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Review Article

Identifying factors of Sustainable supply chain in Iranian Automobile Industries

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Abstract

The automotive industry, as one of the largest and most influential industries in the world, could have a massive effect on the world's lifestyle, monitoring the process of production can improve the sustainability in the supply chain. Sustainable supply chain management (SSCM) has recently received increasing attention among Iranian automobile manufacturers. The previous studies show the important role of sustainability for choosing suppliers, but no studies check the important factors for all of the Automobile manufactures. The purpose of this study is finding the important factors for sustainable supply chain in Iranian Automobile industries. The factors obtained from previous studies and 50 experts shared their idea for this purpose and analyzed by Fuzzy Delphi Method. The results show that Quality, Customer satisfaction, Suppliers' green initiatives, Top management vision, Supply chain configuration are important factors to reach sustainability in automobile industries in Iran.

Keywords: Sustainable Supply Chain; Automobile; Iran; Supply Chain; Delphi Method

Introduction

The governments of the developed nations have started giving importance to environmental aspects, and as a result, organizations have started searching for operations that are environmentally, economically as well as socially sustainable. Sustainability in the meaning of services that build value and do not enact material depletion is paramount for these results. It is the management technique that focuses on access to cookies and their utilization in a green manner, working without polluting either water, soil or air, and being successfully viable for different communities, customers, and workers (Bahramimianrood, 2022; Bathaei et al., 2022). The automotive industry is one of the largest industries and plays a very important role in economy and social life and sadly has a very bad effect on the environment it uses a lot of material and fuel so the pollution and global warming. Consequently, motor manufacturers have incorporated sustainability initiatives within organizations to offset such impacts and enhance citizens' quality of life (Amaral et al., 2020). It has been noted that more and more international companies recently pay much attention to environmental concerns while managing their business activities and processes because of the pressure from the legislation, clients, and competitors. Now, the environmental practices have become inevitable that business organizations integrate these practices into their tactical operational plans to either achieve or sustain their competitive edge (Abdoli et al., 2023). This involves implementing environmental programs and having responsibility for the environment of the whole supply chain (Kazancoglu et al., 2021) as well as considering categorizing and measure their circularity using circularity indicators (Bahramimianrood et al., 2024). Thus, car production in Iran has expanded through cooperation with European firms and through the granting of licenses to overseas manufacturers. Thus, the effects of sanctions and currency crises have been very severe within establishments affecting overall

production and functionality. Renault and Peugeot are examples of international firms that stopped operations because of the new sanctions from the United States; automobile delivery has been affected, and there is a scarcity of spare parts. These issues raise attention that there are still so many deficiencies and problems regarding the sustainable and efficient supply chain management of Iranian automobile companies.

Literature review

Sustainable supply chain management involves managing a wide range of factors and specific, extensive performance targets, that must cover the whole value delivery network and the life cycle of the actual products. Supply Chain Management for Sustainability involves the application of lean management strategies to enhance an eco-efficient supply chain, which focuses on the continuous improvement to supplying goods with minimal waste, in response to the market needs while incorporating environmental, social and ethical concerns into the process (Kenaria & Bahramimianroodb, 2021). These supply chain relationships are therefore made more responsive and stronger by these alliances. This information means that through the lean system, organizational efficiency can be maintained and other sustainability issues tackled as well (Singh et al., 2020). A study by Bathaei et al 2022 conducted with Iran Khodro Company and found out that production flexibility, strategic flexibility, and supply chain agility correlated with the company's performance. Supply chain agility was affected by strategic flexibility, while both the latter and production flexibility impacted firm performance with supply chain agility acting as a mediator. Later in the year 2019, by employing the fuzzy AHP methodology, Zaidi drew attention to supply chain plans for the Iranian automotive sector, with customer orientation, appropriate social network leverage, coupled with the direct engagement policy that was founded on the development of customer trust. The investigation revealed that in the best-selling scenario, Iran Khodro's best-suggested strategy was a 'Defensive' posture that focused more on customers as opposed to rivalries. Considering these observations, it can be suggested that the Iranian automotive industry needs to adopt effective SC management concepts such as the more appropriate, adaptive, and customer-oriented approaches (Bathaei et al., 2022; Streimikis et al., 2024).

