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QUALITY SYSTEM CONDITION FOR SUCCESSFUL BUSINESS AND COMPETITIVENESS

PROCEEDINGS

ASSOCIATION FOR QUALITY AND STANDARDIZATION OF SERBIA

KOPAONIK, 26/05 -28/05/2021

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INTELLIGENT QUALITY MANAGEMENT SYSTEM

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Abstract: *The digital transformation results in the development of new technologies that organizations implement in their business, which increase the serviceability of the system. As the complexity of the system increases, so does the challenge of managing a complex system, due to physical and capacity constraints that people face. Given this, there is a need to develop an intelligent quality management system in the organization that will be based on artificial intelligence, which is similar in nature to the way of thinking of man. By combining artificial intelligence and other technologies within Industry 4.0. an intelligent management system is created. An intelligent management system becomes a mechanism by which compliance with the requirements of management system norms can be much more easily ensured, as well as a basis for developing a competitive advantage in the long run. The paper describes a model of an intelligent quality management system as well as the possibility of combining individual technologies of Industry 4.0. The aim of this paper is to point out the need to include artificial intelligence in the management of the organization, all because of the increasing complexity of the system due to digital transformation.*

Keywords: *digital transformation, intelligent control system, control system, artificial intelligence;*

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1. INTRODUCTION

Digital Transformation and Technology Development Industry 4.0. results in the emergence of new solutions in production. The consequence of this is the development of smart factories, i.e. a different way of organizing production, which allows to increase flexibility and interoperability. [4] Therefore, there is a need to develop new models of quality management of such a system. One of the technologies that has a very large impact on the development of quality management systems, but also management in general, is artificial intelligence.

Artificial intelligence in combination with sensors and big data analysis, i.e. data mining techniques can be used for quality management of the organization through identification of patterns in the

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[4] Oztemel, E. (2020). Introduction to Intelligent Quality Management. Quality Control in Intelligent Manufacturing.

collected data and detection of trends that could affect the system.[5] In other words, through artificial intelligence and learning techniques used by artificial intelligence, such as machine learning and neural networks, and through statistical analysis, it is possible to predict future developments in the process and acquire new knowledge. Once acquired, the knowledge that can be gained, through data mining techniques used on big data, can be stored in the organizational knowledge base and used later in decision making. However, one of the prerequisites for the use of mining techniques as well as the application of artificial intelligence in business is the implementation of digital business transformation.[6] Digital transformation implies a paradigm shift in business aimed at the application of digital technologies in product creation, production, sales and stakeholder relations management.[7] Also, there is a change in organizational culture, reduction of bureaucracy, which allows to increase the flexibility and efficiency of the organization as a whole.

When talking about the impact of digital transformation in the quality management system, the inclusion of artificial intelligence created a new concept, intelligent quality control system. Intelligent quality management system provides a systematic approach to management, which includes data collection, data analysis, development of predictive models to be used for management, etc. The aim of this paper is to show the need to develop the concept of intelligent quality management and capabilities of such a system. The need to develop such a model is the impact of digital transformation on the organization as well as the opportunities that digital transformation provides in the management of complex systems.

2. ARTIFICIAL INTELLIGENCE AND MANAGEMENT SYSTEM

Artificial intelligence is a term that describes a system that is very similar to human intelligence in its way of functioning, i.e. it enables the acquisition of new knowledge through repeated analysis of the environment in which it is located, i.e. collecting and analyzing data from the environment. [8] The ability to analyze large amounts of data in a short time and conduct complex simulations, which includes simulating possible outcomes, discovering organizational knowledge, controlling information collected and even interacting with customers when solving simpler queries, makes artificial intelligence increasingly attractive for implementation and use in business.[9] Considering the ability to learn and detect patterns, artificial intelligence finds special application in the health system where it can be used for the analysis of X-rays, ie the analysis of individual diagnostic examinations and disease detection. [10]

Likewise, the use of artificial intelligence is increasingly common in banking transactions where the specific features of each person can be used to perform a banking transaction without authorization by pin, credit or debit card.[11] A special application of artificial intelligence is in supervision, i.e. in corporate security, where it can be used to analyze risky behavior or authorize entry into business premises.[12] In other words, artificial intelligence in organizations enables much more efficient implementation of activities carried out by people so far with the possibility of storing their

[5] Ansari, F., Fathi, M., & Seidenberg, U. (2011). Evolution of Intelligent Quality Management Process Based on Using Performance Quality Indicators. Wissensmanagement, str. 149-160.

