ISSN: 0974-5823 Vol. 7 No. 8 August, 2022

International Journal of Mechanical Engineering

Sustainable Supply Chain Quality Management Framework: evidence from Iran

Farshad Rezaeian
Department of Industrial Engineering, Rahbord Shomal Higher Education Institute, Rasht, Guilan, Iran

Soroush Avakh Darestani
Guildhall School of Business and Law, London Metropolitan University, London, UK

Fatemeh Zadbagher Seighalani
Department of accounting, Faculty of Moein, Rasht Branch, Technical and vocational university (TVU), Rasht, Iran

How to Cite: Farshad Rezaeian, Soroush Avakh Darestani, Fatemeh Zadbagher Seighalani (2021). Sustainable Supply Chain Quality Management Framework: evidence from Iran. International Journal of Mechanical Engineering 6(1), pp.1-4.

Abstract The objective of this study is to provide a quality management system (QMS) evaluation model pertinent to the automotive industry and the supply chain management to improve organizational sustainability. In the present study, supply chain management criteria and ISO/TS16949 are first identified and evaluated by Content Validity Ratio (CVR). The criteria are weighted and ranked using Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) method. Consequently, the cause-and-effect relationship between the quality system management criteria on supply chain management criteria with Decision making trial and evaluation laboratory (DEMATEL) is evaluated. The results of the weight comparison of the criteria related to ISO/TS16949 show that "engagement of people" obtains the highest and training and customer focus the second highest rank, respectively. Furthermore, comparison of sustainable supply chain alternatives indicates that the "social dimension" gains the first place among others. The cause-and-effect relationship using DEMATEL shows that training, quality, and staff efficiency are the most impact criteria. Customer focus, cost, and engagement of people are the most influence criteria. Although, the present study was applied in case study related to a processing and manufacturing company.

Index Terms - Quality System Management, Supply Chain Management, Sustainability, TOPSIS, DEMATEL

1. INTRODUCTION

Every organization constantly seeks to define and achieve its goals [1]. Obtaining International Organization for Standardization (ISO) certification by a publicly- or privately-owned production or service organization has various internal and external benefits. Benefits of the internal implications of deploying ISO in an organization include: improving the documentation process, achieving a greater awareness of commodity quality monitoring, increasing productivity and efficiency [2]-[5].

Implementing QMS is considered as an important milestone for any company and is a strategic decision to make [6]. Sustainable development of the company and its competitiveness depend directly on the proper functioning of the QMS. Certification of QMS according to ISO 9001 standard can help maintain long-term relationship with customers [7]. The automotive industry is the world 's largest industrial sector and few sectors are expanding globally. An automotive industry that strives to become the world's leader in car making, for instance, should plan for ISO/TS 16949 certification. ISO / TS 16949 is a technical specification designed for compliance with the standards. The purpose of this standard is to develop a QMS that

continuously improves the entire supply chain of the automotive industry by preventing defects, reducing diversity and minimizing waste [8]-[12].
The aims and objectives of the study is to present a QMS evaluation model pertinent to automotive industry standard and supply chain management to improve organizational sustainability in the processing and manufacturing industries, which is considered as an innovative research. Weighing and ranking the relevant criteria of interest is done using TOPSIS technique. Then, the cause and effect relation of the criteria is determined using the DEMATEL technique.
The unique contribution of this work is elaborating a supply chain quality management model for sustainability. For the first time, the model was implemented in a 1st tier supplier of supply chain of automotive industry. Due to that, the special quality system requirements of automotive industry were considered for developing the model. Moreover, the second novelty of this work is using hybrid decision making techniques in this respect for evaluation.
In this paper, an introduction to the subject is presented and then the state-of-the-art is reviewed. In the third section the research methodology is explained that is followed by a section on results of the analysis. The paper concludes by a conclusions and research implications.

