



A Survey of Enterprise Attitude Toward Digital Quality Management in the Context of Industry 4.0

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Abstract. Quality is not only a requirement for products, but also a cornerstone for the survival and development of enterprises. In the fierce market competition, the importance of Quality 4.0 for enterprises is gradually becoming more prominent. Quality 4.0 combined with big data and artificial intelligence technology are the outstanding characteristics and critical components of Industry 4.0. The method used in this research is quantitative research, employing documentation and questionnaires. An online survey is conducted in this study to investigate the attitudes of practitioners in manufacturing enterprises toward Industry 4.0. A total of 497 respondents are collected to calculate the degree of association between enterprise participation, quality professionals, and quality 4.0. All respondents are quality professionals such as quality director, quality manager, and quality engineer. Most of the respondents are from China, while some from ASEAN countries, European countries, and United States. The results show that most of the respondents, around 75%, were involved in the trend of Industry 4.0, meanwhile, they admitted that they play an important role in the era of Industry 4.0. More than 70% of respondents are confident and answered that they understand the meaning of Quality 4.0. The results prove that as a new stage of digital quality management, Quality 4.0 is leading the new trend of enterprise quality management. Most companies have participated in the reform and innovation of Industry 4.0 and have played an important role in Quality 4.0.

Keywords: Quality 4.0, Industry 4.0, big data, artificial intelligence

1 Introduction

With the development of science and technology, the concept of Industry 4.0 proposed by Germany at the Hannover Messe in 2013 has had a far-reaching impact. Under the situation of the widespread popularization and application of the Internet, the needs of consumers are becoming more and more diversified, the boundaries between products and experiences are gradually blurred, the definition of quality has

changed from the traditional “meeting requirements” to “customer perceived value”, quality management has risen to the level of strategic functions, and quality 4.0 has come into being. In the context of Quality 4.0, digital quality management of enterprises is of great significance. It can integrate quality data, processes, tools and methods, and through data analysis and monitoring, find and solve quality problems in a timely manner, reduce production costs and defect rates, and achieve more refined management. At the same time, it helps enterprises achieve more flexible production and supply chain management ^[1], and quickly respond to market changes and customer needs.

However, companies face many problems when implementing digital quality management. Data integration is facing huge challenges, the construction of enterprise information systems is fragmented, and the data definitions and formats of different departments and systems are different, resulting in many difficulties in data. The migration, cleaning, and standardization of historical data are extremely large, complex, and arduous ^[2]. The automation level of data collection and analysis is low, and the manual entry of data is not only inefficient, error-prone and easy to be modified, but also difficult to meet the requirements of quality management for real-time and accuracy. Furthermore, it is difficult to implement automatic data collection, with high investment and difficult coordination. Data security and privacy protection issues are critical. The digitalization of quality management involves a large number of sensitive transmissions and storages, and there is a high risk of data leakage and unintended access and use. So, it is urgent to establish a data security management system and emergency plan ^[3]. In addition, it is difficult to collaborate in the industrial chain, and factors such as system differences and conflicts of interest between different enterprises have increased the difficulty of collaborative operation and information sharing between the upstream and downstream of the industrial chain. Based on this, many scholars have developed a sustainable lean production framework for the manufacturing industry based on Lean Six Sigma and practice-based perspectives when building a theoretical system ^[4], in which the quality management system is the primary area concerning this process, not only the set of key performance indicators commonly used in the global manufacturing sector was identified, the responsibilities and authority for measurement and evaluation in the quality management system were clarified, but also a capability-based graphical model of the quality management system was constructed ^[5]. At the same time, with the help of advanced methods such as structural equation mode, the relationship between total quality management, organizational learning activities and enterprise performance is deeply analyzed, and some of the mediating effects of organizational learning activities in them are explored. In addition, 14 management capabilities ^[6] that play a key supporting role in Industry4.0 were identified, and behavioral descriptors were assigned to them one by one, and corresponding capability models were constructed.

