

Modernization of Quality Management System in the Conditions of Digital Transformation of Enterprise

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Abstract — The subject of the study is – changing the conditions of functioning of the quality management system in the conditions of digital transformation of the enterprise management system. The purpose of the study is to develop methodological provisions for the modernization of the quality management system. The directions of changes are systematized in the article and the basic conditions for the implementation of quality management processes are formed taking into account the drivers of innovative development of the enterprise management system. As a result of the research, the following tasks were solved: actual changes in the quality management system, automation system, information support system for management processes were considered; it was concluded that the introduction of digital technology necessitates the formation of a new information culture based on digital thinking, digital staff engagement and digital initiatives; the consideration of digital technologies as an instrumentation of system-process modeling of an integrated information system is proposed, which involves the creation of a unified information infrastructure of the enterprise's corporate network; systematized quality management methods based on the use of modern digital platforms; the structure of a system of information support for quality management processes was built. The information support system for quality management processes is a tool of the quality management system; the functioning of the integrated information system ensures constant communication in the enterprise management system when making and implementing decisions to improve the quality of processes and improve product quality. The solution to the problem of creating a single information space creates the possibility of constant access and use of unlimited sources of information, which, in turn, allows not only to improve quality management activities, but also to modernize the quality management system through the use of digital technologies and reduce the impact of the "human factor" on the effectiveness and timeliness of the development and

implementation of managerial decisions to improve the quality of processes.

Keywords — drivers of digital transformation, digital standards, restructuring of the quality management system, communication, competition management of digital initiatives.

I. INTRODUCTION

In the context of the digital transformation of enterprise, there are many global changes in all areas of activity, primarily in the enterprise management system, which necessitates the modernization of the quality management system. The introduction of digital technologies is aimed at improving all business processes, using of new methods of additive management, which allows reducing the complexity of processes and ensuring the fulfillment of quality requirements [1]. At the same time, digital transformation involves changing not only the technology and process control technology, but also the need to form a new digital information culture based on digital thinking, which, in turn, is associated with a change in approaches to managing the personnel potential of the enterprise. Digital standards currently used are effective information technologies that can be considered as the main tools of quality management [2].

It should be noted that in the context of the digital transformation of enterprises, the main factor in the development of a quality management system is the use of the following tools: methodology for process-oriented design using a system engineering apparatus, method for system and structural analysis of process quality, method for designing an integrated system of information support for quality management processes, and methodology for designing a

digital enterprise management infrastructure. At the same time, the digital transformation of the enterprise's information system allows switching from traditional methods of process control to methods of digital control of networks of interconnected processes, taking into account the requirements of the process and system approaches to managing the quality of processes and all types of activities, which determines the need to review the content of ISO standards and modernize the quality management system. In the context of digital changes in the enterprise's management system, one of the urgent problems is the strengthening of information security through the application of methods for identification, systematization, coding and archiving of information, as well as the development of additional procedures for managing information support [3].

It should be noted that at present, the introduction of various digital technologies allows solving both production and management tasks related to enterprise development programs:

- ensuring the quality of processes and the competitiveness of products,
- increasing the efficiency and sustainability of the enterprise,
- continuous reduction of costs for the implementation of production and management activities.

The implementation of these areas provides for the digital transformation of the enterprise's quality management system, the development of a standardization clause regulating innovative requirements for the structure and content of the quality management system model, which actualizes the problem of modernizing the enterprise's integrated information support system.

II. METHODS AND MATERIALS

The studies show that at present, many experts consider the digital transformation of enterprises as a new stage in the technological revolution associated with the use of artificial intelligence, blockchain, cloud technologies, predictive analytics methods and the additive process control method (3D-modeling method) [4]. The results of the digital transformation of the enterprise are, first of all, improving the quality of processes and ensuring a high level of product quality, organizing production in accordance with the requirements of regulatory documents, improving the process of making managerial decisions, increasing the efficiency of the enterprise while reducing the risk of losses from deviations in processes and losses while reducing the consumer value of product quality.

It should be noted that the main goals of modernizing the quality management system in the context of digital transformation are:

- continuous improvement of the quality of processes based on diagnostics and monitoring of process parameters to confirm compliance of quality with regulatory and technical documents,

- digital culture based on digital thinking and digital staff engagement,
- increasing the efficiency of decision-making based on the use of information technology and new methods of process quality management,
- the formation of a new personnel potential through continuous training of employees in the use of information technology and the development of digital competencies,
- creation of a single information space based on electronic document management governing the quality management processes at all stages of the product creation life cycle [5].

