist is revealed: from a traditional registrar and controller to a strategic business partner and big data analyst who integrates artificial intelligence, machine learning, Internet of Things (IoT), and blockchain technologies into their work. The study places particular emphasis on the critical problem of technological inertia among Ukrainian enterprises and the widespread use of outdated software with Russian architectural roots (in particular, the 1C/BAS line of systems). It has been proven that in the context of cyberwarfare, such practices create unacceptable security, financial, and reputational risks. The article proposes a multifactorial model for assessing the economic efficiency of the digital transformation of accounting and analytical systems. Unlike traditional approaches to assessing IT investments, the proposed model takes into account not only the direct operational benefits of automating accounting processes but also the financial equivalent of averted cyber risks, as well as the economic benefits of implementing

 DOI: 10.21303/000-0000-0000-0-0.ch3

SDG principles, in particular, access to "green financing" and increasing the investment attractiveness of the enterprise. The model has been tested in practice through scenario-based modeling for a hypothetical medium-sized manufacturing enterprise. The results indicate a positive overall economic effect from implementing a modern digital ERP system and confirm the economic feasibility of the digital transformation of enterprises' accounting and analytical systems.

Keywords

Digital transformation, digitization, digital competencies, Sustainable Development Goals (SDG), innovative technologies, modern digital technologies, artificial intelligence, cybernetic approach, accounting software products, Data-Driven Innovation, information security, accounting and analytical support.

3.1 Introduction

Technology and innovation management have traditionally been based on relevant information support, which has determined the vector and pace of enterprises' economic development. In the classical industrial paradigm, information support was viewed primarily as an infrastructural superstructure – a passive resource which main task was to support current management decisions by providing structured data at the right time. However, in the context of rapid and comprehensive digitalization, which analysts rightly call a "digital whirlwind", this traditional understanding is undergoing a radical transformation. The current stage of development of high-tech solutions is transforming information from a passive service resource into a key, intrinsic driver of the innovation process itself. This conceptual evolution is leading to a natural shift in global scientific and practical discourse towards the proactive concept of "data-driven innovation" (DDI). Static information arrays are being replaced by dynamic, actively adaptive information systems capable of predictive analytics, processing huge amounts of unstructured data in real time, and continuously generating new business models.

Traditionally, the basis for information support for the management of any business entity has been an accounting and analytical system. Accounting, which has functioned as a cybernetic model of socio-economic relations since the Industrial Revolution, is now facing the most serious challenge in its history. Despite the general digitization of society, most companies continue to use outdated approaches to managing information. The transformation of accounting in such enterprises often boils down to primitive digitization – the banal transfer of classic paper registers and double-entry methods to electronic media, completely ignoring the synergistic potential of modern innovations (artificial intelligence, cloud computing, blockchain

technologies). A critical security and institutional problem exacerbates this general technological inertia among specialists and management: the lion's share of Ukrainian businesses continues to operate on Russian software products (in particular, the 1C/BAS line of systems). In the context of full-scale military aggression and constant cyberattacks, this practice not only prevents companies from fully integrating into the global economy of sustainable development but also poses direct threats to corporate security, generating enormous financial and reputational risks.

The modern algorithm for organizing the accounting process must go beyond simple data recording. Abandoning outdated isolated systems (such as Russia's 1C/BAS) is a basic infrastructure prerequisite for digital SDG transformation. The latest cloud platforms can aggregate data from IoT sensors in real time to monitor environmental indicators. It directly correlates with the need for comprehensive modernization of management systems, the application of advanced scientific and practical methods, and the development of innovative equipment to effectively address the consequences of military aggression, environmental, and economic crises [1].

Digital transformation is particularly relevant for overcoming the consequences of crises. The formation of a smart economy in the context of Ukraine's post-war recovery is impossible without the introduction of the latest information technologies, where digital tools act as a catalyst for regional development and comprehensive ecosystem restoration [2]. In addition, the use of information technology and big data enables enterprises and state institutions to conduct in-depth scenario modeling. As modern research shows, integrating IT solutions into process modeling – from express rehabilitation to sustainable restoration of post-conflict territories – is the foundation for making informed management decisions within the framework of modeling safe ecological systems [3]. It is precisely these in-depth analytical capabilities that must be embedded in the core of a modern enterprise accounting and analytical subsystem. Accordingly, there is an urgent need to move from theoretical concepts to applied modelling: the development of clear mathematical tools and empirical confirmation that maintaining the existing status quo is unprofitable in the long term, and that investment in a new SDG-oriented digital accounting system is a critical condition for effective functioning.