In particular, this study focuses on the core group of quality management professionals and conducts an in-depth investigation of the background research on their digital quality management in Industry 4.0 enterprises. High-quality professionals need to be all-rounders. In terms of technical capabilities, it is necessary to be able to harness large amounts of process data, accurately interpret and turn it into the basis

for strategic decision-making [7], be proficient in using cutting-edge technologies such as AR tools, and always build a strong barrier for data security; In terms of methodological ability, it is necessary to be familiar with the tricks of tracing the source of data, screening trusted learning resources, and using new tools to overcome complex problems. On top of the new collaborative virtual platform, in the face of a complex communication network of multiple sites, suppliers and customers [8], it is necessary to ensure the smooth flow of information with excellent social skills; In a distributed work environment, strong leadership, bold decision-making, and the ability to adapt to a wide variety of workplaces, schedules, and frequent job changes are required³. Unfortunately, through questionnaires and interviews with key personnel, it was found that still a part of the current quality professionals lack of understanding of their new roles in Industry 4.0. The implementation of new technologies mostly relies on the innovation team of the headquarters rather than the quality professionals, which has also been confirmed by the head of operations, revealing the gap between the capabilities of quality professionals and the needs of the industry, and how to fill this gap and allow quality professionals to play a key role in the digital quality management process of enterprise has become an urgent problem to be solved [9]. Based on the above research results, this paper will explore the current situation of digital quality management in quality 4.0 enterprises and promote the effective implementation of digital quality management in the context of quality 4.0.

2 Objective

From the perspective of the enterprise as a whole, this paper is to explore and understand the attitudes toward practice and application of enterprise digital quality management in the context of quality 4.0. To understand professionals and enterprises' scale of participation in the trend of industry 4.0, and to analyze whether quality professionals recognize the meaning and role of quality 4.0 from the perspective of internal employees.

3 Method

Qualitative method is used in this survey. A questionnaire is spread to quality professionals around the world via online app. In total of 497 quality executives or quality engineers' respondents are collected. The respondents are from a wide range of countries and regions around the world. Mainly from China, while others from ASEAN countries, European countries, and even United States. The data from the survey are analyzed to understand the professionals' attitude toward the trend of Quality 4.0 and industry 4.0.

4 Outcome

The data from survey were collected and presented in Table 1. and Figure 1. For the question of “whether the company has participated in the trend of Industry 4.0”, 75.5% of the enterprise quality professionals agreed that their company has participated in the trend of Industry 4.0, and 22.22% of the enterprise quality professionals expressed a neutral attitude. There are very few companies left who believe that their companies are not involved in Industry 4.0. For the question of “As a quality professional, I involved in Industry 4.0 and play an important role”, 75.5% of the quality professionals agreed that they participated, 22.51% of the them maintained a neutral attitude, and the rest did not agree. For the question of “As a quality professional, I understand the meaning of Quality 4.0”, 78.63% of respondents agreed, 17.38% respondents maintained a neutral attitude, and the remaining 3.98% of quality professionals answered that they did not agree.

Table 1. Survey results on the attitude toward Quality 4.0 and Industry 4.0.

Attitude Survey questions	Strongly disagree	disagree	neutrality	agree	Strongly agree
Question 1	1.14%	1.14%	22.22%	43.02%	32.48%
Question 2	1.42%	0.57%	22.51%	40.74%	34.76%
Question 3	3.13%	0.85%	17.38%	48.72%	29.91%
Question 1: On a scale of 1 to 5 (1 = Strongly disagree, 5 = Strongly agree), how would you rate your attitude toward this sentence: My company involved in the trend of Industry 4.0?					
Question 2: On a scale of 1 to 5 (1 = Strongly disagree, 5 = Strongly agree), how would you rate your attitude toward this sentence: As a quality professional, I involved in Industry 4.0 and play an important role?					
Question 3: On a scale of 1 to 5 (1 = Strongly disagree, 5 = Strongly agree), how would you rate your attitude toward this sentence: As a quality professional, I understand the meaning of Quality 4.0?					