The processes of digital transformation of the enterprise determine the need for changes in the structure of the quality management system based on horizontal communications, process-oriented and network approaches [6]. The studies of the nature of changes in the quality management system make it possible to distinguish the following main tasks, the solution of which is based on the application of various digital standards for enterprise management:

- development of electronic document management system (EDM technology);
- formation of input and output information modules about resources and processes (ERP technology);
- change control of current process parameters (PDM technology);
- organization of continuous diagnostics, monitoring and control of processes (MES technology);
- risk-oriented process management (MRP and MRP –II technologies),
- continuous improvement of stakeholder relationships (CRM technology),
- modeling of process management, including determining the sequence of work, planning staff activities, equipment selection and design of technological processes (BPM technology);
- development of a rating system for assessing quality, maturity and effectiveness of processes, establishing communications in the system and responsibility for quality (ECM technology),
- process control (MES technology),
- formation of a stakeholder relationship management system (CRM technology).

It should be noted that the issues of modernization of the quality management system in the context of the digital transformation of the enterprise are controversial. The study of the materials of various scientific and practical conferences on the issues of changing the formalized requirements of the international quality management system in the conditions of

the 4th technical revolution made it possible to single out the following points of view of scientists (table 01) [3].

The generalization of the directions of development of the quality management system in the context of the digital transformation of enterprises dictates the need to move from traditional forms and methods of quality management to the creation of an integrated quality management system that operates on the basis of digital standards and IT technologies, allowing for taking into account the interests and requirements of interconnected network enterprises [7, 8].

Particular attention should be paid to solving this issue at high-tech enterprises and in high-tech production. It should be noted that the activities of these enterprises are associated with large expenses for the preparation of production, which focuses on the use of digital quality management standards for all processes and information and communication technologies, which make it possible not only to systematize information flows, but also to structure information communications between the integrated modules systems of information support of quality management processes.

TABLE I. OVERVIEW OF VARIOUS SCHOLARLY COMMENTS ON CHANGES IN QUALITY MANAGEMENT REQUIREMENTS

Author	The content of the author's position on the analyzed issue
Gaivoronsky D.V. Deputy Director of the Department of Science SPbGETU "LETI")	He highlighted the actual problems at the digital enterprise – the quality management system, management systems, process automation systems, information systems
Sheptunov S.A. (Director of the Institute for Design and Technological Information, RAS)	He pointed out the need to formulate proposals for the modernization of the training system for specialists in the field of quality management, as Digital technologies only help reduce time and make the workflow more convenient, but they are not able to change a person
Azarov V.N. (Director of the "European Center for Quality")	He noted the importance of resolving the issue of creating a quality management information support system; described approaches to the design of integrated management systems of a digital enterprise, emphasized that in the process of their creation it is necessary to take into account the standards for the use of information systems and technologies
Egorova E.G. (representative of the certification association "Russian Register")	She summarized that it is not enough to introduce modern technologies: it is necessary to completely restructure the information culture in order to meet the requirements of the digital world, which will require not only a change in the work scheme, but also the content of the official powers of employees
Saxonov E.A. (Professor, Moscow Technical University of Communications and Informatics)	He drew attention to the appropriateness of modeling the information structure of the corporate network of the enterprise, which will solve the issue of ensuring information security

III. METHODOLOGY

The research allows concluding that there is a lack of fundamental scientific research on the issues of modernization of the quality management system in the conditions of digital transformation of an enterprise, the main purpose of which is

the transition from classical methods of management to quality management using digital information technologies. It should be noted that the main condition for the functioning of the integrated quality management system is the formation of a single integrated information support system.

The proposed integrated system of information support for quality management processes allows structuring and systematizing an unlimited amount of internal and external information generated at micro and macro levels of management, which makes it possible to increase the effectiveness of quality management on the basis of timely changes to the processes, justified changes in the current management procedures based on the parallel implementation of real and virtual processes, as well as timely make the necessary changes to the regulatory documentation. These changes should be taken into account when developing a project for the implementation of continuous improvements aimed at improving the quality of processes through periodic statistical control and analysis, which allows recording deviations and analyzing factors ensuring the stability and reliability of processes [9].

The formation of a digital system of information support for quality management processes can effectively solve the following problems:

- collection and analysis of evidence about products, processes and enterprise management systems,
- process monitoring and diagnostics,
- decision making based on employee relationship management,
- taking into account the standard requirements of the quality management system when making changes to the processes,
- identification and analysis of risks associated with untimely identification of the causes of deviations in the processes,
- application of risk-based process quality management methodology.

Based on the results of the research, an integrated system of information support for quality management processes in the digital transformation of the enterprise, the operation of which allows structuring information and improving the efficiency of communications in the quality management system, is proposed (figure 1).

