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Abstract:	

An Exploration of Organizational Readiness Factors for Quality 4.0: An Intercontinental study and Future Research Directions

Purpose: Quality 4.0 incorporates the role of automation and digitization and provides competitive advantage for organizations by enhancing customer experience and increase profitability. The purpose of this study is to critically examine the organizational readiness factors for the successful implementation of Quality 4.0 implementation and assess their technology readiness through a global survey.

Methodology: This study applies a quantitative research methodology to examine readiness factors of Quality 4.0 in organizations by 147 senior management professionals in various organizations including manufacturing and service companies in America, Asia, and Europe participated through an online global survey.

Findings: The readiness factors for Quality 4.0 were critically ranked among manufacturing and service organizations by senior management professionals from three continents. Five significant reasons for non-adoption of Quality 4.0 were lack of resources, inability to link Quality 4.0 with the corporate strategy and objectives, lack of understanding of benefits, high initial investment and the current quality management strategy and methods are already delivering good results hence unsure of the need for Quality 4.0. The handling of big data in quality management was the most important factor for adopting Quality 4.0, irrespective of the size and nature of the organisation. More accuracy and less errors and improved decision-making the factors of adopting Quality 4.0 in service sector were not significant for manufacturing sector. Small and medium-sized enterprises (SMEs) reported that costs and time savings over the long run were not so significant.

Practical implications: This study is focused on the significance of pros and cons of adopting Quality 4.0 in organizations. Senior managers in both large and small and medium-sized enterprises can benefit immensely from understanding before investing heavily towards implementing Quality 4.0. The importance of identified organizational readiness factors for the successful adoption of Quality 4.0 can be used as indicators to understand how ready an organization is to implement Quality 4.0. The top three readiness factors for the successful adoption of Quality 4.0 were identified as: top management commitment, leadership, and organizational culture. Improved understanding of the readiness factors can be highly beneficial to senior quality professionals in both manufacturing and service companies in the journey towards successful implementation of Quality 4.0.

Originality: This is the first empirical study on assessing Quality 4.0 readiness factors at an intercontinental level, and therefore serves as a foundation for many future studies. The study provides a theoretical foundation for the Quality 4.0 in terms of organizational readiness for successful adoption and overcoming implementation challenges. During the planning, implementation, and progress review of Quality 4.0, review the readiness factors while planning and resourcing a Quality 4.0 implementation strategy to ensure effective performance.

Keywords: Quality 4.0, Organizational readiness, Quality Management, Technology readiness, Global survey

1. Introduction

Quality 4.0 valuates the role of quality in an age of increasing digitization and automation of work (Sony et al., 2020). Quality 4.0 use digital tools to manage quality. These modern-day tools help deliver high-quality products and services to customers, resulting in a competitive advantage. These tools improve organization's operational efficiency, product quality, factory outputs, and supply chain flexibility (Sony et al., 2020; Antony et al., 2020). The three aspects of quality "a*) quality of design, b) quality of conformance, and c) quality of performance*" needs are increasingly met using improved technologies such as "*CPS (Cyber Physical Systems), IoT (Internet of Things), RPA (Robotic process automation), Big Data, AI (Artificial Intelligence), and cloud computing*". Quality 1.0 established the founding principles of the quality profession. Quality was assured through inspection and measurement. Quality 2.0 emerged through the industrial revolution, in a period known as Taylorism. A distinction in 2.0 was the adherence to specified standards which was used to indicate acceptable quality levels. Quality 3.0 represents an era from the time of Taylor to the end of 20th Century, it is also known as analog equivalent of digital transformation. This was the time quality was considered as a business imperative, customer satisfaction was emphasized, continuous improvement applied, productivity improvement by efficient processes, standardized work and TQM (Sony et al., 2021). Today, Quality 4.0 represents an advancement of 3.0 through the inclusion of digitalization in all three phases of quality management i.e., "quality of design, quality of conformance and quality of performance" (Sony et al., 2020). Quality 4.0 is an era where digitization is used in process adjustment, signal feedback, adaptive learning, self-induced correction systems and so on. Another facet of Quality 4.0 is the shift from process operators led control-oriented approach to process designers. The machines in Quality 4.0 can self-

regulate different phases of quality management, helps to manage productivity in an objective data-oriented manner (Sony et al., 2021).

Quality 4.0 is in the early stages of development, and therefore, the pros and cons of implementing Quality 4.0 are not clear (Sony et al., 2021). Besides, the pros and cons may differ based on the size of the organization (Small and Medium-Sized Enterprises or SME and Large Enterprises or LE) and sector (Manufacturing and Services) (Antony et al., 2020; Sony et al., 2021). Therefore, the first research question underpinning this study is:

RQ1: What are the pros and cons of implementing Quality 4.0 in different organizations (manufacturing, service, SME and LE)?

In a study among 50 companies in Europe and North America, the motivation, barriers, and readiness factors for Quality 4.0 (Sony et al 2021) were tabulated and depicted in Table 1.

Table 1: Motivation's, barriers, and readiness factors

Motivations	**Barriers**	**Readiness Factors**
Reliable information	High Cost of Implementation & Return on Investment not clear	Top management support
Big data driven QM Programs	Lack of resources	Organizational culture toward Quality 4.0
Improved Customer satisfaction	Lack of implementation knowledge	Leadership
Productivity improvement	Organizational culture	Quality 4.0 vision and strategy
Cost and Time savings in the long run	Competitive advantage not clear	Knowledge and awareness on Quality 4.0
		Customer centredness
		Supplier-centric
		Training and rewards

This study was conducted in with a small sample size of 50, hence, an urgent need for a study that summarises and critically analyses the readiness factors for effective adoption of Quality 4.0 (Sony et al., 2021; Gunasekaran et al., 2019). Besides, the readiness factors may vary depending upon the organization's size, such as SMEs and LEs and for manufacturing and service sector (Sony et al., 2021). Therefore, in this study, the researchers seek to answer the following questions:

RQ2: What are the organizational readiness factors for the adoption of Quality 4.0?

In this paper we focus on the readiness factors before the implementation of Quality 4.0 in several organizations at a global level. The literature review results explicitly indicated that there is a shortage of empirical studies on the topic of Quality 4.0. This is due to the topic being relatively new and not many companies have been implementing it. This study will help understand the current state of Quality 4.0 and how organisations can prepare for implementation and assess its level of adoption. In addition to this, the findings can help managers understand organizational readiness factors that encourage successful implementation. The successful development of organizational readiness can be used to speed up the rate of innovation needed for Quality 4.0 transformation.

