Towards a Better Understanding of Quality 4.0

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Abstract

Industry 4.0(I4.0) or the fourth industrial revolution is a strategy that relies on digital and ubiquitous connectivity enabled by various technologies to transform processes, products, and services through real-time and decentralized decision-making, allowing systems to transition from surveillance to autonomy in collaboration with humans. resulting in the emergence of 'Industry 4.0' The term '4.0' has been applied to a variety of fields, including Quality 4.0, Agriculture 4.0, Agribusiness 4.0, Service 4.0, Logistics 4.0, Health 4.0, and so on, all of which represent the impact of Industry 4.0 on these terms. Quality 4.0(Q 4.0) is a new term that refers to a new and improved approach to quality management, it how we can use the DATA obtained by 4.0 and use it correctly with the quality methodology, the objective of this paper is to explain industry 4.0 as well as quality 4.0 and presented the various quality 4.0 relationships.

Keywords: Quality 4.0; Industry 4.0; Quality management; Data; Connectivity.

Introduction

At the turn of the century, the world is witnessing the fourth industrial revolution and the digital transformation of the business world, dubbed Industry 4.0. The fourth industrial revolution is a success rather than a fad (Ardito et al. 2010). Schroeder et al. 2019; Buer et al. 2018). Since the term "Industry 4.0" was coined in 2011, the digital transformation required by Industry 4.0 has quickly captured public attention. worldwide attention of industrialists and governments Nascimento et al. 2019; Gobakhloo 2018). Since the 18th century, the world has faced the challenge of producing more goods with high quality to satisfy the customer from limited and depleting natural resources to meet ever-increasing consumption demand while limiting negative environmental and social impacts. Furthermore, this paper was divided into five sections: first methodology we will represent the research methodology we used to write this paper, then we analyses 10 articles in this section we will explain the various quality 4.0 relationships, after we will past to discussion, and result to represented what we found, finally the conclusions and future developments.

Objectives

This paper has been divided into five sections: first methodology we will represent the research methodology we used to write this paper, then we analyze 10 articles in this section we will explain the various quality 4.0 relationships, after we will past to discussion, and result to represented what we found, finally the conclusions and future developments.

2. Literature Review

Quality 4.0 refers to the future of quality management achieved using emerging technologies in the context of Industry 4.0 to achieve operational excellence. The shift to a digital way of working in the manufacturing industry is fueling the quality-driven revolution, resulting in greater robustness and efficiency in our processes.

3. Methods

This study's methodology is based on a review of various sources of knowledge to find all relevant literature. Web of Science, Scopus, Google Scholar, and other scientific resources were searched for published work from 2018 to October 2022 using the keyword 'Quality 4.0'. A total of 33 articles from various scientific sources were collected, indicating a high level of interest in this topic even though quality is central to all manufacturing and service sectors, given that 'Quality 4.0' is a buzzword among IT companies and quality management practitioners. Papers that did not sufficiently explore the topic were excluded from the study. It is worth noting that some papers included the buzzword 'Quality 4.0' in the article's keywords but no further investigation was included in the body of the research; these were also excluded. The total number of relevant articles was 12 witch we have analyzed well and prepare reading sheets.

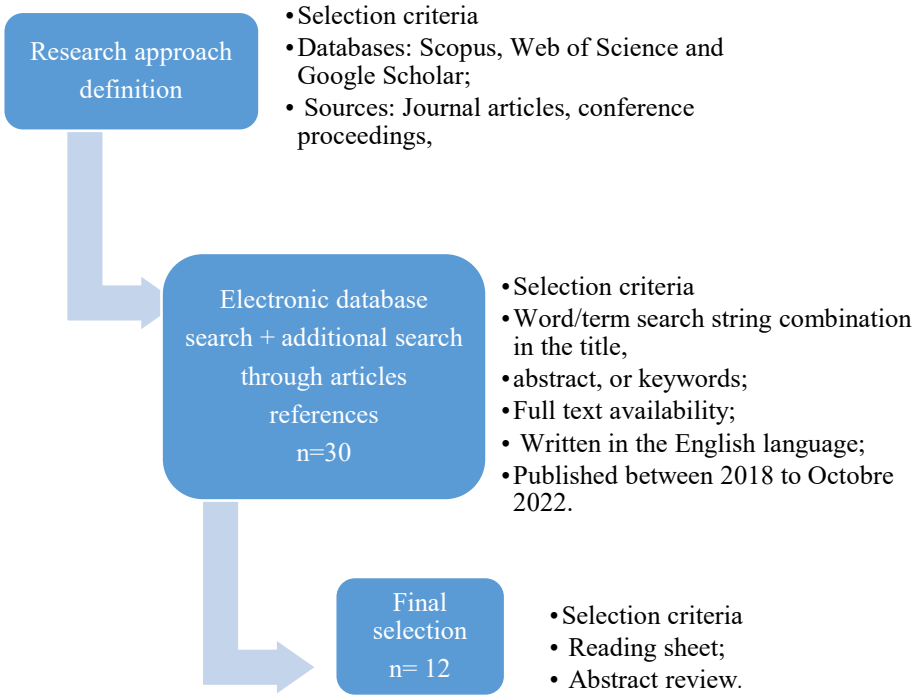

Figure 1. depicts the search process and the criteria used to select articles.