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acquired knowledge in organizational knowledge bases, which allows future application of acquired knowledge in decision-making and management of the organization. However, despite the advantages and opportunities that artificial intelligence has, there is a risk associated with the application of artificial intelligence in business, which concerns the disruption of organizational culture in terms of a different understanding of the human component in the organization.[13] In other words, artificial intelligence can significantly increase the efficiency of the organization but on the other hand can also harden interpersonal relationships as all decisions and all activities begin to be observed through statistical analysis, ie analysis of efficiency and the ability to replace the human component in the organization with automated systems.

A particularly important area of application of artificial intelligence is product quality cycle management, as artificial intelligence enables, in combination with other technologies such as digital twins (DT), which enables the creation of a virtual copy of the product, i.e. virtual design, reducing the time required to develop new products. is of particular importance in market conditions that require high speed product development, especially if it is the IT industry. Furthermore, the possibility of use of AI in the client software can be greatly speed the response to the request and the ability to acquire knowledge of the problems and disadvantages that are commonly related to the product or service.

3. INTELLIGENT QUALITY MANAGEMENT SYSTEM

The digital transformation of business as well as the introduction of digital innovations in factories significantly increases the complexity of the system. Through the possibility of mutual communication of different technologies implemented in the organization, the need for employee intervention is significantly reduced. [14] However, this does not mean that employees as such are no longer needed in the organization but that their educational structure as well as their competencies are changing significantly. Likewise, employees are a necessary component of the system since the system, given its current development, cannot sustain itself.

Since the digital transformation allows the implementation of sensors that will monitor the state of machines and devices in the production process, which means that they collect a large amount of data stored in databases, there is a need to use tools that will analyze the collected data. Number of data using current analysis techniques requires a lot of time and specific knowledge and skills of employees who would analyze such data.[15] Given the complexity and long period of training of such staff, artificial intelligence is emerging as a solution that in the long run can provide the organization with a foundation for the development of competitiveness.

Sensors and the ability to monitor the performance of machines and equipment used in production to monitor and analyze the efficiency and effectiveness of such machines as well as the identification of the period in which it is necessary to conduct regular maintenance or replacement of certain parts.[16] Also, collecting a large amount of data, or using some of the learning methods used by artificial intelligence, allows the development of a system that can predict failures and possible failures of machines and devices that will result in production downtime or possible non-compliance of finished products.

Furthermore, by connecting various technologies, such as IoT (Internet of Things), CPS (Cyber physical system), DT (digital twins), etc., allows mutual communication between the machines and devices in the manufacturing plant. However, communication and information exchange between

[13] Canhoto, A., & Clear, F. (2020). Artificial intelligence and machine learning as business tools: A framework for diagnosing value destruction potential. Business Horizons, str. 183-193.
[14] Oztemel, E. (2020). Introduction to Intelligent Quality Management. Quality Control in Intelligent Manufacturing.
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machines and devices need to be managed and given the physical limitations of man in the speed of information processing compared to artificial intelligence, artificial intelligence is emerging as one possible way to manage such a system. Human physical limitations in the form of working time limitations, workplace efficiency, specific competencies that an employee needs to possess in order to perform a particular activity in the workplace, impose the need to find a more efficient system that will allow faster and more efficient activities.

