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INFORMATION AND COMMUNICATION TECHNOLOGIES AS A TOOL AND INCENTIVE FOR STRATEGIC DECISION MAKING

Purpose. To analyze the peculiarities of the use of ICT and their structural components. To formulate requirements for strategic decision-making systems. To identify the impact of ICT on creation of new opportunities and threats. To form a basic structural scheme of using ICT in strategic decision-making.

Methodology. Methods of critical and comparative analysis were used to determine the topic and purpose of the study. Method of system analysis was used for the formation of the basic structural scheme of ICT when making strategic decisions. The method of induction and deduction was used to study the features of ICT and their structural components. Idealization and formalization method – to analyze the problems and threats associated with the use of ICT. Method of analysis and synthesis – to identify and study in detail the indirect effects of related industries on the formation of strategic decision-making.

Findings. Requirements for decision support and decision-making systems, their software components as well as for the quality of data that determines the relevance of decisions were formulated. The need is pointed out to create powerful information centers that can serve a significant number of enterprises, combining their use with a distributed network of enterprise information centers. The analysis of the dynamics of gas consumption confirmed the situational nature of strategic decision-making by certain consumer groups and the weak level of ICT use.

Originality. The basic structural scheme of ICT uses in making strategic decisions by enterprise management is formed. The reasons for the lack of generalized principles of strategic digital transformation of enterprises are identified. It is established that the state and tendencies of changes of branches which influence the activity of the analyzed enterprise are though indirect but significant and should be subject to the strategic analysis.

Practical value. The proposed basic structural scheme of ICT use can be used as a model in the implementation of ICT at the enterprise. The results of theoretical research and practical testing of the proposed approach can be widely used for the analysis of the dynamics of natural gas consumption.

Keywords: *information and communication tools, intellectual information technology, strategic decision support systems, data mining*

Introduction. Modern information and communication technologies (ICT) not only lead to the introduction of new, effective technological techniques in production and management, but also create new opportunities to increase the efficiency of production and management processes. Nowadays, ICT is a stimulus for the rapid growth of enterprise efficiency and the creation of a new economic environment, which is called “Economy 4.0”. The new stage of the industrial revolution not only provides managers with modern tools, but also poses new challenges to enterprise management, including the most efficient use of the driving forces of Industry 4.0 and the destruction of artificial barriers to the implementation of ICT.

Traditional methods of enterprise management and strategic decision-making, attempts to increase the level of control of subordinates, which is not only a waste of resources but also is a deterrent to initiative reducing the competitiveness of production remain to be a significant obstacle to the implementation of ICT. That is, in addition to objective factors that hinder the effective implementation of new management approaches, there are also subjective ones related to the usual methods of management and psychological characteristics of old school managers with their ignorance of new technological opportunities of ICT. This increases the role of research on the implementation of ICT in management practice, in particular in the management of old industrial enterprises, the management of which has some prejudices about new technologies, to increase the effectiveness of strategic management decisions.

Literature review. Puriy [1] studied the role of ICT in changing the role of strategic management in increasing the efficiency of the enterprise. The article by Kuzmina, et al. [2] is devoted to the optimization of management decisions using ICT. Nitsenko, et al. [3] proposed a synergetic framework that links the development of ICT with business and management. Al-Busaidi, et al. [4] studied the impact of investment in ICT on financial performance of the enterprise. Baber, et al. [5] studied how ICT improves business management by changing business models through the logic of effect and cause and effect. Wrede, et al. [6] detailed the influence of top managers on the digital transformation of enterprises and the reverse impact of ICT on management. Baptista, et al. [7] pointed out the main opportunities and risks associated with digital transformation. Horváth, et al. [8] detailed the driving forces for the introduction of new technologies in management and the main barriers for ICT in industry. Caputo, et al. [9] studied the impact of ICT investment on increasing the efficiency of companies, increasing the role of management in this process. Cennamo, et al. [10] studied the management of digital transformation, its scale and methods of joint generation of benefits. Chaniyas, et al. [11] points out that the use of ICT is not only radically changing planning technologies, but is also a dynamic process of continuous improvement. Zamlynskyi, et al. [12] proposed a nonlinear digital model of enterprise development, which is based on the interaction between ICT and organizational processes. Frank, et al. [13] studied the impact of ICT on the effectiveness of certification technologies and Industry 4.0. Echterfeld, et al. [14] propose digitization of product portfolios using the scenario method and point out

