Quality 4.0 and its impact on organizational performance: an integrative viewpoint

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**Abstract**

**Purpose** – Quality 4.0 is managing quality during the fourth industrial revolution. It is used by modern-day organizations as a strategy to compete and thrive in the marketplace. The purpose of this study is to analyze the potential impact of Quality 4.0 on organizational performance.

**Design/methodology/approach** – This study through an integrative literature review critically analyzed 41 previous literature articles to study the impact of Quality 4.0 on various metrics of organizational performance.

**Findings** – The results of the review suggest that Quality 4.0 may have an impact on financial performance, customer value proposition, internal business processes, learning and growth, environmental performance and social performance.

**Research limitations/implications** – This study is limited by the databases reviewed. The second limitation is that this study considered articles published in the English language. Therefore, articles published in other languages were not considered in this study.

**Practical implications** – Organizations can use the findings of this study to strongly leverage the implementation of Quality 4.0 to reach their strategic objectives and improve competitive advantage.

**Originality/value** – This is the first study to explore the impact of Quality 4.0 on organizational performance through an integrative literature review.

**Keywords** Quality 4.0, Organizational performance, Integrative review, Environmental performance, Social performance

**Paper type** Conceptual paper

1. **Introduction**

Quality is one of the most crucial dimensions of products and services to be adopted in global markets (*ASQ, 2020*). Organizations can attain a competitive advantage in global markets by effectively deploying quality as a strategy to compete with rivals (*Zonnenshain and Kenett, 2020*). With the advent of the fourth industrial revolution, quality management (QM) has undergone a sea change because of the arrival of modern, enabling technologies in QM (*Hyun Park et al., 2017*). Quality 4.0 in simple terms is managing quality in the modern era of Industry 4.0 (*Sony et al., 2020*). The top five motivations to implement Quality 4.0 in...
organizations were found to be (1) reliable information, (2) big data to drive quality programs, (3) improved customer satisfaction, (4) productivity improvement and (5) long-term savings in cost and time. Similarly, the top five barriers were (1) high implementation costs and unclear return on investment, (2) lack of resources, (3) lack of implementation knowledge, (4) weak organizational culture and (5) an unclear link to competitive advantage (Sony et al., 2021). The eight key ingredients for effective implementation of Quality 4.0 were found to be (1) handling big data, (2) improving prescriptive analytics, (3) using Quality 4.0 with effective vertical, horizontal and end-to-end integration, (4) Quality 4.0 for strategic advantage, (5) leadership in Quality 4.0, (6) training in Quality 4.0, (7) organizational culture for Quality 4.0 and, lastly, (8) top management support for Quality 4.0 (Sony et al., 2020). QM models, approaches and practices have evolved from focusing on inspection to quality control to quality assurance to QM and quality by design (e.g. design for Six Sigma; Zonnenshain and Kenett, 2020). Importantly, the frame of quality remains the same – how can organizations meet the needs of the customer. Quality 4.0 is much more than mere technology. It is the symbiotic relationship between humans and technology in a goal-oriented manner to meet the quality strategy and objectives of the organization (Sony et al., 2020). Thus, the authors argue that Quality 4.0 can be treated as a socio-technical system. Until now, the main functions of QM were detection and diagnosis of processes, and failures and anomalies were dominated by in-process controls. But, because of advanced sensing technologies and advanced analytics capabilities, there is an important paradigm shift to prediction and diagnosis of process conditions (shift in process performance) and understanding the performance of quality characteristics, which are critical to both customers and the enterprise. Such a shift aids us to measure and predict the quality of systems and products well in advance of those provided by traditional preventive approaches to assure quality. Such thinking is made possible because of the emergence of big data, automation and data analytics (Zonnenshain and Kenett, 2020).