3.1. Planning and development - activities prior to production

Intelligent quality management system is based on artificial intelligence but also on all the principles that the quality management system emphasizes, which are described in the norm of class 9. However, due to the increasing complexity of the environment and increasing complexity of the system, monitoring and managing such a system. Also, there are a number of advantages that automated systems have compared to humans, and the basic advantages relate to the ability to perform multiple operations in a shorter time, the ability to store and analyze large amounts of data, the ability to quickly predict trends, the ability to communicate with stakeholders and learn based on implemented communication, etc. Thus, an intelligent quality management system, the system is based on artificial intelligence that allows integration and mutual communication of automated systems, collection, analysis and predictive simulation of future movements in the system.

However, one of the basic preconditions for the implementation, i.e. the creation of an intelligent management system, is organizational competence, i.e. technical and technological competence. Technical and technological competence implies the existence of technical assumptions such as infrastructure and technological assumptions, i.e. knowledge of how to use the technique.[17] On the other hand, in addition to technical and technological competence, it is necessary to ensure the competence of human resources, which, despite the digital transformation and its physical limitations, are still a necessary component of the system. In addition, the connection of technical competence, technological competence and human resources competence is carried out through structural competence, which also represents the backbone of the organization. In other words, an organization that does not possess the described competencies cannot carry out the digital transformation in a satisfactory way just as it cannot implement an intelligent quality management system.

An intelligent quality management system consists of three basic components: activities carried out before the start of production, activities carried out during production and activities carried out after production.[18] In other words, the activities carried out before production primarily relate to the product quality development cycle, which includes the analysis of stakeholder requirements, product design and product construction, product testing and product presentation to the customer. On the other hand, the operationalization of the created specification, i.e. the activities carried out during production are related to the monitoring and control of production as well as the management of the entire production process. In the last group of activities, post-production activities, communication with customers is carried out, i.e. analysis of stakeholder satisfaction, analysis of the process cycle and definition of measures for improvement.

3.2. Realization of planned activities - activities during production

Product planning and development is based on gathering stakeholder requests as well as converting stakeholder requests into specifications. Also, in this phase, the analysis of competition, customer satisfaction with the competition product is carried out, production plans are defined, and suppliers are selected who will supply the organization with all the resources needed for production. The ISO 9001: 2015 standard defines several requirements related to these activities, most of which are defined in point 8 of the standard.

[17] Buntak, K., Kovačić, M., & Martinčević, I. (2020). Impact of digital transformation on knowledge management in organization. Advances in Business Related Scientific Research Journal, str. 36-47.
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Specifically, point 8.2. sets management requirements for products and services, and as a mechanism to meet these requirements can be used, among other things, artificial intelligence that can effectively analyze in a short time a large number of different requirements that customers submit and can be used to respond to customer inquiries if implemented in a customer support system.[19] Likewise, the implementation of artificial intelligence allows the creation of knowledge about the most common complaints, customer requirements, as well as general feedback that customers send to the organization.

Also, as an example, digital twins (DT), virtual reality (VR), or artificial intelligence should be mentioned as some of the mechanisms by which compliance with point 8.3 can be ensured. which is related to the design and development of products and services. In this context, with the help of AI it is possible to construct the product much more efficiently, i.e. to design it and conduct a simulation of its functioning. Likewise, a product prototype can be presented to a customer.[20] On the other hand, DT enables the creation of a digital replica of an existing product and its manipulation[21] i.e. adaptation to customer requirements as well as the possibility of virtual presentation using virtual reality (VR). On the other hand, augmented reality allows interaction with the product being created and its testing which can serve as a basis for creating improvements on the product.[22] It should be emphasized that the use of all described technologies is exclusively a mechanism by which compliance with the requirements of the standard can be ensured and that it is necessary to ensure the competence of human resources that use the described technologies.

