Quality Festival 2023
ISBN 978-86-6335-104-2

Jovana Nikolić[1]
Miladin Stefanović
Nikola Simić

DEVELOPMENT OF A FRAMEWORK FOR DEFINING THE CONCEPT OF QUALITY 4.0

Abstract:*Industry 4.0, better known as the Fourth Industrial Revolution, is a concept that refers to the application of high technologies, such as the Internet of Things (IoTI), cybernetics, machine learning, automation of production and the entire business. This concept aims to improve efficiency, productivity, and flexibility and reduce costs. On the other hand, Quality 4.0 is the integration of smart technologies and digitalization into the manufacturing process to improve quality control and increase efficiency. It involves using IoT devices, machine learning, and big data analytics to monitor and optimize production processes in real time, resulting in reduced defects, increased productivity, and improved product traceability. By using these technologies, manufacturers can reduce the risk of defects and downtime, increase productivity, and improve product traceability. Quality 4.0 is an essential aspect of Industry 4.0. It represents the integration of digital technologies into the quality control process. The main objective is to achieve higher quality products, reduce defects, and optimize production processes using real-time data analytics. This approach emphasizes the importance of data-driven decision-making in manufacturing and highlights the benefits of integrating data analysis into quality control processes. Overall, Quality 4.0 focuses on improving the quality of products and processes using modern technology, resulting in increased efficiency, productivity and flexibility.*

Keywords:*Quality 4.0, Industry 4.0, Quality Management; Competencies,Knowledge Management*

1. Introduction

The world has experienced three industrial revolutions. The first one, which occurred in the late 1700s and early 1800s, was fueled by innovations in steam and water power, which enabled factories to expand their production capacities and potential locations. Before this, factories were situated near rivers to harness water wheel energy. Later, the discovery of electric power and infrastructure developments led to the mass production of machines and the expansion of iron ore production. The expansion of railways facilitated the procurement of supplies and delivery of finished products in the US. The widespread availability of energy sparked the development of digital computing, with the emergence of

Corresponding author: Jovana Nikolić
Email: jovana.nikolic.jag@gmail.com

mainframe and client-server computers, the Internet, and e-commerce. The third industrial revolution emerged in the late 1960s with the programmable logic controller, which brought about process automation through the control of tank filling, motor starting and stopping, and sequencing control events.

Just 20 years ago, companies could barely redirect phone calls within departments or sell through websites. Today, it is an integral part of the workday. Mobile devices and cloud computing have led to an expansion of services, as different communication channels (phone, web, tablets) have fully shifted towards customers.

The first industrial revolution was characterized by the invention of steam-powered machinery, followed by the use of electric power and assembly line production in the second. The third industrial revolution saw innovations in computing and industrial automation. The fourth industrial revolution is defined by the integration of machine intelligence, pervasive computing, accessible storage, and robust connectivity. It builds on the foundation of the previous industrial revolution, including digitalization, computer networks, robotics, artificial intelligence, smart machines, smart factories, modelling and simulation, nanotechnology, transportation, and other smart components of development (Zonnenshain&Kenett, 2020). Accompanying Industry 4.0 is Quality 4.0.

Quality 4.0 represents the knowledge and philosophy of understanding the aspects and trends of Industry 4.0 and its fundamental characteristics, such as virtual system, real-time work, modularity, and the ability to be preventive, simulate, and understand the relationships that Industry 4.0 establishes. Improving any process in an organization contributes to the development of the organization's competitiveness. Therefore, it is necessary to manage quality properly in Industry 4.0. Quality is imperative in business.

The concept of Quality 4.0 has emerged as a response to the demands of Industry 4.0, where digitalization and automation have transformed the way we work and produce goods. To define Quality 4.0, it is necessary to develop a framework that takes into account the specific characteristics of this new industrial revolution. The first step in developing such a framework is to identify the key features of Quality 4.0. These may include, among others, the use of big data and analytics, the integration of advanced technologies such as artificial intelligence and machine learning, and the implementation of continuous improvement processes that are data-driven and agile. Once the key features have been identified, the next step is to define the scope of Quality 4.0. This may involve identifying the industries or sectors that are most likely to benefit from Quality 4.0, as well as the specific quality metrics that will be used to measure the effectiveness of Quality 4.0 processes.