4. Data Collection

Defining quality 4.0

Quality “4.0” is a branch of the industry 4.0 (I4.0) movement associated with the digital transformation process connected with emerging technologies. Quality 4.0 could be defined as the application of Industry 4.0 technologies to quality management methods and tools. According to Reference, “Quality 4.0 does not replace traditional quality methods, but rather builds and improves upon them” . The impact of I4.0 on manufacturing extends beyond the physical production of goods to include aiming for flexibility, smartness, cost-effectiveness, and resilience across all processes and functions Among the technologies mentioned are artificial intelligence and machine learning. That, as the heart of smart manufacturing, can be used to improve quality. With its automation, connectivity, and digital access capabilities, Industry 4.0 should be able to boost efficiency and productivity of quality management methods and tools. It may occur by enabling intelligent monitoring and diagnostics, automatic tracking of equipment and materials, and real-time decision-making, particularly in situations where the process is becoming increasingly volatile.

Quality 4.0 is the application of modern technology to support people development and to expand the potential of quality tools in the pursuit of superior organizational results.

Quality management and Industry 4.0
According to Zaidin et al. (2018), the opportunity of quality management industry 4.0 are divided into 3 things including strategy, operations and environment and people:

- Strategy: From a strategic standpoint, Industry 4.0 is a good business model of modeling participation that boosts competitiveness. Understanding the business's strengths and weaknesses allows it to optimize the output of the business model to reach a large potential market. Furthermore, recent research has agreed that there is a slightly positive impact, particularly on rewards obvious strategies, on improving implementation.

- Operations: The operation is a part of the business association that includes vouchers and product delivery to the customer. The operation requires unique physical equipment, such as raw resources and sub-assemblies, such as personal computers with the main motherboard, as well as mobile phones and automobiles. The professional association must meet the ideal conditions to ensure that he is capable of matching free market activity.
- Environment and people: Using centered data, Industry 4.0 can trace the release of the carbon trail while also reducing greenhouse gas emissions.

The opportunities and challenges in implementing Industry 4.0 for quality management revealed by a practical overview of an Austrian electronic production and service company . The recent challenge study's findings are shaped by the three key characteristics of Industry 4.0: horizontal, vertical, and end-to-end manufacturing integration.
- Integration vertical: Industry 4.0 is distinguished by a large volume of data released. This is due to the new availability of data aggregates that combine data from various sources, which was previously impossible. A challenge ahead is to provide transparent and useful information understandable by people by processing and managing large amounts of data.

- Horizontal integration: As a result of the horizontal aspect of Industry 4.0, some new business models emerge. Customers will be able to track and trace their packages or order items in real time without needing to know the exact location of the package. Horizontal integration also enables customers to coordinate with product activities at any time and from any location.

- End-to-end engineering integration: Industry 4.0 cannot perform complex or non-repetitive tasks. Although the machines provide high quality and redundancy, automation technology is currently incapable of detecting the complex production problem. We are the only humans who can work on customizable or complex production jobs.

Quality 4.0 and Technologies
According to the literature review, the most common quality 4.0 topics are technology and its implications for quality, business management and strategy models, systems, and human or intangible factors. The use of technology for quality management is represented in a variety of information sources, and it appears to be the most direct way of connecting quality to technology. Most products, services, and operations can now be controlled automatically throughout the value chain thanks to smart machines and operators equipped with augmented reality technologies. Furthermore, the development of disruptive technologies has allowed for rapid advancements in business models and, as a result, management approaches. As a result, quality management approaches have evolved to accommodate the evolution of thinking and evaluating quality through good services between the technical and social aspects of digital transformation. In the literature, the social aspect of Quality 4.0 has received less attention than the technological aspect.

Radziwill (2018) proposes six Quality 4.0 technologies: AI, Big Data, Blockchain, Deep Learning, Enabling Technologies (sensors, actuators, RFID, IPv6, and so on), Machine Learning and Data Science. Meanwhile, Jacob (2017a) classified Quality 4.0 technologies into four groups: Big-Data, connectivity, collaboration, and data-presentation [.

Quality 4.0 and DATA/connectivity
The generation of data within the digital value chain has increased exponentially because of new production systems. Appropriate data use can result in improved quality management practices. To maximize the benefits of error analysis and correction methods, data-driven quality regulation is required. Big-Data has enabled the collection of real-time data. All data can be combined and used to discover relationships. Quality 4.0 is more than just basic or advanced data collection and analysis. It is the ability to discover hidden relationships or patterns in various variables that traditional

data analysis tools cannot. Artificial intelligence, machine learning, and deep learning are examples of new data scientific tools.

People can use smart devices to transmit and receive information that will help them in their roles at their various locations. The Products may include data generated during production. Furthermore, products can provide data on their performance in the field to help with product improvement. This data includes faults, the operating environment, the circumstances of failure, and even customer feedback (Jacob, 2017a; Ngo & Schmitt, 2016; Radziwill, 2018). This data can be compared to data from other devices, processes, and ERP systems, leading to a causal explanation of defects and root cause analysis. Connecting all aspects of the manufacturing value chain, such as people, products, devices, and processes, to other business management solutions such as ERP and the quality management system.