Sustainability Supply Chain Conceptual Models

A conceptual model of Sustainable Supply chain Management (SSM) (Ageron et al., 2012) introduced seven factors which are Reasons for SSCM, Performance criteria for SSCM, Greening supply chains, Characteristics of suppliers, Managerial approaches for SSCM, Barriers for SSCM, Benefits and motivation for SSCM. Tables 1 shows all of the sustainable supply chain factors based on three dimensions of sustainability: Economics, environment and society. Those are obtained from previous studies (Ageron et al., 2012; Giunipero et al., 2012; Gopalakrishnan et al., 2012; Govindan et al., 2015; Hsu et al., 2016; Rodríguez et al., 2016; Shaverdi et al., 2013; Su et al., 2016; Tseng & Bui, 2017; Wiengarten et al., 2018). As shown in Figure 1.

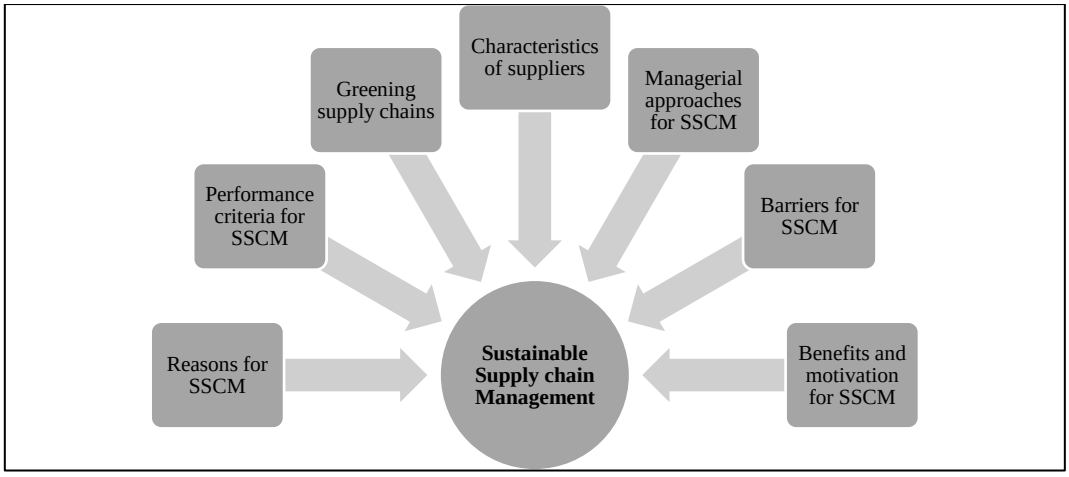

Figure 1 Sustainable supply chain management (SCM) model based on (Ageron et al., 2012)

Table 1: Sustainable supply chain management factors

Main factor	Factors	code
Reasons for SSCM factors	Top management vision	A1
	Government regulatory requirements	A2
	Nature of business	A3
	Customer expectations	A4
	Competitor actions	A5
	Stakeholders such as NGOs	A6
	Suppliers' green initiatives	A7
Performance criteria employed for SSM factors	Quality	B1
	Price	B2
	Reliability	B3
	Service rate	B4
	Delivery	B5
	Flexibility	B6
	Certification	B7
	Associated services	B8
	Long term relationships	B9
	Geographic proximity	B10
	Environmental issues	B11
	Economic dependency	B12
	Personal relationships	B13
	Social responsibility	B14
Greening supply chains factors	Waste reduction	C1
	Savings from packaging	C2
	ISO 14 001 certification	C3
	Lean management	C4
	Eco-design	C5
	Production resources system	C6
	Clean programs	C7
	Product life cycle management	C8
	Green transportation channels	C9
	Reverse logistics	C10
	Large scale companies	D1
	Strategic suppliers	D2

Characteristics of suppliers' factors	Small and medium-sized enterprises	D3
	Geographically near suppliers	D4
	Non-strategic suppliers	D5
Managerial approaches for SSCM factors	Active	E1
	Collaborative	E2
	Reactive	E3
	Pro-active	E4
	Individual	E5
Barriers for SSM factors	Financial costs	E6
	Green investments	E7
	Return on investment	E8
	Supplier's facilities	E9
	Focal company's facilities	E10
	Supply chain configuration	E11
	Suppliers' firm size	E12
	Supplier's location	E13
	Product characteristics	E14
	Green induced changes	E15
	Focal firm's previous sustainability experiences	E16
	Top management commitment	F1
	Suppliers' human skills	F2
	Supplier's top management commitment	F3
	Suppliers' firm culture	F4
	Company human skills	F5
Benefits and motivations for SSM Factors	Customer satisfaction	G1
	Supplier's capabilities to innovate	G2
	Trust in suppliers	G3
	Supplier lead-time	G4

Methodology

The aim of this study is to identify the important factors for sustainable supply chain. In the first step, the 61 factors are extracted from the previous studies. In the next step by using the fuzzy Delphi and experts' opinions, the important factors found. In this study 50 experts participated in filling the questionnaire.