Organizational performance is a major aspect in developing, implementing and monitoring a strategic plan. It also helps in setting future strategic direction (Teeratansirikool et al., 2013). Organizational performance can also be thought of as an indicator, which is used to measure how well an organization accomplishes its objectives (Ho, 2008). Organizational performance if it is only based on financial measures, will lead to short term results. Hence, the balanced scorecard was developed as a means to recognize and include non-financial measures (Kaplan and Norton, 1998; Kaplan and Norton, 2005) as a response to this. Previous studies have demonstrated that QM practices positively influence some metrics of organizational performance (Mehralian et al., 2017; Montes et al., 2003). However, there is no study yet that specifically analyzed the impact of Quality 4.0 on organizational performance. The next section describes the research methodology, followed by key findings, discussion, conclusion and scope of future research.

2. Research methodology
This study utilized an integrative review to examine the concepts of Quality 4.0 and its impact on organizational performance. An integrative literature review is a form of research that reviews, critiques and synthesizes representative literature on a topic in an integrated way. The outcome of such a review is the development of new frameworks and perspectives on the focal topic (Torraco, 2005). The primary goal in this research was to add to the knowledge of Quality 4.0 and organizational performance by conducting a wide review of literature in the field of Quality 4.0. Torraco’s (2005) guidelines were followed to conduct the review. The literature review is conducted to answer the authors’ primary research question: “What is the impact of Quality 4.0 on organizational performance?”
2.1 Data sources
The first step was to search electronic databases such as “Scopus, Web of Science, Academic Source Premier (EBSCO), Google Scholar, Business Source Premier (EBSCO), Emerald, IEEE Xplore Digital Library, JSTOR, ProQuest Dissertations and Theses, Science Direct, Taylor & Francis and World Public Library.” The search criteria employed for this study included: Quality 4.0 and organizational performance, Quality 4.0 and financial/economic performance, Quality 4.0 and environmental performance, Quality 4.0 and social performance/society, Quality 4.0 and the customer, Quality 4.0 and operations, Quality 4.0 and employees and finally, Quality 4.0 and sustainability. The scope was restricted to the past 20 years, i.e. 2001 to 2021. This study included conference proceedings and trade articles of reputed publishers such as ASQ, because Quality 4.0 is an emerging research area. Since Quality 4.0 is a developing research area, reports and webpages of reputed and leading professional QM bodies such as ASQ were also utilized in this study.

2.2 Inclusion and exclusion
The screening process was designed with a goal of finding articles that were focused on Quality 4.0 and organizational performance. Theoretical, qualitative, quantitative studies, conceptual articles and viewpoint articles were included in the study. Only articles in the English language were included, with any publications appearing on Cabell’s Blacklist (a database of predatory and deceptive journals; Das and Chatterjee, 2018) excluded from the study. Articles were also excluded if they did not focus on Quality 4.0 or organizational performance or if there was a poor research design therein and unclear arguments presented.

2.3 Screening
In this phase, a broad search of the literature was carried out, which was based on the inclusion criteria. The abstract was first reviewed along with the titles. The duplicates were removed due to this. The full articles were then read so that inclusion/exclusion criteria can be applied. The references listed in the articles were also read so as to include articles from this, which were not featured in the original search (Sony, 2019).

2.4 Data analysis
There is no clear-cut standard for analyzing an integrative review, but some authors have adopted a similar approach to integrative review (Conn et al., 2003; Burke and Hutchins, 2007). The main goal of the study was to understand the impact of Quality 4.0 on organizational performance. The methodology adopted by several authors were considered, and the following steps were taken into account (Smith et al., 2009; Whittemore, 2005):

1. The retained articles were read a number of times to determine the quality of the writing. Further, articles were classified into themes to reduce and compare data within the articles. It also helped to analyze and further synthesize themes and patterns within the literature samples.

2. The quality of each group of articles was assessed by evaluating the focus and findings of the authors regarding Quality 4.0 and organizational performance.

3. The quality of the theoretical articles was determined by the description of Quality 4.0 and by the quality of the knowledge of the topic.

4. The value of the knowledge was determined by the ability to communicate ideas effectively and clearly in an unbiased way (Kitson, 2006).
(5) Also, the research articles' quality was evaluated based on design, sample characteristics, measurement, statistical analysis and relevance to knowledge development (Sony, 2019).

