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Comprehensive Study on Industry 4.0, Service Quality, and Total Quality Management

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Abstract- The purpose of this study is to examine the present status of the literature with regard to the relationships among Industry 4.0, quality management, and Total Quality Management (TQM). This article's goal was to identify the topics and concerns that should be brought up while discussing with regard to termed quality 4.0. A systematic review of the literature was used in this study. For this review study around 15 papers from various sources were examined in total using predetermined selection and exclusion criteria. The topics were divided into the following four categories, creating value for the company using high-quality (big) data, analysis, as well as the use of artificial intelligence (AI) to develop a high-quality 4.0 culture and expertise for high-quality staff members, co-creating value for customers; and deploying cyber-physical platforms and enterprise resource planning (ERP) to assure quality and control. This essay also attempted to investigate whether Quality 4.0 had a definition based on established practices.

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Comprehensive Study on Industry 4.0, Service Quality, and Total Quality Management

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Abstract- The purpose of this study is to examine the present status of the literature with regard to the relationships among Industry 4.0, quality management, and Total Quality Management (TQM). This article's goal was to identify the topics and concerns that should be brought up while discussing with regard to termed quality 4.0. A systematic review of the literature was used in this study. For this review study around 15 papers from various sources were examined in total using predetermined selection and exclusion criteria. The topics were divided into the following four categories, creating value for the company using high-quality (big) data, analysis, as well as the use of artificial intelligence (AI) to develop a high-quality 4.0 culture and expertise for high-quality staff members, co-creating value for customers; and deploying cyber-physical platforms and enterprise resource planning (ERP) to assure quality and control. This essay also attempted to investigate whether Quality 4.0 had a definition based on established practices.

As for limitations of this research can be known as some restrictions on the quantity and validity of the papers it reviewed. There may have been some interesting papers that were overlooked accidentally.

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I. Introduction

I4.0, a high-tech strategy plan to boost the competitiveness of the German manufacturing industry, was first suggested in Germany in 2011. It immediately became clear that numerous additional concerns may be included under the I4.0 terminology. In reality, I4.0 may be thought of as an entirely novel framework in which "cyber-physical systems" (CPSs) are inter- connected to one another via the Internet of Things (IoT) or the World Wide Web, culminating in the development of a smart factory [1].

Enterprises today adopt a variety of technologies, including additive manufacturing, robots and collaborative robots (COBOT), smart sensors, smart human interfaces (SHI), augmented reality also known as AR, self-driving automobiles, big data, and analytics, artificial intelligence (AI), simulation, and virtualization, to mention just a few. Over time, numerous new technological advances as well as traditional technologies incorporated through the internet entities have been invented and introduced. Since I4.0 is an emerging field, there are some undiscovered avenues for research, particularly those related to the management of quality and the overall quality management (TQM) industry as a whole. According to the literature analysis, only a small number of studies have examined I4.0 and its close ties to quality management, and also the TQM quality tools and principles. As a result, by analyzing the state of the literature in terms of the connections between I4.0, quality management, and TQM, and suggesting new research directions, this study seeks to broaden this type of discourse [2]. Throughout the connection between I4.0 and TQM enables fresh TQM implementation practices. Fig.1. such as, customer focus, leadership, people engagement process approach, improvement, evidence-based decision making, management of relationships and, quality assurance of quality.

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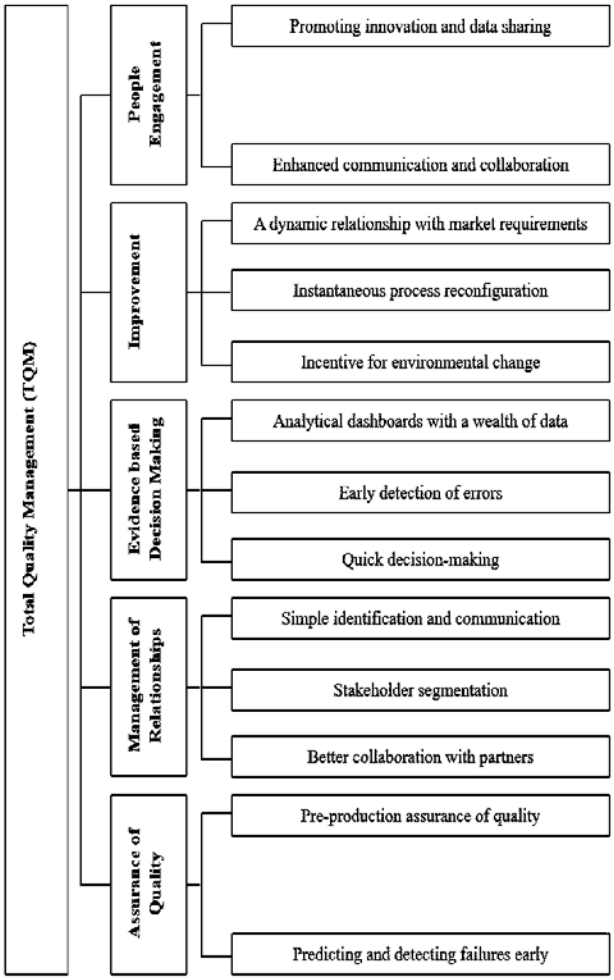