Table 2. Results comparison among different regions around the world.

Region Name	Question No.	Strongly Disagree	Disagree	Neutrality	Agree	Strongly Agree
ASEAN Countries	Question 1	1.96%	0.00%	19.61%	39.22%	39.22%
ASEAN Countries	Question 2	1.96%	0.00%	17.65%	45.10%	35.29%
ASEAN Countries	Question 3	0.00%	0.00%	11.76%	45.10%	43.14%
European Countries	Question 1	0.00%	0.00%	9.43%	54.72%	35.85%
European Countries	Question 2	0.00%	0.00%	13.21%	41.51%	45.28%
European Countries	Question 3	0.00%	0.00%	20.75%	47.17%	32.08%

United States	Question 1	0.00%	0.00%	22.00%	36.00%	42.00%
United States	Question 2	0.00%	0.00%	18.00%	44.00%	38.00%
United States	Question 3	0.00%	0.00%	20.00%	52.00%	28.00%
China	Question 1	3.79%	6.12%	19.24%	43.15%	27.70%
China	Question 2	6.71%	3.50%	16.03%	41.11%	32.65%
China	Question 3	3.50%	7.00%	16.33%	43.15%	30.03%

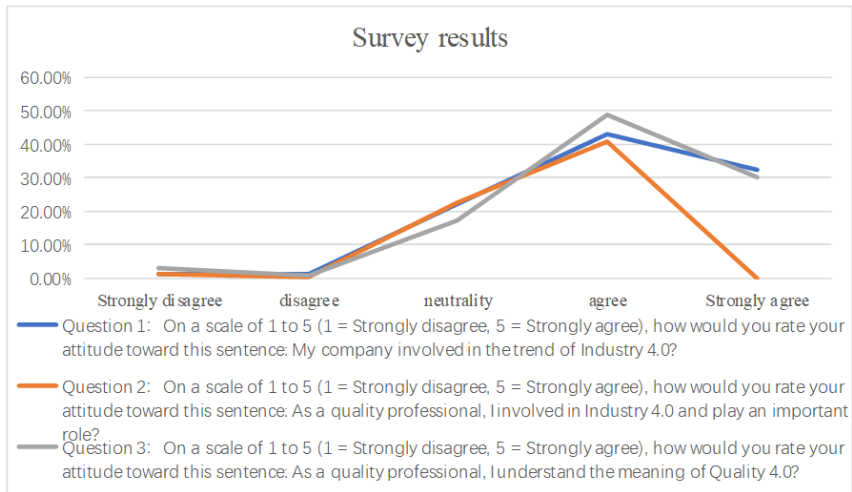


Fig. 1. Survey results on the attitude toward Quality 4.0 and Industry 4.0.

The comparison results among ASEAN countries, European Countries, United States, and China are shown in Table 2. It is very clear that nobody disagrees with all three questions in developed regions for example European countries and United States. For Question 1 that related with company involvement in the trend of Industry 4.0, European countries' result is outstanding, reach 90% respondents choose to agree and strongly agree. That proved Europe developed Industry 4.0 and will continue leading it in the future. When compared to other regions, Chinese respondents is the worst among all regions that this paper studied. Around 10% disagree and strongly disagree with the trend of Quality 4.0, Industry 4.0, and the leading role of quality professionals. The results are even worse than ASEAN countries, which normally be considered developing regions.