2. Literature review

As Quality 4.0 is an emerging topic hence the definition, benefits & challenges, barriers and organizational readiness factors (Sony et al., 2021) are not widely discussed in literature. We have implemented traditional literature review (Hart, 2018). The databases used for this study include "*Google Scholar, Scopus Emerald, Web of Science, ProQuest, IEEE Xplore Digital Library, JSTOR, Academic Source Premier (EBSCO), Taylor & Francis, Business Source Premier (EBSCO)*". Flick (2015) suggest for an emerging research area Industry / practitioners literature should be considered as to gain practical insights. Therefore, this study has included conference proceedings and articles published by reputed professional bodies including American Society of Quality (ASQ). The keywords used in this study were "*Quality 4.0, Quality 4.0 benefits, Quality 4.0 advantages, Quality 4.0 challenges, Quality 4.0 barriers, Quality 4.0 difficulties, Quality 4.0 + Quality management, Quality 4.0 + Lean, Quality 4.0 + Six Sigma, Quality 4.0 + lean Six Sigma, Quality 4.0 + quality management, Quality 4.0 + quality control. Quality 4.0+ quality assurance, Quality 4.0 + quality tools, Industry 4.0 + Quality management" etc.* The exclusion criteria were articles published in predatory journals

with the Cabell's list[14] used as a guidepost. Such articles were omitted from this study. The remaining articles were read and formed the basis for the traditional literature review.

A. Quality 4.0 –Definition

Industry 4.0 has brought in a technological revolution in modern business (ASQ, Quality 4.0). Industry 4.0 includes many technologies including additive manufacturing, IoT, Big Data Analytics, cloud-based manufacturing, CPS, Simulation, Internet of Service (iOS), Radio Frequency IDentification (RFID), Enterprise Resource Planning (ERP), Social manufacturing, and Social product development (Yang, 2017; Liao et al., 2017). The term "Quality 4.0" refers to the future of quality within the context of Industry 4.0 (ASQ, Quality 4.0). The Quality 4.0 definition is evolving and recent qualitative studies have defined Quality 4.0 as "*the use of advanced technologies such as IoT, CPS, Cloud computing to design, operate and maintain adaptive, predictive, self-corrective, automated quality systems along with improved human interaction through quality planning, quality assurance, quality control and quality improvement to achieve new optimums in performance, operational excellence, and innovation to meet the vision, mission and goals of an organisation*" (Antony et al., 2021). Tomorrow's quality leaders must use and share quality reports, analytics, and improve reporting with data that enables quick, situational decision making. In order for Quality Management Systems and Quality professionals to succeed and enhance profits an organization, quality processes and data need to be integrated and embraced in organisations (Burke et al., 2017).

In addition, to the familiar and well established quality management tools and principles, new Quality 4.0 tools should be developed to incorporate emerging Industry 4.0 technologies (Watson, 2019; Rainnie and Dean, 2020).

B. Benefits and challenges of Quality 4.0

Digital technologies can contribute to improving quality in many ways. To cite an instance, organizations are using sensors to monitor the production process through digital twins through real time data analysis and use predictive algorithms for operational and maintenance needs (ASQ Quality 4.0; Watson, 2019). Digital tools help quality professionals to carry out their jobs in a cost effective, efficiently, and timely manner. In addition to the developments in technology, cultural transformation of the organization should also be given adequate consideration. (Jo, 2017; Atkinson 1989). Souza et al., 2021 studied similar themes of total QM (TQM) and Industry 4.0 and discuss the importance of interaction of technology, quality and people. Further they propose TQM 4.0 where in all three dimensions are related to each

other and further suggests the importance of all three dimensions. The benefits of Quality 4.0 will be reduced costs of quality. This is achieved by improving operational efficiencies, reduced non-conformances, improved product design, increased revenue, improved product compliance, reduced supplier defect rates, on-time deliveries, faster time to market of products (Sony et al., 2020; BCG, 2019). Many organizations suggest that Quality 4.0 can create enhanced value, but very few have a proper quality strategy implemented (Kupper et al., 2019). Another point of view is how the digital transformation can enhance quality. In addition to product and process quality, for the Industry 4.0 to be successful the quality management body of knowledge (encompassing models, systems, techniques, and tools) should be coupled with extensive application of experience. This can support the planning, implementation, and improvement of Industry 4.0 processes. Therefore, Quality 4.0 can improve Industry 4.0 quality and results (Fonseca et al., 2021; Hyun Park et al., 2017). In addition, to achieve an enduring and comprehensive benefits from technological implementation in organizations, a clear quality focus and solid management of systems are required (Rowlands 2018; Rowlands and Milligan, 2019).

C. Barriers to Quality 4.0 and transformational change

The barriers to transformational change in organisations are vital considerations especially in digital transformation. In organizations that successfully incorporate innovation into their overall strategy there is increased productivity and competitiveness (Cefis and Marsili, 2011). Rauch et al. identified 6 obstacles and barriers to designing highly flexible technological manufacturing in a digital transformation context under four categories: economic/financial; cultural, technical and lack of competencies (Rauch et al., 2020).

One of the common issues in implementing technological changes are financial issues, especially for SMEs (Sanberg and Aarikka-Stenroos, 2014; Mohnen and Rosa, 2002), and studies on Quality 4.0 have also demonstrated cost as an issue. Cultural issues, (for example lack of management support, poor organizational structure and resources) also play an essential role in the introduction of new practices (Rauch et al., 2020; Orzes et al., 2020). Resistance to change is because innovation brings changes, and technology can eliminate manual jobs and redundancies (Modrak and Soltysova; 2020). The efforts made by organizations to initiate and implement a transformational change successfully are heavily dependent on adequate preparation before the implementation phase and is known as readiness for change (Imran et

al., 2016). Several authors have addressed the failure of change as being caused by lack of readiness (Hensley and Dobie 2005; Sony and Naik, 2019; Napier et al., 2017).

D. Readiness for Quality 4.0

Several factors are common in organizational readiness for organizational change. Näslund (2017) suggests, organizational readiness is crucial for any change initiative, including Operational Excellence initiatives (e.g., Lean / Lean Six Sigma). Some authors compare the successful implementation of digital transformation to project management (Cervone, 2016). A wealth of research is written about organizational change readiness regarding specific change initiatives such as Industry 4.0, operational excellence improvement programs such as Lean Six Sigma, Quality Improvement programs, technology introduction, and digital transformation (Naslund, 2008). However, organizational readiness for technology and digital transformation can be more complex. According to Sony and Naik (2019), readiness themes for Industry 4.0 include "*Organizational strategy; level of digitalization in the organization; level of digitalization in the supply chain; smart products and services; employee adaptability, and top management involvement and commitment*". A study by ASQ, DGQ and BCG (2019) found that both readiness and implementation of Quality 4.0 were being affected by a shortage of digital skills and talents. Furthermore, the 2019 study suggests about strategic plan and having a quality culture integrated throughout the organisation to enable technological transformation. The new quality management skills for Quality managers 4.0 were "communication, critical thinking, teamwork, openness of leadership to change, motivation, decision making, efficiency, ethic, customer orientation, conflict management, commitment, assertiveness, creativity, emotional intelligence, focus on results, flexibility and negotiation" (Santos et al., 2021).