Fig.1: TQM in Relation to Industry 4.0

II. Research Problem

It is necessary to find out If the technology called data science and industry 4.0 is essential for the management of overall quality of something to be at a very high level in any company. Therefore, if there are any business organizations that have not adapted to the industry 4.0 technology, there is a problem whether this technology will affect their quality management. Regarding this should be studied.

III. Research Objectives

The main goal of this review paper is to analyze the current state of the literature in the context of the relationship among Industry 4.0, quality management, as well as total quality management. Additionally, this study aimed to find gaps within the literature and identify topics and issues that might be thought of as the most relevant in relation to the well-known quality 4.0. Regarding those would be further discussed through the study.

IV. Review of Literature

In this section the author has used past work, past scholars literature to give more strengthen to this research topic and for the purpose of giving more value to the background of this study.

a) Industry 4.0 Landscape

According to Zonnenshain and Kenett, the quality of the product, quality of process, quality of service, management quality, design quality, and information quality are the six stages through which quality is said to have progressed, according to the authors [3]. The latter is substantially connected to the advancement of the production operation system software and the enterprise resource planning, or ERP (Enterprise Resource Planning), system. With this strategy, organizations are shifting their focus away from products and through data, and quality combined with I4.0 has been recognized as an entirely discipline of data driven.

developed a transition plan for Quality 4.0, with managing data being related to the final stage [4].The writers also covered the significance of adding value within the organization so that people may access the appropriate data and share it with coworkers at every level of the hierarchy. The preceding study demonstrated how technologies from I4.0 enable the acquisition of high-quality, previously unobtainable data. The authors claim that the difficulty is in deciding where, how, and what to gather, as well as how to analyze the generated massive data [5]. In order to improve the quality of design, data could be gathered throughout the entire product cycle, based on past research, big data will enable companies to better balance design factors like the expense and value of the product by enabling an understanding of customers' needs [6]. This problem with the data raises yet another important issue pertaining to how people are attempting to handle quality data alongside the many CPSs provided by I4.0. This, was stated by Radziwill, due to the fact that intelligent automation is becoming more prevalent in organizations as a result of digital transformation [7].The issue also has an impact on quality professionals who must acquire new skills to help their businesses successfully adopt I4.0. Gregory H. Watson investigated the implications of big data and AI (artificial intelligence) on the quality occupations and individuals associated with quality management, notably the Six Sigma field [8]. The difference between quality professionals and data scientists will be replaced by a new approach known as "collaborative analytics. "According to Ai Qiang Lipaper in this particular issue found important implications for human capital in the product-service structure of I4.0; the findings of the article implied that employees are undeveloped regardless of the impact of staff in utilizing the digitization and value collaboration, and researchers require an organization with learning capabilities for the "diffusion of innovation" [9]. I4.0 technologies are expected to meet high expectations from both employees and quality managers. The necessity for traditional ideas of quality to adapt to I4.0 developments and difficulties was examined by Pavol Durana in 2019 [10]. According to the authors, I4.0 implementation and quality management are closely related to the development of a culture of quality rather than being solely technological.

b) Technologies of Industry 4.0

Refers to the below Fig. 2 and this illustrates those new areas after digital transformation of the I4.0.

Fig. 2: Digitalized transformation of the industry 4.0.

i. *Big Data*

Is a term used to describe the latest wave of technologies and infrastructures that allow businesses to find, collect, and analyze enormous amounts of data. Organizations generate more information as a result of using increasingly sophisticated tools, processes, and products[11].

ii. *Cloud Computing*

Is a smart network production paradigm known as cloud-based manufacturing facilitates product personalization, more worldwide collaboration, knowledge innovation, and a quicker capacity to react to market changes [12].

iii. *Internet of things*

The Internet of Thing is a technological infrastructure that makes it possible to identify, locate, track, and monitor items as well as gather and transmit data between devices. It is a synthesis of many technologies centered around the linkage between actual things and the internet[13].

iv. *Cyber Security*

The digital environment of the 4th industrial revolution connects people, machines, products, and other entities, forming interconnected industrial networks that extend across the supply chain. For processes to be successfully completed in real-time, digital interactions among points need to be trustworthy and secure. As a result, a few of the most essential criteria to stop cyberattacks is cyber security. In fact, it acts as an effective shield against threats and instability for digital operations [14].

