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ACCOUNTING AND ANALYTICAL SUPPORT OF ENTERPRISES IN THE DIGITAL ECONOMY

Purpose. To analyze features of accounting and analytical support in the digital economy; to consider areas of IT-technology in accounting and auditing; to suggest approaches increasing their effectiveness; to develop a mathematical algorithm for evaluating the effectiveness of the use of IT-technologies in accounting and auditing.

Methodology. The methods used include: abstraction – in formulating the topic and purpose of the study; content analysis – to identify features of accounting and analytical support for the functioning of enterprises in the digital economy; ascending from the abstract to the concrete for the formation of directions for implementation of accounting and analytical support; idealization and formalization – to systematize functions of IT-tools and options for their implementation; induction and deduction – to create block- algorithm for the formation of enterprise reporting; mathematical formalization – to assess the effectiveness of the use of IT-technologies.

Findings. It is established that there are both obstacles and incentives for the introduction of IT-technologies. The factors of this and their influence are analyzed. A block algorithm of formation of the enterprise reporting with a combination of IT-technologies and methods of accounting and audit is created. The developed algorithm allows the formation of real-time operational reporting for the control of management decisions. The functions of IT-tools and variants of their implementation have been systematized.

Originality. The synergetic effect of combining IT-technologies and accounting is revealed. Its origin is detailed by combining the functions of all forms of accounting and auditing in a single IT-system. A criterion for evaluating the implementation of IT-tools is proposed. It is established that the trend, not the absolute value of this indicator, is a significant factor in the analysis.

Practical value. Comparative analysis of the structure of the functions of IT-tools and accounting allows identifying unrealized opportunities. Also, the block algorithm of reporting and the criterion approach to the evaluation of IT-tools are useful for researchers and practitioners.

Keywords: *accounting and analytical support, information tools, efficiency evaluation criterion, block algorithm, synergistic effect*

Introduction. Modern processes of economic transformation of the world's leading countries are due to the rapid introduction of the latest technologies in all spheres of human activity, primarily information and communication. The impact of these technologies on economic processes is so great that a special definition began to be used for the modern economy – Economics 4.0.

These changes also could not but influence the sphere of accounting and auditing. The range of these changes in this sphere is extremely wide: from electronic document management and verification of primary data – to the formation of real-time analytical reporting of extreme complexity, analytical and prognostic studies on management decisions based on financial and economic indicators of the enterprise, use of accounting and audit data to detect fraud, negligence, stop criminal activity using modern algorithms. Nowadays we are no longer talking about information technology as a tool for automating routine activities and a method for increasing the efficiency of accounting and auditing. The reality is the transfer of traditional accounting and auditing to a new level.

The use of modern information systems creates new opportunities in big data processing, efficiency of powerful information flows, provides not only accounting and control of key indicators of financial and production activities: cost of pro-

duction, structure and level of costs, profitability, etc., but also operational information to enterprise management to effectively ensure the optimal values of these indicators in future periods, to neutralize risks and threats, which is especially important in the current economic crisis. In view of this, in Ukrainian realities the task is to reform the accounting and auditing system at an accelerated pace, using IT technologies, according to the approaches and standards tested by developed countries.

Literature review. Khorunzhak, et al. [1] studied the problems of accounting for transactions taking into account the realities of the digital economy. Korol, et al. [2] analyzed the world experience in implementation of information technologies in accounting and auditing. Spilnyk, et al. [3] stated that information technology forms a new paradigm of accounting. Khorunzhak, et al. [4] studied the use of statistical models for the formation of control functions of accounting. Hamova, et al. [5] studied the latest algorithmic approaches and ways to improve accounting and auditing. Vyniatynska, et al. [6] developed an algorithmic approach to cost optimization analytically studying the state, structure and intensity of the dynamics of production costs. Calinescu [7] proposed creative accounting and audit of economic activity of enterprises. Skrynkovskyy, et al. [8] studied the features of the audit system in Ukraine on the basis of international standards for the use of information systems in accounting and management. Naz-

arova, et al. [9] developed a theoretical and methodological basis for the use of IT audit as a tool for strategic management. Storozhuk, et al. [10] studied in detail the features of financial reporting and the use of IT technologies in the G7. Kovalevska, et al. [11] developed a sequence of implementation of IT technologies in the process of enterprise management by implementing the contours of a single information space. Zamura, et al. [12] studied the possibilities of information accounting and audit of natural capital, its features and benefits.