that this is a promising approach to strategic management. Gurbaxani, et al. [15] studied the growth of economic efficiency through the use of ICT, which leads to changes in the business environment, company strategy, organizational structure and capabilities. Heavin, et al. [16] analyzed the factors that ensure the success of ICT in business and proposed methods of management in making decisions about digital transformation. Ekman, et al. [17] researched the impact of the level of interaction between headquarters and subsidiaries and the manageability of subsidiaries' relationships with their local markets on ICT effectiveness. Kretschmer, et al. [18] studied the formation of a new organizational structure with the introduction of ICT, which requires new approaches to management. Yevdokimova, et al. [19] found out that the implementation of ICT is conducted in several ways, the optimal one of which is the formation of dynamically stable benefits with the development of a portfolio of temporary benefits.

Unsolved aspects of the problem. There are some gaps in the above analysis of research on this issue, despite the wide range of aspects and tasks related to this area of corporate management transformation. Thus, for the Ukrainian realities it is not detailed what exactly determines the successful competitive position of the enterprise with the introduction of ICT in the management process; the basic structural scheme of ICT use for strategic decision-making of enterprises has not been formalized; the features of ICT, intended for both operational and strategic management, have not been studied; the structural components of such systems have not been analyzed; the emergence of new, unprecedented problems and threats associated with the use of ICT and the incentives for enterprises to accelerate business transformation in the context of Industry 4.0 have not been indicated.

Purpose. To analyze the peculiarities of the use of information and communication technologies (ICT) and their structural components. To formulate and stratify the requirements for interactive automated systems for strategic decision support. To identify the impact of ICT on the emergence of new opportunities and new problems and threats. To form a basic structural scheme of ICT use in making strategic decisions by enterprise management.

Methods. Conducting scientific research required the use of general and special methods of cognition. Methods of critical and comparative analysis were used to determine the topic and purpose of the study. The method of systems analysis is used to form a basic structural scheme of ICT use in strategic decision making. The method of induction and deduction is used to study the features of ICT and their structural components. The method of idealization and formalization is involved in the analysis of new problems and threats associated with the use of ICT. The method of analysis and synthesis was used to identify and study in detail the indirect effects of related industries on the formation of strategic decisions of the enterprise.

Results. Strategic decision-making in enterprise management, according to the approach proposed by G. Simon, can be divided into three stages: information, planning and the stage of choosing the best option from a set of possible solutions. During the preparatory, informational stage, primary information as to the events that require decision-making is accumulated and selected. At this stage, the level of relevance of the collected information must be assessed. The planning stage includes the development of decision-making options, their detailing and forecasting of the likely consequences of implementing decisions in practice. At the selection stage, selection criteria are formed, alternatives are substantiated and selected, a plan of implementation and provision of necessary resources is formed, monitoring of the implementation of the chosen option is organized. The success of each of these stages ensuring its effectiveness is due to the proper use of ICT capabilities and resources.

According to the results of the study, it is established that ensuring a successful competitive position of the enterprise

through the introduction of ICT in the management process is due to the following positions: formation of strategic perspective of the enterprise, consistency of this perspective and investment in digital transformation; commensurate level of interest and awareness of the top management of the enterprise in the feasibility of ICT and opportunities to finance innovation in appropriate amounts; possession of sufficient intangible assets and know-how of intellectual property; capacity and level of updating the ICT material base; the level of realization of opportunities for the use of digital technologies. The proposed stratification allows formalizing the comparison of the degree of readiness to ensure a successful competitive position of its own enterprise as well as competitors in the conditions of digital modernization of enterprise management.