3.2 From double-entry bookkeeping to SDG-oriented digital accounting systems: a cybernetic approach and the evolution of information support for management

Technology and innovation management have always been based on appropriate information support. At the level of a business entity (enterprise), information

support has traditionally been considered from two aspects. First, it is a structure of integrated computer systems and resources designed to support the activities of a business entity by providing the necessary information at the right time and in the right format [4]. Second, it is a system of complete, reliable, and timely information necessary for business entities to operate effectively and make informed management decisions [5]. However, recently, more and more scientists have considered the system (symbiosis) of these approaches when defining "information support" [*6*].

In the context of rapid digitalization, the traditional understanding of "information provision" is transforming. While in the classical paradigm of innovation management, information was viewed primarily as a passive resource to support management decision-making, the current stage of digital technology development is transforming it into a key intrinsic driver of the innovation process. In contemporary global scientific discourse, this conceptual evolution is reflected in a natural transition from the paradigm of infrastructural *"information provision/support"* to the proactive concept of *"data-driven innovation" (DDI)* and the development of integrated digital capabilities of enterprises. Under the influence of digitalization, the emphasis is shifting from scientific to practical: static information arrays are being replaced by dynamic information systems *(Information Systems in Innovation Management)* capable of predictive analytics and real-time processing of *Big Data*. Accordingly, information support for technology and innovation management should now be viewed not as a separate service link, but as a comprehensive digital ecosystem of the enterprise. It is this ecosystem that determines the enterprise's ability to continuously generate innovative technological solutions and business models and adapt to a rapidly changing and uncertain external environment.

The basis of information support for management (primarily technology and innovation management) has traditionally been and continues to be the accounting and analytical system. In the context of digitalization, the digitalization of accounting objects takes place simultaneously with the accounting and analytical system. As a result, the change in the accounting and analytical system should include all stages of digitalization involving the application of modern digital technologies. However, for the most part, the digital transformation of the accounting and analytical system does not use all the capabilities of modern digital technologies.

It should be noted that the accounting system, as a component of the management information support system, has long been considered a simulation model of the business entity's activity. This approach is still relevant today. Moreover, this model is cybernetic, and its construction uses elements of the accounting method, which have been used since the Industrial Revolution (1780–1851). Despite being "tested" and "verified" over time, most of the approaches in this model, in the context

of digitalization and the implementation of the Sustainable Development Goals, need to be revised.

Today is characterized by the digital transformation of almost every sphere of human life. However, the formation of information in the accounting and analytical management support system of most business entities is still carried out according to the traditional information processing algorithm – from the moment of receipt of the primary document to the preparation of reports. That is, we are talking about the fact that, even now, information is formed in the accounting and analytical system through the digitization of traditional (paper) accounting forms. And this is at a time when the use of digital technologies is rapidly expanding. Companies generate and use vast amounts of data that can be integrated into accounting and analytical systems and, accordingly, used to inform management decisions. Scientists and practitioners are aware of the potential of modern digital technologies for developing various strategies, which, in turn, will enable companies to manage innovation: to optimize business models and increase business efficiency [7]. It is possible to believe that when implementing digital transformation, it is necessary to take into account that the greatest effect from the use of modern digital technologies (information and communication technologies (ICT), cloud computing, artificial intelligence (AI), big data, Internet of Things (IoT), blockchain, etc.) is given by their systematic use. The synergistic effect resulting from their interconnection creates many opportunities for intelligent products, services, market accessibility and business expansion [8].

Undoubtedly, the role of English as an international language of communication has changed in the modern digital world, as it has become a technical standard, without which the transfer of knowledge is almost impossible [9, 10]. Modern management of innovations is impossible without combining local data stores with global networks. The predominance of English-language data in training AI and data mining models effectively establishes it as the primary foundation for modern knowledge. Consequently, the ability of digital infrastructure to interpret English fluently has become a benchmark for effective technology management, as it dictates the speed of access to international patents and technical standards.

In the conditions of digitization, we are observing a transition from ordinary translation to the formation of flexible multilingual knowledge systems. The use of English as the basic language in technology management helps to eliminate the time gap between the emergence of an innovation and its practical application [11]. It underscores the need for IT solutions that automatically reconcile English-language technical concepts with national regulations, ensuring the accuracy of management processes. Accordingly, it is the systematic use of modern digital technologies that

makes it possible to increase the quality, timeliness, multivariate nature, and relevance of the information generated in it.