The final number of papers in this study was 41 papers. The search process is depicted in Figure 1.

The entire number of articles was then critically analyzed to gain an understanding of the state of the overall knowledge about Quality 4.0 and Organizational performance.

3. Key findings

The literature study, analysis of relevant articles and integrated literature review identified the following themes: (1) financial performance of the organization, (2) customer value proposition performance, (3) internal business processes performance, (4) learning and growth performance, (5) environmental performance and (6) social performance (Table 1).
3.1 Impact of Quality 4.0 on financial performance of the organization

The fourth industrial revolution promises to expand business opportunities for organizations due to the increased distribution spectrum of digital products and services through digitalized supply chains (Santos et al., 2017). Responsive and agile manufacturing systems because of digitalization have enabled the mass customization of products and services and enhanced organizational revenue opportunities (Sony and Naik, 2019). From a quality perspective, resulting in personalized service quality, mass customization and a personalized production process will help organizations to meet the increasing needs of customers (Hyun Park et al., 2017). Also, manufacturing automation will drastically improve the quality of conformance (Sony et al., 2020). Manufacturers can now monitor a product throughout all the stages of the process because of improved information flow. Besides, accurate customer needs assessment and improved responsiveness to customer needs are also possible because of increased automation of all production-related activities and through the utilization of big data analytics. The improved quality of products and services will improve customer satisfaction, and this will result in enhanced revenue and competitive advantage (Pearce and Pearce, 2020). In addition to this, artificial intelligence-based customer relationship management (AI-CRM) will also influence customer acquisition, development and retention (Libai et al., 2020), and this will lead to expanded revenue opportunities and growth. This will increase the total revenue earned by an organization. Increased automation arising from the fourth industrial revolution will result in improved real-time monitoring of value and non-value-added activities (Rüßmann et al., 2015). To cite an example, information sharing is one of the main challenges in supply chain design, and the use of technology such as digital twins will help information dissemination in all elements across the supply chain (Chen and Huang, 2020). Besides, big data generated within the organization and external to the organization across the entire supply chain will enable efficient resource utilization. Big data will also provide the flexibility to reduce non-value-added activities and will enable dynamic resource scheduling in the manufacturing of products (Rüßmann et al., 2015; Sony, 2020). Therefore, the productivity of technical systems will be at its optimum because of automation, resulting in a reduction of the marginal cost of manufacturing products. The gross profit margin, net profit margin of the organization may increase because of an increase in revenue and reduction in cost. With the increased use of collaborative robots (COBOTS), the human elements of work that are dangerous, repetitive and monotonous will be lessened. Hence, human intellect will now be able to be devoted to higher-order jobs and more

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| 1  | Financial performance               | • Increased total revenue  
• Reduced cost of quality  
• Improved quality of conformance and performance                                 |
| 2  | Customer value proposition          | • Better analyze customer needs dynamically  
• Help to better understand CTQ  
• Increased customer satisfaction                                                |
| 3  | Internal business processes         | • Enhanced success rate of new product introductions  
• Reduced time to market of new products  
• Improved quality, reliability and safety                                          |
| 4  | Learning and growth                 | • Improve knowledge skillsets of organizational learning and innovation      |
| 5  | Operational and environmental performance | • Reduced scrap, rework, waste and better use of resources                  |
| 6  | Social performance                  | • Enhanced quality of work-life of employees  
• Low-cost, high-quality products and services  
• Improved working conditions for workers                                           |