The functioning of the integrated information support system allows constant analysis of the nature of changes in the processes, the causes of deviations and the nature of the consequences, and also provides the opportunity for all employees to use unlimited information on methods, tools, processes, requirements for input and output information about changes in the quality management system. Based on the results of the analysis, the communications and information in the quality management system are adjusted. The input data (customer relations, the results of the assessment and selection of resource suppliers, the results of qualification audits of personnel) and the weekend (customer

feedback, audit results, recommendations for improvement) are evaluated. Based on the generalization and systematization of the information received, decisions are made and actions

aimed at improving the quality of processes and the quality of information support is described.

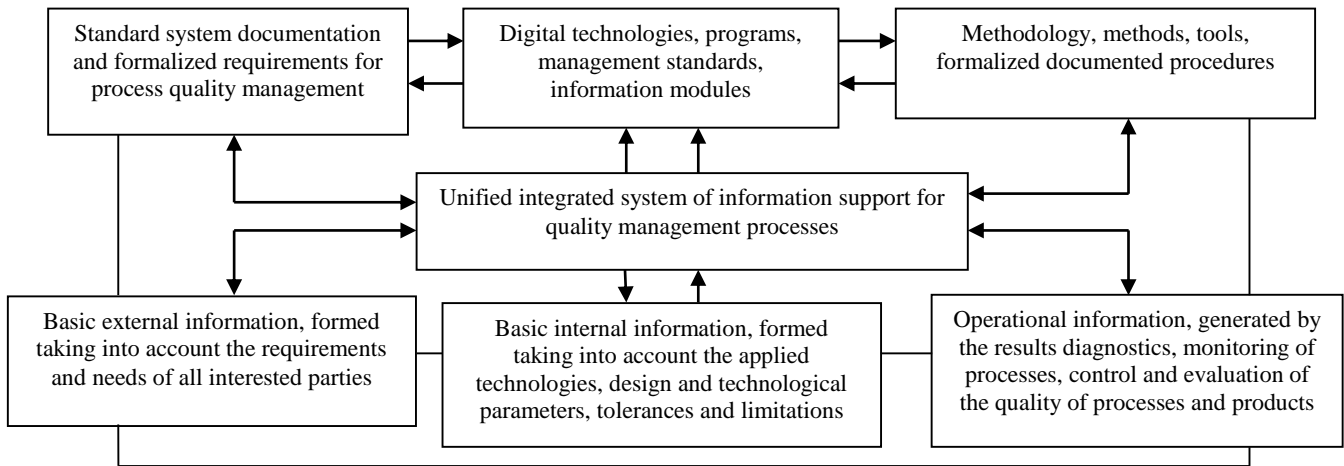


Fig. 1. The structure of an integrated system of information support for quality management processes

The effectiveness of the analysis of the functioning of the quality system by the management, the output of this process will depend on the level of decisions made according to the input data, on their validity and appropriateness, that is, on the degree of personnel involvement in the activities to develop the quality system. In all cases, success depends on how clearly employees understand the essence of the processes, how appropriate their decisions are, and also on the degree of mastery of digital technologies for process quality management [10, 11].

IV. RESULTS

It is advisable to use the above methodology for the formation and functioning of an integrated system of information support for quality management processes when developing a project for the development of a quality management system in the context of digital transformation of an enterprise. It should be noted the need to take into account internal constraints that are associated with insufficient digital involvement of staff. The following limitations and ways of their elimination in the conditions of digital transformation of the quality management system are formulated:

- 1) The degree of readiness of employees to ongoing changes (it is necessary to organize continuous training in the use of digital management standards in practice).
- 2) The level of digital thinking of staff (it is advisable to support managerial initiatives of employees; motivate participation in multidisciplinary teams that will initiate the use of digital technologies).
- 3) Misunderstanding of the new values of digital organizational culture (focus on rapid change and the desire for leadership, ensuring unlimited awareness of employees in the manifestation of managerial initiatives).
- 4) Misunderstanding of the increasing complexity of the information space, this leads to a rapid increase in the scale

and complexity of knowledge (motivation to participate in training programs based on HR technologies).

- 5) Lack of motivation for leadership and focus of staff on changes (management of internal competition of management initiatives of staff).
- 6) Rigid mechanisms for the transfer and accumulation of corporate knowledge (quality management of the information space based on the establishment of reliable horizontal communications in the quality management system).
- 7) The information space goes beyond the boundaries of a digital enterprise and is distributed throughout all value-creation chains (creating a transparent infrastructure of a single information space).

An analysis of these limitations allows highlighting important areas of modernization of the quality management system:

- the formation of a digital corporate culture focused on change in combination with the digital management of business processes, which contributes to the formation of competitive advantages;
- motivation for leadership and focus on changes stimulate employees to participate in decision-making based on continuous monitoring of processes;
- competition management of personnel initiatives, which is considered as competition between employees, including managers, in which each employee must assert himself, based on personal initiative and digital knowledge.