The main tool of information and communication technologies that is used in the strategic decision-making process is decision support systems (DSS).

For the convenience of enterprise management, DSS are often implemented as interactive automated systems. We have formulated and stratified requirements for the most adapted systems according to the analysis of strategic management tasks, for the solution of which managers use DSS.

The requirements to be met by the most adapted DSS include: suitability of poorly structured data and tasks for processing; possibility for simultaneous use by managers of different levels, which provides proper problem detailing and structured solutions; ability to support interconnected and consistent tasks; suitability to support the implementation of all stages of the decision-making process: intellectual, planning and selection stage; completeness of the information base of templates on decision-making methods; flexibility of the core algorithms of the information system and the suitability of DSS for use in the conditions of changes: organizational structure of the enterprise, the scope of its activities, market conditions, and others; suitability of the information system for modification; the ability of DSS to improve the efficiency of management processes; support for various modeling methods; suitability of the information system for the use of not only databases but also knowledge bases.

The peculiarity of DSS, designed not only to make operational, tactical decisions, but also to solve problems of strategic management of the enterprise, is its ability to work with extremely large amounts of diverse information; to conduct in-depth data analysis; to form complex data structures necessary for the formation of solutions to the problems of strategic forecasting, planning and management.

Components of such DSS should be programs that, using aggregate data, enable the management of enterprises and organizations to substantiate strategic decisions, ensure proper relevance of these decisions aimed at forming sustainable growth of key financial and economic indicators of the enterprise and make it able to offer risk mitigation options.

The study found out that information and communication technologies can be both a tool to increase the efficiency of the strategic decision-making process and increase its relevance, and create new, never seen before, problems and threats. These negative manifestations of the use of ICT include, in particular, security and confidentiality issues, accelerating the devaluation of the human capital of highly qualified personnel with many years of experience, polarization of work areas, and so on.

Failure to address these issues can lead to ineffective management actions, slowing the growth rate of economic performance of the enterprise, not pursuing a strategic policy, but a policy of responding *ex post facto* to challenges and risks.

That is why there are no generalized conceptual principles of strategic digital transformation of enterprises in the scientific literature, as the rapid development of ICT is constantly creating new opportunities and new challenges.

Therefore, in Ukrainian realities, approaches and forms of digital transformation of enterprises, methods and techniques of strategic decision-making are often formed by enterprises in

an eclectic way and using the experience of the most successful implementation of ICT in a group of homogeneous enterprises.

This reduces the pace of digital transformation of enterprises, reduces the efficiency of ICT and leads to the accumulation of not only positive experience, but also experience of errors and moving the wrong, dead-end ways to solve problems that arise during the formation of Industry 4.0.

The study found out that modern competitive approaches to the formation of strategic forecasts, which are the basis for strategic decisions at present, need more and more computing power.

This is because big data is often needed to generate forecasts and assess the environment. Not only the activities of a homogeneous group of enterprises, companies in a particular region or industry should be analyzed. To form strategic decisions, the analysis of information should not be limited even within the country, as even the activities of small businesses today are also affected by the general situation at the world market. Large amounts of data require the use of significant amounts of resources. Therefore, there is a world experience in implementing the policy of assisting national governments in the formation and operation of information centers that serve a significant number of enterprises.

An example is the IT4Innovations Center for Supercomputing, located in the industrial Moravian-Silesian Region of the Czech Republic. The capacity of the center not only ensures the formation of reliable forecasts for industry but even allows determining the parameters and timing of natural disasters, which is also an important factor for detailed strategic planning of enterprises. The German government program "Industry 4.0", which, in particular, promotes the use of intelligent networks and cyber physical systems, is also an example of an effective centralized system of strategic forecasting for industry. In our opinion, centralized systems should be connected to interactive information systems of individual enterprises in a networked way. This will strengthen the ability of such integrated systems to develop strategic decisions and plan operational tasks in an optimal way.