The Delphi methodology may be an ancient prediction approach that does not need massive samples. It is often used to come up with knowledgeable agreements for complicated topics (Hartman, 1981). The Delphi methodology suffers from low convergence professional opinions and a lot of execution value. In this study, the five-point linguistic scales used and shows at Table 2.

3.1 The FDM Process

When using the FDM method in a study, there is a sequence of steps to be followed:

Step 1: Interview the experts to determine the importance of the evaluation criteria of the variables that will be measured by using linguistic variables.

Step 2: Convert all linguistic variables to fuzzy triangular numbering (triangular fuzzy number

Step 3: For every factor, use the vertex method to calculate the average.

Step 4: Defuzzification the weights.

Step 5: According to Cheng and Lin (Cheng & Lin, 2002), The overall group consensus should be more than 70 percent. If the data is found otherwise, the second of FDM needs to be done.

Table 2: Five Point Linguistic Scale

Linguistic Scale	Triangular fuzzy number
Very Important	(0.75, 1, 1)
Important	(0.5, 0.75, 1)
Moderately Important	(0.25, 0.5, 0.75)
Unimportant	(0, 0.25, 0.5)
Very Unimportant	(0, 0, 0.25)

Results

At the beginning of this study, there were 61 factors identified from the previous studies to represent both agile supply chain and sustainable supply chain, and then the factors were grouped into 7 groups. The FDM was used to choose the most important factors from those (table 3) 7 groups, based on the questionnaire returned by 50 experts. Table 3 shows the average weight based on fuzzy numbers and final crisp numbers. Based on FDM, factors that have a weight more than 0.7 were accepted.

Table 3: Final FDM weights

Code	Fuzzy numbers (L,M,U)	Final score	Code	Fuzzy numbers (L,M,U)	Final score
A1	(0.53, 0.77, 0.91)	0.73*	D1	(0.51, 0.76, 0.90)	0.72*
A2	(0.43, 0.66, 0.84)	0.64	D2	(0.51, 0.76, 0.92)	0.73*
A3	(0.50, 0.75, 0.90)	0.72*	D3	(0.38, 0.62, 0.80)	0.6
A4	(0.52, 0.77, 0.89)	0.73*	D4	(0.41, 0.65, 0.82)	0.62
A5	(0.52, 0.76, 0.90)	0.72*	D5	(0.37, 0.61, 0.79)	0.59
A6	(0.38, 0.61, 0.79)	0.59	E1	(0.51, 0.75, 0.88)	0.71*
A7	(0.56, 0.80, 0.93)	0.76*	E2	(0.43, 0.66, 0.84)	0.64
B1	(0.65, 0.90, 0.98)	0.84*	E3	(0.52, 0.76, 0.90)	0.72*
B2	(0.52, 0.76, 0.90)	0.72*	E4	(0.44, 0.67, 0.86)	0.65
B3	(0.50, 0.75, 0.90)	0.72*	E5	(0.46, 0.70, 0.88)	0.68
B4	(0.39, 0.62, 0.79)	0.6	E6	(0.37, 0.61, 0.82)	0.6
B5	(0.43, 0.67, 0.84)	0.65	E7	(0.43, 0.67, 0.85)	0.65
B6	(0.43, 0.66, 0.84)	0.64	E8	(0.41, 0.64, 0.82)	0.62
B7	(0.33, 0.56, 0.76)	0.55	E9	(0.33, 0.57, 0.80)	0.57
B8	(0.38, 0.61, 0.80)	0.59	E10	(0.36, 0.59, 0.80)	0.58
B9	(0.39, 0.61, 0.80)	0.6	E11	(0.51, 0.76, 0.90)	0.72*
B10	(0.32, 0.55, 0.75)	0.54	E12	(0.39, 0.62, 0.81)	0.6
B11	(0.45, 0.69, 0.85)	0.66	E13	(0.41, 0.66, 0.84)	0.63
B12	(0.35, 0.57, 0.76)	0.56	E14	(0.36, 0.58, 0.79)	0.57*
B13	(0.40, 0.61, 0.80)	0.6	E15	(0.36, 0.61, 0.83)	0.6
B14	(0.40, 0.63, 0.83)	0.62	E16	(0.42, 0.64, 0.81)	0.62
C1	(0.43, 0.66, 0.84)	0.64	F1	(0.51, 0.75, 0.89)	0.72*
C2	(0.35, 0.57, 0.81)	0.57	F2	(0.51, 0.76, 0.92)	0.73*
C3	(0.43, 0.67, 0.85)	0.65	F3	(0.34, 0.58, 0.78)	0.56

