The use of intelligent information technologies in the development of managerial decisions during organizational changes

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Abstract. In change management, there emerges the problem of making timely and relevant managerial decisions. During the entire process of change, it is necessary to make decisions that ensure the success of changes, which is rather difficult in conditions of insufficient or, otherwise, abundant information and limited resources. The purpose of the study is to explore the possibilities and present the advantages of using intelligent information technologies in change management. The objectives of the study are to identify the features of decisions made during the period of changes; to identify the factors affecting the implementation of information analytical activities, and to review digital technologies that can accelerate decision making and improve its quality in change management. The results of the study have been obtained on the basis of an analysis of trends in the development of the IT market, the data on the introduction of advanced information technologies into company management for the period of 2020-2021, and an expert survey. Taking into account the formulated requirements for managerial decisions during the period of changes, a methodology for using intelligent information technologies in change management has been developed. Within the framework of the proposed methodology, there is established the relationship between the tasks of change management and information support. There is conducted a review of the digital technologies that can be used in managerial decision-making when implementing changes. The results of the study can be used in the development of an information system model that provides support for managerial decision-making during changes in the company. Key words: change management; organizational changes; information technologies; managerial decisions.

1 Introduction

The need for changes in the organization has become so frequent that change management has turned from one-time events into a constantly implemented direction of managers’ work. In change management, there emerges the problem of managerial decision-making, starting with the initiation of changes and ending with the correction of goals after the project of

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changes has been completed. As the process of change progresses, decisions must be made to ensure successful changes. Management theory has developed a wide variety of procedures and methods for making managerial decisions. However, the development of managerial decisions during organizational changes must be based on taking their features into account.

Taking into account the peculiarities of change management as an approach in management and the uniqueness of each change, it is necessary to provide appropriate information support for decision-making. The use of intelligent information technologies is very useful in change management because there are tasks that are difficult to formalize and there is a need to make managerial decisions in conditions of limited or, otherwise, excessive information. The uniqueness of each situation of change and the problems of their implementation no longer fit within the scope of knowledge and experience possessed by a limited circle of managers. The problem can be solved by accessing knowledge bases compiled from many sources.

Developing an organization’s response to external changes involves their constant monitoring. The external environment is known to be very complex, and its factors are interdependent and dynamic.

Rapid technological changes are taking place in the business environment, which requires high speed and quality of innovation from companies [1]. The speed of response depends on many factors, including the receipt of timely and important information. In countries with transition economies, there are a number of problems in the information services market that hinder its development and restrict entrepreneurs in making decisions [2, p. 20]. This requires searching for opportunities to access information, including the cooperation of organizations or the development of their own communications.

With significant dynamics of commodity markets, it becomes relevant to establish an intersectoral balance. Changes affect enterprises of a particular industry and organizations of related industries. An example of this is the intersectoral balance model that is used to predict the demand for railway services [3]. The study of the external environment contributes to the timely detection of opportunities. This makes it possible to find investors and implement innovative projects, which increases the technological level of the company [4, p. 238]. Changes in an organization are necessary to eliminate problems that hinder its development. The impact of customer service problems is particularly noticeable. For example, due to inefficient supply chains, the sales volume of individual manufacturers decreases [5, p. 384], which reduces resources for innovation.

The use of information technologies solves the problems of increasing the efficiency of management. Research is underway to solve the problem of increasing customer satisfaction while simultaneously reducing the time spent on the development of new products via system design [6]. To record the transition of an organization by stages of development, it is proposed to use digital life cycle records that can be used to protect enterprise information and as a knowledge management tool [7]. The platform approach increases the value of digital and information technologies for expanded service offerings and contributes to operational efficiency [8]. The use of artificial intelligence allows one to reduce dredging costs and negative environmental impacts [9].

The following issues are becoming relevant: the use of digital twins, the implementation problems emerging in this context, and the integration with other digital technologies [10]. There has been described the use of a digital twin for the purpose of developing sustainable intelligent production systems in order to ensure quality and reduce the time of product creation [11]. The efficiency of a production system based on optimization involving the use of a digital twin can increase by 34.46% [12].