Organizational readiness models, particularly about technology change, can tend to focus on technology readiness. Still, the dimensions of readiness fell along six areas (People, Strategy, Technology, Process, Leadership, and Innovation) can be considered the most important critical dimensions for most organizations, irrespective of their size and industry (Hizam-Hanafiah et al., 2020). Organizational performance and knowledge positively influence a firm's innovation and readiness (Martin-de Castro et al., 2011; Jimenez- Jimenez and Sanz-Valle, 2011). Technology readiness is an integral part of organizational readiness. Studies have discussed the importance of developing enabling technologies such as IoT, additive manufacturing, cloud computing, autonomous robots, cyber-physical systems, Big Data,

augmented reality, and artificial intelligence (Frank et al., 2019). To evaluate readiness, however, the extent of implementation of these technologies must be assessed in line with organizational competencies in these technologies (Hensley and Dobie, 2005). Maturity assessment models are essential in assessing digital transformation readiness in essential digitization, cross departmental, horizontal and vertical, full digitization, and optimized complete digitization (Leyh et al., 2017).

However, the organisation is setup, it is widely accepted in the literature related to transformational change that there are several common themes on which organizational readiness depends on; a devolved structure, IT infrastructure, an open communications organization, optimised business processes, measurement of key performance indicators, and a culture of trust, all establishing the foundations for a knowledge learning organization (Siemieniuch and Sinclair, 2004).

Knowledge resources are important strategic elements for organizational performance. Better management of knowledge leads to competitive advantage. Garvin defines learning organization as "an organization skilled at creating, acquiring and transferring knowledge, and modifying its behaviour to reflect new knowledge and insights" (Garvin et al., 2008). Learning in organizations is dynamically evolving process and will be developing over a period of time (Garvin et al., 2008; Moustaghfir and Schiuma, 2013). The readiness factors to change in manufacturing and services can be common shared, good communication, training, employee participation, involvement, strategic planning, and power are essential aspects of managers' strategies to promote readiness (Okumus and Hemmington, 1998). Service organisations are very different from manufacturing organizations these differences can increase complexity of quality management in services. The differences between manufacturers and services include higher levels of customer participation, locations dictated by proximity to customers, higher labour intensity, intangibility, and difficulty in measuring service output performance (Halpern et al., 2021, Lovelock and Gummesson, 2004).

In summary, the literature around organizational readiness and change indicates organizations must have certain readiness factors around leadership and top management support, strategic alignment of change, an organizational culture embracing of change, employee engagement and involvement, communication, knowledge about the fundamentals of Quality 4.0, training, and awareness of and for the change initiative, as well as customer and supplier involvement. Companies must make the digital transformation and Quality 4.0 strategy an integrated

component of their corporate strategy. Also, leaders should whole heatedly support these programs. Organizations should help employees to be trained in the new quality 4.0 skills. Finally, companies must install infrastructure that supports connectivity throughout the entire supply chain while ensuring cybersecurity and be able to assess their implementation of technology in terms of maturity and readiness. Success in a transformational change such as Quality 4.0 must consider the system as a whole and not in parts. It calls for holistic understanding of the system and taking measures for its success.

3. Methodology

An online survey was used because it enables fast data collection. Besides it also helps in easily sending the questionnaires to respondents (Reja et al., 2003; Ball 2019). The online survey instrument consisted of two parts. The first part was devoted to acquire data about the organization and participants, e.g., sector, type of organization, designation etc. The second part gleaned information about various facets of implementation of Quality 4.0 in the organization. Purposive sampling technique was used to reduce the chance for selection error. It assured experienced and knowledgeable respondents (Eisenhardt, 1989) in the study such as quality directors, quality managers and quality engineers. This study used the modified Dillman approach to maximize the responses by using multiple strategies (Dillman et al., 2014 and King et al., 2014). Internet survey response rates are often relatively low. Hence, Dillman et al., 2014 suggested that self-administered surveys can be improved by applying several techniques, such as multiple contacts, personalized communications, respondent-friendly construction, and other design features. LinkedIn is one of the most popular social networking platforms for professionals (Power, 2015), and hence we used this platform to contact quality professionals and details about the study were provided. Respondents who accepted the invite were sent the online questionnaire through multiple channels such as email, SMS, WhatsApp, LinkedIn personal messaging system, etc. Special care was taken in designing the questionnaire so that anyone can complete it in the shortest possible manner so that the professionals will not be discouraged from completing it. Check boxes were used wherever possible (Ball, 2019; Antony et al., 2020; Antony et al., 2020, Antony and Sony, 2021). Each of the question was designed based information from literature reviews. The questions and their source are depicted in Appendix A. Piloting of the study was carried out with ten respondents as it helps to check the reliability and validity of the instrument. Besides, the instrument can also be checked for clarity of the questions, readability, and time taken for competition. It also affords an opportunity to further revise the survey instrument (Marshall, 2005; Youngman, 1978).

Five experts were chosen from Industry with 10 years' experience in the quality management. The other five were academicians with at least five published articles in quality management, as first author. All the responses from the experts were positive, and minor changes to the wording of the questionnaire were made, so that clarity and readability of the questions would be further improved. The revised questionnaire was sent to 500 quality professionals. The quality professional's participant profile includes a) Director of Quality, b) Operational Excellence Professionals, c) Quality Engineers and d) Senior Quality Managers in three continents (Asia, North America, and Europe). The Quality Director, Quality Engineer, and Quality Manager represents a majority of quality professionals in the modern era. In a global study on quality professionals, these three categories of quality professionals were found to match the overall population of Quality professionals (Antony and Sony, 2021). The contacts details of these quality professionals were obtained from LinkedIn. They were subsequently contacted by email or personal messaging via LinkedIn.

Table 2: Sample Characteristics

	Quality Director	Quality Engineer	Quality Manager	Grand Total
Female				
Manufacturing				
Asia	1			1
Europe	2	2	2	6
North America	3	2	4	9
Service				
Asia		1		1
Europe	2		2	4
North America	1	2		3
Male				
Manufacturing				
Asia	2	2	8	12
Europe	18	8	31	57
North America	10	1	9	20
Service				
Asia	6	2	6	14
Europe	1		8	9
North America	2	2	7	11
Grand Total	**48**	**22**	**77**	**147**

The methodology was adopted from previous studies (Antony et al., 2020; Antony and Sony, 2021). Three criteria used to select the respondents; 1) the respondents should have knowledge of Quality 4.0; 2) they should be working in quality related roles such OPEX professionals,

quality director, quality manager, quality engineer, etc 3) the last criteria was they should be employed in service, manufacturing, or public sector. This study was carried out for 38 weeks as many organizations were not adopting Quality 4.0 yet, and many quality professionals were unfamiliar with the concept of Quality 4.0. A total of 147 complete responses were received. The completed response rate was 29.4%. A 20% survey response rate is considered as acceptable for online survey (Easterby-Smith et al., 2021). The sample characteristics are given in table 2. The online survey questionnaire was sent to all the quality professionals on the same day. The time trend extrapolation technique was used (Armstrong and Overton, 1977), to test for non-response bias. This was done by comparing the early and later participants. The participants who responded in first four weeks were categorised as early participants. The late respondents were categorized as those who participated in the last four weeks (Antony and Sony, 2021).