Table 1. Summary of findings from the literature
motivating work, leading to improved productivity and safety of workers. For example, the use of COBOTS has resulted in a reduction in the number of accidents in the Carlsberg corporation (Thomas, 2020). COBOTS are known to reduce ergonomic hazards, improve safety, increase the quality of products and reduce absenteeism (Simões et al., 2020; Cohen et al., 2021). This results in further reducing the operational costs in the organization. However, the financial leverage and debt-to-equity ratio may be high for the short term, if the company uses finances, from debt to buy Industry 4.0 assets, such as cyber physical systems, internet of things (IoT), etc. Additionally, from a quality perspective, this will improve the quality of conformance and quality of performance, which results in a reduction in internal and external failure costs. Even in the quality of design, the use of AI will bring about a paradigm shift wherein design innovations and decisions are made by artificially intelligent machines (Ghoreishi and Happonen, 2020). The use of AI will help organizations overcome past limitations of highly interactive human inputs into the design processes. Therefore, concepts such as scalability of processes and intelligent adaptation of process-based design requirements are possible. This will help organizations to better implement economies of scope and scale for reducing the production cost. There would be an increase in the inventory turnover ratio as products that meet customers’ needs would be in high demand and an automated just-in-time (JIT) system will help the organizations to reduce overstocking. This is because inventory would be dynamically monitored using IoT with algorithms. The return on assets may be low initially, as the cost of digital assets of Industry 4.0 will take time to break even. Thus, the Quality 4.0 implementation from a financial perspective will be profitable in the long run.

3.2 Impact of Quality 4.0 on the customer value proposition
A product goes through various stages of transformation from raw materials to finished goods (Waters, 2017). The new-age manufacturing concept such as cloud manufacturing, which is a service-oriented business model to share manufacturing capabilities and resources on a cloud platform, has changed paradigms in manufacturing. This changing paradigm has resulted in sustainability in terms of collaborative design, greater automation, improved process resilience and enhanced waste reduction, reuse and recovery (Fisher et al., 2018). These technological revolutions in manufacturing warrant increased technology use in QM. In Quality 4.0, technologies such as IoT are used in all stages so that individual monitoring of each product concerning designed quality characteristics is possible in all stages (Watson, 2019). Apart from that, the concept of increased sampling points is made possible by big data generated in different phases of manufacturing with intelligent algorithms monitoring the output at each stage (Hyun Park et al., 2017). In addition to that, the predictive capability of algorithms will help to predict the probability of future outcomes; therefore, it will help quality professionals to make important decisions (Zonnenshain and Kenett, 2020). Therefore, poor-quality products can be detected early on in each process stage and remedial actions are taken so that quality is built into the product (right first time). Low skill and repetitive activities such as inspection are automated, and hence, the chances of human errors are further minimized with the implementation of Quality 4.0 (Salimova et al., 2020). Furthermore, the data monitoring of product usage will further help to predict the remaining useful life of the product (Vo et al., 2020). Thus, the outgoing quality of products manufactured in the Quality 4.0 system would be higher compared to traditional QM practices.

The costs of internal failure and external failure will be lower, thus resulting in lower overall costs of poor quality (COPQ). Therefore, the per-unit cost of the product manufactured in Quality 4.0 will be lower with a higher profit margin compared to traditionally manufactured ones (Sony et al., 2020). The continuous interaction an organization may have with the customer will allow the company to better analyze the customer needs dynamically (Gerlitz, 2015). The product usage data from the customer end will help to understand the critical quality
characteristics (CTQ), dynamic performance attributes, threshold attributes and excitement attributes of customer satisfaction (Ferreirinha et al., 2019). Thus, product designers will have a wealth of information to incorporate various functionalities and lessons learned into product design to satisfy customers (Bilstein and Stummer, 2020). The end-to-end integration in the fourth industrial revolution will further enlarge the role of manufacturers (Sony, 2018). Product servitization, which is the conceptualization of a product as a service, will be realized because of the high contact a manufacturer will have with the customer (Tabaklar and Yildirim, 2020). This is possible due to the relaying back of product usage data from the customer to the manufacturer, resulting in customized after-sales services. For example, a power transformer operating in a customer’s premise could relay back performance and functionality data related to its mechanical operations and parts to the manufacturers. This relaying back of information will help the manufacturers to design unique servicing and warranty offerings for its business-to-business (B2B) customers, resulting in cost-effective maintenance of equipment (Bettiol et al., 2017). Besides, it affords the manufacturers to have strategic partnerships with various service organizations in different localities based on customer product usage data. Such partnerships will benefit everyone, as it would be a transparent data-based partnership with quantified business opportunities rather than based on blind trust for business opportunities (Salam, 2021). Therefore, Quality 4.0 implementation will be a success in the eyes of customers as the unit price of the product will be low and quality, functionality and serviceability will be high leading to a satisfied customer.