Another important aspect of developing a framework for Quality 4.0 is to identify the stakeholders who will be involved in the process. This may include manufacturers, suppliers, customers, regulators, and other relevant parties, and it will be important to ensure that their needs and requirements are taken into account when defining the concept of Quality 4.0.

Finally, the framework for Quality 4.0 should include a roadmap for implementation, which outlines the steps that will be taken to achieve the desired outcomes. This may involve the adoption of new technologies and processes, the training of employees, and the establishment of new partnerships and collaborations.

In summary, the development of a framework for defining the concept of Quality 4.0 requires a thorough understanding of the key features, scope,

stakeholders, and implementation roadmap. By taking these factors into account, it is possible to create a comprehensive and effective framework that can help organizations to achieve the full benefits of Quality 4.0.

However, Quality 4.0 requires more than just technological advancements. It raises the bar for stakeholder requirements by elevating them to a new level. New technology becomes one of the foundational components of the Quality 4.0 approach.

This paper focuses on the significance of Quality 4.0, highlighting the knowledge required by managers to keep pace with the rapid changes that Industry 4.0 brings.

2. Literature review

Quality 4.0 refers to the fourth generation of quality management, which is based on modern technologies such as artificial intelligence (AI), the Internet of Things (IoT), and cloud computing to ensure greater efficiency and precision in quality management (Carvalho et al., 2021). In this context, AI can be used to predict quality by analyzing data and predicting potential quality problems before they occur (Sader et al., 2022). Moreover, AI can be used to automate quality control by automatically identifying and correcting quality problems in real-time, optimizing processes, and primarily analyzing processes to identify areas for improvement to increase quality and efficiency (Ament &Goch, 2001). Ultimately, one of the fundamental advantages of using AI is analyzing large amounts of data related to quality to ensure a better understanding of trends and potential problems.

The most critical application of AI in quality management is automated quality control. Automated quality control leverages AI to automatically detect and correct manufacturing errors. Machine learning algorithms are used to analyze production data to identify trends and issues (Dilthey& Heidrich, 1999). This technology can also automatically determine product acceptability criteria and evaluate the quality of each product. This enables faster and more accurate decision-making regarding product acceptability and reduces the risk of releasing low-quality products into the market (Escobar et al., 2021). By embracing automated quality control, organizations can enhance their quality management practices and deliver high-quality products to their customers.

Furthermore, since Industry 4.0 emphasizes the collection of a large amount of data, there is a challenge in analyzing them, especially when it comes to management systems. In this context, if we talk about data analysis and reporting using artificial intelligence, machine learning algorithms analyze the data to identify trends and problems, and based on that, automatically generate reports and recommendations for improvement (Sader et al., 2022). This technology enables fast and precise data analysis and facilitates decision-making regarding improvements in processes and products. The results also help reduce the risk of releasing low-quality products and increase production efficiency and effectiveness (Sader et al., 2022).

In general, the concept of Quality 4.0 emphasizes the automation and digitalization of processes through the use of technologies such as AI and IoT, increased accuracy in assessing and predicting quality, agility and fast response to quality issues, agility in adapting processes, integration of data from various sources, and ultimately increased efficiency in quality management (Nenadál et al., 2022). In this context, efficiency is increased through the automation of processes using artificial intelligence and digital technology that automate quality control processes and eliminate errors (Aziz & Dowling, 2019). Similarly, predicting

problems through machine learning algorithms enables the prediction of issues in processes and products, which allows for the preventive resolution of problems before they reach the final product (Larson & Boland, 2019).