The works by foreign scholars, in particular Abdel-Rahman Kh., El-Dalabeeh [13, 14] also raise the issue of effective use of information technology in accounting and auditing. Foreign scientists consider various current issues of using automated information systems (AIS) in accounting. Thus, Ahmad [15] considers the implementation of AIS to detect abuses using control as a moderator. Al-Dmouretall [16] proposes to predict business performance with the help of multiple linear regression and neural network using accounting data as independent variables. Meiryman, et al. [17] studied the impact of improving operational activities through the use of accounting information systems to improve the quality and reduce the cost of products and services. Kravetettall [18] studied aspects of improving the effectiveness of internal control of accounting activities using AIS. In [19, 20] ways to improve the efficiency of accounting using cloud computing big data and neural networks are considered.

Unsolved aspects of the problem. The analysis of the body of scientific literature indicates a large amount of research on this topic and a wide range of aspects considered by scientists. However, the features of accounting and auditing in the digital economy need further study. It also requires attention to the study on the implementation of the latest opportunities for accounting and auditing and justification of new approaches to increase the effectiveness of their implementation. The choice of an integrated indicator of the effectiveness of the introduction of information technology in the field of accounting and auditing, the rationale for this choice and its strict mathematical formalization requires detailed attention.

The purpose. To analyze the features of accounting and auditing in a digital economy. To consider the directions of realization of the newest technologies in accounting and audit and to offer approaches to increase the efficiency of their introduction. To develop a mathematically formalized approach to evaluating the effectiveness of information technology.

Methods. General and special methods of cognition were used to perform the research, the results of which are presented in this article.

In particular, the method of abstraction and the method of comparative analysis were used in formulating the topic and purpose of the study. This was preceded by the use of the method of critical analysis of scientific literature on selected issues.

The method of content analysis was used to identify the features of accounting and auditing in the digital economy.

The method of ascending from the abstract to the concrete allowed detailing the directions of realization of the newest possibilities of accounting and auditing and offering approaches to increase the efficiency of their implementation.

The method of idealization and formalization, and the method of analysis and synthesis were used to systematize the functions of information tools and options for their implementation. The introduction of the method of system analysis allowed identifying the synergistic effect of information tools and methods of accounting and auditing.

The method of induction and deduction was used to create a block algorithm for generating enterprise reporting using IT-technologies.

The method of mathematical formalization was used to form an approach to evaluating the effectiveness of information technology.

Results. The study found out that accounting, which in essence is the basic function of enterprise management and pro-

vides the management process at all levels, generates more than 4/5 of the information needed to form relevant management decisions. The opinion is confirmed that given the current realities and the current legal framework, the accounting and auditing process has institutional, institutional and methodological barriers to cross-functional cooperation with strategic management of the enterprise, which greatly complicates the provision of operational and analytical information needed to form appropriate management policy.

At the same time, the analysis found out that there are significant incentives for the management of Ukrainian enterprises to implement modern accounting and auditing practices.

For example, one of such incentives is to form transparent reporting that meets global norms and standards in the form of presentation, and is clear and familiar to international investors and which also helps to get access to world exchanges and, in general, is in line with the trend of integration of domestic enterprises into the world market.

The task is not only the effective use of modern information tools and approaches in operational and strategic activities of the enterprise, but also the formation of an appropriate structure for optimal use of these information tools and their appropriate adaptation to the realities of management and production.

This, above all, creates incentives to increase human capital, strengthen the staff of structural departments of enterprises that are related to the sphere of accounting and auditing or, ex officio, have relations with this sphere, for example, consume information prepared while conducting accounting and auditing.