The validity of the management decisions taken, in turn, has a positive effect on the business entity as a whole. Each enterprise operates in a certain external environment – region, industry, country, etc. Thus, groups of profitable, innovative enterprises create profitable industries, countries, etc. A condition for a successful business is its innovativeness, which also applies to the information support system, primarily the accounting system. It has already happened in history. The invention and widespread use of double-entry bookkeeping made balance sheet generalization possible and, respectively, provided users with information about financial status. It had a positive effect on the implementation of effective management solutions and contributed to the economic growth of both the economy as a whole and its individual branches (spheres). Today, there is a transformation of the modern accounting paradigm and an expansion of accounting boundaries toward integrated reporting. Modern trends are changing requirements for information support in implementing the Sustainable Development Goals.

Any economic entity carries out its activities in a specific institutional environment and functions under the influence of socio-economic conditions. As a result, a business entity (enterprise) can be considered as an open cybernetic system with internal and external connections. This system permanently interacts with the external environment. Input flows, including information flows, enter the accounting and analytical system, are processed, and, after this, are transformed into outputs used by external users. In the context of digitization, the nature of information flows fundamentally changes: information, including accounting and analytical data, becomes a defining resource for development, and the efficiency of its processing affects competitiveness.

Analysts at the Global Center for Digital Business Transformation at IMD, together with Cisco, emphasize the transformation of modern business models through the use of digital technologies and metaphorically compare their impact to a "digital vortex" that is gradually transforming industry by industry [12]. It causes a structural restructuring of the economy. Thus, spheres of activity, under the influence of digitalization, either transform (acquire new qualities) or disappear; in turn, completely new ones emerge. It is accounting, as a system of accounting and analytical support, that acquires new qualities, expands its boundaries, and becomes an intellectual and information management platform.

Modern scientists and practitioners mostly focus on the social importance of information and connect the trends of social and economic development with the processes of information creation, transmission, and use (economic, environmental, social, and managerial). At the same time, information systems play a significant role

and implication in the modern digital innovation economy. These systems have a complex hierarchical structure and multi-level management mechanisms. An important structural element of this system is the accounting and analytical components. The accounting and analytical system itself forms the generalized and structured information for users of all levels – from internal management to external stakeholders – and, moreover, for various purposes (tax, financial, management, etc.). In the light of modern digital technologies, the retrospective nature of accounting information is overcome. Consequently, the possibility of interactive influence on economic events in real time arises when making optimal management decisions.

In concern with classical management theory, accounting is a management function. As a component of the management system, it operates in an environment that is constantly changing under the influence of macroeconomic, technological, and social factors. Achievements influenced the development of the accounting system in various fields. Thus, at one time, the invention of paper contributed to the development of paper registers; the advent of computer technology enabled the automation of accounting procedures; and the development of modern digital technologies enables the integration of accounting with analytics and forecasting. At the same time, the accounting system directly influences the development of the economic environment. As stated by W. Sombart [13], the spread of the use of double-entry and balance-sheet generalization is not due to information requirements for the development of capitalist relations, but rather creates the conditions for this development. This is exactly what W. Sombart emphasized in "Der moderne Kapitalismus", arguing that the formation of capitalism was closely related to the development of adequate accounting. Based on the logic of the so-called "Sombart thesis", the systematization of economic processes through mechanisms of double-entry bookkeeping not only reflected economic reality but also shaped a new type of economic thinking, managerial rationality, and entrepreneurial behavior. This means that accounting methodology and tools are not only adapted to the conditions of economic life but also directly affect it.

Within the scope of globalization and the need to guarantee the implementation of the Sustainable Development Goals in a competitive environment, the enterprise's internal and external relations (logistics, technology, organization, etc.) are complex. It necessitates the formation of flexible, active and adaptive accounting and analytical systems capable of working in real time and integrating financial and non-financial information. The effectiveness of the accounting and analytical system is achieved through its influence on the object of management, based on the possibilities for influence and the ability to adapt to changes in the external environment and to the information requests of internal users (an active-adaptive system).

The enterprise's accounting and analytical system is a complex, multi-level structure characterized by a hierarchical structure and a well-developed system of internal and external connections. As part of the cybernetic approach, it is advisable to consider it as a system of transformation of incoming information flows into output results

$$Y = R \times X,$$

where X – input information (economic events, external regulatory requirements, stakeholder requests, socio-economic and environmental factors); R – transformation mechanism (elements of the accounting method, assessment rules, data processing algorithms, digital technologies, analytical models); Y – source information (reporting, management indicators, analytical financial and non-financial indicators).

Under the condition of automated accounting procedures (digitization), such a cybernetic system actually functioned as a "black box". Information users received a ready-made information product. At the same time, they did not have the opportunity to monitor the process of obtaining the result. Double-entry accounting was a universal and relatively stable R operator that provided a standardized model for displaying business processes.