For an individual information and communication system of an individual enterprise, designed to form strategic forecasts in the industry, we have proposed a block diagram that can serve as a basis for further modular improvement of ICT use by enterprise management (Fig. 1).

The proposed structural scheme divides the process of forming a system of strategic decision-making into certain stages (Fig. 1). This allows forming algorithms on a block basis, i.e. in accordance with the rank of the stage. It also opens the possibility to use the approach of DFD-analysis on the formation of the information parent block of the previous stage of the block – the descendant of the next stage, which accordingly implements these hereditary characteristics. It is preceded by the stage of "Formation of goals and priorities" which is followed by the stage of "Strategic analysis", which in accordance with the objectives implements the processes of diagnosis of internal and external environment to operational and strategic depth. The next stage is "Formation of corporate strategies" according to which these strategies should be detailed at all organizational and production levels, including each of the subsystems. The result is the formation of a strategic program of action, which should be based on sufficient resources, which should be allocated in full.

Strategic controlling should accompany the whole process of implementing a strategic action program at all stages.

Even a cursory glance at the structural scheme of strategic decision-making shows that the task is impossible without the use of ICT.

Qualitative primary data are required for the formation of relevant solutions.

The degree of data quality is proposed to be assessed by the following items: internal consistency of information (accuracy and reliability); contextual coherence (relevance, timeliness and

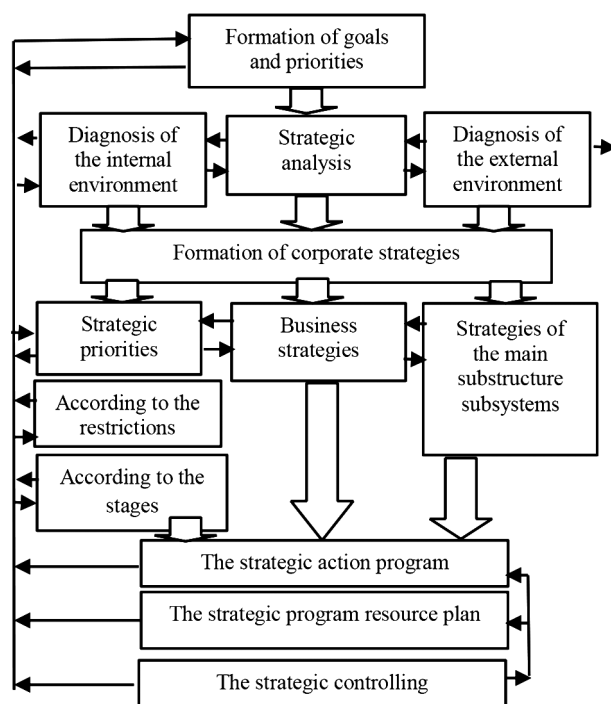


Fig. 1. Basic structural scheme of using ICT for strategic decision making

degree of completeness); representative consistency (consistency, lack of double interpretation, conciseness); safety of use.

The main requirement to the formation of quality data should be to reduce the level of uncertainty proposed for the manager's choice of strategic options.

Not only the related group of enterprises, the industry to which the research enterprise belongs, their immediate environment, but also the state and trends of other industries, whose impact on the activities of the analyzed enterprise is indirect, other external influences with a wide range of factors which is possible to analyze with the existing power of ICT used.

For a practical example, an analysis of a significant amount of information on the energy sector, whose work determines the proper functioning of enterprises in other sectors of the economy, is conducted.

The use of natural gas for production needs as a marker of the general market situation and a variant of the express analysis of the level of introduction of ICT by Ukrainian producers to make important decisions was subject to detailed analysis.