The demographic variables were subjected to Chi-square analysis. It was found that there was no difference in the demographic variables of early and late participants ($p>0.05$). In self-reported assessment, socially desirable responding could be an issue, and hence we informed the participant's anonymity (Paulhus, 1984). The data qualitative data (pros and cons, etc.) was analysed using Atlas 7.0, a popular qualitative text analysis software (Woods et al., 2016. The non-adoption, pros, cons etc. were first coded as it is a meaning unit. The particular meaning unit is "the constellation of words or statements that relate to the same central meaning" (Graneheim and Ludman, 2004). Subsequently, they were classified into higher-order themes and the frequency counted using the word cruncher feature of Atlas. Percentages, frequency analysis were conducted on quantitative data.

4. Key Findings

The analysis plan is briefly summarised in figure 1.

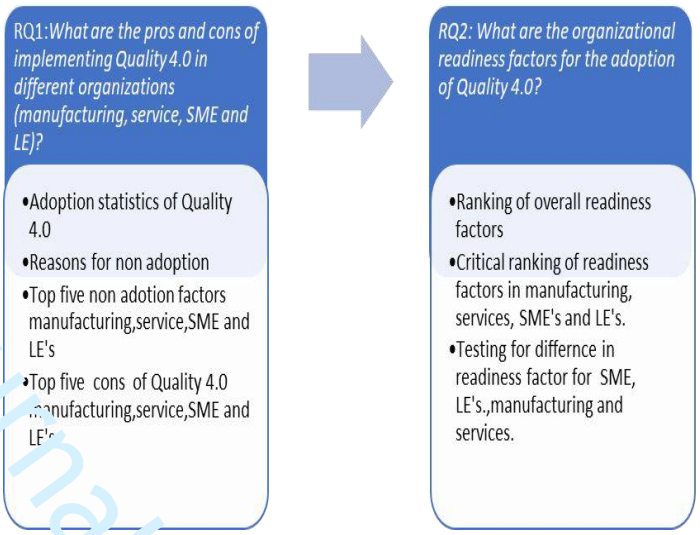


Figure 1: Analysis Plan

Table 3: Organizations adopted Quality 4.0

	Large Enterprise (LE)		LE Total	Small & Medium Enterprise (SME)		SME Total	Grand Total
Continents	**Manufacturing**	**Service**		**Manufacturing**	**Service**		
No	**46**	**15**	**61**	**16**	**4**	**20**	**81**
Asia	5	5	10	3	2	5	15
Europe	33	4	37	8	1	9	46
North America	8	6	14	5	1	6	20
Yes	**39**	**13**	**52**	**4**	**10**	**14**	**66**
Asia	5	6	11		2	2	13
Europe	20	3	23	2	5	7	30
North America	14	4	18	2	3	5	23
Grand Total	**85**	**28**	**113**	**20**	**14**	**34**	**147**

The respondents in this study were asked, "*Has your organization adopted Quality 4.0?"* The results are explained in table 3. The table 3 shows that 45% (66/147) of organizations have adopted Quality 4.0. Moreover, it was found that 65% (43 /66) of companies who adopted Quality 4.0 were manufacturing and 35% (23/ 66) were service organizations. In addition, 46% (52/113) of companies who adopted Quality 4.0 were large enterprises. Similarly, 41% (14/34) were SMEs. Around 45% (30/66) of companies who have adopted Quality 4.0 were from the European continent.

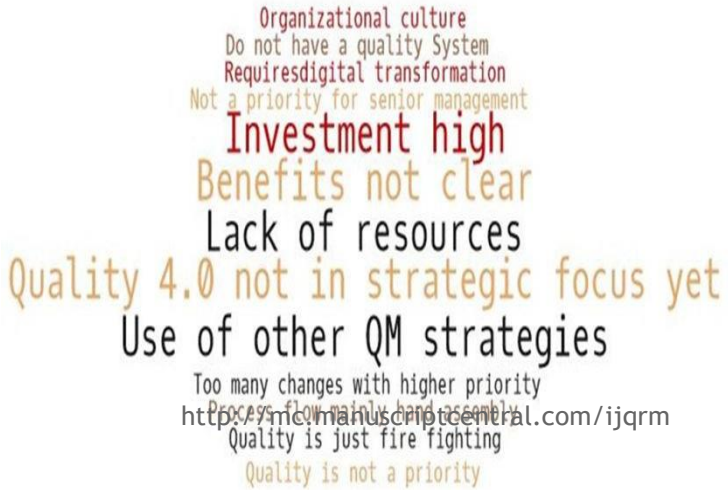
Table 4: Top five Non-Adoption Factors	
Factors	**Frequency**
Lack of resources	28
Quality 4.0 is not linked to corporate strategy	22
Benefits not clear	15
Investment high	11
Use of other QM strategies & Method	8

Chi-square test was carried out to test whether the adoption of Quality 4.0 is dependent on the sector (manufacturing/service). It found to be non-significant Pearson Chi-Square test (p-value = 0.128). The same analysis was conducted between the type of organizations (SME or LE) and adoption of Quality 4.0 and it was also found to be non-significant (p-value = 0.619). Further, continents (Asia, Europe, or North America) and adoption of Quality 4.0 analysis also revealed it was non-significant (p-value = 0.331). Chi-square test was also carried out to test whether the adoption of Quality 4.0 was dependent on quality professionals (Quality Director, Quality Manager or Quality Engineer) and it was found to be non -significant (p-value = 0.416).

Table 5: Top five pros of adopting and implementing Quality 4.0				
	Manufacturing	**Service**	**SME**	**LE**
	Frequency (rank)			
Big Data handling Quality Management	66(1)	32(2)	9(4)	89(1)
Reliable data	53 (2)	X	16(2)	38(4)
Productivity Improvement	44 (3)	X	22(1)	24(5)
Cost and Time Savings in the long run	39 (4)	26(3)	X	65(2)
Improved Customer satisfaction	22(5)	36(1)	X	58(3)
More accuracy and less errors	X	18(4)	5(5)	
Improved decision making	X	11(5)	X	
Faster and transparent Processes	X	X	12(3)	

Note: X = Does not feature in top 5

The reasons for non-adoption of Quality 4.0 were asked to the participants. The results are tabulated in Table 5. The word cloud for the non-adoption



factors is illustrated in Figure 2 was plotted using Atlas.