3.3. Customer service and process analysis - activities after production

The largest number of technical and technological innovations in Industry 4.0. refers precisely to the activities performed during production, such as monitoring the operation of machines and managing the operation of machines, control of manufactured products and testing compliance with customer requirements, etc. When it comes to the requirements of ISO 9001: 2015, which are related to activities during production, some of the requirements are set out in point 8.5. in which the requirements related to production and traceability are described. In this context, the implementation of sensors on machines and devices used in production allows monitoring of their performance as well as identification of a possible problem. On the other hand, data collection creates a database based on an analysis that can predict future process trends.[23] On the other hand, the interaction between machines and devices in production can be achieved through IoT, which also enables the exchange of information between machines. Sharing information can make it easier to track production and the stage at which production is.[24] On the other hand, CPS enables remote plant management as well as the ability to solve simple production downtime without the need for employee intervention, and AI allows monitoring compliance with customer requirements and the

[19] Hopkinsona, P., Perez-Vegab, R., & Singhala, A. (2018). Exploring the use of AI to manage customers' relationships. Academy of Marketing Workshop: Artificial Intelligence in Marketing–The field, research directions, and methodological, str. 7.

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[24] Boyes, H., Hallaq, B., Cunningham, J., & Watson, T. (2018). The industrial internet of things (IIoT): An analysis framework. Computers in industry, str. 1-12.

ability to separate non-compliant products from the batch before the batch is delivered to the customer.[25]

In other words, the implementation of sensors in the production line enables realistic monitoring of production and the possibility of extracting all products that do not comply with the requirements. On the other hand, employees who are directly involved in carrying out certain activities in the process can use technologies such as augmented reality to carry out the activities for which they are in charge much more efficiently. Given this, augmented reality allows the display of activities that the employee must perform on a visor located directly in front of the employee's eyes, which reduces the risk of performing activities inappropriately and reduces the risk of non-compliance due to employee error.

The development of smart factories opens the possibility of using RFID chips that are placed directly on the semi-finished product, and which contain information about the necessary activities that need to be carried out. Such chips also enable the display of information to the employee, which may be related to the personalization of the product.

3.4. Intelligent quality management system model

Post-production activities primarily relate to the provision of serviced services to customers or users as well as customer relationship management. At this stage, there is also the possibility for customers to advertise the product or report any non-compliance that the organization needs to analyze. On the other hand, after the production, i.e. the end of the process cycle, it is necessary to analyze the performance of the cycle and identify places where it is possible to implement improvements. Since there is a possibility of implementing sensors on machines and devices used in production, it is possible to collect many different information, or a large amount of data that can be analyzed and from which different days of mining techniques can identify pattern or organizational knowledge. Such activities can be carried out by artificial intelligence, which can also signal a possible pattern that can result in non-compliance. Furthermore, the use of artificial intelligence in answering customer or user inquiries can replace the need for employees working in call centers or help via chat.

Figure 1 shows the proposed conceptual model of an intelligent quality management system. The model is divided into three types of activities with an overview of the possible interconnection of different technologies to shape the management system.

[25] Long, G., Lin, B., Cai, H., & Nong, G. (2020). Developing an Artificial Intelligence (AI) Management System to Improve Product Quality and Production Efficiency in Furniture Manufacture. Procedia Computer Science, str. 486-490.