Even a cursory analysis indicates a trend of significant reduction in the number of non-domestic consumers of natural gas for the period 2018–2021 (Fig. 2). The functional dependence of the dynamics of the number of commercial consumers of natural gas over time is uneven and is characterized by abrupt changes and different direction of trends in adjacent

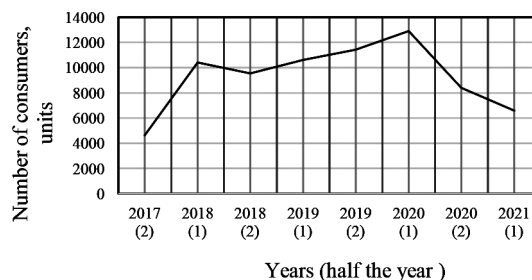


Fig. 2. Dynamics of the number of non-domestic consumers of natural gas, units

time intervals (Fig. 2). This indicates in particular the significant impact of the studied factor on large numbers of consumers in various industries.

The analysis indicates that a significant reduction in the number of consumers was observed in 2018, with some stabilization in 2019, the reduction resumed in 2020 and only in the first half of 2021 there was a slight decline. That is, the situation was shocking for consumers. A detailed analysis was conducted to determine the main causes and trends of the commercial gas market.

It was found out that, although the final half-yearly amount of natural gas consumed correlates with the tariff weakly (UAH per 1 GJ) – the correlation coefficient is 0.429, and correlation coefficient for the total number of commercial consumers with the tariff is 0.36 (Table 1), a detailed analysis of industrial enterprises divided into groups according to consumption volumes forms a different picture.

The analysis indicates that consumers of different groups react differently to changes in tariffs, i.e. the level of forecasting of the possible increase in tariffs and its consequences for different groups of consumers is obviously different. Thus, large consumers (130 million cubic meters) significantly reduce the difference in semi-annual volumes of natural gas consumption after 2020 (Table 2) and consumption volumes in general (Table 3 and Fig. 3). At the same time, the total number of such consumers tends to grow from year to year. Thus, the ratio of 2019 to 2018 is 348.5 %, the ratio of 2020 to 2019 is 189.69 %. This indicates confidence in the market situation and the proper level of strategic management of large enterprises, in particular investments in energy-saving technologies and ICT. The level of correlation of parameters of the price of natural gas – the volume of consumption in 2018–2021 for this group of consumers is high – 0.87. Their reaction to the increase in tariffs is rational in the strategic perspective.

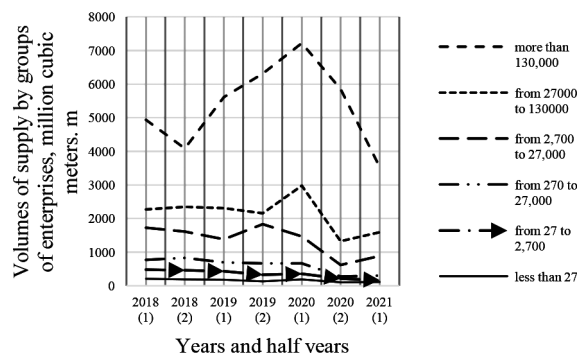


Fig. 3. Supply of natural gas in accordance with certain groups of enterprises in terms of consumption, cubic meters

Consumers with consumption volumes from 2700 to 27,000 cubic meters responded in mid-2019 with a sharp reduction in the number of operating enterprises (Fig. 2), i.e. the response to the challenge of this group of consumers is situational.

Consumers with consumption volumes from 27,000 (inclusive) to 130,000 reacted atypically for the nearest groups – from 2,700 (inclusive) to 27,000 and over 130,000 (inclusive). The analysis of the data indicates a trend of decreasing specific consumption (volume of consumption by a homogeneous group of enterprises to their number) of natural gas by the enterprise – 2018 relative to 2021 (Fig. 2).