Figure 2: Word cloud for non-adoption theme

The lack of resources such as technology, finance, knowledge was voted as the first non-adoption factor for Quality 4.0. The second non-adoption factor, according to the respondents, is that Quality 4.0 is not linked to corporate strategy. This suggests that most organizations have not included Quality 4.0 as a corporate strategic initiative. The third non-adoption factor is that benefits are not clear, and organizations find it challenging to evaluate the benefits of Quality 4.0 implementation. The fourth non-adoption factor is to do with the initial high investment for Quality 4.0 implementation. The fifth factor is that many organisations are already using other QM strategies and methods and hence difficult to adopt Quality 4.0. The top five pros of implementing Quality 4.0 are tabulated in Table 4.

The handling of big data in quality management has appeared to be the most important pros of adopting Quality 4.0, irrespective of the size and nature of the organization. Reliable data is one of the key drivers, which will help the organizations in all functions of management such as planning, leading, organizing, controlling, and coordinating (Drucker, 1998). In quality management, reliable data plays a significant role in the quality of design, conformance and performance. Implementation of Quality 4.0 would allow the data acquisition and processing to be digitized and therefore, the information would be reliable, timely, and relevant (Sony et al., 2020). Consequently, it features in the top five in all sectors (refer to Table 65), except service organization. Implementation of Quality 4.0 will lead to cost and time savings in the long run, and it features in all except in SMEs. The implementation of Quality 4.0 may lead to escalation in prevention and appraisal costs, however, in the long run due to reduced internal

and external failure costs the initial costs will be offset leading to cost and time savings in the long run. Moreover, many SMEs are operating their businesses with a short-term profitability mind-set rather than developing a strategic plan for the long run

Table 6: Top five cons of implementing Quality 4.0

	Manufacturing	Service	SME	LE
Factors	**Frequency (rank)**			
High Implementation Cost	84(1)	28(1)	26 (1)	86(1)
Lack of financial Resources	68(2)	16 (4)	16 (4)	68(2)
Lack of implementation knowledge	54(3)	26 (2)	19(3)	61(3)
Organizational Culture	39(4)	X	10(5)	40(4)
Lack of Senior Management Support	22(5)	18 (3)	21(2)	19(5)
Intensive training of people	X	15(5)	X	X
X = Does not feature in top 5				

The respondents were asked to choose the top five cons of implementing Quality 4.0. The top five cons of implementing Quality 4.0 according to various respondents are shown in Table 6. Table 6 illustrates that the high implementation cost for implementing Quality 4.0, lack of financial resources, lack of implementation knowledge, lack of senior management and non-readiness or unpreparedness of organizational culture and the top five cons. However, it is worth mentioning that organizational culture was not listed as one of the cons of implementing Quality 4.0 in the context of service sector. As service is a people dominated organisation, intensive training of the workforce has appeared to be more important than culture. This is perhaps something which requires further investigation by the researchers in the future studies.

The internal consistency of the instrument used to measure Quality 4.0 readiness factors was assessed using Cronbach Alpha. The results are depicted in table 7. Cronbach Alpha of above 0.7 indicates higher internal consistency (Nunnally, 1994) suggesting the proposed scale is accurately measuring Industry 4.0 readiness factors.

Factor analysis was not carried to check the dimensionality because the number of items of readiness factors were 65, and considering the recommendation of Hair et al. (2014) at least five cases per item, the sample size was not adequate. Besides, Quality 4.0 being a recent phenomenon getting such a large sample size was not possible, especially considering the researchers' criteria to elicit quality information. To identify the most critical Quality 4.0 readiness factors, the respondents were given a five-point Likert scale for each item of Quality

4.0 readiness factor. *"(1) Strongly disagree; (2) Disagree; (3) Neither agree nor disagree; (4) Agree; (5) Strongly agree*." The mean scores are tabulated and normalisation normalization technique offered by Adabre and Chan (2019).

The Normalized value was calculated as "*(mean – minimum mean) / (maximum mean – minimum mean*)".

Table 7: Cronbach Alpha of quality 4.0 readiness dimensions	
Readiness Factors	**Cronbach's Alpha**
Top Management Support	0.8999
Quality 4.0 Vision and Strategy	0.902
Leadership for Quality 4.0	0.955
Trainings & Rewards	0.966
Knowledge and Awareness of Quality 4.0	0.934
Organizational Culture	0.97
Customer readiness	0.923
Supplier readiness	0.951

Critical success factors were identified using the criteria that the normalized value ≥ 0.50 [75]. Table 8 depicts the overall readiness factors. The critical readiness factors in large and SME are depicted in table 9 and 10 being the essential factors of readiness.

Table 8: Overall Readiness Factors		
Readiness Factor	**Mean Scores**	**Normalisation**
Top Management Support	4.00	1.00
Leadership	3.94	0.91
Organisational Culture towards Quality 4.0	3.86	0.80
Customer readiness	3.83	0.74
Knowledge and Awareness on Quality 4.0	3.80	0.70
Quality 4.0 Vision and Strategy	3.73	0.61
Supplier readiness	3.59	0.41
Trainings & Rewards	3.30	0.00

Further, to test the difference between mean scores of readiness factors in LE and SME, a t-test was carried out as depicted in table 10. T-test have been found to be preferred to be over signed rank procedure for data with Likert scale (Meek et al., 2007). It has been used in various

recent studies for group comparisons where the Likert scale was used (Longoni and Cagliano, 2018; Von Haartman and Bengtsson, 2015; Wang et al., 2020).

The critical readiness factors in the manufacturing and service sectors were carried out as depicted in Tables 12 and 13. The critical readiness factors in the service sector were carried out in order to test the difference between mean scores of readiness factors between manufacturing and service sector, a t-test was carried out and depicted in Table 14.

It was found that leadership and Training & Rewards differed across sectors. The t-test was used to test the group difference between manufacturing and service sector.

The correlations analyses indicated that CSFs are not highly correlated, besides the observations are independent. In addition, the dependant variable has mutually exclusive and exhaustive categories i.e., adopting Quality 4.0 or not.

Table 9: Readiness factors for Large Enterprises

Readiness Factor	Mean Scores	Normalisation
Top Management Support	4.18	1.00
Leadership	4.08	0.87
Organisational Culture towards Quality 4.0	3.97	0.72
Customer readiness	3.96	0.70
Quality 4.0 Vision and Strategy	3.93	0.67
Knowledge and Awareness on Quality 4.0	3.87	0.58
Supplier readiness	3.68	0.32
Trainings & Rewards	3.45	0.00

A binary logistic regression (Tranmer and Elliot, 2008) was performed to ascertain the readiness factors on the likelihood that organizations have adopted Quality 4.0. It was done because independent variables are continuous and dependant variable is binary "1" indicating adoption of Quality 4.0 and "0" non-adoption of Quality 4.0. The logistic regression model was statistically significant, $\chi^2(1) = 41.892$, $p < .0005$. The model explained 36.4% (Nagelkerke R^2) of the variance in organizations have adopted Quality 4.0 and correctly classified 72.8% of cases. A low Nagelkerke R^2 *have been found acceptable in studies such 0.171 (*Vostanis et al., 2006) as depicted in Table 15.