Intelligent information technologies are especially useful for change management as they make it possible to analyze economic, political, technological, social and natural factors and make a managerial decision. We have to admit that in conditions of a chaotic environment,
atypical situations, multitasking and the need to make decisions quickly, human abilities, even those of highly qualified managers, are limited and insufficient to process a large flow of information. It is important to remember that a manager does not always deal with changes only. In normal practice, work on change projects is superimposed on current activities, which already means an increase in the intensity of managers’ work.

The problem of building information systems of managerial decision-making and development support implies the problem of integrating information with intelligence, which is reflected in publications devoted to building artificial intelligence. Research is being conducted on the optimization modeling of integrated planning, in which integration with modern IT systems is ensured. Thus, there has been developed a linear optimization model which is aimed at improving the efficiency of decision-making in the production and sale of cement [13]. In many applied areas there exists a problem of integrating incomplete and unreliable information. There is proposed an approach for integrating different information from heterogeneous databases that is based on mediation [14]. To improve the system of decision support in construction, the issues of integration of fragmented data from autonomous databases have been considered. For these purposes, a structure has been proposed that automatically integrates incompatible data from various sources into a convenient format for input into industrial construction applications [15]. Technologies for intelligent systems integration are used to ensure the safety of coal mines [16].

Despite the widespread coverage of the use of intelligent digital technologies in many areas, including company management, the issues of information systems support for decision making in organizational change management require special attention. The development of systems to support real-time managerial decision-making remains the current objective of automation of management process.

The purpose of the study is to explore the possibilities and present the advantages to using intelligent information technologies in change management. The objectives of the study are to identify the features of decisions made during the period of change; to establish the relationship between the objectives of change management and information support; and to review digital technologies that can accelerate decision-making and improve its quality in change management.

2 Materials and Methods

In the course of research, there were studied scientific publications on the chosen topic (artificial intelligence in company management, information technology in decision-making). Some judgements and conclusions were based on the author’s experience in implementing organizational changes in companies of different sizes and fields of activity. To prepare the material, the data on the introduction of advanced information technologies in the management of companies for 2020-2021 were collected and analyzed. In particular, there were examined the data on the revenue of participants on the ranking list of Russian hardware and software developers. Based on the materials of news agencies, there were studied forecasts of the development of the world ICT-market, as well as trends and directions related to information technologies development in economics and management, and to process innovations in leading and developing countries.

General scientific methods were used in the study: a systematic approach to solving the problem, analysis, synthesis, unity of logical analysis and dialectical development, and an expert survey. The expert survey was conducted among the managers involved in the implementation of changes in companies and the engineers who design and maintain information systems of commercial and industrial enterprises and banks in large Russian cities.
3 Results

Change management is aimed at forming a management system adequate to the environment, competitive advantages, the company’s compliance with market requirements, and creation of a competitive product. In terms of organizational development, change management contributes to a smooth transition from one stage of the company’s life cycle to another. All this requires the adoption of timely and sometimes anticipatory managerial decisions. Preventive response allows one to reduce possible damage in case of negative factors’ interference. The reaction of the company’s management to the conditions that have already arisen sometimes does not leave a wide choice of actions; changes are more expensive and more difficult. Each change program is a unique managerial invention, the uniqueness of the conditions, goals, objectives, resource provision and causes of change being taken into account. Since there is no fixed set of influencing factors and their strength, it is quite difficult to talk about the programmability of solutions. The uncertainty of the outcome of changes and the high level of risk involved in their implementation requires appropriate measures to reduce the risk in case a decision to initiate changes is made. Changes are almost always painful and incur additional costs, so the decision to implement them should be well-justified.

Hence, managerial decisions implemented in the process of making changes must meet a number of requirements:

- timeliness (in many cases, proactive development),
- reasonableness (making changes implies bearing costs, taking risks, and overcoming resistance),
- focus on goals that are relevant at the end of the changes,
- lower risks related to the implementation of decisions in comparison with the case when such decisions are not made (rejection of changes carries a greater risk to the company than in the case of making changes).

Relevant, necessary, timely and complete information about the object of changes and the conditions for their implementation can improve the quality of decisions made. Such information related to the new business requirements and to the manufactured product can already be considered as a basis for making a decision to start changes.

The constant need for information, the request of which must occur interactively, is a characteristic feature of decision making in change management. While in a classical decision-making process information is collected and analyzed at the beginning, before or during the goal setting, in change management it is increasingly necessary to adjust the goal in the course of changes. This happens because during the period of changes, the environment and the composition of influencing factors change. Actually, this circumstance stipulates increased requirements for information support of decision-making.