3.3 Impact of Quality 4.0 on internal business processes
The performance on an internal business perspective revolves around its impact on the operations, customer management, innovation processes and regulatory processes. Quality 4.0 implementation from an operations perspective will lead to a reduction in non-value-added activities (BCG, 2019), which result in improvement in throughput rate, reduction in Takt time and cycle time. The uses of IoT in Quality 4.0 leads to increased monitoring of the manufacturing process and hence will result in the reduction of the lead time. Quality 4.0 implementation reduces internal and external failure costs (Antony et al., 2020), because of improved quality of products, and hence, the cost of quality will be reduced. The increased monitoring of manufacturing resources (Carvalho et al., 2021) online will result in a reduction in wastes and thereby operational efficiency. The increased monitoring of factors of production because of Quality 4.0 (Arsovski, 2019) will result in productivity gains. Supplier QM is an important function that will improve with Quality 4.0, because of the multiway flow of information along the supply chains. The transparency of information in the supply chain will allow stakeholders to monitor various quality characteristics along the supply chain (Manavalan and Jayakrishna, 2019). Also, relaying real-time planning and forecasting information along the supply chain will help upstream suppliers to better manage their production, resulting in better supplier QM (Demartini and Tonelli, 2018). The real-time tracking of supplier information such as inventory levels and supplier management internal policies will help in supplier management (Gunasekaran et al., 2019). Supplier trust and partnerships will also be further strengthened due to real-time data sharing, resulting in better supplier relationship management (Goecks et al., 2020). Also, the first pass yield of the process would drastically improve with the implementation of Quality 4.0 because of real-time monitoring and control, which is advocated in Quality 4.0 (Scott, 2019). Besides, other COPQ costs, the cost of quality checks, defect rates, rework rates, product-related complaints and warranty claims may be significantly reduced. Customer satisfaction and on-time delivery will improve because of the implementation of Quality 4.0 (Küpper et al., 2019). Availability of real-time data about customers will improve CRM and help in new customer acquisition by the personalization of products and through customer retention (Gil-Gomez et al., 2020; Panayiotou et al., 2019).
The digital transformation of the organization may result in increased understanding of customer needs, better alignment of product development with operational process issues, a better understanding of the product and service life cycle and new distribution channels (Arromba et al., 2020). The success rate of new product introductions will increase, and the time to market for new products will be reduced. Quality 4.0 will improve product safety (Scott, 2019), as all the major CTQs are monitored dynamically, and poor-quality products are weeded out early in the process. Besides, real-time product usage data will help the algorithms to pick up failure patterns before the actual failure of the product (Daher et al., 2020). The improved quality and reliability of the product, along with reduced cost because of implementation of Quality 4.0 (Zonnenshain and Kenett, 2020), will result in the attraction of new customers, improved retention of existing customers, the opportunity for new markets and also the success rate of such products will improve. The reliability of the process and products would improve through the implementation of Quality 4.0 (Zonnenshain and Kenett, 2020; Sony et al., 2020), and hence, it will make it safer for the employees and the customer. In addition, process parameters can be monitored online, leading to better regulatory compliance of various standards and best practices of manufacturing.