2.1. Industry 4.0

Industry 4.0 is a new trend in manufacturing that relies on advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), robotics, 3D printing, and more (Buntak et al., 2019). AI and machine learning (ML) technologies are used in Industry 4.0 to automate and improve production processes. They enable manufacturers to use data algorithms and models for automated decision-making, data analysis, fault prediction, and production process optimization. AI and ML also help to reduce production time and costs while increasing efficiency and productivity (Kovačić et al., 2022). Regarding the second most important technology of Industry 4.0, IoT, (Madakam et al., 2015) explain that this technology enables the connection and communication between various devices and sensors in the production environment.

This allows for the automatic collection of data on production processes, device activities, and product quality. IoT also enables devices and production processes to be managed remotely and dynamically adjusted to production needs (Makadam et al., 2015). Furthermore, IoT technology helps improve production efficiency and quality, as well as reduce time and costs in production as discussed in (Farooq et al., 2015).

Generally speaking, Industry 4.0 emphasizes greater automation in the production process, increased use of artificial intelligence and data analytics, increased connectivity among production machines and equipment through the Internet of Things, improved flexibility and adaptability of production, and increased personalization of products and services (Buntak et al., 2021). All of this provides the possibility of insight into the performance that production processes develop in real-time, which also allows for the identification of opportunities for improvement. One of the particularly significant advantages highlighted, in addition to those mentioned, is increased connectivity and compatibility, which refers to the cooperation of different technologies and systems in the production process as described in (Burns et al., 2019). This includes linking different machines, devices, sensors, and networks to ensure real-time communication and data sharing. This level of increased connectivity enables manufacturers to respond more quickly and efficiently to changes in demand and the market and to adjust production according to customer needs. This also leads to a reduction in losses and an increase in efficiency in production processes.

In addition, it is worth mentioning digitalization, as discussed by Sanchez et al. (2020), refers to the use of information technologies and data networking to create a centralized database for all production processes. This integration of data enables manufacturers to quickly access information on production, products, and operations, and to use it to make decisions on improving production efficiency and quality (Sanchez et al., 2020). Increased digitalization also leads to greater security and transparency in processes, which helps prevent errors and ensures continuous improvement in production.

Increased adaptability and flexibility of production, also an important component of Industry 4.0 emphasized by Fragapane et al. (2022), refers to the ability of manufacturers to quickly and efficiently change their production to respond to changes in market demand. This is achieved through the use of highly automated and connected technologies, which enable fast and easy changes to the production process. This

production flexibility allows manufacturers to respond to market and customer needs faster and more efficiently, ensuring success in a dynamic market environment. It also leads to greater competitiveness and innovation in production. However, despite all the advantages mentioned, there are also several drawbacks (Fragapane et al., 2022). The main drawbacks include high costs of implementation and upgrading of existing equipment, the need for experts to work with advanced technologies, cyber security and the risk of hacking attacks, incompatibility and obsolescence of technologies and devices, and difficulties in adapting workers to new technologies and processes, etc. (Kovačić et al., 2022).

2.2. A framework for Quality 4.0

Quality is a key dimension of products and processes. It is considered a competitive advantage for companies and organizations in the global market. Quality models and practices have gone through several evolutionary steps throughout modern history - from inspection, control, and quality assurance, to quality management and design quality. These quality models follow the evolution and revolutions in the industry (Zonnenshain&Kenett, 2020).

Industry 3.0 is accompanied by Quality 3.0, which has been particularly intensively developed in the last decade of the twentieth century and the first two decades of the twenty-first century, through international standards such as ISO series 9000, 14000, 27000, 31000 and others. The Quality Management System (QMS) standard series ISO 9000, along with the ISO 27000 series (Information Security), have followed the technology of the third industrial revolution (Perović, 2019).