IILITERATURE REVIEW

With the increasing competitiveness via globalization, the competitiveness of today's organizations in the supply chain has increased and it includes all the channels of the chain and foreign organizations. However, inter-organizational perspectives on product quality have limitations. Therefore, manufacturers should focus on inter-organizational quality approaches such as supply chain quality management. Since supply chain quality management will enable manufacturing companies to meet customer needs in a competitive market [13].
Sustainability is considered as a strategic management philosophy. Applying quality principles, practices and techniques to all levels and performance of companies seek to improve customer performance and satisfaction [14]-[17]. The philosophy of quality management seeks excellence, productivity, sustainability and competitiveness in the organization, with a continuous and collective focus on improving processes, systems and methods [18], [14], [15], [19]. The purpose of standardization is to create an international model for the implementation and deployment of quality assurance and management systems that has been widely accepted around the world. QMS is defined in order to stabilize the quality level and quality improvement is implemented in the organization through process improvements. Implementing supply chain quality management enables companies to improve organizational performance [20]. One of the most challenging industries in the world is the automotive industry, which operates under the pressures of time-of-delivery and the cost. For suppliers to be successful, they need to keep their pressures under control, know specific customer characteristics, and emphasize continuous improvement. ISO Certificate TS/16949 can be of assistance. In this context, ISO TS16949 was designed to cover quality management in the automotive supply chain. It is based on eight management principles: customer focus, leadership, involvement of human resource, process approach, system approach, continuous improvement, evidence-based decision making, and mutual benefit relationship. ISO/TS 16949 also emphasizes the specific needs of customers [21].
Helping keep automotive customers and getting new customers by covering the specific needs of customer's efficient processes and processes that lead to product quality improvement is of great importance. By demonstrating a commitment to quality, increase customers' expectations of the organization and it helps the organization retain its customers and attract new customers (ISO-company).

Quality management system (ISO TS16949)	References
Customer focus	[22], [23]
Leadership	[22], [23]
Involvement of human resource	[23], [24]
Process approach	[23]
System approach	[23]
Continuous improvement	[22], [23]
Evidence based decision making	[22], [23]
Mutual benefit relationship	[22], [23]

Research Criteria

Sustainable supply chain management	References
Environmental management system	[25]
Staff efficiency	[24]
Training	[24]
Reducing waiting time and just in time delivery	[26]
Engagement of people	[22]
Improving response to changing market needs	[26]
Demand-based management	[26]
Ensure certification	[27]
Cost	[27]
Quality	[27], [28]
Supply chain integration	[22]
Product life cycle	[28]
Reuse (recycling)	[28]

Figure 1
Research Framework

Extensive research has been carried out on the evaluation of quality system management and supply chain management, each of which has addressed this in some way. To the best of our knowledge, no research work has been reported on providing a systematic and effective QMS evaluation model pertinent to the automotive industry standard and supply chain management to improve organizational sustainability in the processing and manufacturing company by far. Although the flow of management integration research is available, research is limited in three ways, namely quality management, supply chain management and sustainability.

III. RESEARCH METHODOLOGY

The present study is applied research in terms of objective. In this work, we collect research data in the context of a population or statistical samples using a questionnaire. Method of data collection is categorized as: field and library. A library method was used for research literature and a field method was used to by asking experts to complete a questionnaire.

In the present study, after selecting the topic and expressing the problem, preliminary studies were carried out and the research background was examined. In the next step the indicators were identified (section 3.1). Then, the evaluation of the indices was calculated by CVR. After identifying the factors, the questionnaire was designed and distributed among experts (section 3.3). After collecting the questionnaire, criteria of interest were weighted and ranked using TOPSIS method. Then, the cause-and-effect relationship between the quality system management criteria on supply chain management criteria were evaluated using DEMATEL (section 4). Finally, conclusions and future suggestions are presented (sections 5).

Research Criteria

Selecting right criteria to evaluate and study for hypothesis testing is one of the main elements of research. These criteria were identified and selected in consultation with the cited literature. Figure 1 shows the criteria selected based on the state-of-the art and also shows ISO TS16949 criteria.

Framework Development

Previous research was first studied and then of ISO TS16949 and sustainable supply chain management criteria were identified. Then, according to the CVR, the criteria were evaluated and finally 21 criteria were selected. Then, the data were collected by a questionnaire and analyzed by TOPSIS and DEMATEL.

Formation of a Questionnaire

Questionnaire is a common tool for data collection. The questionnaire is considered to be impersonal tool. Due to impersonal feature and the distance between the researcher and the event, the questionnaire needs to be designed and adjusted so that it does not require further explanation [29]. Questionnaire of TOPSIS and DEMATEL is used for this research.

Research population and Expert Selection Method

Selecting the right experts in the field under study is one of the steps that is very effective in the quality of the answers. The criteria for selecting individuals must first be determined. These criteria must be fully consistent with the research topic and the model under consideration. According to Saaty (2002) theory, ten experts are sufficient for studies of pairwise comparison [30].

