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Presenting a Conceptual Model of Sustainable Supply Chain with Indicators in Dimensions of Economic, Social, Environmental, and Governance in Iranian Automotive Industry

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Abstract

Today's competitive world has led managers to shift from traditional management to scientific management. Supply chain management is one of key issues in industries because, considering a high number of competitors in today's competitive world, competition has been extended from company level to the level of competition on their supply chain. For any organization seeking to achieve its goals in conditions of economic competition, timing, and quality of services, especially in an economic environment is characterized by globalization of business and acceleration of industrial cycle.

Thus, this study was conducted to identify supply chain sustainability factors by applying fuzzy Delphi approach. Firstly, by reviewing theoretical literature, four dimensions of economic, social, environmental, and governance were selected as main dimensions as well as 46 indicators as sub criteria. Finally, after three stages of Delphi method, experts agreed on 41 indicators. The indicators that have been most agreed upon by experts are: the use of non-renewable energy in the environmental dimension with a score of 0.84, the rate of employees trained in the social dimension with a score of 0.80, financial performance and market share and quality. In addition, product safety in the economic dimension with a score of 0.77 and interaction and partnership with stakeholders and value creation for shareholders and stakeholders in the governance dimension with a score of 0.77. Now, managers can increase the sustainability of the supply chain by considering these indicators in targeting and formulating the relevant strategy.

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Introduction

Given complex and dynamic business environment of recent years, companies must look for an effective solution in order to survive in fierce global competition market. According to many experts in today's competitive world, competition has shifted from corporate level to the level of competition between their supply chains. Supply chain management has become a strategic issue for any company seeking to achieve its goals in terms of economic competitiveness, time, and quality of service, especially in an economic environment characterized by globalization of business and acceleration of industrial cycle (Ghadikolae and Divkolaei, 2014). Globalization of demands has placed supply chain management beyond economic issues, especially issues such as achieving fair working conditions, environmentally friendly production, and at crossroads of sustainable development, usually in terms of economic, social, and environmental factors. Supply chain management has become a growing concern for companies of all sizes and a wide range of industries. Sustainable environmental and social standards throughout the supply chain ensure companies achieving at least stable performance (Seuring, 2013). Due to growing awareness regarding the environment and sustainability around the world, and increasing community knowledge, organizations cannot ignore sustainability concerns in the business. To increase business performance and competitive advantage, selecting sustainable suppliers is an important decision in industrial supply chain. Sustainability-focused supply chain is concerned with expansion of green supply chain, where it evaluates social metrics along with economic and green metrics from supply chain context. Including environmental, economic, and social aspects to ensure sustainable development has been the most important strategic task of business organizations in recent years. Suppliers can play an important role in implementing supply chain plans and achieving social, environmental, and economic goals (Luthra, 2017). Companies have been forced to facilitate their performance from economic accountability to shareholders to sustainable performance for all shareholders. Sustainability has become a topic involving a process from designing a product to post-consumer product management worldwide. However, it is important to improve not only the company itself but also Supply Chain (SC) performance (M.C. Fritz, 2017).

A summary of the articles reviewed is given in Table (1) (see Table 1 here).

Review of the Literature

Chain is a concept that has been outdated for decades. In the meantime, attempts have been made to come to terms with whole complexity, all-encompassing phenomena that are at core of the lives, which on the other hand they are at heart of them. Concept of sustainable supply chain management has been introduced in recent years (Buyukozkan,2011) . Sustainability is a kind of development satisfying needs of the current generation without limiting ability of future generations to develop their needs. With emergence of concept of sustainability, companies are keen to report sustainability reporting, which is an optional activity with two main objectives: 1) assessing the current status of the organization in terms of social, environmental, economic and governance dimensions 2) sharing firms̀ efforts and improvements in relation to sustainability to shareholders, employees, and their counterparts. Consequently, supply chain sustainability and sustainability measurement has gained a lot of attention in this regard. Concept of sustainability has not yet become popular in Iran (Olfat and Mazrooii, 2014).

