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EVALUATION OF SYSTEM QUALITY USING INFORMATION TECHNOLOGIES

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Communication processes within socio-economic systems play a key role in ensuring the effective functioning of quality management systems (QMS), particularly when implementing the ISO 9001:2015 standard. Imperfect information links, the presence of overloaded or isolated elements, and inconsistencies in information transmission channels lead to reduced management efficiency, information loss and an increased risk of inadequate management decisions. In complex socio-economic systems, characterised by multi-level structures, a large number of interacting elements and highly dynamic changes, communication takes on the characteristics of a complex network structure. Therefore, theoretical research into the structure of communications within QMS and the development of methods for their optimisation based on a systems approach is a pressing scientific issue [1].

The task of improving the effectiveness of QMS operations necessitates the development of new approaches to the analysis of communication processes, which take into account their non-linear nature, the presence of feedback loops, the influence of the external environment, and the human factor. Traditional methods of analysis, based on a local examination of individual processes or expert assessments, do not allow hidden structural defects in the system to be fully identified. Communication processes have a complex topology, where interactions between elements form a coherent network, the properties of which cannot be reduced to the characteristics of individual components. This necessitates the use of formalised mathematical models capable of reflecting the structure and intensity of information links [2].

Particular attention has been paid to the design phase of the QMS, as it is at this stage that its structural foundation is established, and errors are most critical in terms of the subsequent costs of rectifying them. The application of the proposed approach enables the early diagnosis of structural deficiencies, the identification of potential risks of information loss, and the justification of decisions regarding the optimisation of the communication structure.

The aim of this paper is to develop a mathematical model of communication processes in quality management systems based on graph theory and systems analysis, which allows us to investigate the structural characteristics

of the system, assess its resilience to communication disruptions, and identify critical elements that influence it's functioning.

The report proposes representing the QMS as a directed graph, where the vertices correspond to individual processes or subsystems, and the edges represent the information links between them. To formalise the structure, a direct communication matrix (adjacency matrix) is used, the elements of which reflect the presence or absence of a connection between the corresponding elements of the system. This approach allows a transition from a qualitative description of communications to their quantitative analysis.

The results of the study show that the effectiveness of the QMS is significantly influenced by factors such as the density and uniformity of link distribution, the presence of central (critical) nodes, and the degree of redundancy in information channels. The structural-topological analysis carried out allows us to identify isolated vertices, which indicate a lack of necessary communications; hanging vertices, which do not receive incoming information; and dead-end vertices, which do not transmit information further. The presence of such elements negatively affects the integrity and efficiency of the system's operation.

To quantitatively assess the quality of a communication system's structure, it is proposed to use connectivity metrics, which characterise the degree of system integration; the rank of elements, which determines their relative importance based on the number of connections; and a resilience metric, which reflects the system's ability to maintain functionality in the event of the loss of individual communication links. The use of these indicators allows not only for an assessment of the system's current state, but also for a comparative analysis at various stages of design and implementation.

Thus, the use of systems analysis methods and graph theory to study communication processes in QMS ensures more sound management decisions, facilitates the optimisation of information flows, and enhances the reliability of the system's operation under conditions of uncertainty and dynamic environmental changes. The proposed approach provides a basis for the further development of decision-support tools in the field of quality management and can be used to improve the organisational structures of enterprises.

References

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