In the conditions of digitalization, the mechanism of data transformation changes its character from being static into dynamic. It blends the algorithms of automated data processing, elements of artificial intelligence and analytical forecasting models. Digitalization enables the provision of information to assess achievement and promote implementation of the Sustainable Development Goals (blockchain technology in the context of the circular economy, transparency in the chain of value creation, "E-audit", etc.). As a result, it has a positive effect on the ecological and social components of sustainable development. It is possible to agree with scientists on the prospects and possibilities of introducing bio-inspired artificial intelligence technologies based on modeling complex processes, for example, in the management system for restoring territories affected by the war [14]. Given the capabilities and prospects of the digital accounting and analytical system, it can no longer be considered a "black box", since the digital environment provides transparency, tracking, and analytics for transformational procedures. It is especially important in the context of implementing the Sustainable Development Goals [15]. Reaching these goals demands a qualitatively new information base that encompasses not only financial results but also environmental, social, and managerial aspects of the enterprise's activities. In other terms, it is the amplifying of the traditional accounting

paradigm into an integrated system for measuring managerial, social, and environmental value. In this regard, the transformation of the accounting and analytical system from a "black box" to a partially "transparent (white) box" is observed. Not only the quality of reporting, but also the company's ability to integrate sustainability principles into its business models and innovation processes depend on the methodological approaches, digital technologies, and algorithms that serve as the basis for transforming input data.

The enterprise's accounting and analytical system is considered to be an open system with dynamic links. The external environment simultaneously influences such a system while it is shaping the environment through information mechanisms. The evolution from the "black box" stage of automation (digitization) of accounting procedures to a digital, adaptive and transparent (white) box – an information system that meets the requirements of the implementation of the sustainable development paradigm is a logical stage in the development of the information management model (**Fig. 3.1**).

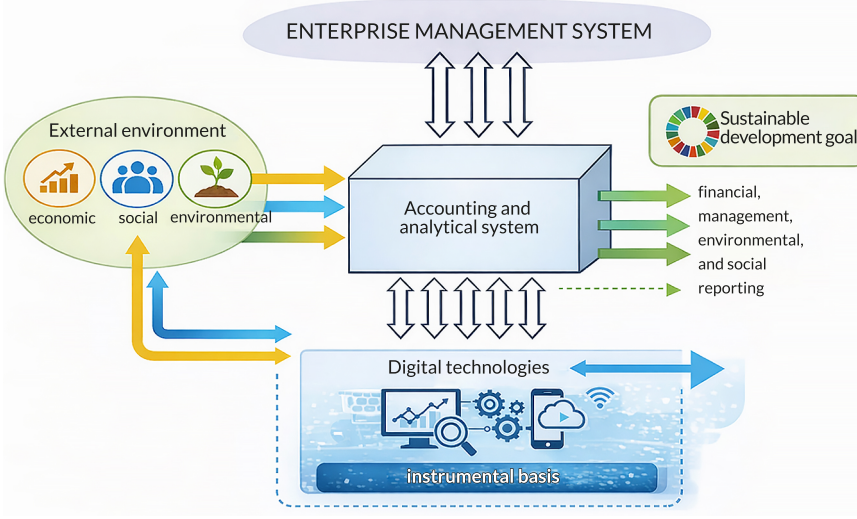

Fig. 3.1 Accounting and analytical system
in the context of ensuring the implementation of Sustainable Development Goals
Source: compiled by the authors using AI based on [15, 16]

Thus, the modern accounting and analytical system not only reliably reflects economic events but also shapes the company's long-term trajectory. In the context

of the use of digital technologies and the implementation of the sustainable development paradigm, there is a need not only for the technological updating of accounting tools, but also for the development of their theoretical foundations.

The dominance of the information function in the modern economy necessitates the formation of a new concept of accounting and analytical support for the management of technologies and innovations. This concept is based on a combination of a cybernetic approach and digital technologies, and focuses on information support for the implementation of the Sustainable Development Goals. In this context, the modern transformation of the accounting and analytical system is a historically determined stage of development. However, if in previous historical periods changes in the accounting paradigm were evolutionary and gradual, then the modern stage corresponds to a revolutionary technological shift and is characterized by unprecedented speed. Digital transformation does not just modernize accounting tools; it changes the very logic of the formation, processing, and interpretation of economic information. Within the new information model of the economy, the accounting and analytical system is transformed from recording the facts of economic life in retrospect into a center for integrating financial, technological, environmental, and social data and for determining the future.

Therefore, there is a conceptual transition from the traditional "reflection" of economic reality to its active modeling through modern digital technologies (information algorithms, digital platforms, analytical models, etc.). Digital transformation should integrate the principles of sustainable development and information support for strategic management into the accounting and analytical system. At the same time, there is not only an expansion of the list of indicators, but also a systemic transformation from the structure of input data to the logic of their transformation into the output reporting format.