3.4 Impact of Quality 4.0 on learning and growth
Quality 4.0 implementation will foster a data-driven organizational culture where each product transformation process is monitored dynamically. Besides, each employee will be quality conscious and will be aware that their performance is monitored in real time (Sony et al., 2020; Trushkina et al., 2020). This instils a culture based on performance rather than favoritism. In addition, the time to proficiency will be reduced, as the feedback would be data-based and result in a faster learning process. The Quality 4.0 professionals’ skillsets are changing, and modern-day professionals are data scientists who can handle databases, big data, find hidden patterns in large datasets, extract useful information through statistical data analysis and create unique QM opportunities (Hyun Park et al., 2017; Antony and Sony, 2021). Hence, implementation of Quality 4.0 will help employees to be up to date on these new-age competencies, which increase knowledge and skill retention. Repetitive jobs will be automated in modern organizations, and what remains for humans are jobs with higher-order competencies (Bonekamp and Sure, 2015). Therefore, adapting to such jobs would require employees to unlearn and learn new competencies (Sony and Aithal, 2020). Quality 4.0 employees are knowledge-based workers, and hence, knowledge is the key element these employees use at their workplace (Sony et al., 2020). The transfer of training would be very high because of new learning of Quality 4.0-specific skills. The changing dynamics of QM warrants them to retrain and generate new organizational knowledge, which will help organizations to maintain their competitive advantage. The digitalization of the organization will help employees to generate information that can be used to enhance organizational learning (Tortorella et al., 2020) and will be an important tool for Quality 4.0. Besides, digital transformation will result in innovative business models, products or services (Nambisan et al., 2019), and organizational learning will be an important tool for the success of these new business models. The new-age digital innovation teams, which are the key elements for the success of the digital transformation of the organization (Hadjielias et al., 2021), will also be a significant element in Quality 4.0 implementation. The increased usage of digitalization and automation in Quality 4.0 will result in higher revenue per employee.

3.5 Impact of Quality 4.0 on environmental performance
In Quality 4.0, digitization is used to optimize signal feedback and process adjustment. Also, adaptive learning supports self-induced correction within processes or systems (ASQ, 2020). Thus, it is imperative to suggest that Quality 4.0 promotes resource efficiencies in an organization. It reduces scrap, rework and waste because of continuous digital monitoring of
each of the sub-processes in a manufacturing environment (Küpper et al., 2019). Besides, there is a shift from control-oriented thinking to design-oriented thinking for process improvement using modern tools and technologies. This shift enables individual resource monitoring in terms of the input–output transformation model. Also, machines are designed for self-regulation, and hence, these production systems do not deviate from their intended design parameters. Self-regulation results in the judicious use of the input of production systems such as labor, capital and energy. Thus, Quality 4.0 contributes to the judicious use of resources (non-renewable and renewable) in manufacturing processes (Shin et al., 2018). This will result in the reduction of the fossil fuel consumption ratio, energy wastage, water consumption, steam wastage and improve energy efficiency. The major technological tools of Quality 4.0 are AI, big data, augmented reality (AR), blockchain, deep learning, enabling technologies (such as IoT, industrial internet of things (IIoT), integrated systems, virtual reality, AR and cloud computing) (Carvalho et al., 2021), machine learning, data science and advances in manufacturing such as three-dimensional (3D) printing (ASQ, 2020). The use of modern technologies such as 3D printing has immense benefits in terms of less pollution, more eco-friendly environments and utilization of recyclable materials, higher energy use and less material wastage (Khosravani and Reinicke, 2020). The digital transformation of the organization has benefits in terms of environmental impact reduction, reduced emissions, reduction in water, energy and raw material wastage (Oláh et al., 2020). In a circular economy, the resources stay in the system for a long time and provide maximum value. Then, toward the end of its life cycle, the various components are recovered (Bag et al., 2020). Quality 4.0 enables continuous monitoring across all the phases of the resource life cycle; hence, the recovery or reuse process toward the end-of-life cycle would be better optimized. Furthermore, the use of technology in manufacturing enables the use of the ten Rs of sustainability-based approach such as refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle and recover (Bag et al., 2021). Quality 4.0 implementation will further complement the principles of each of the Rs in manufacturing. Therefore, it can provide options for cleaner production and can help firms achieve a competitive edge over their competitors (Kirchherr et al., 2017). Therefore, Quality 4.0 implementation will improve the environmental performance of the organization.