Despite negative forecasts, the IT market in Russia is showing growth. Thus, the total revenue of the top 40 participants on the ranking list of Russian hardware and software developers increased by 25% in 2020 compared to a year earlier and amounted to 334 billion rubles. The leaders of the rating are as follows: 1C company with a revenue of 65 billion rubles, then X Holding (56.7 billion from the production of equipment and software development) and Kaspersky Lab (50.6 billion rubles). The total revenue of the participants on the CNews 100 ranking list increased by 28.6% in 2020 in comparison with 2019 and amounted to 2014 billion rubles. Thus, the revenue of one hundred of the largest IT companies exceeded the threshold of 2 billion for the first time in 20 years [17].

According to the forecast of the global ICT market development (the market of information and communication technologies), its volume will amount to 4296.4 billion in 2022, including corporate software (571.7), devices and equipment (778.9), IT services (1193.5), and telecommunications (1504.7) (Source: Gartner (April 2021)). On average, the market growth will be 5.5% in 2022 [18].
According to Gartner, the main trends in IT development in 2022 will be [19]:

- **Data Fabric.** It is architecture for flexible and sustainable data integration between business users and platforms. As the number of disparate repositories has grown, the demand for Data Fabric has grown and continues to grow.

- **Privacy Enhancing Computing (PEC).** It is expected that in the next three years, most large companies will start using PEC methods. This will protect all confidential information at the software level.

- **Cloud platforms.** In 2021, 40% of digital initiatives were based on cloud platforms. By 2025, this figure will be up to 95%.

- **Artificial intelligence.** Gartner believes that the era of AI is coming. In the current year, the development of more effective tools in this direction has been predicted. By 2025, 10% of companies implementing advanced AI solutions will have earned 3 times more on this compared to those with older solutions.

- **Geographically distributed enterprises.** The spread of remote mode turns exclusively office companies into distributed ones, in which employees are geographically removed. Switching to such a model allows one to increase financial results.

- **Autonomous systems.** Such systems are able to change their algorithms themselves, without updates from outside. Soon they will become the norm and will be used everywhere.

According to the information agency “International Data Corporation”, there is an annual increase in spending on information and communication technologies (ICT) in the world (Figure 1). It is predicted that the costs of digitalization of processes and automation of companies’ activities will increase.

![Fig. 1. Global ICT spending (2018-2023). Source: the Information Agency “International Data Corporation”](image)

Digital technologies for obtaining, processing and analyzing information about the company’s status are widely represented. However, the business analytics of the company being changed differs from the analytics performed in static mode. Firstly, when changes are made, not only the quantitative parameters but also the qualitative essence of the company change. The qualitative characteristics of a company change throughout its life cycle and as new requirements emerge. Secondly, the dynamism of business intelligence in change management ensures its sensitivity to influencing factors. Thirdly, all the parameters, including those set for the purpose of changes, must be measurable. Numerical measurability makes it possible to use suitable digital technologies, monitor the process of changes, and evaluate the effectiveness of their results.

The quantitative measurability of the company’s parameters for the formation of an information system model and the choice of information technologies is a solved issue in terms of financial and economic assessment of activities, since there are financial reporting standards and accepted financial indicators. However, when the issue arises about the
assessment of marketing, staff, organizational structure, corporate culture and some other factors of the internal environment, there is a need for the selection of measurement indicators. In order to measure the results of the strategy, methods of evaluating investment projects can be used, but they also have limitations when evaluating the strategic results of changes.

Traditionally, changes in an organization were initiated under the influence of internal reasons, whether it was the director’s will and desire or unsatisfactory performance. Internal spheres and processes were also analyzed on a regular basis in order to detect problem areas and determine subsequent optimization. The internal environment, which includes a well-known set of factors (such as organizational structure, production, finance, staff, and so on) is a zone that is influenced by managers. Managers built and debugged systems for collecting and processing information about the company with the help of required indicators. In particular, this is how management accounting is carried out. On the contrary, the study of the external environment is an almost uncontrollable zone. The need to ensure the company’s adaptation to it requires, first of all, knowledge about what is happening in it. Since in modern conditions the external environment significantly affects business efficiency, business analytics should not be limited to collecting information for making decisions about changes. Information support throughout the change process also determines their success. But in addition to the changes made and, accordingly, the acquisition of new parameters of the organization, it should reconsider its relations with partners in order to take into account mutual interests. It also requires the use of information technologies that monitor the effectiveness of the partnership, ensuring customer relationship management.