Table 10: Readiness factors for Small Enterprises		
Readiness Factor	**Mean Scores**	**Normalisation**
Knowledge and Awareness on Quality 4.0	3.56	1.00
Organisational Culture towards Quality 4.0	3.50	0.92
Leadership	3.49	0.91
Top Management Support	3.44	0.83
Customer readiness	3.39	0.76
Supplier readiness	3.32	0.67
Quality 4.0 Vision and Strategy	3.05	0.30
Trainings & Rewards	2.83	0.00

Hosmer and Lemeshow Test is another metric for determining model fitness (Allison, 2014; Menard, 2000; Georgakopoulos et al., 2020). These statistics are reported in Table 16. The hypothesis that the proposed model fits well to the results was based on the significance value of the Hosmer and Lemeshow test and the value should be greater than 0.05 (Menard, 2000; Georgakopoulos et al., 2020). In our case the significance value is 0.402, indicating the model fits the data. An often-cited cut-off probability for classification is 0.5 (Phillips et al., 2015); above 0.5 we classify as "No" and otherwise. George and Mallery (2011) describe that the 0.5 cut value is the preferred value. It is therefore used to separate outcomes into adoption of Quality 4.0 or non-adoption of Quality 4.0 classes.

Table 11: Readiness factors difference between Large and SME's				
Readiness Factor	**LE**	**SME**	**t-test**	**P-value**
Top Management Support	4.18	3.44	2.490	.014
Quality 4.0 Vision and Strategy	3.93	3.05	3.091	.002
Leadership	4.08	3.49	2.097	.038
Trainings & Rewards	3.45	2.83	2.278	.024
Knowledge and Awareness on Quality 4.0	3.87	3.56	1.053	.294
Organisational Culture towards Quality 4.0	3.97	3.50	1.627	.106
Customer readiness	3.96	3.39	1.936	.055
Supplier readiness	3.68	3.32	1.181	.240

The model achieved 72.8 % correct classification percentage in terms of the Quality 4.0 adoption, as depicted in Table 17. In other words, this model can predict with 72.4% accuracy the Quality 4.0 adoption with the readiness factors. 70% correct classification is acceptable in

studies and significant predictive power in validation (Yilmaz and Belbag, 2016; Press and Wilson, 1978; Malo et al., 2004).

The significant risk factors, which significantly contribute to the not adopted Quality 4.0 probability, are those factors, the significance value of which is equal or less than 0.05, the characteristics are depicted in table 18.

Table 12: Critical readiness factor in manufacturing sector

Readiness Factor	Mean Scores	Normalisation
Top Management Support	3.91	1.00
Leadership	3.79	0.85
Organisational Culture towards Quality 4.0	3.73	0.78
Knowledge and Awareness on Quality 4.0	3.69	0.72
Customer readiness	3.68	0.70
Quality 4.0 Vision and Strategy	3.60	0.61
Supplier readiness	3.54	0.53
Trainings & Rewards	3.12	0.00

The readiness factor leadership is the most crucial factor which predicts the adoption of Quality 4.0 by organizations, and it is also found to be positive. It indicates that as a unit increase in the leadership increases to a slight increase (0.777 units) in the probability of Quality 4.0 adoption. Or in other words, it can be interpreted that one-unit increase in leadership increases the odds ratio of adoption of Quality 4.0 by 2.175.

Table 13: Critical readiness factor in service sector

Readiness Factor	Mean Scores	Normalisation
Leadership	4.33	1.00
Top Management Support	4.24	0.84
Customer readiness	4.20	0.78
Organisational Culture towards Quality 4.0	4.19	0.76
Knowledge and Awareness on Quality 4.0	4.06	0.54
Quality 4.0 Vision and Strategy	4.05	0.53
Trainings & Rewards	3.77	0.06
Supplier readiness	3.74	0.00

Table 14: Readiness factor differences between manufacturing and service sector				
	Manufacturing	**Service**	**t-test**	**P value**
Top Management Support	3.91	4.24	-1.16229	0.247026
Quality 4.0 Vision and Strategy	3.60	4.05	-1.665	.098
Leadership	3.79	4.33	-2.073	.040
Trainings & Rewards	3.12	3.77	-2.616	.010
Knowledge and Awareness on Quality 4.0	3.69	4.06	-1.351	.179
Organisational Culture towards Quality 4.0	3.73	4.19	-1.675	.096
Customer readiness	3.68	4.20	-1.899	.060
Supplier readiness	3.54	3.74	-.710	.479

Table 15: Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	155.507[a]	.272	.364

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 16: Hosmer and Lemeshow Test			
Step	Chi-square	df	Sig.
1	8.328	8	.402

Table 17: Classification Table[a]					
			Predicted		
			Quality 4.0 adoption		Percentage Correct
	Observed		No	Yes	
Step 1	Quality 4.0 adoption	No	61	20	75.3
		Yes	20	46	69.7
	Overall Percentage				72.8

a. The cut value is .500

Table 18: Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Leadership	.777	.347	5.016	1	.025	2.175	1.102	4.292
	Top manage support	.171	.224	.586	1	.444	1.187	.766	1.840
	Quality 4.0 vision & Strategy	.165	.244	.456	1	.500	1.179	.730	1.904
	Training & rewards	-.169	.251	.454	1	.500	.844	.516	1.382
	Knowledge and awareness of Quality 4.0	.368	.284	1.685	1	.194	1.445	.829	2.519
	Organizational culture for Quality 4.0	-.426	.303	1.972	1	.160	.653	.360	1.184
	Customer readiness	.246	.211	1.351	1	.245	1.278	.845	1.934
	Supplier readiness	-.146	.194	.569	1	.451	.864	.591	1.263
	Constant	-4.335	.871	24.757	1	.000	.013		

a. Variable(s) entered on step 1: Lr, TMS, QVS, TR, KA, OC, CR, SR.

5. Discussion, Implications and Limitations

The first research question (RQ1) in the study was to investigate the pros and cons of implementing Quality 4.0, the findings of our global study suggest that more than 70% of participating companies who have adopted Quality 4.0 were manufacturing compared to services. Moreover, more than 60% of the manufacturing companies were from Europe. It was quite surprising to observe that although a high proportion of respondents represent manufacturing companies in our study, the percentage of companies who have adopted Quality 4.0 were higher in service compared to manufacturing. Moreover, it was also observed that more quality managers and directors have responded to the survey compared to quality engineers in many companies. Further breakdown of analysis has showed that 55% of companies highlighted that they have not yet adopted Quality 4.0.