c) Importance of industry 4.0 for Quality

Albert Albers in 2016, conducted study on “how I4.0 technologies might impact business performance” [15]. Industry 4.0 may greatly increase the satisfaction of customers, as estimated by 45% of the participants, by eliminating the use of faulty products and offering better service. The design team and production operations may get automated and quick transmissions of customer data and information. According to Nicola

Cobelli and Andrea Chiarini in 2019, businesses that want to use digital applications can't only grow their technological capacity [16]. To handle those socio-technical developments, these organizations should acquire and strengthen effective relationship and collaboration abilities. The study also highlighted how I4.0 technologies have a substantial impact on the phenomenon that is known as "digital servitization" [17]. With the help of smart sensors and radio frequency identification (RFID), all kinds of data and information relating to materials in shipment, work that is being done, and finished items may be detected, monitored, and registered [5].The opportunity to automatically gather and examine typical quality ensure/control information as well as data, such as peer review and the findings of an audit non-conforming commodities, and calibration outcomes, to mention a few, is now available. Additionally, CPS particularly intelligent detectors, SHI, and RFID could be beneficial in reducing errors and defects in human and automated activities [18].

d) TQM Implementation Practices Relation to Industry 4.0

Considering a variety of valid reasons, including those referred to as Total Quality Management principles, proper maintenance of an organization's entire condition management is necessary. The author encounters discussed how general approaches to quality management affect Industry 4.0 in this section. In this way, they are connected to industry 4.0 Fig. 1.

i. *People Engagement*

All service providers should contribute equally to quality management in a company with efficient quality management. In other words, employees in every position of authority inside the company ought to provide this. It has an impact on the productivity of the company, and industry 4.0 helps to achieve this goal by helping to maintain effective internal communication and collaboration.

In this industry 4.0, enterprise resource planning tools and artificial intelligence make it simple for anyone to contribute new goods to the company, which promotes innovation [19].

ii. *Improvement*

The continuation of the business is one of quality management's key goals. That is, to maintain a high level of customer satisfaction while meeting their demands and ensuring the company's continued existence by upgrading its manufacturing operations. In other words, this is a unique place to perform the root cause analysis that influences the incidence of an error. A company organization's continuous survival and the ongoing process improvement of production are supported by this industry 4.0.

It improves the performance of the overall production process itself. Also, this industry 4.0 helps to early detection of machine breakdown, machine maintenance. This industry 4.0 is useful to detect system failures early [19].

iii. *Evidence Based Decision Making*

Decisions made based on accurate data and information only affect the survival of the business, achieving the goals of the business and saving the unnecessary expenses of the business. Industry 4.0 as well as big data, artificial intelligence and cloud computing help to make such decisions efficiently. Also, industry 4.0 industries help to know the breakdowns of machine systems in the early stages as well as to maintain them in a timely manner [19].

iv. *Management of Relationships*

All the factors that contribute to the effectiveness of any organization in which quality control is implemented. It is very important to maintain good and productive relationships between investors, suppliers, consumers and other parties. It affects the organization to maintain a steady flow of goods and services.

Effective communication and collaboration between all departments in the institution leads to good quality management. For example, suppliers are constantly aware of the organization's demand volumes, enabling problem-free product supply and customer demand. It is with the help of data science [19].

v. *Assurance of Quality*

Industry 4.0 helps to produce more advanced products with high technology and high quality. This industry 4.0 helps to identify any defect in a product item with the help of smart technology, improve the efficiency of the processes, and make corrections to produce defect free products[19].

V. Results and Discussion

The defining of Quality 4.0 was our first step. We discovered some attempts, as was previously said, but they are unrelated to any theoretical approaches. Therefore, the author should further try to clarify the term through investigations that allow for the confirmation or rejection of certain research predictions, such as case studies or surveys.

Finally, the researcher think that a lot of papers have been written about the investigation of Industry 4.0 ciber physical systems to be used for enhancing quality assurance and control issues like recognizing products and routing in addition to tool as well as gauge management in the literature. There are several more pieces of I4.0 literature on technical subjects that researchers didn't consider taking into account for our review work. As was already mentioned, research is necessary to contextualize the findings from these articles into a more widespread Quality 4.0

implementation paradigm. Future researchers can complete their studies further regarding this area. Therefore, this study is a good attempt for future scholars to complete their studies further improving this subject [1].

VI. Conclusion

Researchers believe the research's conclusions would be intriguing from a practical standpoint even if it were based on an SLR. Many useful and well-researched approaches could be used by experts and leaders in the development and implementation of their own quality 4.0 models. The author has conducted this study by studying the literature investigations of previous studies. Only 12 past scholarly research articles have been taken into consideration when completing this study. According to the recent literature surveys, the investigation looked at the way industry 4.0 might affect quality.

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