3.6 Impact of Quality 4.0 on social performance
Quality 4.0 impacts the stakeholders both internal and external to the organization. One of the fundamental benefits of Quality 4.0 is delivering good-quality products and services that meet the customer needs (Sony et al., 2021). The products manufactured using Quality 4.0 will be safer because of automated manufacturing processes (Zonnenshain and Kenett, 2020). Another point to consider is that the most dominant factor in the developed world would be the rapid growth of an older and aging population (Drucker, 2001). The birth rate is well below the death rate; thus, these developed countries will have to deal with immigration issues of employees. The full-time employment of employees is the thing of the past (Drucker, 1999). Managing these employees is a significant managerial and social issue when implementing Quality 4.0. Employment laws and regulations are changing to accommodate these changes. However, the decline of younger populations will fundamentally change the labor market structure (Drucker, 2017). Thus, Quality 4.0 implementation involves continuous training and retraining of employees and hence will be a social challenge. The social implications of Quality 4.0 will make society a knowledge society. The skillsets required for quality professionals will be of a higher order, as repetitive tasks would be automated (Antony and Sony, 2021). To cite an example, quality inspector jobs may be redundant and would be done by COBOTS, and self-regulating machines will manage their quality. Knowledge will be the key resource required for carrying out a task (Buhr, 2015). The three characteristics of the workforce in the knowledge society will be (1) reduction of
global borders because knowledge travels faster, (2) upward mobility as knowledge can be acquired by anyone with an education and (3) the potential for success or failure, as anyone can acquire the means of production, but not everyone will be successful in the job (Drucker, 1999). These factors can interact with each other and create a highly competitive environment for organizations and individual employees. Every institution in society such as business organizations will have to be competitive to survive. Customers will be aware of global quality standards and the expected quality of products and services within these standards because of the knowledge revolution (Buhr, 2015). This will lead to organizations indulging in intense rivalry among firms to meet and exceed the global quality standards so that competitive advantage can be maintained (Mikko, 2020). Structural social changes will also be evident because of the increase in knowledge workers because most of Quality 4.0 skills will be knowledge-based technical skills such as data science, programming, configuring and maintaining state-of-the-art systems. Also, soft skills such as creativity, conflict resolution and emotional intelligence will be a required skillset in the digital era (Sony and Aithal, 2020). Manufacturing output will increase manifold times in the Quality 4.0 era, as digitalization enables scalability (Küpper et al., 2019). The per-unit cost of the product will be lower because of reduced internal and external failure costs, and society will benefit in the long run because of reduced prices of products and services. Monotonous and laborious work, which is done by humans, will be done by robots or high-tech machines (Cohen et al., 2021); hence, the quality of work life of the employees will improve. Quality 4.0 implementation will impact the social performance in terms of low-cost high-quality products and services, improved working conditions for workers, training and development of workers and the creation of a knowledge society.