The concept of "Industry 4.0" was presented at the Hanover Fair in 2011 to describe the fourth industrial revolution. It is based on digital transformation to find adequate responses to disruptive changes related to customers, organizations, and organizational boundaries. New business models have been developed for it, emphasizing trust, transparency, and security through digitization. The first introduction of the term "Quality 4.0" was in the American Society for Quality (ASQ) Future of Quality Report in 2015. Based on this approach, we can expect a renaissance of quality tools and methods through themes (Arsovski, 2019):

- Quality as inspection.
- Quality as design.
- Quality as empowerment, i.e. TQM (Total Quality Management) and Six Sigma for a holistic approach to quality, greater responsibility, and empowerment of everyone for continuous improvement.
- Quality as discovery, in adaptive and intelligent environments for solving challenges and problems.

To follow Industry 4.0 requires more knowledge than previously needed. This demands a more advanced approach to quality to understand the technology and its application. What is this increased knowledge and advanced approach, and what needs to be understood? The answers to these questions can be found by resolving the causes of the inefficient automation and digitalization processes in previous applications, from the perspective of quality management principles and approaches.

In addition to the new possibilities of Industry 4.0 such as smart factories, autonomous systems, the Internet of Things, and machine learning, Quality 4.0 aims to leverage new technologies to mobilize quality management practices and organizational excellence. The focus of Quality 4.0 is to reduce costs, improve quality, facilitate compliance, and increase the efficiency of quality operations. (What is Quality 4.0).

In summary, the concept of Quality 4.0 is formulated as follows (Tadić, 2022):

Main pillars of Industry 4.0 + Quality Control = Quality Control 4.0.

To achieve effective Quality 4.0, it is crucial to overcome outdated beliefs and negative traditions, including traditional methods, procedures, and structures, as well as blind obedience to authorities. Quality 4.0 emphasizes the role of digital technology in transforming management systems and promoting organizational culture, as well as enhancing competencies, democratic leadership, process synchronization, teamwork, and continuous learning.

Quality 4.0 supports the digitalization of quality management, based on the digitization of quality technology, processes, and people. Its model consists of 11 axes (Arsovski, 2019): (1) data, (2) analytics, (3) connectivity, (4) collaboration, (5) application development, (6) scalability, (7) management system, (8) compliance, (9) culture, (10) leadership and (11) competence.

Data is crucial for continuous improvement. Without collecting and analyzing robust data, it is impossible to form future recommendations and plans for improving quality. With the help of connected Industry 4.0 devices, accurate real-time data can be used to empower agile decision-making (What is Quality 4.0). For example (Zonnenshain&Kenett, 2020):

- Collect as many different types of data and perspectives on each situation as possible.
- Use data to develop a deeper understanding of the business context and problems at hand.
- Develop an understanding of variation, both in the data and in the overall business.
- Confront uncertainty and the possibility of making mistakes.
- Recognize the importance of high-quality data and invest in reliable sources and improvements.

Quality 4.0 emphasizes the use of big data **analytics** as one of its main aspects. Data from IoT and other sources are uploaded to cloud storage and analyzed using AI-based algorithms to recommend or make decisions. Quality data mainly relates to rejections and the number, types, and causes of defects. Conclusions are drawn from quality reports based on data analysis that includes recommendations.

Connectivity in the proposed Quality 4.0 framework refers to the existence of quality circles within an organization, consisting of representatives from different departments. These representatives can be connected through ERP systems, where data related to quality is inputted by the quality and other departments, and reports are generated using quality tools. Quality circle meetings are held frequently, either physically or remotely, to monitor and control the quality of products and services. Real-time quality reports are presented via ERP systems using quality tools such as histograms, Pareto charts, control charts, and FMEA. The connectivity dimension of the Quality 4.0 framework ensures that all departments in the organization are working towards the same strategic direction decided by the leadership (Zulqarnain, et al., 2022).

Scalability in Quality 4.0 refers to the ability of the quality management system to adapt and grow with the needs of the organization. This includes the ability to add new products or services, as well as the ability to expand operations to new markets or regions. Scalability is important because it allows organizations to stay competitive in a rapidly changing business environment.