5 Discussion

With the continuous progress of science and technology and the increasingly fierce market competition, enterprise digital quality management has become an important driving force for business development. As a new stage of digital quality management, Quality 4.0 is leading the new trend of enterprise quality management. According to the data of the questionnaire, most companies have participated in the reform and innovation of Industry 4.0 and have played an important role in Quality 4.0, but there are still some companies that have not participated, and quality professionals do

not even understand the meaning of Quality 4.0. From this survey we can see that around 80% professionals and enterprises involved and supported this trend, it proved that with the development of science and technology, Quality 4.0 is inevitable. In European countries, the score of company involvement higher than the quality professional understanding, it means that quality professionals lag behind the development of Industry 4.0 and Quality 4.0 in that area. For the rest of the regions, the results are reverse, it means that company owners and top management teams lag behind. Quality professionals should try to make more efforts to educate. Governments also need to provide more resources to facilitate the development of Industry 4.0 to catch up with the trend. And quality professionals from China and ASEAN countries should also improve their own awareness and skills to meet the gap of the Quality 4.0 knowledge.

6 Conclusion

Digital quality based on big data and artificial intelligence is not only a requirement for products, but also the cornerstone of enterprise survival and development. In the fierce market competition, the importance of quality 4.0 for enterprises is self-evident. Industry 4.0 is an inevitable innovation, while a large part of enterprises is trying their best to keep up with the pace of innovation. Unfortunately, there are still some enterprises and quality professionals are lag behind, they were not aware of the meaning of Quality 4.0 and Industry 4.0. They may face the risk of being obsolete by The Times. For developing countries, the government should provide more resources, for example investment in key digital technology to facilitate the company develop Industry 4.0. Quality professionals in developing regions have to improve their skills that could lead Quality 4.0 related businesses in their organizations. Therefore, a detailed in-depth study of digital quality management systems in every aspect of Quality 4.0 is required to facilitate the development of the industry in the future, for example the new skill matrix that required by Quality 4.0, the technical hurdles list that should pay more attention by the government.

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References

1. Z. J. H. Tarigan, J. Mochtar, S. R. Basana, and H. Siagian, "The effect of competency management on organizational performance through supply chain integration and quality," *Uncertain Supply Chain Management*, vol. 9, no. 2, pp. 283–294, 2021, doi: 10.5267/j.uscm.2021.3.004.
2. J. Butt, "A strategic roadmap for the manufacturing industry to implement industry 4.0," Jun. 01, 2020, MDPI AG. doi: 10.3390/designs4020011.

3. K. S. P. N. Kannan and A. Garad, "Competencies of quality professionals in the era of industry 4.0: a case study of electronics manufacturer from Malaysia," *International Journal of Quality and Reliability Management*, vol. 38, no. 3, pp. 839–871, Feb. 2021, doi: 10.1108/IJQRM-04-2019-0124.
4. P. Tiwari, J. K. Sadeghi, and C. Eseonu, "A sustainable lean production framework with a case implementation: Practice-based view theory," *J Clean Prod*, vol. 277, Dec. 2020, doi: 10.1016/j.jclepro.2020.123078.
5. Kadarova, J., & Tucek, D. (2019). "Competences in the quality management system evaluation based on the most worldwide used key performance indicators," *Quality – Access to Success*, Vol. 20, no.169, pp. 29–41. April 2019.
6. S. V. Shet and V. Pereira, "Proposed managerial competencies for Industry 4.0 – Implications for social sustainability," *Technol Forecast Soc Change*, vol. 173, Dec. 2021, doi: 10.1016/j.techfore.2021.121080.
7. M. Hernandez-de-Menendez, R. Morales-Menendez, C. A. Escobar, and M. McGovern, "Competencies for Industry 4.0," *International Journal on Interactive Design and Manufacturing*, vol. 14, no. 4, pp. 1511–1524, Dec. 2020, doi: 10.1007/s12008-020-00716-2.
8. Z. J. H. Tarigan, J. Mochtar, S. R. Basana, and H. Siagian, "The effect of competency management on organizational performance through supply chain integration and quality," *Uncertain Supply Chain Management*, vol. 9, no. 2, pp. 283–294, 2021, doi: 10.5267/j.uscm.2021.3.004.
9. G. Santos et al., "New needed quality management skills for quality managers 4.0," *Sustainability (Switzerland)*, vol. 13, no. 11, Jun. 2021, doi: 10.3390/su13116149.

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