After designing the questionnaire, we make final corrections and try to present their final work to an expert in order to benefit from their comments. The statistical population of this research is 10 managers and specialists working in processing and manufacturing company. The criteria for choosing an expert are education (Bachelor and Master), work experience (at least 5 years) and over 21 years of age (the main criterion for choosing an expert in this field is work experience and knowledge of supply chain and quality system management).

Processing and manufacturing company is as one of the manufacturers of automotive spare parts (types of hydraulic shock absorbers for light and heavy vehicles) that is established in 1977 in Iran. In 1997, it obtained a standard certification from Iran National Standards Organization. Also in 1998, it he received ISO 9002 certification and has been able to obtain numerous certificates to this day.

Weighted Entropy

"Entropy" is a statistical measure used in the social sciences, physics and information theory. The entropy method can be used to evaluate the weights when the data of a decision matrix is fully specified. The idea of the above method is that if the dispersion be the greater in the values of an index, thus it is the more important. Entropy in the realm of information theory is a measure of uncertainty which is expressed by the distribution of the specified probability P_i. Measurement of this uncertainty (E_i), by Shannon, is equation 1:

$$E_i=S(P_1 ,P_2,\ldots,P_n)= -k \sum_{i=1}^{n} [P_i] \times \ln [P_i] \quad (1)$$

Note that in the entropy method, the positive or negative indices will have no effect on the method of calculating weights [31].

Analysis of the Data

The methods available in this study are TOPSIS, DEMATEL. Criteria weighing and measuring the dimensions of the criteria are performed using the TOPSIS tool and the cause and effect relationships of supply chain criteria in processing and manufacturing is identified also DEMATEL [32].

IV. RESULTS

Implementation of the model

At this step, the model presented in the processing and manufacturing company is implemented. The implementation steps are described in more detail below.

CVR calculations

After extracting the variables from previous research, the acceptable CVR value for the number of specialists was 0.62. The output criteria that have this value are shown in Table 1.

Table 1.
Acceptable criteria after calculating CVR

Row	Criteria	
1	Economic	Cost
2		Quality
3	Environmental	Environmental Management System
4	Social	Staff Efficiency
5		Training
6		Customer focus
7		Leadership
8		engagement of people

TOPSIS Calculation Results

The proximity to the ideal positive and negative solution as well as the ranking of the alternatives is calculated. as shown in Table 2.

Table 2.
proximity to the ideal positive and negative solution as well as the ranking of alternatives

Result		Proximity Coefficient
1	Social	0.755008
2	Economic	0.323808
3	Environmental	0.316873

According to the results, leadership has gained the highest weight and engagement of people has obtained the lowest weight.

DEMATEL Calculation Results

The results listed in Table 3 show the influence and impact of the criteria.

Table 3.
Sorted results R + J, R-J

Impact		Influence	
Training	24.0923	Customer focus	0.7307
Quality	23.3799	Cost	0.6518
Staff Efficiency	22.3953	Engagement of people	0.1135
Leadership	22.341	Training	-0.1169
Cost	21.9495	Leadership	-0.1575
Customer focus	21.2731	Quality	-0.2189
Environmental Management System	21.1972	Staff Efficiency	-0.4326
Engagement of people	20.9151	Environmental Management System	-0.5702

Results shows that the impact of training and the influence of customer focus is higher than other criteria. Also, the impact of engagement of people and the influence of the environmental management system is lower than other criteria. Our work results are in line with several researches. The research work by Bastas & Liyanage (2019) showed that integration of quality management and supply chain and sustainability drives

sustainable development of organizations and improves the organizational performance [22]. Results of Fonseca et al. (2017) showed that planning, designing, implementing and controlling change improves the organizational performance [33]. Also the results of Jabbour et al (2014) showed quality management (ISO9001 quality certification, comprehensive quality management and supplier) are recognized as key records of environmental management, green supply chain management and green performance of organizations [34].

V. DISCUSSION AND CONCLUSION

The main purpose of this study was to present a QMS evaluation model pertinent to automotive industry standards and the supply chain management to improve organizational sustainability. To this end, some selection criteria were first identified and the criteria weighted and the dimensions of criteria were ranked by TOPSIS method. Cause and effect relationships of supply chain criteria in processing and manufacturing were identified using DEMATEL.