Based on the foregoing, an algorithm for the development and implementation of a project to modernize a quality management system in the digital transformation of an enterprise is proposed (table 02).

In order to solve the problem of ensuring the involvement of enterprise personnel in the implementation of the project for the development of a process quality management system in the context of the digital transformation of the enterprise, the following tasks must be solved:

- staff training in the use of digital technologies;
- training of personnel of the modern 8D methodology to manage and improve the quality of processes;
- identification of responsibility for the results of ongoing changes;
- ensuring the interest of employees in the implementation of changes;
- motivation to participate in cross-functional quality management teams [12].

It should be noted that in the context of the digital transformation of the enterprise, the involvement of the staff is appropriate to consider not as a state, but as a relationship that can be developed using specific programs and various digital technologies. Therefore, the digital involvement of the staff is an indicator of the personal interest of each employee in ensuring the greatest compliance with their own goals and goals of the enterprise, taking into account full responsibility for the quality of the processes.

TABLE II. THE CONTENT OF THE STAGES OF DEVELOPMENT AND IMPLEMENTATION OF THE PROJECT OF MODERNIZATION OF THE QUALITY MANAGEMENT SYSTEM

Stage	Content
1) Formulation of goals and objectives of organizational design	– analysis of priority problems and solutions; – analysis of the causes and nature of restrictions on achieving goals; – systematization of information for decision-making and task setting; – change implementation planning
2) Diagnostics of changes	– analysis of the symptoms (causes) of changes; – hypotheses to explain the reasons; – verification of the scientific and validity of hypotheses; – selection and concretization of the main directions of change
3) Selection and justification of decisions related to the implementation of changes	– formulation of alternative solutions and analysis; – economic justification and assessment of the effectiveness of decisions; – development of measures to overcome staff resistance to ongoing changes; – implementation of decisions, control and analysis of results
4) Formulation of directions and implementation of changes	– monitoring the processes of introducing changes in the system; – making adjustments to the processes; – assessment of the quality of measures to introduce changes; – the formation of conditions for the introduction of changes
5) Assessment of the results of the implementation of changes	– assessment of the results of the implementation of changes; – identification of ways to further improve the quality of processes; – assessment of the results of the implementation of the modernization directions of the quality management system

Digital engagement should be considered as an important driver of the enterprise’s digital transformation, in which employees are able to use digital and social channels to receive information, which provides for interested interaction, increased responsibility, changes in the content of work and decision-making on improving the quality of processes using team methods [15, 16].

The creation of an integrated system of information support for quality management processes and the organization of personnel access to an unlimited database help to increase the level of digital involvement of personnel, motivate their participation in decision-making to improve the quality of processes, are a tool for substantiating decisions and ensure their application in professional activities.

V. CONCLUSION

Thus, the conducted research on the directions of modernization of the quality management system in the conditions of digital transformation of the enterprise allows drawing the following conclusions.

1) The digital technologies used to control the quality of the processes involve the use of one of the basic principles of the total quality management system – the universal responsibility of all employees of the enterprise, which, in turn, helps to solve the problem of digital staff involvement.

2) Within the framework of the concept of a single information space, an important area of modernization of the quality management system is the creation of an integrated system of information support for quality management processes, which allows employees to constantly be informed about digital technologies being introduced and use unlimited information modules for making decisions on improving quality.

3) In the context of team quality management, an important role is given to managers of all levels of management who are responsible for the results of innovations and for the formation of a digital organizational culture in the enterprise.

4) The main factors (conditions) of the digital modernization of the quality management system are: digital leadership of managers, digital communications, digital information, digital involvement of personnel, digital culture.

5) To increase the effectiveness of the functioning of the quality management system in the context of digitalization, it is necessary to form a digital operating model of the management process, which is the process execution algorithm. Elements of the algorithm are the following procedures and methods:

- accounting and analysis of factual information,
- a formalized procedure for confirming compliance with requirements,
- monitoring and control procedures,
- decision making procedure in negative situations,

- procedure for digital redesigning of processes based on information about process deviations.

6) The implementation of the modernization project of the quality management system determines the need to review the content and standardization of management procedures prescribed in the process quality maps, to bring to each of the employees of the enterprise through training in the basics of predictive analytics, the use of which allows simulating various options for the processes and choose the best option.

Thus, the implementation of the proposed areas of modernization of the quality management system in the conditions of digital transformation of the enterprise allows increasing the efficiency of the system; ensuring the involvement and responsibility of personnel for the quality of processes and the quality of their results; developing an effective management strategy that contributes to the achievement of goals with minimal cost.

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