In general, the analysis of the available data shows that the factor of rising natural gas prices has different levels of incentives to reduce consumption for different consumer groups. This is indicated by different values of correlation coefficients in the studied groups.

Table 1

Consumption of natural gas by non-domestic consumers of Ukraine for the period 2017–2021

Year	Half a year	Number, units	Volume of supplied natural gas		The average price of natural gas, excluding VAT		Average price of natural gas, including VAT	
			million cubic meters	TJ	UAH for one thousand cubic meters	UAH per GJ	UAH for one thousand cubic meters	UAH per GJ
2017	2	–	4638.7	171,805.4	7653.32	206.64	9183.99	247.90
2018	1	83,777	10,394.0	384,966.0	7733.6	208.81	9280.28	250.57
2018	2	73,988	9536.1	353,190.0	9175.7	227.96	11,010.88	273.50
2019	1	69,576	10,619.0	393,302.0	7585.6	204.81	9102.69	245.77
2019	2	70,791	11,422.0	423,036.0	5499.5	148.47	6599.36	178.17
2020	1	69,370	12,889.0	477,366.0	4297.7	116.04	5157.24	139.25
2020	2	51,694	8398.0	311,038.1	5044.8	136.21	6053.76	163.45
2021	1	54,804	6596.8	244,324.5	7455.75	201.31	8946.90	241.57

Table 2

The ratio of non-domestic natural gas consumption in the second half of the year to the first

Year	Consumer groups by consumption, million cubic meters					
	up to 27	from 27 (inclusive) to 270	from 270 (inclusive) to 2,700	from 2,700 (inclusive) to 27,000	from 27,000 (inclusive) to 130,000	130,000 (inclusive) and above
2018	1.173146	0.963586	0.92712203	0.768961	0.862069	1.142857143
2020	1.401854	2.296367	1.53358925	0.534229	0.169553	1.066974596

Table 3

Primary data of the analysis of natural gas consumption by non-domestic consumers of Ukraine for the period 2017–2021

Consumption, million cubic meters	The specific volume of natural gas consumption by the company, 2018 to 2021	Average consumption for half a year, million cubic meters	Correlation coefficient, price – volume of consumption
up to 27	1.90	159.08	0.381929
from 27 (inclusive) to 270	1.30	352.89	0.540170
from 270 (inclusive) to 2,700	2.44	602.12	0.448789
from 2,700 (inclusive) to 27,000	5.19	1361.32	0.183745
from 27,000 (inclusive) to 130,000	2.67	2140.06	0.308610
130,000 (inclusive) and above)	8.65	4659.2	0.850690

It also indicates that the directions of decision-making, which, of course, are strategic for enterprises, should be different, according to the group of homogeneous enterprises and the goal.

Unfortunately, the analysis also allows us to conclude that today in the Ukrainian reality the situational nature of making important decisions is more typical for businesses in certain groups.

The conclusion of the analysis is that the management of most industries does not use ICT for strategic planning, or this use does not lead to relevant strategic decisions.

The results of the study on the dynamics of gas consumption by non-domestic consumers are a clear example of the application of only one aspect of the analysis of indirect environmental impacts on enterprises and the need to use ICT to form strategic decisions along with the study on large amounts of information.

Conclusions. As a result of the research, the basic structural scheme of ICT use in making strategic decisions by the management of enterprises is formed. This scheme can be used as a model in the implementation of ICT at the enterprise.

The reasons for the lack of generalized conceptual foundations of strategic digital transformation of enterprises are identified. It is pointed out that a serious reason for this is the fact that the rapid development of ICT is constantly creating both new opportunities and new challenges. Business management must spend the necessary resources to neutralize these challenges. In particular, it is necessary to solve problems related to security and confidentiality, acceleration of the devaluation of human capital of personnel with many years of experience, polarization of areas of work and so on.