The Quality Management System (QMS) is the foundation of Quality 4.0. The QMS provides a framework for managing quality that is based on data, analysis, and

continuous improvement. The QMS is integrated with other systems in the organization, such as Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM), to ensure that quality is considered at every stage of the product or service lifecycle.

Compliance is another important dimension of Quality 4.0. Compliance refers to the organization's ability to adhere to regulatory requirements, industry standards, and customer specifications. Compliance is critical for organizations that operate in highly regulated industries such as healthcare and aerospace. Culture, leadership, and competence are also important dimensions of Quality 4.0. These dimensions refer to the attitudes, behaviours, and skills of the people within the organization. A culture of quality and a commitment to continuous improvement is essential for the success of Quality 4.0. Effective leadership is also critical for creating a culture of quality and driving continuous improvement. Finally, the competence of the people within the organization is important for ensuring that quality goals are met and that the organization can adapt to changing circumstances.

In summary, Quality 4.0 is a comprehensive framework for managing quality in the digital age. It is based on data, analysis, and continuous improvement, and it encompasses dimensions such as data, analytics, connectivity, collaboration, application development, scalability, compliance, culture, leadership, and competence. By embracing Quality 4.0, organizations can stay competitive in a rapidly changing business environment, meet regulatory requirements and customer expectations, and drive continuous improvement across all aspects of their operations.

Adaptability means that an increased capacity to support data, users, devices, and analytics can increase a company's scalability. This means that companies can integrate all their data sources and systems in one place, on a larger scale than was previously possible.

The **quality management system** is a conventional part of the Quality 4.0 framework and covers the existence and application of standardization, in the form of SOPs, quality reviews, improvements, management engagement, corrective and preventive actions, etc. This management system within Quality 4.0 relies on technologies that allow management to observe statistics in real-time, control panels, and the organization's KPIs. Communication of organizational policies, SOPs, and KPIs can be facilitated by using ERP-based systems within Quality 4.0. Especially in life sciences, compliance can be a major priority in quality management. Quality 4.0 can automate and digitize compliance processes and further reduce overall quality costs.

The most significant elements of Quality 4.0 are the speed of design, production, and delivery, as well as the quality of software and data processing. Some authors have developed a quality strategy that can meet the demands of Industry 4.0. The strategy is called "Open Quality" and involves freedom in creating the characteristics of a product. The concept of Quality 4.0 must inevitably follow the trends of Industry 4.0 and the technological possibilities that have emerged with it (Tadić, 2022).

The **culture** within the proposed framework of Quality 4.0 refers to the quality culture of the organization. This dimension of the Quality 4.0 framework can be assessed through the existence of quality circles and the use of quality management tools, as well as knowledge and understanding that action should be based on the conclusions drawn from the results of these tools. It involves trust in employees in organizational processes and procedures and trust of the organization in its employees. The culture

includes offering rewards and recognition for performance improvement (Tadić, 2022). Effective leadership in Quality 4.0 requires a deep understanding of key technologies driving digital transformation, including artificial intelligence, machine learning, the Internet of Things, and big data analytics. Leaders must also understand how these technologies can be used to optimize quality processes and improve the quality of products and services.

Leadership in Quality 4.0 requires a combination of technical knowledge, change management skills, and a commitment to continuous improvement and innovation. Effective leaders in this field must be able to leverage new technologies and data to foster excellence in quality and cultivate a culture of accountability and ownership among employees. In addition, Quality 4.0 requires a shift in leadership style from a hierarchical approach to a more collaborative and participatory approach. Leaders must be able to facilitate communication and collaboration among different teams and departments, as well as between the organization and its suppliers and customers. This requires the development of strong interpersonal and communication skills, as well as the ability to build and maintain relationships based on trust and mutual respect. Overall, effective leadership in Quality 4.0 is crucial for organizations to stay competitive and adapt to the rapidly changing business environment. It requires a combination of technical expertise, change management skills, and strong interpersonal and communication skills, as well as a commitment to continuous learning and improvement.