4. Discussion
Quality 4.0 is the future of quality and operational excellence in the era of Industry 4.0 (Watson, 2019), and hence, it is pertinent to study the impact of Quality 4.0 on organizational performance. Quality 4.0 represents an opportunity to utilize those Industry 4.0 technologies to realign quality functions with broader organizational strategy (Küpper et al., 2019). The impact of Quality 4.0 on the financial performance of the organization would be an increase in total revenue and growth, gross profit margin, gross net profit margin and high inventory turnover ratio. Besides, the total cost of operation, marginal production cost, internal and external failure costs would be reduced. However, return on assets may be low till the fixed costs of digital assets break even. Therefore, the impact of Quality 4.0 on financial performance is very positive in the long run; this is because the fixed cost of implementation of Quality 4.0 is high due to acquisition of technologies, equipment, new tools and processes, but over the period, it will break even (Sony et al., 2021). Other long-term financial performance would be increased revenue from growth and increased productivity. The impact of Quality 4.0 on the customer value proposition would be in terms of a better understanding of customer needs, data-driven product development, automated manufacturing and continued product usage data monitoring. These benefits will help the organizations to expand their offerings, render better CRM, develop strategic partnerships, increase the geographical reach of products and services through digital channels, and develop new client bases and better retain old clients (Hyun Park et al., 2017; Shin et al., 2018; Rowlands and Milligan, 2020; Chiarini, 2020). Furthermore, Quality 4.0 implementation will help customers in terms of availing the superior-quality products at low prices and better service through products as a service concept. There will also be improved product safety because of monitoring of product usage data by intelligent algorithms and built-in subroutines in products, improved data driving CRM and prognostics algorithms to predict remaining useful life and failure prediction (Pedersen, 2017; Küpper et al., 2019; Watson, 2019;...
The impact of Quality 4.0 on the internal business process will have a positive impact on operations, customer management, innovation and regulatory compliance. The four stages of Quality 4.0 analytics such as descriptive, diagnostic, predictive and prescriptive analytics (Zonnenshain and Kenett, 2020) will positively impact the dimensions of internal business processes. In general, in operational terms, the benefits would be in terms of improving operational metrics such as first-pass yields, cost of quality inspections, defect rates, rework rates, product-related complaints, reduced warranty claims and increased customer satisfaction and on-time delivery (Radziwill, 2018; Shin et al., 2018; Küpper et al., 2019; ASQ, 2020).

The impact of Quality 4.0 on the learning and growth dimension would be in terms of improving the knowledge and skillset of employees, which will help them to adapt toward the higher-order skillset. Organizational learning and innovation would also be enhanced due to big data-driven QM programs. The increased connectedness, intelligence and automation of Quality 4.0 (Radziwill, 2018) will help in reflective learning and growth of both the employees and organizations. Besides, the value proposition of Quality 4.0 such as augmentation of human intelligence, improving the quality of decision making, better anticipating circumstances, events, new opportunities and problems. Quality 4.0 will provide increased awareness of products, process and people; new opportunities for continuous improvement; and building in transparency, traceability and auditability (Radziwill, 2018). These elements will help to augment various dimensions of employees and organizations to successfully implement QM. The impact of Quality 4.0 implementation will have a positive impact on the environmental performance by judicious resource utilization, continuous monitoring of environmental parameters, along with quality characteristics in each of the sub-processes, use of advanced manufacturing technologies will help to enhance the ten Rs. The impact of Quality 4.0 on social performance would be society having an opportunity to consume low-priced, high-quality, safe products and the development of a knowledge society. Most quality professionals will be knowledge workers, employees with higher-order skills, which will drive increases in manufacturing output. Therefore, the overall impact of Quality 4.0 on organizational performance will be positive, and there will be interaction effects of other performance dimensions on each other.

5. Conclusion

Quality 4.0 is the new buzzword in academia and industry. However, studies on the impact of Quality 4.0 on organizational performance is scant. This study puts forward a conceptual analysis of previous literature to propose a relationship between Quality 4.0 and organizational performance. The dimensions of organizational performance studied are financial performance, customer value proposition, internal business processes, learning and growth, environmental performance and social performance.

This conceptual research paper and future research should explore the impact of Quality 4.0 on each of the performance dimensions. First, a case study would be ideal as this affords the study of many variables that may impact the performance. Also, it would help to study the interrelationships among these variables. A qualitative study will also help to understand the impact of Quality 4.0 on these dimensions and to understand the mechanisms behind the effect. This will also help to propose a process model of Quality 4.0 and why it impacts the organizations on various dimensions. A quantitative study will help to clarify the nature of the relationship between the Quality 4.0 and proposed dimensions, along with possible mediating and moderating mechanisms. Quality 4.0 is an emerging area of study, and hence, there are few studies in these areas. This study is limited by the databases reviewed. The second limitation is that this study considered articles published in the English language. Therefore, articles published in other languages were not considered in this study.
References


Further reading

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