In ranking the sustainability dimensions, the social dimension was ranked first among the other dimensions. Using the DEMATEL method, the cause and effect relationship between the criteria was investigated. The results showed that the impact of training, quality, and efficiency of staff were more than other criteria as well as customer focus influence, costs, and engagement of people is more than other criteria. Training and customer-focus identified the second and third priorities, respectively.

According to the results obtained in the present study it is recommended to upgrade on methods and models to engage people and to pay more attention to the social dimension in the day to day practices in the companies. Also, people through their encouragement, empowerment and participation success at all levels of organization and goals achieved for improvement. In the field of training, it is suggested that the length of the training courses be short and more emphasis be placed on the number of people trained and more training courses be held. In order to improve customer-focus, it is suggested to consider measures to reduce the waiting time of delivery and attention to needs of them. The use of higher quality materials and parts, as well as improving and more precise product testing processes, is a way to increase the quality of the company's products.

Any research is a building block of further works. Our work is not an exception, thus, it can lead to further research in this area. It is recommended, for instance, to use other multi-criteria decision-making tools in future research and to compare that with our proposed method. Nevertheless, our proposed method can be implemented across different industries, and can be also amalgamated with other existing indicator sets and tools.

REFERENCES

[1] A. Mohammadi, and S. Avakh Darestani, “Green supplier selection problem using TOPSIS extended by D numbers in tractor manufacturing industry”, Int. J. Services and Operations Management, Vol. 32 No. 3, pp.327-338, 2019.

[2] G. K. Kanji, “an innovative approach to make ISO 9000 standards more effective”, J. Total Quality Management, Vol. 9 No. 10, pp. 67-78, 1998.

[3] B. Withers, and M. Ebrahimpour, “Does ISO 9000 Affect the Dimensions of Quality Used for Competitive Advantage?”, *European Management Journal*, Vol. 18 No. 4, pp. 431-443, 2000.

[4] I. Heras-Saizarbitoria, G. Arana, and E.San Miguel, “An Analysis of the Main Drivers for ISO 9001 and other Isomorphic Metastandards”. Review of International Comparative Management, Vol. 11 No. 4, pp. 562-574, 2010.

[5] S. Georgiev, and E. Georgiev, “Motivational factors for the adoption of ISO 9001 standards in Eastern Europe: The case of Bulgaria”, *Journal of Industrial Engineering and Management (JIEM)*, Vol. 8, No. 3, pp. 1020-1050, 2015.

[6] C. Talamo, and N. Atta, “Invitations to Tender for Facility Management Services: Process Mapping, Service Specifications and Innovative Scenarios”, Springer International Publishing, 2018.

[7] S. Lukichev, and M. Romanovich, “The quality management system as a key factor for sustainable development of the construction companies”, Procedia Engineering, Vol. 165. pp. 1717 – 1721, 2016.

[8] D. Hoyle, “Automotive quality systems”, handbook (2nd ed.). Oxford: Elsevier Ltd. 712, 2005.