C4	(0.43, 0.67, 0.86)	0.65	F4	(0.47, 0.72, 0.89)	0.69
C5	(0.52, 0.76, 0.92)	0.73*	F5	(0.43, 0.68, 0.85)	0.65
C6	(0.51, 0.76, 0.92)	0.73*	G1	(0.55, 0.77, 0.89)	0.74*
C7	(0.40, 0.63, 0.83)	0.62	G2	(0.52, 0.77, 0.93)	0.74*
C8	(0.41, 0.64, 0.82)	0.62	G3	(0.52, 0.76, 0.89)	0.72*
C9	(0.39, 0.63, 0.82)	0.61	G4	(0.48, 0.71, 0.90)	0.69
C10	(0.41, 0.66, 0.86)	0.64	Total	*20 factors were accepted	

According to Table 3, the first column is the factor's code based on the questionnaire from the 50 experts. The second column is the weights of factors that represent fuzzy numbers (L= lower, M= medium, U= upper) and the third column is the final factors weights showed in script numbers. Only 26 factors with (*) in Table 3 were accepted as the final score is >0.7. These numbers are the average score of the experts' answers using Fuzzy method. Then these final scores are converted to linear numbers. Table 4 shows the Accepted factors with their ranking.

Table 4: Accepted factors of sustainable supply chain

Rank	Factor	Code	Weight	Rank	Factor	Code	Weight
1	Quality	B1	0.84	11	Competitor actions	A5	0.72
2	Suppliers' green initiatives	A7	0.76	12	Price	B2	0.72
3	Supplier's capabilities to innovate	G2	0.74	13	Return on investment	E3	0.72
4	Customer satisfaction	G1	0.74	14	Large scale companies	D1	0.72
5	Top management vision	A1	0.73	15	Supply chain configuration	E11	0.72
6	Eco-design	C5	0.73	16	Trust in suppliers	G3	0.72
7	Production resources system	C6	0.73	17	Nature of business	A3	0.72
8	Strategic suppliers	D2	0.73	18	Reliability	B3	0.72
9	Collaborative	F2	0.73	19	Active	F1	0.72
10	Customer expectations	A4	0.73	20	Financial costs	E1	0.71

Discussions

Consequently, based on the literature review using the fuzzy, Delphi method, this study first of all, recognizes the Iranian automobile industry's 61 factors for assessing sustainable supply chains. The identified factors were then ranked by experts, reducing the list to 20 factors having scores greater than (0.7). They were Quality, Top management vision, Nature of business, Customer expectations, Competitor actions, Suppliers' green initiatives, Price, Reliability, Eco-design, Production resources system, Large scale companies, Strategic suppliers, Return on investment, Supply chain configuration, Active, Collaborative, Large companies, Specific supplier capabilities, Ended up being very satisfied, and green pursuits/innovations of the supplier. Among these, Quality was rated the

best, then Suppliers' green efforts, Customer satisfaction, Supplier's capacity to change, and Top management commitment.

The focus on Quality corresponds to trends that were evident in the past and are still relevant suggesting that the availability Sector of Quality can be recognized as one of the main sources of competitive advantage in the automotive industry (Saragih et al., 2020). Quality is defined as product features, manufacturer's reliability, and ownership experience resulting in customer loyalty. Likewise, the attention to such green activities can be explained by the increasing significance of environmental issues in the sphere. Green innovation defines green goods, green processes and green management and also asserts that improving environmental performance will also correspondingly improve the competitiveness of the economy (Abadi et al., 2021). The third variable that has been identified is customer satisfaction, which emphasizes the need to retain the customers in the supply chain for as long as possible to realize favorable business relations. The suggestions derived from these results also confirm the importance of quality, green innovation, and customer satisfaction in attaining sustainable supply chain in the automobile industry (Junaid et al., 2022).

Conclusion

Monitoring the supply chain is very important for companies where updating their supply chain can improve performance. One of the customers and governments' demands is paying attention to the environment and for this purpose, the companies are trying to increase their sustainability functions. Sustainable supply chain is popular these years in aspect of social, economic and environment. This paradigm increased in paying attention to environment and materials in the whole chain. The automobile industry is a great industry in the world. Countries are trying to invest on this industry to decrease their cost and improve the performance. If the companies' managers focus on the supply chain, it can improve performance. However, for the automobile industry, it is very important to pay attention to green environment invitation because if it does not pass the environment test, the company will not be allowed to send their automobile to the market. At the same time, designing based on market demand to satisfy the customers is very important because it will attract people's attention.

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