Thus, the transformation of accounting in the context of digitalization involves both technological updates to the toolkit and changes in the functional load of the accounting and analytical system, with a shift toward compliance with the paradigm of sustainable development. Theoretical understanding of this transition requires its practical confirmation and quantitative measurement. On the path of digital transformation, there is a need to assess the effectiveness of transformational processes and the compliance of the accounting and analytical system with modern requirements and the ability to ensure transparency, responsibility and innovation of management decisions, which requires the development of appropriate tools for measuring the achieved level of digital transformation and SDG integration of the enterprise's accounting and analytical system.

3.3 Empirical assessment and modeling of the transition to an SDG-oriented digital accounting ecosystem

Full support for implementing the Sustainable Development Goals seems impractical without the digital transformation of the accounting and analytical systems. The analysis of modern accounting practices in Ukrainian enterprises indicates a significant gap between the requirements for the accounting and analytical system in the context of the sustainable development paradigm and modern management information needs, and the accounting practices of Ukrainian businesses. Accounting and taxation specialists have historically exhibited a certain professional inertia, which remains the case today amid the introduction of the latest digital technologies [17]. However, overcoming this inertia and transitioning to innovative systems opens fundamentally new perspectives, as the accountant's role in digitalization is transformed. Accounting specialists have unique expertise and a deep understanding of business processes [18]. Thanks to this, they can become effective strategic partners for IT specialists in the design and maintenance of information systems. In this new paradigm, the accountant is not just the end user of the software, but also its co-developer and the defender of the interests of stakeholders (people with interests and decision-making authority). Specialists of the accounting service have skills in data governance and monitoring compliance with regulatory requirements (compliance). Accounting specialists, in accordance with their professional duties and competencies, should play a leading role in the intellectual analysis of both structured and unstructured data (Data Mining). Their skills in working with financial information, understanding the algorithms that govern its formation and content, allow them to build analytical models as accurately as possible and interpret their results. In fact, there is a transformation of the professional model of an accountant from a traditional internal "registrar" and "controller" (gatekeeper) to a full-fledged business partner.

In the context of the digital transformation of accounting and analytical procedures, the introduction of blockchain technology, which changes both the accounting process and its content, is of particular importance. Placing transactions on a private blockchain increases transparency, the reliability of information, and the quality of reporting. At the same time, the nature of work changes: the algorithmic recording of transactions ensures the minimization of traditional routine record-keeping. At the same time, databases become available not only to accountants but also to accounting specialists, who are transformed from "recorders" of the facts of economic life to analysts of economic events. The role of a specialist is transformed: it ceases to be a simple recorder of primary data and becomes an analyst. Now the focus is on the

development of accounting policies, in-depth financial analysis and expert review of contracts for compliance with the law and economic benefit.

Changes in technology and functional roles require accounting professionals to evaluate and develop their personal digital competencies critically. Given that the use of modern, innovative digital technologies significantly changes the nature of accounting work, the set and level of competences necessary for successful accounting are changing accordingly, and the requirements for modern accounting specialists are increasing. Despite the spread of information in society about the prospect of replacing accounting specialists with modern digital technologies (primarily artificial intelligence), the labor market demand for modern accounting and analytical specialists is increasing, as are the requirements for the breadth of their competencies.

Accounting and analytical workers traditionally work with large arrays of structured information. But modern digital technologies also require the presence of unstructured information, such as text, images, audio and video, drawings, graphics, etc., which must be taken into account when making management decisions. This approach requires the formation of new competencies and creativity.

Innovative technologies in the context of digital transformation require changes to the information support of the enterprise management system, primarily in accounting and analytics. At the same time, there is a need for appropriately qualified specialists who can creatively approach the solution of professional problems, are prepared to work with modern digital technologies, and continuously update and develop their competencies, primarily digital ones [19].

Today, the most relevant and adapted to the requirements of modern accounting and analytical support are such digital technologies as artificial intelligence [20], machine learning, technologies for working with large data arrays (Big Data) and their intelligent analytics (Data Analytics), as well as distributed ledger systems (Blockchain) [21, 22]. The most effective is the complex use of modern digital technologies, which yields a synergistic effect. At the same time, precisely because of the use of such digital technologies, the reorientation of accounting and analytical support from the traditional retrospective recording of economic events to the implementation of the prognostic (predictive) function of accounting and analytical systems becomes possible. Such trends are positive in view of the need for information support of strategic management. In this regard, the evolution of accounting information systems, which for a long time were considered primarily as a technical tool for management information support, is of particular importance. This approach was objectively determined, according to which the functional load of accounting systems was limited to the display of economic transactions, the implementation of resource control and the formation of financial statements.