The timely selection of key determinants of the impact of modern information technologies by expert analysis is a sufficiently sensitive factor for increasing the efficiency of production from the introduction of these technologies into the practice of accounting and auditing, which allows focusing on promoting the most important factors in increasing the effectiveness of these technologies

Unfortunately, practical experience shows that, nowadays, the process of forming an appropriate structure for the use of IT-technologies, their adaptation to modern management and production conditions with the implementation of systematic modernization of the enterprise is not always uniform and systematic. There are many prerequisites for this.

Thus, it is established that the factors that hinder the introduction of information technology in the processes of accounting and auditing for domestic realities are:

- insufficient level of information literacy not only of the population in general, but also of professional staff of relevant departments of enterprises and their lack of readiness to promote change;
- inconsistencies in the regulatory and legal support of auditing and accounting activities and frequent changes in the regulatory framework, which complicates the algorithmic formalization of various aspects of these activities;
- significant cost of licensed software, especially special purpose software;
- the use of non-unified software by interacting participants of the Ukrainian market (for example, in the seller-buyer relationship), which complicates or even prevents their business communication;
- unwillingness of Ukrainian market participants to bear the appropriate costs of information security and neutralization of threats.

According to analytical research, IT-technologies in accounting, auditing, and related management activities using a systematic approach were understood as a single system of tools and methods for collecting, accumulating, processing, protecting and storing, transporting and using data related to accounting and auditing. Moreover, the system approach has led to the presence of this system of all inherent system properties – integrity, emergence, and so on.

So, Fig. 1 shows the results of a systematic analysis of the implementation of information technologies, which in particular indicate the emergence of the functions of IT-tools to expand the capabilities of accounting and auditing and technological options for their implementation.

It is the interaction of the latest tools of accounting and auditing and information technologies that create a synergistic effect, which provides a sharp increase in the efficiency of traditional accounting.

Comparative analysis of the proposed structure and realities of the implementation of IT-technologies in a particular enterprise allows identifying previously unrealized opportunities of the Economy-4.0.

But the process of interaction between the latest tools of accounting and auditing and information technologies is ambivalent. It brings not only positive results but also has negative consequences.

New risks and threats manifest themselves in unexpected ways in various aspects of the application of IT-technologies and raise the level of danger to a new level. This requires additional compensatory funding to avoid and neutralize threats, use new technological techniques and methods to protect against information risks, not previously inherent in the process of accounting and auditing.