Quality 4.0 and Lean six sigma

The cycles are data driven to achieve accurate results with LSS lean six sigma, which has a systematic effect on waste and cost reduction (Polk 2011). Because Industry 4.0 technologies enable the collection of ever-increasing amounts of data, the use of various data mining techniques such as big data analysis, data mining, and process mining is critical. Decision makers save time by identifying what is difficult to see at first glance using mining techniques. Furthermore, the accuracy is high because the decisions are based on data. Even though many businesses have implemented lean manufacturing and six sigma, few are satisfied with the results (Guarraia et al. 2008). Because quality problems are complex, modeling and optimization are difficult**.** Because quality problems contain large amounts of data, modeling or optimization is difficult. Data or information is a factor in the production of goods or services. This compels decision-makers to save as much data as possible to avoid making poor decisions. The massive data collected in the era of Industry 4.0 increases the risk of making bad decisions, even though they are necessary for making decisions. Text mining, machine learning, deep learning, artificial neural networks, and basic data mining techniques such as clustering, association, prediction algorithms, classification, and process exploration aid in making correct and optimal decisions at various stages of LSS. As a result, the use of mining techniques in LSS cycles is critical for business.

5. Results and Discussion

Quality 4.0 is critical for all manufacturing industries' management. **The technologies** used in this revolution are critical to creating a culture in which all employees are held accountable for quality and transparency. Thus, analysis with various organizations of various sizes and designs is required to understand the effect of various cultures and management types on the effective adoption of Quality 4.0. **Big Data** enables a comprehensive and integrated view of consumer demands, which can be used to improve the overall quality of the manufacturing system. Maintaining product lifecycle quality is one of the most notable aspects of Quality 4.0. By collecting and testing product consumption, **artificial intelligence** can successfully track service level. In the future, transparent and visible support from top-level management will help consumers have a positive perception of Quality 4.0. Quality 4.0 has become critical to the survival of the manufacturing industry.

Any process, from product development to front-office business transactions and everything in between, should be consistent. Currently of rapid change, Quality 4.0 is more of a concept of consistency as a method of containment than a tool for prevention. Quality 4.0 is fascinating, and some of the innovations will be used in quality manufacturing for many years. This quality revolution is founded on a collective quality strategy that ensures quality is a top priority in manufacturing. Furthermore, it aims to increase consumer and supplier chain accountability for quality throughout the company. Systems integration, computer-aided design and manufacturing, the usefulness of manufacturing robots, computer vision, data request configurations, and so on are the most important elements associated with implementing the Quality 4.0 philosophy throughout manufacturing. **Human-machine interface**, intelligent machines for production, optimized solutions, global digitization, precise measurement practices, and other concepts also help to strengthen the effective implementation of quality 4.0 principles in manufacturing areas.

This paper aims to explain industry 4.0 as well as quality 4.0. Based on a literature review, we have presented the various quality 4.0 relationships. Furthermore, one of its anticipated outcomes contributes to an accepted definition of the concept. According to the literature review, the most common Quality 4.0 topics are technology and its implications for quality, business management and strategy models, systems, and human or intangible factors. The use of technology for quality management is represented in a variety of information sources, and it appears to be the most direct way of connecting quality to technology. Most products, services, and operations can now be controlled automatically throughout the value chain thanks to smart machines and operators equipped with augmented reality

technologies. Furthermore, the development of disruptive technologies has allowed for rapid advancements in business models and, as a result, management approaches. As a result, through good connectivity between the technical and social sides of digital transformation, quality management approaches have adapted to the evolution of the way of thinking and evaluating quality. In the literature, the social aspect of Quality 4.0 has received less attention than the technological aspect. Nonetheless, there is growing concern about the issue. Not only is human-machine interaction critical, but topics such as leadership, training and education, and the development of a supportive organizational culture have also been identified as critical to long-term transformation. Based on these findings, we highlight several key Quality 4.0 topics and propose a new definition for a better understanding of the concept.

4. Conclusion

In this study we start to give the different definition of quality 4.0 and it's suggesting that 'Quality 4.0' is a new quality management trend. As a result, both theoretical and practical aspects of quality management practices will be altered in the future. Quality management practices are recommended to identify technological advancement as a key enabler of successful quality standard implementation in the Quality 4.0 era. According to the literature review, the most common Quality 4.0 topics are technology and its implications for quality, business management and strategy models, systems, and human or soft factors. The use of technology for quality management is represented in a variety of information sources, and it appears to be the most direct way to connect quality to technology. The majority of products, services, and operations can now be controlled automatically across the value chain thanks to intelligent machines and armed operators equipped with augmented reality technologies. The paper concluded that big data is so important for deep learning techniques, connectivity, collaboration, and data presentation are the main Quality 4.0 technologies.

Therefore, to give a more in-depth view of quality 4.0, we have prepared a questionnaire that we will publish to have a clear view of the industry and quality 4.0

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