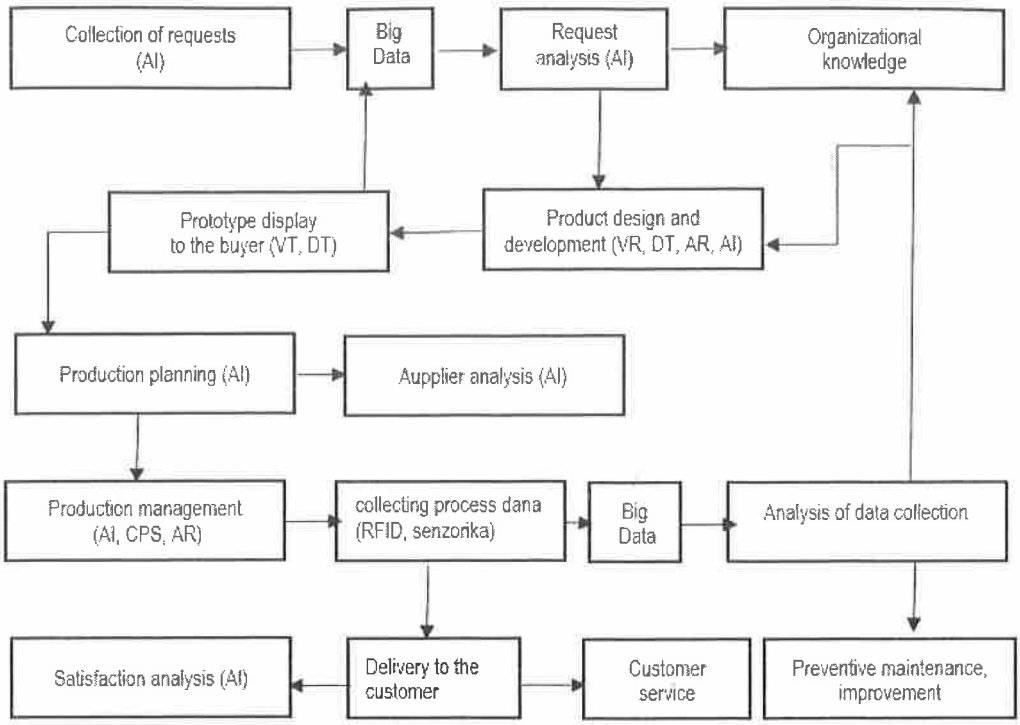

Figure 1: Model of intelligent quality management system

Source: Author

Although the model is based on artificial intelligence, artificial intelligence as such cannot function on its own and cannot manage the organization independently. In other words, employees use artificial intelligence to use it to carry out intended activities in communication and product development. Also, technologies using CPS that allows remote control, DT that allows the development of a digital copy of physical reality, virtual reality (VR) and augmented reality (AR) that allow interaction with the digital version of the product, or its prototype. By collecting information and analyzing it, it is possible to create or identify organizational knowledge that can later be used in a new cycle of product development. On the other hand, all collected information is contained in big databases from which using mining techniques and AI can identify the trend, or pattern as well as the need for improvement, or preventive maintenance of machines and devices used in production. On the other hand, AI can be used to solve simpler customer inquiries as well as to analyze non-compliance, which can become the basis for creating organizational knowledge about the problem, or customer complaint.

4. CONCLUSION

The intelligent quality management system is based on all the principles that the quality management system according to the ISO 9001: 2015 standard emphasizes. However, technologies developed within Industry 4.0, and in most cases artificial intelligence, are used to meet the requirements defined in the standard. Intelligent quality management system starts from the quality paradigm that sees the management aspect, and less technical aspect, which means that it is necessary for quality management to analyze suppliers, analyze the requirements of all stakeholders, analyze competition and their products and services, collect and analyze process performance and manage organizational knowledge. The described technologies become a mechanism, i.e. they become a resource that organizational employees use in management. However, for the implementation of an intelligent quality management system, it is necessary to

ensure technical and technological competence, and then to ensure human resources competence and ultimately structural competence. The described model can become a destructive technology that can provide the organization with a competitive advantage in the long run. On the other hand, the model requires the organization and change of the educational structure of employees since employees must possess specific competencies that will enable them to handle and manage the described technologies. Otherwise, the implementation of such technologies will not result in the development of a significant competitive advantage in the market.

In the presented model, it is possible to implement a much larger number of technologies. However, the aim of the paper is to point out the possibilities offered by Industry 4.0. and artificial intelligence in general as well as point out the need for the current understanding of management to change the paradigm due to changes related to the opportunities offered by new technologies such as artificial intelligence as well as opportunities to develop a competitive advantage due to the implementation of such technologies. Also, due to the use of new technologies in production as well as due to the collection of a large amount of information, man due to his limitations is not able to conduct complex analyzes in a short time as well as unable to manage a complex system without technology. Given this, the digital transformation brings with it the need to develop an intelligent quality management system.

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