Conducting information and analytical activities in change management is stipulated by a number of prerequisites:

- the persistence of making changes. In modern organizations, changes are regular. Changes sometimes take place in several cycles, change programs are implemented simultaneously. Informatization and digitalization of the change process will contribute to the quality of managerial decisions and the monitoring of the results of changes in the current mode.

- Functioning and active development of the Internet business. The initial informatization of the company determines the analytical tasks in change management.

- The availability of digital technologies that provide accelerated collection, transmission, processing of information and its storage.

- The ability to receive cloud service through information platforms.

The following methodology is proposed for the use of intelligent information technologies in change management:

1) select a change model (define the objectives and stages of changes);
2) formulate the need for information for each stage of changes;
3) select intelligent information technologies that ensure high quality management decisions, taking into account the frequency of changes, the need for changes, the required efficiency of decision-making, the frequency of selected facilities being monitored, financial resources and other conditions.

The model of changes is determined based on the causes and type of changes, about which there are relevant publications on change management. For example, a methodology of flexible change management processes has been proposed that allows responding to a dynamic market [20]. For the purposes of our research, we are going to focus on the second and third points of the methodology in more detail.

As far as the second point of the proposed methodology is concerned, the need for information when accomplishing change management objectives depends on their composition, methodological content and implementation cycles.
When making changes aimed at ensuring the compliance of the enterprise with the external environment, there are two objects for tracking: the environment of the company and its condition. Firstly, it is necessary to obtain information on both of these research objects, which requires the complication of the information system. Secondly, the information received should not only be analyzed separately, but also compared in order to identify inconsistencies and gaps for making managerial decisions before the end of the change programme. There arises the issue of the relationship between the objectives of change management and information support, which will be embodied in the adopted model of the information system and selected information technologies. Figure 2 presents one of the possible schemes for the relationship between change management objectives and information support.

- The study of the external and internal environment, detection of inconsistencies and breaks
- Preparation, assessment of development options, risk assessment
- Resistance assessment
- Assessment of resource capacity for change
- Monitoring the results of changes

**Fig. 2.** The interconnection between the objectives of change management and information support.

Figure 2 shows that each change management objective sets a corresponding objective for information support. The cyclical nature of changes forms a new information request when achieving the current objective of changes.

As far as the third point of the proposed methodology is concerned, in case of frequent and constant changes in the organization, it is possible to form an information system that includes the use of appropriate information technologies to improve the speed and quality of managerial decisions. We are going to review the main technologies with consideration of their advantages.

When choosing digital technologies for the development of managerial decisions during changes, Big Data becomes of particular interest. The array of Big Data technologies is wide enough to collect and process data in the course of change management. Thus, statistical analysis and predictive analytics allow one to identify tendencies and trends in the development of a situation or an object. Spatial analysis enables one to build optimal routes and reduce transportation costs. Visualization of analysis data ensures visual assessment of the situation, seeing the weaknesses and strengths of the company. Simulation modeling makes it possible to compare alternatives and present results of changes, as well as the development of the situation without changes. Artificial neural networks help ensure the relevance of internal changes to external ones, the interactivity of decisions and data about the object and reduce risks. Machine learning helps free up managers’ time and resources,
prepare alternative solutions and reduce the influence of the human factor in decision-making. Data Mining makes it possible to identify new patterns, turn big data into useful information for decision-making and optimize business processes. Crowdsourcing helps ensure the collection of information and finding non-trivial solutions.

The advantages to using Big Data technologies in change management are that they make it possible to process a large amount of data into information useful for decision-making, justify the need for changes, evaluate alternative options for their implementation and reduce risks during their implementation.

One should also pay attention to cloud computing. These digital technologies make it possible to use third-party computing and network resources if the company does not have its own, and provide greater reliability in terms of data storage.

The Internet of Things carries a great potential for making managerial decisions and changes in multinational companies.