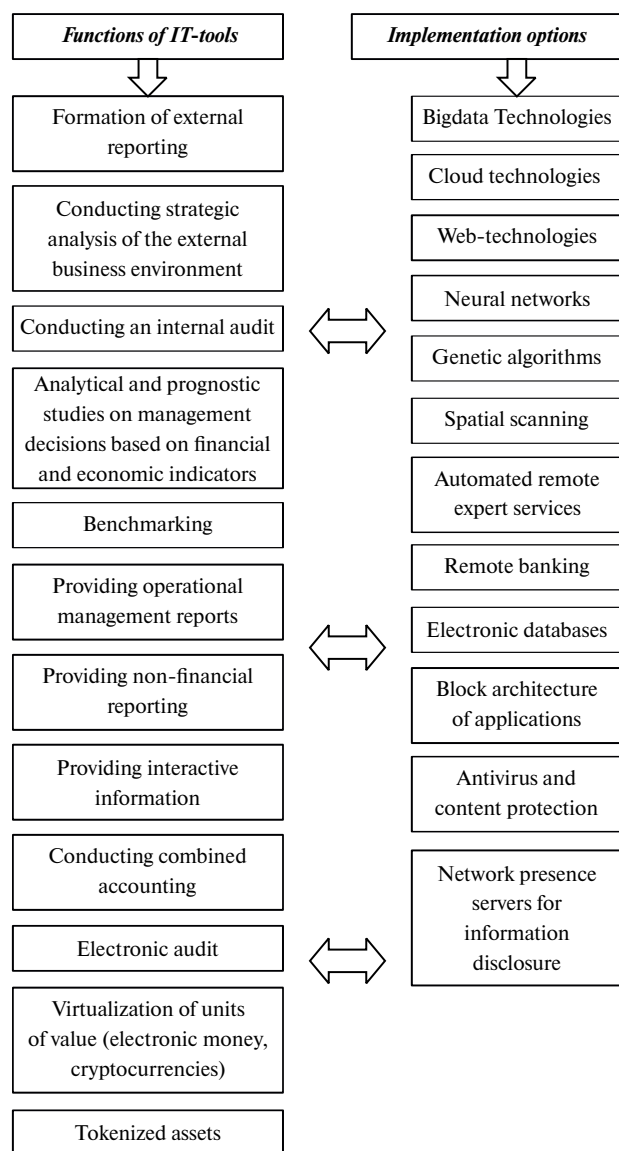


Fig. 1. Functions of IT-tools to expand the capabilities of accounting and auditing and increase the efficiency of their implementation and options for their implementation

The approval on August 27, 2021 of the introduction of electronic audit (e-audit) by the Cabinet of Ministers of Ukraine in accordance with Order of the Ministry of Finance No. 561 of 15.09.2020 is a specific illustrative example of the use of IT-technologies in accounting and auditing. This Order amended the Procedure for providing documents of the taxpayer if a documentary audit by the tax service is necessary.

This is in line with European practice. Thus, e-audit has been introduced by the Organization for Economic Co-operation and Development in Europe (OECD), which has introduced the Standard Audit File for Tax (SAF-T).

This standard regulates the collection of taxpayer accounting data and provides access to them for the tax service. This not only makes it impossible to manipulate data, but also simplifies tax reporting and minimizes additional tax audits.

Information on the availability and condition of assets, changes in equity and liabilities must be submitted to the State Tax Service by the taxpayers along with the detailed data on the financial and economic condition of the enterprise, etc. using an electronic file of a specialized SAF-T Form.

The main advantage of e-audit is the ability to use special algorithms for analyzing primary accounting documents and verify the proper payment of taxes. This significantly increases the efficiency of tax administration and minimizes the cost of resources on this for both fiscal authorities and taxpayers.

The use of e-audit will also help solve the following tasks:

- introduction of risk-oriented methods before (which will reveal inaccuracies in accounting) and during the official inspection;
- increasing the effectiveness of tax audits and simplifying them;
- creating opportunities to improve accounting and auditing for the operational conduct of internal audit;
- reduction of burdensome inspections for the taxpayer and inconveniences of their conduct;
- reducing the number of violations of tax legislation and related litigation;
- reducing the influence of the "human factor" on the formation of tax reporting.

Thus, a comprehensive analysis of the feasibility and results of e-audit is a concrete example of the systematic application of IT-technologies in the practice of accounting and auditing that raises the accounting and auditing process to a new level that meets European norms and rules.

In particular, it is noteworthy that the introduction of e-audit opens the possibility of using a synergistic effect while integrating internal and external audit processes.

Views on accounting automation are undergoing a revolutionary change with the widespread introduction of modern IT-technologies in the practice of accounting and auditing. One moves from the automation of individual tasks to the practice of system automation of all enterprise management processes. This led to the transition to the use of IT-technologies, which should combine the functions of all forms of accounting, operational, statistical accounting and all forms of audit on the basis of a single information system.

This, in turn, changed the approaches to the methods and techniques of collecting, processing, verifying the relevance of primary information, and its systematic analysis using big data technologies.

Such IT-technology should use convenient and adaptive interfaces for data import and export, create prerequisites for automation of all stages of accounting and auditing processes, maintain interaction with timely updated databases, especially databases on business accounts, regulatory changes in accounting forms and reporting.

Fig. 2 shows a block algorithm for generating enterprise reporting using the above advantages of combining information technology and modern methods of accounting and auditing.