Sustainable Supply Chain Management (SSCM) provides economic, social, and environmental needs occurring in materials and service flows between suppliers, manufacturers, and customers. Sustainable supply chain, material flow management, information and capital as well as inter-company collaboration along the supply chain accompanied with the goal of integration across all three dimensions of sustainable development (economic, environmental, and social) are the concepts derived from ideas of relevant stakeholders. In sustainable supply chains, it is the members who apply social and environmental criteria so as to stay within the supply chain (Ghadikolae and Divkolaei, 2014).

Due to growing awareness regarding the environment and sustainability around the world, and increasing community knowledge, organizations cannot ignore sustainability concerns in the business. To increase business

performance and competitive advantage, selecting green and sustainable suppliers is an important decision in industrial supply chain. Sustainability-focused supply chain is dealt with expansion of green supply chain, where it assesses social metrics along with economic and green metrics from supply chain context. Including environmental, economic, and social aspects to ensure sustainable development has been the most important strategic task of business organizations in recent years. Suppliers can play an important role in implementing supply chain plans and achieving social, environmental, and economic goals(Luthra,2017).

In the past decades, a variety of stakeholders have been involved in process of sustainable development. The Triple Bottom Line (TBL), as a very popular theory in business was developed by Elkington in 1998. This view takes into account environmental, economic, and social dimensions. Accordingly, companies have been forced to facilitate their performance from economic accountability to shareholders to sustainable performance for all stakeholders. Sustainability has become a topic involving a process from designing a product to post-consumer product management worldwide. However, it is important to improve not only operations of the company itself, but also performance of the supply chain (M.C. Fritz, 2017).

The automotive industry, as an old and important industry that accounts for a large share of the country's GDP, in all parts of its life cycle, from the exploitation of natural resources, to the manufacture, production, consumption and then direct and indirect consumption. The environment is there. Also, as the domestic car market is saturated, domestic automakers need to focus on the regional and global markets. Due to the increasing pressures and regulations of state and non-governmental organizations and consumer demand, car manufacturers around the world are reinforcing their sustainable management. Therefore, the managers of the automotive supply chain should consider their decisions in addition to current costs, environmental aspects and social costs (Olfat et al,2011).

Proposed Model

In this section, after reviewing the studies on indicators in four economic, environmental, social and governance dimensions of supply chain sustainability are presented in the following table. Figure (1) shows proposed conceptual model of these indicators obtained from using fuzzy Delphi approach, as agreed by the experts.

Table 1. Summary of reviewed papers

Authors	Purpose of the article
Md Abdul Moktadir et al ,2018	this study identifies such barriers and examines the causal relationships between them with an aim to facilitate the effective implementation of SSCM in the Bangladeshi leather processing industry
Deepak Mathivathanan et al ,2018	This study provides a foundation for industrial managers to understand the inter influences among the practices and increases the probability of successful implementation of SSCM practices within the automotive industry.
Fu Jia et al ,2018	The paper concludes by identifying gaps in the literature that require further research on this topic, particularly for the context of developing countries.
Minhao Zhang et al ,2018	This research proposes a hierarchical structure of sustainable supply chain management and develops a multi-item measurement scale to reflect the specific management practices of sustainable supply chain Management.
Ardian Qorri et al ,2018	This study creates better comprehension of how existing approaches evaluate sustainability of supply chains and provides new insights into sustainability performance measurement approaches, supply chain configuration, and metrics selection.
A. Rajeev et al ,2017	This article attempts to understand the evolution of sustainability issues by analyzing trends across industries, economies, and through the use of Various methodologies.
Pezhman Ghadimi et al ,2017	This paper proposes a practical decision making approach to evaluate and select the most sustainable suppliers for an automotive spare part manufacturer licensed under a France-based automotive organization.