Failure to address these issues can lead to ineffective management actions, slowing the growth rate of economic performance of the enterprise, not pursuing a strategic policy, but a policy of responding ex post facto to emerging threats.

It has been established that the main ICT tool used in the strategic decision-making process is interactive decision support systems. As a result of the analysis of strategic management tasks, for the solution of which managers use DSS, requirements were formulated and stratified for the most adapted systems, their software components and data quality, which determines the relevance of strategic decisions.

As the formation of relevant strategic decisions requires the analysis of large amounts of poorly structured data, the need has been identified to create, with the assistance of the

state, information centers that can serve a large number of enterprises, combining the use of such centers with a distributed network of enterprise information centers.

It is pointed out that the complexity and scale of the tasks required by the digital transformation of enterprises often contributes to a simplified approach of management to solving strategic management problems, using an eclectic approach and copying the experience of homogeneous enterprises without proper analysis. This reduces the pace of digital transformation of enterprises, decreases the efficiency of ICT and leads to the accumulation of not only positive experience, but also the experience of mistakes and waste of resources.

The study found out that modern competitive approaches to the formation of strategic forecasts, which are the basis for strategic decisions, require analysis of not only a homogeneous group of enterprises or only their environment.

The state and trends of changes in industries, whose impact on the activities of the analyzed enterprise is indirect but significant, should also be analyzed.

As a practical example, the analysis of the dynamics of natural gas consumption as an energy resource by non-domestic consumers is given. The analysis of the dynamics of gas consumption confirmed the situational nature of strategic decision-making by certain groups of consumers.

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Інформаційно-комунікаційні технології як інструмент і стимул прийняття стратегічних рішень

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Мета. Проаналізувати особливості застосування інформаційно-комунікаційних технологій (ІКТ) і їх структурних компонентів. Сформулювати вимоги до систем

прийняття стратегічних рішень. Визначити вплив ІКТ на утворення нових можливостей і загроз. Сформулювати базову структурну схему використання ІКТ у прийнятті стратегічних рішень.

Методика. Методи критичного й порівняльного аналізу використані для визначення теми й мети дослідження. Метод системного аналізу – для формування базової структурної схеми використання ІКТ у прийнятті стратегічних рішень. Метод індукції й дедукції – для дослідження особливостей ІКТ та їх структурних компонентів. Метод ідеалізації та формалізації – для аналізу нових проблем і загроз, пов'язаних із використанням ІКТ. Метод аналізу й синтезу – для виявлення та детального дослідження опосередкованих впливів суміжних галузей на формування стратегічних рішень підприємства.

Результати. Сформульовані вимоги до систем підтримки та прийняття рішень, їх програмних компонентів і до якості даних, що обумовлює релевантність рішень. Указано на необхідність створення потужних інформаційних центрів, що спроможні обслуговувати значну кількість підприємств, поєднуючи використання таких центрів із розподіленою мережею інформаційних центрів підприємств. Проведений аналіз динаміки споживання газу підтвердив ситуативний характер прийняття стратегічних рішень певними групами споживачів і слабкий рівень застосування ІКТ.

Наукова новизна. Сформована базова структурна схема використання ІКТ у прийнятті стратегічних рішень менеджментом підприємств. Виявлені причини відсутності узагальнених засад стратегічної цифрової трансформації підприємств. Встановлено, що стратегічному аналізу мають підлягати стан і тенденції змін галузей, вплив яких на діяльність аналізованого підприємства є нехай навіть опосередкованим, але значущим.

Практична значимість. Запропонована базова структурна схема застосування ІКТ може бути використана як модельна при впровадженні ІКТ на підприємстві. Результати і теоретичного дослідження, і практичної апробації запропонованого підходу до аналізу динаміки споживання природного газу можуть бути широко використані.

Ключові слова: інформаційно-комунікаційні засоби, інтелектуальні інформаційні технології, системи підтримки прийняття рішень, інтелектуальний аналіз даних

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