[9] T. Sturgeon, J. Van Biesebroeck, and G. Gereffi, “Value chains, networks and clusters: Reframing the global automotive industry”. Journal of Economic Geography, Vol. 8 No. 3, pp. 297–321, 2008.
[10] G. Civcisa, and A. Grislis, “ISO/TS 16949 among Latvian production companies focused on automotive industry”. Agronomy Research, Vol. 12, No. 1, pp. 255–262, 2014.
[11] A. E. Di Noia, and M. Nicoletti, “ISO 14001 certification: Benefits, costs and expectations for organization”. Studia Oeconomica Posnaniensia, Vol. 4, No. 10, pp. 94–109, 2016.
[12] F. d. O. Neves, E. G. Salgado, L. A. Beijo, J. M. S. Lira, and L. H. Ribeiro, “Analysis of the quality management system for automotive industry- ISO/TS 16949 in the world”, Total Quality Management & Business Excellence, Vol. 32, No. 2, pp.1-24, 2018.
[13] M. Ajali, E. Asgharizadeh, H. Safari, I. Ghasemian Sahebi, “Analysis of Relationships between Gas Supply Chain Quality Management factors with the Combined Approach of Fuzzy Interpretive Structural Modeling and Path Analysis”, Industrial Management Studies, Vol. 5 No. 46, pp.27-55, 2017.
[14] J.R. Evans, and W.M. Lindsay, “The Management and Control of Quality”, South-Western Cengage Learning, 2010.
[15] A.C. Fernandes, P. Sampaio, M. Sameiro, and H.Q. Truong, “Supply chain management and quality management integration”. Int. J. Qual. Reliab. Manag. Vol. 34, pp. 53–67, 2017.
[16] M.H. Nguyen, A.C. Phan, and Y. Matsui, “Contribution of quality management practices to sustainability performance of Vietnamese firms”. Sustain, Vol. 10, pp. 1–31, 2018.
[17] F. Talib, Z. Rahman, and M.N. Qureshi, “A study of total quality management and supply chain management practices”. Product. Perform. Manag. Vol. 60, pp. 268–288, 2011.
[18] A. Bastas, and K. Liyanage, “Sustainable supply chain quality management: A systematic review”, Cleaner Pro*duction,* Vol. 181, pp. 726–744, 2018.
[19] M. Terziovski, and P. Hermel, “The role of quality management practice in the performance of integrated supply chains: A multiple cross-case analysis”. Qual. Manag. J. Vol. 18, pp. 10–25, 2011.
[20] C. Kuei, C. N. Madu, and C. Lin, “Implementing supply chain quality management”, Total Quality Management, Vol. 19 No. 11, pp. 1127–1141, 2008.
[21] R. Luburić, “Quality Management Principles and Benefits of their Implementation in Central Banks”, Journal of Central Banking Theory and Practice, Vol. 3, pp. 91-121, 2015.
[22] A. Bastas, and K. Liyanage, “Integrated quality and supply chain management business diagnostics for organizational sustainability improvement”, Sustainable Production and Consumption, Vol. 17, pp. 11–30, 2019.
[23] A. Pakdoost, and J. Moradi, (2010), Technical Specification ISO / TS16949: 2009 (International Standard Organization), Pishgam Poyesh System Co., Tehran, Iran, 2010.
[24] M. Kashi, D. Kaveh, and T. Sadeghi, “Identifying the Most Important Factors in Successful Implementation of a Quality Management System in a Service Organization”, Journal of Standard and Quality Management, Vol. 4 No. 14, pp. 58-71, 2014.
[25] M. Zarezadeh, Interconnection of Environmental Quality Management System and Sustainable Development, First National Planning Conference, Environmental Protection and Sustainable Development, Hamedan, Hegmataneh Environmental Assessors Association, Iran, 2013.
[26] M. Ghazizadeh, S. Safari, F. Noroozzadeh, and Gh. Heidari, “Integration of supply chain management approaches in the form of LARG supply chain using Multi Attribute Decision Making Techniques in Saipa company”, Journal of executive management, Vol. 6, No. 14, pp. 113-134, 2015.
[27] L. D. Pop, and N. Elod, “Improving Product Quality by Implementing ISO / TS 16949”, Procedia Technology, Vol. 19, pp. 1004-1011, 2015.
[28] M. W. Wakjira, H. Altenbach, and P. JanakiRamuluc, “Optimization of manufacturing sustainability in the Ethiopian industries”, Procedia Manufacturing, Vol. 21, pp. 890-897, 2018.
[29] A. Aliahmadi, “Research method and Thesis Writing Guide”, Knowledge Production, Tehran, Iran, 2010.
[30] T. L. Saaty, “Decision making with the Analytic Hierarchy Process”. Scientia Iranica, Vol. 9 No. 3, pp. 215-229, 2002.
[31] M. Momeni, “Recent Issues in Operations Research”, University of Tehran Management School Press, Iran, 2013.
[32] A. Habibi, “SPSS Software Application Training”, Electronic Publishing, Parsmodir Website, 2013.
[33] L. M. Fonseca, J. P. Domingues, Reliable and flexible Quality Management Systems in the automotive industry : monitor the context and change effectively, *Procedia Manufacturing,* Vol. 11, pp.1200 – 1206, 2017.

[34] A. B. L. D. S. Jabbour, C. J. C. Jabbour, H. Latan, A. A. Teixeira, and J. D. H. C. Oliveira, “Quality management, environmental management maturity, green supply chain practices and green performance of Brazilian companies with ISO 14001 certification: Direct and indirect effects”. Transp. Res. E, Vol. 67, pp. 39–51, 2014.