These competencies include an understanding of the principles of Industry 4.0 and Quality 4.0, as well as the ability to apply new technologies and tools to improve quality and operational efficiency. They also relate to understanding and applying data management and analytics approaches to make fact-based decisions. Competent individuals in Quality 4.0 can identify opportunities for innovation and implement new business strategies and models supported by digital transformation. **Competencies** in Quality 4.0 are crucial for the success of organizations struggling with rapidly changing markets and customer needs. (Tadić, 2022).

Based on all the characteristics of Quality 4.0 mentioned above, the following benefits of its implementation can be highlighted: it improves the quality of decision-making, human intelligence, and transparency, adapts to new changes, eliminates defects, and so on.

3. Knowledge management in Quality 4.0

Knowledge management (KM) refers to the process or set of processes through which an organization uses individual and collective intelligence within itself to achieve its strategic goals (Calvo-Mora et al., 2015). Ultimately, it aims not only to create and/or acquire knowledge but also to include the practices involved in storing, retaining, transferring, and using available knowledge (Dovleac, 2021).

Regarding the possibility of implementing KM and tools in companies that have implemented total quality management (TQM) practices, different studies emphasize the complementarity of these two disciplines (Paulzen, 2002; Liderman et al., 2004; Molina et al., 2007). In the context of Quality 4.0, which is becoming a trend for companies that want to leverage the advantages brought by technology and Industry 4.0, the role of KM becomes clearer, and the question of data collection and effective management becomes more urgent.

Knowledge management in Industry 4.0 plays a crucial role in enabling organizations to leverage their collective knowledge and expertise to create a competitive advantage. The first aspect of knowledge management in Industry 4.0 is the use of data analytics and artificial intelligence (AI) to collect and analyze large amounts of data generated by sensors and other digital devices in the production process. This data can be used to identify patterns, optimize processes, and inform decision-making. The second aspect of knowledge management in Industry 4.0 is the use of collaborative technologies to facilitate knowledge sharing and collaboration between teams and departments. Cloud-based platforms, social media, and other digital tools can be used to create virtual communities where employees can share knowledge, ask questions, and collaborate on projects in real time. Ultimately, knowledge management in Industry 4.0 involves the use of advanced training and development programs to ensure that employees have the skills and knowledge necessary to use digital technologies in their work. This may include providing training on data analytics, AI, and other technologies, as well as broader concepts of Lean production, continuous improvement, and agile methodologies.

Overall, knowledge management is crucial for success in Quality 4.0. By utilizing advanced technologies for gathering, analyzing, and sharing knowledge, organizations can improve their quality management processes and deliver better products and services. Investing in knowledge management can be key for organizations that want to remain competitive in the dynamic business environment of Industry 4.0.

4. Conclusion

The concept of quality has followed industrial and social development. Four stages of the industrial revolution are distinguished for the first aspect of development. Current definitions or those from twenty years ago can be used for Quality 4.0, provided that they are properly interpreted, which requires understanding. Such definitions include: quality is an attitude; quality is a process of change that enables the organization to learn about the unspoken desires and needs of the customer; quality is a framework for improvement, a way of life, culture, and thinking, i.e. understanding.

Quality 4.0 aims to democratize Industry 4.0 technology, i.e. to distribute it more fairly among employees, so that it is no longer only available to privileged and rarely qualified individuals but to a larger number of those involved in continuous learning processes. Technology affects people's lives, relationships, and ability to work together. It connects individuals, machines, data, analytics, devices, and processes. The collaboration enabled by these connections is the foundation for improvements and innovations, as well as more efficient Quality 4.0.