Many change management tasks can be solved by using a digital twin. The possibilities of its application are very wide, since it can be the embodiment not only of physical objects to be changed or monitored, but also of systems and processes. The digital double records past results and makes a forecast, which is important when developing managerial decisions. In some cases, social networks may be involved in the collection and processing of information.

In the general flow of information, which can be both important and useless for a decision-maker, digital technologies allow one not to miss essential data and build a methodology for responding to weak signals.

The fact indicative of the introduction of intelligent information technologies in change management is the information model of changes. The creation of such a model will facilitate the adoption of high-quality management decisions. However, it is essential to keep in mind the difficulties that you will have to face when creating it: 1) the course of changes depends on many factors, each of which needs to be identified and analyzed in terms of its impact on the success of changes, 2) the results of changes (changes in the parameters of an organization) are achieved by influencing the elements that constitute the change, 3) an organization is a system of a higher order in relation to its constituent elements that affect its effectiveness; at the same time, an organization is subject to the influence of the environment as a more complex system. When constructing an information model of changes, the principle of isomorphism can be used, which implies that for each element, connection and function of the phenomenon, there is a corresponding component in the model image. Therefore, the information model, being a reflection of changes in the organization, becomes a manageable phenomenon.

4 Discussion

The information that managers have to deal with when making changes is becoming increasingly difficult to formalize, so standard databases and decision-making systems can only be taken as a basis for further development. The link between the flow of information to be processed and change management is business analytics. On the one hand, it responds to the improvement of the methodology of economic activity management, on the other hand, it includes an array of software tools developed on the latest technological solutions.

The relationship between change management objectives and information support shown in Figure 2 is described for the case of process change management. If a systematic approach is used in change management, objectives of information support can also be formulated for each element of the change management system.

The analysis of practical application of automated control tools, as well as of information and analytical management support systems taking into account the increasing volume of
information, revealed the practical need to create and use automation tools based on artificial intelligence. The growing complexity of information and its processing systems should not cause any difficulties for the manager when making decisions related to the peculiarities of database functioning and operations of intermediate analytics. This problem can be solved in several ways: 1) introduce intermediate hardware and software elements into the architecture of existing systems, combining disparate networks into a single computing environment, and ensure network interaction with intelligent components; 2) replace existing automated complexes with new intelligent control systems that are provided with new integrated hardware and software.

However, it should be taken into account that according to world statistics, the share of successful IT projects equals 31% on average (the data are derived from Standish Group, CHAOS Report). A project is considered successful when all its goals are achieved within the planned time and budget. Consequently, most of the IT projects (69%) are unsuccessful (problematic) [21].

The response time, the one-time nature of changes, the resources allocated and an increase in the intensity of managers’ work due to the simultaneous maintenance of the functioning of the facility and the changes in it do not allow one to spend an excessive amount of time on information and analytical systems developed specifically for each change.

An important factor in the introduction of digital technologies to management is the availability of intellectual labour potential and educated specialists, as well as taking into account the features of intellectual labour [22].

5 Conclusions

Business analytics is a field of activity based on technologies of obtaining, processing, storing and analyzing data on the economic activity of economic entities. The digital transformation of business analytics entails the emergence of new forms of its implementation which imply the use of intelligent information technologies. Based on such technologies, the improvement of business analytics itself makes it possible to remove methodological limitations, expand the range of objectives and areas of analytical work (among which there may be analytical support for change management). In order to manage changes, in turn, there is a need to explore the possibilities of digital technologies for use in the development of managerial solutions.

The study has identified requirements for managerial decisions that increase the effectiveness of changes (timeliness, validity, orientation to relevant goals, comparison of risks when making changes and abandoning them).

It is established that the adopted model of the information system and the selected information technologies should ensure the interrelationship between the objectives of change management and information support.

There have been determined the features and problems of business analytics implementation in a company in which changes are being made.

There have been defined the prerequisites that oblige one to conduct information analytical activities in change management, namely the constant implementation of any changes, the active development of Internet business, and the availability of digital technologies.

Among the digital technologies that may be useful for making managerial decisions during the period of changes, there have been selected Big Data, Cloud computing, The Internet of Things, and a digital twin.

The advantage to using digital technologies is that they allow one not to miss significant data and build a methodology for responding to weak signals.
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