Due to the modern interpretation, this limitation does not align with users' information requests, the modern paradigm of sustainable development, or the challenges of today. Complex socio-economic transformations, in particular the consequences of the COVID-19 pandemic and, for Ukraine, challenges associated with full-scale military aggression, as well as global problems of climate change, environmental degradation, and demographic challenges, etc., create new requirements for management information support. Under such conditions, accounting information systems gradually go beyond purely economic tools and expand their functional load to information support for social and environmental management.

The possibility of functioning of environmental and social management information support systems is based on their integration with modern analytical platforms, risk management systems and intelligent data processing technologies. The combination of the capabilities of artificial intelligence, blockchain technologies, Big Data tools, and cloud infrastructure is an objective prerequisite for the functioning of a modern accounting and analytical system aimed at providing informational support for strategic management and integrating environmental, social, and management information. Transforming the accounting and analytical system and expanding its boundaries has a positive effect on society's perception of accounting information as transparent, objective, multivariate and relevant in accordance with the principles of social responsibility of business.

The processes of international standardization and institutionalization of accounting intensified after the creation of the International Accounting Standards Board (IASB) and the International Federation of Accountants (IFAC), and they significantly affect the development and functioning of accounting and analytical systems. In general, the unification of methodological approaches to the formation of financial information increased its comparability and compatibility at the global level. At the same time, excessive standardization reduces the flexibility of accounting information systems, limiting their ability to adapt to new information requests and innovative technological solutions quickly. That is why the current stage of the development of accounting and analytical systems requires implementing measures to overcome limitations by introducing modern digital technologies.

Such a shift enables a new level of functionality in accounting information systems. It fulfils not only business requirements but also public expectations for transparency, accountability, and sustainable development. Concurrently, the modern accounting software market in Ukraine is chiefly controlled by products focused on automating routine processes.

The modern algorithm for organizing the accounting process in most traditional programs is conceptually no different from that of paper-based accounting. In fact,

only data digitization is undertaken to speed up operations, reduce errors, and generate regulatory reporting. Empirical data confirm the technological conservatism of the system: according to the results of surveys of practicing accountants in the Kirovograd region, the vast majority use standard accounting modules, with the BAS (73.2%) and MASTER product lines declared as the leaders: accounting (23.5%), while the level of systematic implementation of modern digital technologies in accounting practice remains at 17.3% (fully represented by cloud technologies in combination with traditional software products). In addition, when analyzing the state of software in Ukraine, it is necessary to note a critical problem that goes beyond technological backwardness and directly concerns national and corporate security. Despite official statistics and state regulations, a significant number of Ukrainian enterprises continue to operate on 1C: Enterprise software. The declared market leader, the BAS (Business Automation Software) product line, is an adaptation of the 1C platform that has retained its architectural heritage, database construction logic, and basic information processing algorithms, casting doubt on its legitimacy.

In the context of full-scale military aggression and permanent cyberwarfare, the use of software that is of Russian origin or has close architectural ties to it is absolutely unacceptable. It creates critical vulnerabilities in the corporate information security system, poses a threat of strategic economic data leakage, and carries direct sanctions and reputational risks for businesses [23, 24].

In addition to the security factor, the outdated monolithic architecture of 1C/BAS-type systems is fundamentally incapable of serving as a full-fledged data conversion operator in the modern cybernetic model of sustainable enterprise development. They are mostly isolated local systems that are difficult to integrate with global cloud services, unable to aggregate data from IoT sensors in real time (e.g., for monitoring environmental emissions, energy consumption, or carbon footprint) and do not support built-in machine learning algorithms for predictive analytics of innovative processes. Accordingly, abandoning outdated software is not only a matter of information hygiene and security, but also a basic infrastructure prerequisite for the digital SDG transformation of Ukrainian companies. However, management often slows this process due to the perceived high cost of capital investment in transitioning to modern international ERP systems.

Overcoming this cognitive and managerial barrier requires the development of clear mathematical tools that will enable economic justification for maintaining the status quo (working with outdated and unsafe systems) as more costly in the long term than investing in a new, transparent digital system. It requires the development of a comprehensive model to assess the effectiveness of the digital transformation of accounting and analytical support.

In classical economic theory, the assessment of the feasibility of implementing new software is traditionally based on calculating the direct economic effect resulting from the automation of routine processes (reduction of labor intensity, savings in working time, reduction of administrative costs). However, in the context of the digital economy, high security risks, and the global transition to the sustainable development (SDG) paradigm, such a narrow approach is conceptually incomplete.