The developed algorithm indicates new opportunities for real-time operational reporting to control the effectiveness of

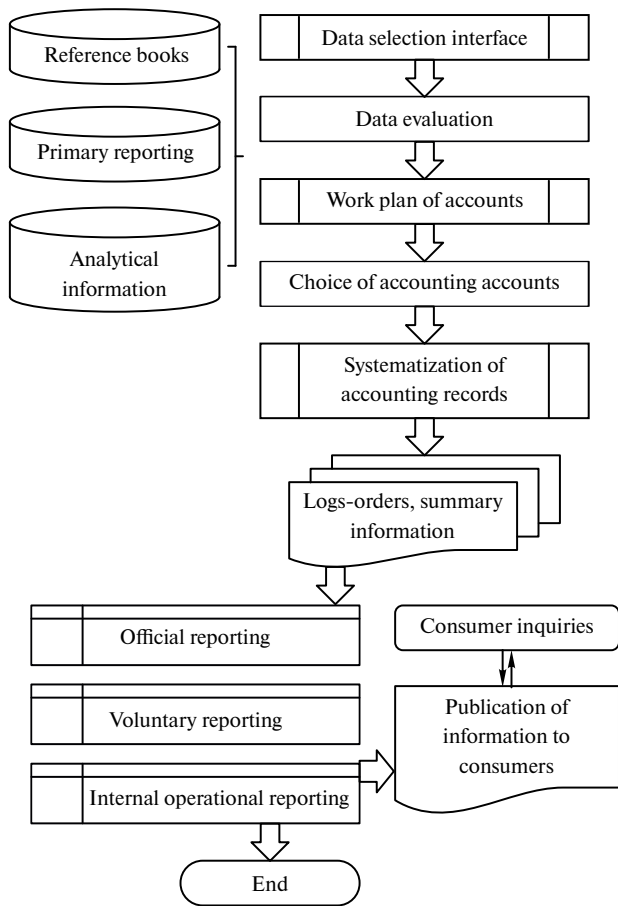


Fig. 2. Block algorithm of enterprise reporting using IT-technologies

management decisions to improve certain financial and economic indicators of the enterprise, identify unauthorized access to cash flows and unauthorized changes in reporting, control the level of relevance of accounting and so on.

Different approaches are used to evaluate the effectiveness of the use of information tools in reference sources [2, 11].

The most appropriate, in our opinion, is the valuation technique, which is based on comparing the ratio of total benefits (in monetary terms) of information tools to the total cost of their implementation during a certain reporting period – a quarter of a year, half a year, a year.

Mathematical formalization of this approach allowed offering an analysis of trends in the integrated indicator of the efficiency of information technology and the cumulative effect of its application of the following type

$$\Delta\varepsilon = \frac{\sum_i^n \bar{A}\bar{X}_i}{\sum_j^m B_j},$$

where $\Delta\varepsilon = \varepsilon_t - \varepsilon_{t+1}$ is the change in the integrated efficiency indicator in the time interval $t \dots (t+1)$; $\theta = \sum_i^n \bar{A}\bar{X}_i$ is a cumulative effect of information technology application; \bar{A} is a dimeric matrix of total benefit ratios; \bar{X}_i is a linear matrix of variables with indices $i \dots n$; B_j is costs of information technology implementation by indices $j \dots m$.

Benefits, for example, include: reduction in time spent on processing primary documentation, time on reporting, etc. (then \bar{A} is a set of reductions in time to perform individual tasks, \bar{X}_i monetary evaluation of the stages of individual

tasks); increase in the competitiveness of the enterprise (for example, by measuring the change in the number of consumers of products or services, the subsequent assessment of increased sales, subsequent assessment of profits), etc.

Losses may include: the cost of computer hardware and software; cost of labor of new specialists of information and analytical service; the cost of information services of third-party organizations (for example, payment for cloud resources, remote banking and expert services), and others.

The rate of increase in changes in the integrated indicator of the efficiency of information technologies indicates the feasibility of their use in the areas of accounting and auditing as well as management.

Decrease in $\Delta\varepsilon$ proves non-systematic and inefficient implementation of new technologies.

Practical research has shown that the determining factor for establishing the appropriate level of effectiveness of IT-integration into the practice of accounting and auditing is not so much the absolute value of the overall economic result from the introduction of new technologies, but the growth rate of integrated efficiency indicator. This growing rate is evidence that there is a long-term systemic impact of the introduction of IT-technologies in the practice of accounting and auditing as well as management.

The presence of a steady rate of increase in the efficiency of information technologies also indicates the success of management decisions on their implementation and adaptation of information technology to all spheres of accounting.