Morgane M.C. Fritz et al ,2017	this paper emphasizes the need to define precisely which sustainability aspects can be found in the different dimensions of sustainability and shows the importance of the governance 8dimension in sustainability research
Yevgeniya Arushanyan et al ,2017	This paper presents the sustainability assessment framework for scenarios (SAFS), a method developed for assessing the environmental and social risks and opportunities of future scenarios, provides guidelines for its application and demonstrates how the framework can be applied.
Chun-Mei Su et al ,2016	this study proposes a hierarchical grey decision-making trial and evaluation laboratory method to identify and analyze criteria and alternatives in incomplete information
Hendrik Reefke, David Sundaram,2016	this study confirms, questions and extends knowledge on sustainable supply chain Management. The identified themes are integral for the management and performance of sustainable Supply chains.
Stefan Winter, Rainer Lasch,2016	The research findings contribute to the literature on sustainable supply chain management with empirical insights about the application and importance of environmental and social criteria in supplier evaluation.
Sunil Luthra et al ,2016	This work proposes a framework to evaluate sustainable supplier selection by using an integrated (AHP), (VIKOR), a multi-criteria optimization and compromise solution approach. Initially, 22 sustainable supplier selection criteria and three dimensions of criteria (economic, environmental, and social) have been identified through literature and experts' opinions.
Ali Esfahbodi et al ,2016	this paper develops and empirically assesses an integrated SSCM performance framework underpinned by the Resource Dependence Theory (RDT), Linking SSCM practices and their relationship with organizational performance.
Miriam M. Wilhelm et al ,2016	We employ agency and institutional theory arguments to explore the conditions under which first-tier suppliers will act as agents who fulfill the lead firm's sustainability requirements (i.e., the primary agency role) and implement These requirements in their suppliers' operations (i.e., the secondary agency role).
Jury Gualandris, et al ,2015	We synthesize a model that proposes how firms might address accountability for sustainability issues in their supply chain.
Duygu Turker ,Ceren Altuntas,2014	the current study attempts to fill this void by conceptually mapping the current situation of sustainable supply chain management (SSCM) in the fast fashion industry by analyzing reports from 9 companies That use the same reporting guidelines.
Emilie Chardine-Baumann, Valérie Botta-Genoulaz,2014	we propose a framework for sustainable performance characterization and an analytical model for Sustainable performance assessment. The framework is used to characterize a company's sustainable Performance in the economic, environmental and social fields.
Mohsen Varsei et al ,2014	This paper aims to provide a framework, which can assist focal companies in the development of sustainable supply chains. Sustainable development from an industrial perspective has extended beyond organizational boundaries to incorporate a supply chain approach.
Stefan Seuring,2013	The paper summarizes research on quantitative models for forward supply chains and thereby contributes to the further substantiation of the field.
Atefeh Amindoust et al ,2012	In this paper the sustainable supplier selection criteria and sub-criteria are determined and based on those criteria and sub-criteria a methodology is proposed onto evaluation and ranking of a given set of Suppliers.
Suhaiza Zailani et al ,2012	The study found environmental purchasing has a positive effect on three categories of outcomes (economic, social and operational), whereas sustainable packaging has a positive effect on environmental, economic and social outcomes. The results have empirically proven that SSCM practices have a positive effect on sustainable supply chain performance, particularly from the economic and social perspective.