Management knowledge plays a crucial role in Industry 4.0 as well as Quality 4.0 due to the complexity of processes, the need for fast decision-making, the development of new business models, and the need for new skills development. Organizational growth and development rely on organizational knowledge that needs to be adapted to new conditions and technologies. Moreover, it should be noted that employees' knowledge changes due to rapid technological changes that require new skills. Organizations are encouraged to create a knowledge base and to disseminate knowledge according to the needs at various organizational levels. This is imperative to enable a basic competitive advantage and to improve business performance. In Quality 4.0, management knowledge is important for managing quality processes and quality assurance in complex

manufacturing environments. Effective quality management in Industry 4.0 requires not only an understanding of quality standards but also data management skills, analytical abilities, decision-making skills, and the ability to successfully manage teams and processes.

Furthermore, the development of new quality standards and frameworks that are specifically designed for Industry 4.0 and Quality 4.0 will continue to evolve. This includes the development of new metrics and performance indicators that can better capture the performance of digital processes and products.

Finally, the focus on human factors and the development of new skills and competencies for quality professionals will be an important aspect of future development in Quality 4.0. As technology continues to advance, the need for skilled workers who can effectively manage and utilize these technologies will become increasingly important.

References:

Ament, C., &Goch, G. (2001). A process-oriented approach to automated quality control. CIRP *Annals*, *50*(1), 251-254. doi: 10.1016/S0007-8506(07)62116-7

Arsovski, S. (2019). Social-oriented quality: from quality 4.0 towards quality 5.0. *In 13th International Quality Conference* (Vol. 13, pp. 397-404).

Aziz, S., & Dowling, M. (2019). Machine learning and AI for risk management. *Disrupting Finance: FinTech and Strategy in the 21st Century*, 33-50.

Buntak, K., Kovačić, M., &Mutavdžija, M. (2021). The influence of industry 4.0 on transport and logistics in the context of supply chains. *Business Logistics in Modern Management Proceedings*, Osijek.

Buntak, K., Kovačić, M., &Mutavdžija, M. (2019). Internet of things and smart warehouses as the future of logistics. *Tehničkiglasnik, 13(3),* 248-253. doi: 10.31803/tg-20190215200430

Burns, T., Cosgrove, J., & Doyle, F. (2019). A Review of Interoperability Standards for Industry 4.0. *Procedia Manufacturing*, *38*, 646-653. doi: doi.org/10.1016/j.promfg.2020.01.083

Calvo-Mora, A., Navarro-García, A., &Periañez-Cristobal, R. (2015). Project to improve knowledge management and key business results through the EFQM excellence model. *International Journal of Project Management*, *33(8)*, 1638-1651. doi: doi.org/10.1016/j.ijproman.2015.01.010

Carvalho, A. V., Enrique, D. V., Chouchene, A., & Charrua-Santos, F. (2021). Quality 4.0: an overview. *Procedia Computer Science*, *181*, 341-346. doi: doi.org/10.1016/j.procs.2021.01.176

Dilthey, U., & Heidrich, J. (1999). Using AI methods for parameter scheduling, quality control and weld geometry determination in GMA-welding. *ISIJ International*, *39(10),* 1067-1074. doi:doi.org/10.2355/isijinternational.39.1067

Dovleac, R. (2021). Knowledge management systems in Quality 4.0. In *MATEC Web of Conferences* (Vol. 342, p. 09003). EDP Sciences. doi: 10.1051/matecconf/202134209003

Escobar, C. A., McGovern, M. E., & Morales-Menendez, R. (2021). Quality 4.0: a review of big data challenges in manufacturing. *Journal of Intelligent Manufacturing*, *32*, 2319-2334. doi: doi.org/10.1007/s10845-021-01786-z

Farooq, M. U., Waseem, M., Mazhar, S., Khairi, A., & Kamal, T. (2015). A review on internet of things (IoT). *International journal of computer applications*, *113*(1), 1-7. doi:10.5120/19787-1571

Fragapane, G., Ivanov, D., Peron, M., Sgarbossa, F., &Strandhagen, J. O. (2022). Increasing flexibility and productivity in Industry 4.0 production networks with autonomous mobile robots and smart intralogistics. *Annals of operations research*, *308*(1-2), 125-143. doi: doi.org/10.1007/s10479-020-03526-7