Conclusions. It is established that accounting and auditing, which are the basis of enterprise management, provide more than 4/5 of the amount of information required for the formation of relevant management decisions. The opinion is confirmed that given the current realities and the current regulatory framework, the accounting and auditing process has institutional, institutional and methodological barriers to cross-functional cooperation with strategic management of the enterprise, which significantly complicates the provision of operational and analytical information needed for effective management policy.

The existence of incentives for the management of Ukrainian enterprises to introduce modern accounting and auditing practices has been established. Factors that hinder the introduction of information technology in the accounting and auditing processes for domestic realities have also been identified.

The preconditions for the formation of a synergetic effect of the combination of IT-technologies and accounting and auditing processes at all stages of their implementation are analyzed. The emergence of a synergetic effect by combining the functions of all forms of accounting, operational, statistical accounting and all forms of audit on the basis of a single information system is detailed.

The advantages and new opportunities that open up for the introduction of this IT-technology are analyzed using the example of the introduction of electronic audit.

The block algorithm of formation of the enterprise reporting with the systemic use of advantages of a combination of information technologies and modern methods of accounting and audit is created. The developed algorithm indicates new opportunities for real-time operational reporting to control the effectiveness of management decisions to improve certain financial and economic indicators of the enterprise, detection of unauthorized access to cash flows and unauthorized changes in reporting, auditing and so on.

As a criterion for evaluating the effectiveness of the implementation of information tools, a mathematically formalized and suitable for algorithmization integrated indicator of the efficiency of information technologies and the overall effect of its application is proposed. This indicator is realized as a specific value of benefits from the latest technologies per unit of total costs of their implementation. The study found out that an important factor for the analysis is not the absolute value of this indicator, but its trend – the rate of increase or decrease and the sustainability of this trend.

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Обліково-аналітичне забезпечення функціонування підприємств в умовах цифрової економіки

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Мета. Проаналізувати особливості обліково-аналітичного забезпечення функціонування підприємств в умовах цифрової економіки. Розглянути напрямки ІТ-технологій в обліку та аудиті. Запропонувати підходи зростання їх ефективності. Розробити математичний алгоритм оцінювання ефективності використання ІТ-технологій в обліку та аудиті.

Методика. Використані методи: абстрагування – при формуванні теми та мети дослідження; контент-аналізу – для виявлення особливостей обліково-аналітичного забезпечення функціонування підприємств за цифрової економіки; сходження від абстрактного до конкретного для формування напрямів реалізації можливостей обліково-аналітичного забезпечення; ідеалізації та формалізації – для систематизації функцій ІТ-інструментів і варіантів їх реалізації; індукції й дедукції – для створення блочного алгоритму формування звітності підприємства; математичної формалізації – для оцінювання ефективності використання ІТ-технологій.

Результати. Встановлено, що для запровадження ІТ-технологій є перепони та стимули. Чинники цього та їх вплив проаналізовані. Створено блочний алгоритм формування звітності підприємства із поєднанням ІТ-технологій і методів обліку та аудиті. Розроблений алгоритм дозволяє формування оперативної звітності в режимі реального часу для контролю управлінських рішень. Проведена систематизація функцій ІТ-інструментів і варіантів їх реалізації.

Наукова новизна. Виявлено синергетичний ефект поєднання ІТ-технологій та обліку та аудиті. Деталізовано його виникнення за поєднання функцій усіх форм обліку та аудиті в єдиній ІТ-системі. Запропоновано критерій оцінювання впровадження ІТ-інструментів. Встановлено, що вагомим чинником аналізу є тренд, а не абсолютне значення цього показника.

Практична значимість. Порівняльний аналіз структури функцій ІТ-інструментів і обліку дозволяє виявити нереалізовані можливості. Також корисними для науковців і практиків є блочний алгоритм формування звітності та критеріальний підхід до оцінювання ІТ-інструментів.

Ключові слова: обліково-аналітичне забезпечення, інформаційні інструменти, критерій оцінювання ефективності, блочний алгоритм, синергетичний ефект

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