Given that the accounting and analytical system is a cybernetic system capable of generating non-financial information for stakeholders, it is necessary to apply an extended multifactor assessment model. It is proposed an original approach to determining the overall effect of the digital transformation of the accounting system (E_{trans}), which accounts not only for direct operational benefits but also for the cost of averted security risks and the strategic advantages from implementing SDG criteria.

Mathematically, the integral economic effect (net present value of transformation) can be formalized by the following function

$$E_{trans} = \sum_{t=1}^{n} \frac{\left(\Delta C_{oper,t} + \Delta V_{SDG,t} + R_{mit,t}\right) - \left(I_{dig,t} + C_{tearn,t}\right)}{\left(1+r\right)^{t}},$$

where n – calculation horizon (life cycle of the implemented information system, usually 3–5 years); t – calculation period (year); r – discount rate (reflects the cost of capital of the enterprise); $C_{oper,t}$ – increase in savings on operating transaction costs due to the digitization of processes in year t; $\Delta V_{SDG,t}$ – additional economic benefit (Value) generated by increased transparency and the ability to monitor the implementation of Sustainable Development Goals (this indicator includes savings on loan servicing (through access to "green financing" at reduced rates) and capitalization growth by attracting socially responsible investors); $R_{mit,t}$ – cost of averted risks (Risk Mitigation) (reflects the financial equivalent of minimizing threats from the use of dangerous software such as 1C/BAS); $I_{dig,t}$ – capital expenditures for digital transformation (purchase of licenses for a modern ERP system, configuration of cloud infrastructure, integration with IoT sensors, etc.); $C_{tearn,t}$ – these are expenses for staff training (mastering new technologies or processes) in period t

$$R_{mit,t} = P_{attack,t} \times L_{fin,t},$$

where $P_{attack,t}$ – expert probability of a successful cyberattack, database lockout, or government sanctions due to the use of outdated/compromised software

architecture; $L_{fin,t}$ – total potential financial losses (loss of income due to suspension of operations, penalties for confidential data leaks, loss of business reputation).

The traditional preservation of the status quo (the use of software products developed based on 1C: Enterprise) is mistakenly regarded by the management of most economic entities as "zero losses". However, in the context of full-scale military aggression and total digitalization, the real cost of this approach is quite high: the exponentially growing indicator $R_{mit,t}$ and lost opportunities $\Delta V_{SDG,t}$ significantly exceed investments in digital transformation ($I_{dig,t}$).

For empirical testing of the proposed mathematical model, scenario modeling was conducted using the example of a representative conditional business entity – a medium-sized manufacturing enterprise (hereinafter, Alfa LLC).

Initial modeling conditions: Alfa LLC has an annual turnover of UAH 100 million, a loan portfolio of UAH 10 million, an accounting staff of 5 people, and currently uses outdated, now-banned BAS software (an adapted analogue of 1C). Management is considering transitioning to a modern, international-class cloud-based ERP system with built-in big data analytics and SDG reporting capabilities. The calculation horizon (n) is 3 years, and the discount rate (r) is set at 15% (0.15).

The choice of a 15% discount rate ($r = 0.15$) for scenario modeling is not accidental and reflects the macroeconomic realities of Ukrainian business. First, this rate aligns with the weighted average cost of capital (WACC) for Ukrainian medium-sized businesses and the indicative accounting rate set by the National Bank of Ukraine. Second, it reflects the level of alternative returns on risk-free investments in the Ukrainian financial market (in particular, returns on corporate deposits and government bonds). Thus, discounting at a 15% rate allows for the time value of money, inflation expectations, and the market premium for the risk of introducing innovative technologies to be taken into account, thereby making the calculated economic effect as close as possible to real management conditions.

The initial data used to calculate the variables are based on average market indicators and expert assessments of the Ukrainian IT market and consulting companies (**Table 3.1**).

Based on the collected data, it is possible to calculate the integral economic effect (E_{trans}) and present the results in **Table 3.2**.

The calculation proves the mathematical and financial validity of abandoning outdated 1C/BAS systems. The integral economic effect of switching to a modern digital system for a medium-sized enterprise is more than UAH 1 million over three years, and the project payback period is slightly more than one year.

Particular attention should be paid to the structure of the economic effect. In the traditional (outdated) management paradigm, management only takes into account

direct operational savings ($\Delta C_{oper,t}$), ignoring indicators $\Delta V_{SDG,t}$ and $R_{mit,t}$. Without taking into account the averted security risks and access to "green" investments, the payback period for such a project would seem too long to management, which explains the total digital inertia of the market.