The significant reasons for non-adoption of Quality 4.0 were reported to be: lack of resources, not sure how to link Quality 4.0 with the corporate strategy and objectives, lack of understanding the actual benefits of Quality 4.0, high initial investment on the initiative and finally the current quality management strategy and methods are already delivering good

results, and hence it is unsure for the need of implementing Quality 4.0. The respondents were asked to identify the top five pros and cons of adopting Quality 4.0 in their respective firms. It was found that there were some common pros shared between both manufacturing and service companies. The handling of big data in quality management has appeared to be the most important pros of adopting Quality 4.0, irrespective of the size and nature of the organisation. However, two pros identified and deemed important within the service settings were not deemed important within the manufacturing settings. These were more accuracy and less errors and improved decision-making.

It was also surprising that respondents from the small and medium-sized enterprises (SMEs) reported that costs and time savings over the long run are not so significant. Perhaps this is attributed to the fact that SMEs have developed a cultural mind set of short-term profitability and quick wins and not very keen to have a long-term transformation of becoming a world class organisation and create competitive advantage using Quality 4.0 (Antony, Vinodh and Gijo, 2017). It was also apparent that handling big data for tackling quality-related problems in processes, productivity improvement, and reliable data are the top three pros shared between large companies and SMEs.

The cons of adopting Quality 4.0 shared between manufacturing and service organizations are high implementation costs, lack of financial resources, and lack of knowledge as to how to go about and implement Quality 4.0. It was quite interesting to note that training was never considered one of the cons for manufacturing firms compared to service firms. This is because manufacturing companies have a more matured organizational culture for general quality management practices than service firms (Antony and Sony, 2021). The top five cons of adopting Quality 4.0 were identical between both large and SMEs. However, training of people did not appear to be a disadvantage for both clusters as the transformation of organizations through Quality 4.0 would not be possible without intense training of employees across the businesses at all levels. The second research question (RQ2) in this study was to investigate about the organizational readiness factors for the adoption of Quality 4.0. The top three readiness factors for the successful adoption of Quality 4.0 are identified as: top management commitment, leadership and organizational culture. This is consistent with most other operational excellence initiatives we have witnessed in the past (Antony and Banuelas, 2002; Laureani and Antony, 2012; Laureani and Antony, 2018). Although both large enterprises and SMEs share similar readiness factors, it was clear that the training and reward/recognition system in SMEs had a mean score of less than 3 (i.., 2.83) compared to their larger counterparts

with a mean score close to them 3.5. This is attributed to the fact that SMEs do not have adequate budget and resources in the implementation of Quality 4.0 and moreover many SMEs do not have a reward/recognition system in place for employees, who are delivering projects of this nature (Alexander et al., 2019; Antony, 2008).

This study also revealed a significant difference in the mean scores of four readiness factors between large enterprises and SMEs: leadership, management commitment, training and reward system, and Quality 4.0 vision and strategy. Our findings also suggested a significant difference in the means of two readiness factors between manufacturing and service firms: leadership and training and reward/recognition system in place. This makes sense as the style of leadership in manufacturing and service firms may be quite different, and the cultural characteristics are also viewed to be quite different for these sectors. Moreover, both sectors' reward and recognition system are not also identical due to cultural differences between them. In addition, the study also reveals that there was a significance difference in the means of two readiness factors across the three continents, which are: Quality 4.0 vision and strategy as well as Leadership. It was interesting to learn that both readiness factors are strongly correlated to leadership as leaders should develop the plan for Quality 4.0. They should also try to make sure that there is a strong alignment between Quality 4.0 and the strategic goals of the organization (Sony et al., 2020; Antony et al., 2020; Sont et al., 2021). There is also a need to study critical success factors for Quality 4.0 and to study the impact of CSF in organizations with different strategies. Future studies should also categorize them according to firm strategy (cost leadership, differentiation and Innovators (continuous innovators, modular innovators, architectural and radical innovators).

The final part of the research was to understand the relationship between the readiness factors considered in the study and the successful adoption of Quality 4.0 through a binary logistic regression model. This model was seemed practical as the dependent variable is binary (success or failure regarding the adoption of Quality 4.0). The model suggests that leadership is the most significant factor one should consider for the successful adoption of Quality 4.0. If the leaders are not supportive and demonstrating their commitment to the Quality 4.0 initiative, the probability of failure can be relatively high and moreover, it will be a waste of time, cost and energy for many people involved in the journey.

5. Implication and Limitation of the study

There are two significant implications for this study. The first implication will be focused on the significance of pros and cons of adopting Quality 4.0 in organizations. The authors have identified the pros and cons. Senior managers in both large and small and medium-sized enterprises can understand them before investing heavily on the Quality 4.0 journey. The second implication is about the importance of organizational readiness factors for the successful adoption of Quality 4.0. These factors can be used as indicators to understand how ready an organization is to implement Quality 4.0. Organizations which are not ready will have a tough time in implementing Quality 4.0. The authors would like to highlight that the readiness factors listed in the paper can be highly beneficial to senior quality professionals in both manufacturing and service companies who would like to embark on the journey of Quality 4.0.

Our study is limited in ways that can be addressed in future research. As most companies are at their very early stages in adopting Quality 4.0, the number of samples used in the study was as comparatively smaller. There was no representation of companies from Australia and South America for this study. The authors would continue to collate data from these continents in future studies. Moreover, there appears to be a lack of maturity for Quality 4.0 in most companies based on our findings and therefore we anticipate more exciting results in the future research. Therefore, more models need to be collated in the future for better and robust conclusions. The future agenda includes several semi-structured interviews with several senior quality professionals involved in implementing Quality 4.0 in both service and manufacturing organisations. Moreover, the authors are also keen to develop a systematic and practical roadmap for implementing Quality 4.0.

6. Conclusions and Agenda for Future Research

The modern evolution of quality management due to fourth industrial revolution is Quality 4.0. The authors would argue that many can create and sustain competitive advantage by successfully implementing Quality 4.0, despite its nature and size. This research looked into the pros, cons and readiness factors for the successful adoption of Quality 4.0 in both manufacturing and service organizations. The handling of big data has appeared to be the most important pros of adopting Quality 4.0, irrespective of the size and nature of the organization. Furthermore, lack of resources is the top non-adoption factor for Quality 4.0. The cons of adopting Quality 4.0 shared between manufacturing and service organizations are: high implementation costs, lack of financial resources and lack of knowledge in the introduction

and development of Quality 4.0. The top three readiness factors for the successful adoption of Quality 4.0 are identified to be: top management commitment, leadership, and organizational culture. The most important readiness factor which is crucial and predicts adoption of Quality 4.0 is leadership. Thus, a strong leader who advocates Quality 4.0, will help the organization to adopt Quality 4.0 in the organization.