Sader, S., Husti, I., &Daroczi, M. (2022). A review of quality 4.0: Definitions, features, technologies, applications, and challenges. *Total Quality Management & Business Excellence*, *33(9-10)*, 1164-1182. doi: doi.org/10.1080/14783363.2021.1944082

Sanchez, M., Exposito, E., & Aguilar, J. (2020). Industry 4.0: survey from a system integration perspective. *International Journal of Computer Integrated Manufacturing*, *33*(10-11), 1017-1041. doi: 10.1080/0951192x.2020.1775295

Kovačić, M., Mutavdžija, M., Buntak, K., & Pus, I. (2022). Using artificial intelligence for creating and managing organizational knowledge. *Tehničkivjesnik*, *29*(4), 1413-1418. doi: 10.17559/TV-20211222120653

Kovačić, M., Čičin-Šain, M., &Milojica, V. (2022). Cyber security and tourism: Bibliometric analysis. *Journal of process management and new technologies*, *10*(3-4), 75-92. doi: 10.5937/jouproman2203075K

Larson, D. B., & Boland, G. W. (2019). Imaging quality control in the era of artificial intelligence. *Journal of the American College of Radiology*, *16*(9), 1259-1266. doi: 10.1016/j.jacr.2019.05.048

Linderman, K., Schroeder, R. G., Zaheer, S., Liedtke, C., & Choo, A. S. (2004). Integrating quality management practices with knowledge creation processes. *Journal of operations management*, *22*(6), 589-607. doi: 10.1016/j.jom.2004.07.001

Molina, L. M., Lloréns-Montes, J., & Ruiz-Moreno, A. (2007). Relationship between quality management practices and knowledge transfer. *Journal of operations management*, *25*(3), 682-701. doi: 10.1016/j.jom.2006.04.007

Madakam, S., Lake, V., Lake, V., & Lake, V. (2015). Internet of Things (IoT): A literature review. *Journal of Computer and Communications*, *3*(05), 164. doi: 10.4236/jcc.2015.35021

Maganga, D. P., &Taifa, I. W. (2022). Quality 4.0 conceptualisation: an emerging quality management concept for manufacturing industries. *The TQM Journal*. doi: 10.1108/tqm-11-2021-0328

Nenadál, J., Vykydal, D., Halfarová, P., &Tylečková, E. (2022). Quality 4.0 maturity assessment in light of the current situation in the Czech Republic. *Sustainability*, *14*(12), 7519. doi: 10.3390/su14127519

Paulzen, O., Doumi, M., Perc, P., &Cereijo-Roibas, A. (2002). A maturity model for quality improvement in knowledge management.

Perović, M.. (2019). Razumijevanje je u osnoviKvaliteta 4.0 iljučuspješnostiIndustrije 4.0. *Festival kvaliteta 2019*. 46. Nacionalnakonferencija o kvalitetu. Kragujevac.

Tadić, D. M. (2022). Phases of quality development: Concluding with the concept of quality 5.0. *Tehnika*, *77*(5), 643-647.

Zulqarnain, A., Wasif, M., & Iqbal, S. A. (2022). Developing a quality 4.0 implementation framework and evaluating the maturity levels of industries in developing countries. *Sustainability*, *14*(18), 11298. doi: https://doi.org/10.3390/su141811298

Zonnenshain, A., &Kenett, R. S. (2020). Quality 4.0—the challenging future of quality engineering. *Quality Engineering*, *32*(4), 614-626. doi: 10.1080/08982112.2019.1706744

Jovana Nikolić
Faculty of Engineering,
University of Kragujevac,
Kragujevac,
Republic of Serbia
jovana.nikolic.jag@gmail.com

Miladin Stefanović
Faculty of Engineering,
University of Kragujevac,
Kragujevac,
Republic of Serbia
miladin@kg.ac.rs

Nikola Simić
Faculty of Engineering,
University of Kragujevac,
Kragujevac,
Republic of Serbia
nikolasimicva@hotmail.com