Table 3.1 Initial parameters for modeling the economic effect of digital transformation at Alfa LLC

Indicator (model variable)	Economic meaning and calculation algorithm	Amount, UAH/year
Capital investments ($I_{dig,t}$)	One-time expenses in the zero period: purchase of modern cloud ERP licenses, server configuration, and architecture integration (expert market assessment)	800000
Staff training costs ($C_{tearn,t}$)	One-time costs: training for accounting staff to overcome inertia and master new digital skills	100000
Operational savings ($\Delta C_{oper,t}$)	Annual savings in payroll and related expenses thanks to automation (freeing up 30% of the working time of 5 accountants with an average salary of UAH 25,000/month)	450000
Benefits of SDG orientation ($\Delta V_{SDG,t}$)	Annual savings on loan rates. Access to green financing programs thanks to transparent SDG reporting reduces the loan rate (UAH 10 million) by 2%	200000
Avoided risks ($R_{mit,t}$)	Annual loss minimization. Probability of a cyberattack on Russian software (15%) × potential losses from downtime and data loss (UAH 1,500,000)	225000

Source: compiled by the authors based on expert assessments

Table 3.2 Calculation of the integral economic effect of digital transformation at Alfa LLC

Year	Cash flow of benefits, UAH	Discount rate (r = 15%)	Present value of cash flow, UAH
0	–900000	1.000	–900000
1	875000	0.8696	760900
2	875000	0.7561	661588
3	875000	0.6575	575313
Net integral economic effect (E_{trans})			1097801

Source: calculated by the authors based on the collected data

Thus, the mass transition of economic entities to modern, innovative technologies is a critically necessary step not only to ensure national information security but

also to ensure the full integration of Ukrainian business into the global economy of sustainable development.

3.4 Conclusions

The study of the transformation of information support for technology and innovation management leads to conclude that, in the context of the digital economy, the enterprise's accounting and analytical system is undergoing a profound evolutionary restructuring. There is a conceptual transition from a closed industrial "black box", focused primarily on retrospective recording of economic facts, to a transparent, flexible, and proactive cybernetic system capable of integrating structured and unstructured big data arrays to ensure the implementation of Sustainable Development Goals. Global digitalization is radically changing the functional role of accounting professionals: by automating routine operations through artificial intelligence, smart contracts, and distributed ledger technologies, accountants are evolving from simple registrars to full-fledged strategic business partners and data analysts. In this new role, professional English language skills are transformed from an additional skill into a fundamental competence, allowing specialists to operate with primary sources of global financial analytics and use English-language artificial intelligence algorithms to predict risks in real time. At the same time, empirical analysis of the current state of information support for Ukrainian enterprises reveals a critical problem of technological inertia and the use of outdated software from the 1C/BAS architectural line. It has been proven that, in the context of permanent cyberwarfare, the operation of such systems is unacceptable, as it poses enormous risks of information leakage and blocks businesses' ability to integrate into international value chains. To overcome managerial cognitive barriers, a multifactorial mathematical model for assessing the overall economic impact of digital transformation has been proposed. Its practical testing in a typical medium-sized enterprise convincingly shows that management's traditional understanding of the status quo as "zero costs" is completely wrong. By taking into account not only direct operational savings but also the financial value of averted security risks and the strategic benefits of access to green financing, it has been mathematically proven that potential losses from using outdated systems significantly exceed the capital investments required to implement modern digital technologies. Accordingly, the comprehensive rejection of outdated products and the digital transformation of the accounting and analytical systems are an unavoidable prerequisite for ensuring information

security and fostering sustainable, innovative development of Ukrainian business entities.

Conflict of interest

The authors declare that there is no conflict of interest in relation to this paper, as well as the published research results, including the financial aspects of conducting the research, obtaining and using its results, as well as any non-financial personal relationships.

Funding

The study was performed without financial support.

Data availability statement

The data that support the findings of this study will be made available by the authors on reasonable request.

Use of artificial intelligence statement

The authors have used artificial intelligence technologies solely to verify the correctness and consistency of the English translation of the manuscript in an academic style. In particular, the authors used the generative language model ChatGPT (OpenAI, GPT-5.1 Thinking) for language checking and minor stylistic refinement. The authors bear full responsibility for the content of the final manuscript; the AI tool is not credited as an author and is not responsible for the reported results.

Acknowledgments

The authors received no specific support from individuals or organizations that should be acknowledged beyond their institutional affiliations stated in the manuscript.

Authors' contributions

Lesia Kononenko: Conceptualization, Theoretical framework, Research design, Supervision, Writing – review & editing.

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Yuliia Hlavatska: Academic writing support, Language editing, Writing – review & editing.

Oksana Abramova: Methodological support, Interpretation of results, Writing – review & editing.

Serhii Kononenko: Empirical research design, Data analysis, Visualization, Writing – original draft.

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