APPENDIX A

Survey Questionnaire		
	Questions	**Sources**
1	• Has your organization adopted Quality 4.0 yet? If No, what are the possible reasons for non-adoption of Quality 4.0? • In your opinion, what are the pros of implementing Quality 4.0? • What are the cons of implementing Quality 4.0?	Sony et al, 2020; Antony et al., 2020; Zonnenshain and Kenett, 2020; Gunasekaran et al., 2019
2	**Top Management Support and Commitment** a. The top management in my organisation is committed to Quality 4.0 b. Top management is supportive of our efforts to improve Quality 4.0 initiatives c. Top management communicates the importance of Quality 4.0 at all levels across the organisation d. Top Management allocates right resources in terms of people, time and costs for Quality 4.0.The Company uses external experts/consultants on a regular basis to evaluate the overall Quality 4.0 performance	Sony et al, 2020; Antony et al., 2020; Sony et al., 2021; Chiarini, 2020; Flynn et al., 2995
3	**Quality 4.0 Vision and Strategy** a. My organisation knows exactly what they want to become by implementing Quality 4.0 b. There is an alignment of Quality 4.0 with corporate strategy and objectives c. Quality 4.0 Strategy is communicated clearly throughout the company at all levels d. Quality 4.0 Strategy is integrated with our Operational Excellence methodologies (e.g.: Lean). e. My organisation uses Hoshin Kanri to ensure that Quality 4.0 is aligned with the Corporate Strategy and	Antony et al., 2020; Sony et al., 2021; Haque et al., 2016; Brandenburger J. et al. 2021

	Goals. All employees understand the vision and strategy of Quality 4.0.	
4	**Leadership** a. Leaders in the organisation are committed to Quality 4.0. b. Leaders evaluate all Quality 4.0 ideas based on facts c. Leaders in my organisation have a vision for leadership for Quality 4.0 d. Leaders encourage teamwork and cross-functional problem solving to achieve specific goals set within Quality 4.0 e. Leaders promote big data driven decision making culture f. Leaders manage the pace of change due to Quality 4.0 implementation g. Leaders in my organisation continue to focus more on using Quality 4.0 technologies to protect their positions rather than as bold investments to drive disruption h. Leaders nurture the workforce within the organisation for Quality 4.0 i. In my organisation Leaders motivate employees in Quality 4.0 j. In my organisation Leaders empower employees in Quality 4.0. k. Leaders inspire employees in my organisation to actions on Quality 4.0	Antony et al., 2020; Sony et al., 2021; Oberer and Erkollar, 2018; Akcay Kasapoglu, 2018; Frick et al., 2021; Pederson, 2017
5	**Training & Rewards** a. Employees are trained on the concepts, principles, and tools of Quality 4.0 across the organisation. b. Organisation systematically assess the Quality 4.0 training needs. c. Organisations introduce a reward and recognition system at team level for implementation of Quality 4.0 projects across the organisation Incentive programmes are available for employees who help to improve processes and eliminate unnecessary steps using Quality 4.0. d. Annual bonuses are available for employees who help to improve processes and eliminate unnecessary steps using Quality 4.0 e. Training is focussed on projects on Quality 4.0 to deliver better and faster results than conventional methods of quality management. f. Organisation encourages training on certifications on Quality 4.0. g. Organisations use reimbursement rather than prepayments for Quality 4.0 individualised trainings. h. Organisations tests whether employees gained the most or the least from a specific Quality 4.0 training program.	Sony et al, 2020; Antony et al., 2020; Sony et al., 2021; Gill and Mataveli, 2016; Yadav et al., 2021; Carvalho et al., 2021

	There is a strong interaction between organisation and Quality 4.0 training institutes	
6	**Knowledge and Awareness on Quality 4.0** a. Employees have an awareness of the purpose and benefits of implementing Quality 4.0. b. Employees understand the rationale behind Quality 4.0 and the changes to come in the organisation as part of the introduction and implementation. c. Employees have required knowledge of Quality 4.0 tools and their potential applications. d. Workers are able to perform different Quality 4.0 tasks as part of their daily job e. Shop-floor employees drive Quality 4.0 suggestion programme which can complement existing quality management system standards (ISO 9001). f. Workers are qualified enough to contribute to solving Quality 4.0 problems as a team. g. Workers have emotional competence to handle Quality 4.0 implementation challenges	Antony et al., 2020; Zonnenshain and Kenett, 2020; Brandenburger J. et al., 2021; Armani et al., 2021.
7	**Organizational Culture** a. Organizational culture fosters employees to communicate freely about Quality 4.0. b. Organizational culture promotes a data-driven mind-set at all levels c. Organizational culture promotes change towards Quality 4.0 and break down all silos and barriers associated with this change d. Employees are empowered to make improvements on their own processes as part of Quality 4.0 initiative. e. The reasons for change due to Quality 4.0 are well communicated to employees f. Organisations uses strategies to convince employees for Quality 4.0 change g. Employees are not scared of Quality 4.0 changes within the organisations because of clear communication. h. Employees are made to understand that future would be better due to Quality 4.0 implementation i. Employees insecurities due to implementation of Quality 4.0 are systematically handled by the organisation j. Employees have a growth mindset in the organisations for Quality 4.0 k. HR department ensures that employees are motivated to undertake the change and participate in the change management program for Quality 4.0 l. Employees are encouraged and mentored by HR department so that they act as achange agents for Quality 4.0	Antony et al., 2020; Kupper et al., 2019; Gimennez-Espin et al., 2013; Kinzel, 2017; Radziwill, 2018.

	m. HR department looks for employees who can act as catalysts for change to motivate other employees to participate in the Quality 4.0 n. HR department energizes employees by highly supportive environments that nurture and reward talent to implement Quality 4.0	
8	**Customer Readiness** a. There is awareness of what product features customers value and are willing to pay for after implementing Quality 4.0., b. Feedback is sought regularly, and surveys/meetings are often held with customers to improve product design and quality, and service involvement using Quality 4.0. c. Customers participate in the initial design process using Quality 4.0 d. Valued customers are brought into visit the plant to provide some ideas about Quality 4.0 that the company can follow. e. Customers help Quality 4.0 initiatives by providing information about their future demands. f. There is a system in place for collecting customer complaints using the tools of Quality 4.0 and traditional tools of quality so that problems can be avoided in the future	Sony et al, 2020; Antony et al., 2020; Sony et al., 2021; Zonnenshain and Kenett, 2020; Dukic et al., 2021
9	**Supplier Readiness** a. A clear strategy using Quality 4.0 is in place by which to evaluate supplier performance in terms of quality, delivery and cost. b. Suppliers are aware of product designs and participate heavily during design and development using Quality 4.0. c. Raw materials and purchased parts are not inspected thoroughly due to effective process control plans using Quality 4.0 as they come from qualified suppliers. d. Using Quality 4.0 suppliers are monitored consistently for delivering raw materials on time e. Suppliers are cooperative and committed to maintaining a long-term relationship with their customers and help them in implementing Quality 4.0. f. Suppliers are provided with customer feedbacks so that they can use Quality 4.0 tools to improve.	Kaya and Aycin, 2021; Sharman and Joshi, 2020; Ramezani and Jassbi, 2020; Negash et al., 2020; Rowlands and Milligan, 2020

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