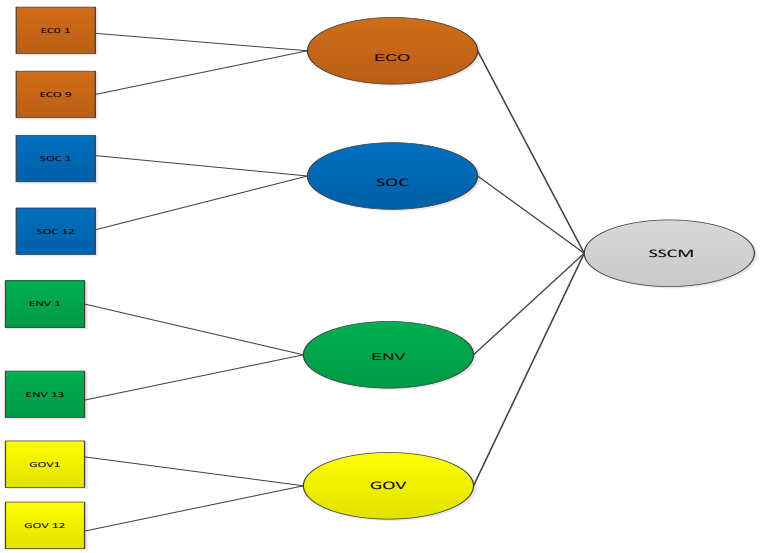

Figure 1. Proposed conceptual model of research

Table 2. Supply chain sustainability dimensions, indicators, and related code

Row	Dimension	Indicators Code	Indicators
1	Economic	ECO 1	Financial performance and market share
2		ECO 2	Amount of income from green products
3		ECO 3	Product quality and safety
4		ECO 4	Timely delivery of goods and services
5		ECO 5	Brand management, brand reputation
6		ECO 6	Economic crisis management
7		ECO 7	Fight against corruption, money laundering, bribery
8		ECO 8	Revenue from recycling
9		ECO 9	Resource Productivity
10	Social	SOC 1	Amount of trained staff
11		SOC 2	Recruitment of local forces
12		SOC 3	Employing local suppliers
13		SOC 4	Entrepreneurial culture and entrepreneurship support
14		SOC 5	Improving infrastructure and community health
15		SOC 6	Support educational and charitable and non-profit institutions
16		SOC 7	Employee management with emphasis on employee social welfare
17		SOC 8	Non-Discrimination in Employment (Employment of Persons with Disabilities and Gender Non-Discrimination)

18		SOC 9	Ethics
19		SOC 10	Occupational Health and Safety
20		SOC 11	Customer Satisfaction
21		SOC 12	Transparency information
22	Environmental	ENV1	The rate of use of non-renewable energy
23		ENV2	The destructive effects of the organization's services and products on the environment
24		ENV3	Not taking into account environmental factors in investments
25		ENV4	Sue management in water, paper, energy consumption
26		ENV5	Lack of waste and waste management
27		ENV6	Lack of energy management in the transportation and replacement of telecommunications technology
28		ENV7	The amount of waste generated
29		ENV8	The amount of noise pollution
30		ENV9	Greenhouse gas emissions
31		ENV10	Use of environmentally friendly raw materials
32		ENV11	Use of dangerous and toxic substances
33		ENV12	The amount of air pollution
34		ENV13	Lack of effective use of byproducts
35	Governance	GOV 1	Engage and engage with stakeholders
36		GOV 2	Create value for shareholders and stakeholders
37		GOV 3	Partner with lawmakers and impartial political assistance
38		GOV 4	Corporate Governance Principles and Compliance with Laws
39		GOV 5	Business values and ethics
40		GOV 6	Diversity of suppliers and relationships based on transparency, impartiality and integrity with suppliers
41		GOV 7	Evaluate suppliers' performance based on principles and policies
42		GOV 8	Having management systems
43		GOV 9	Determine responsibility and power to achieve goals
44		GOV 10	Research and Development
45		GOV 11	Senior Management Commitment
46		GOV 12	Having long-term relationships with suppliers

Research Method

Since, this study was carried out to identify supply chain sustainability factors based on social, economic, environmental, and governance domains, its results can be applied in supply chain management according to the purpose of an applied research. Experts included 7 industry executives who have both worked in-service training and sustainability management. 3 experts were university professors investigated on supply chain sustainability and published ISI papers. Fuzzy Delphi approach was used to refine the indexes and translate experts' opinion. Implementation steps of the fuzzy Delphi method were a combination of performing Delphi method and analyzing information using fuzzy set theory definitions. The fuzzy Delphi peak execution algorithm is shown in Figure (2).

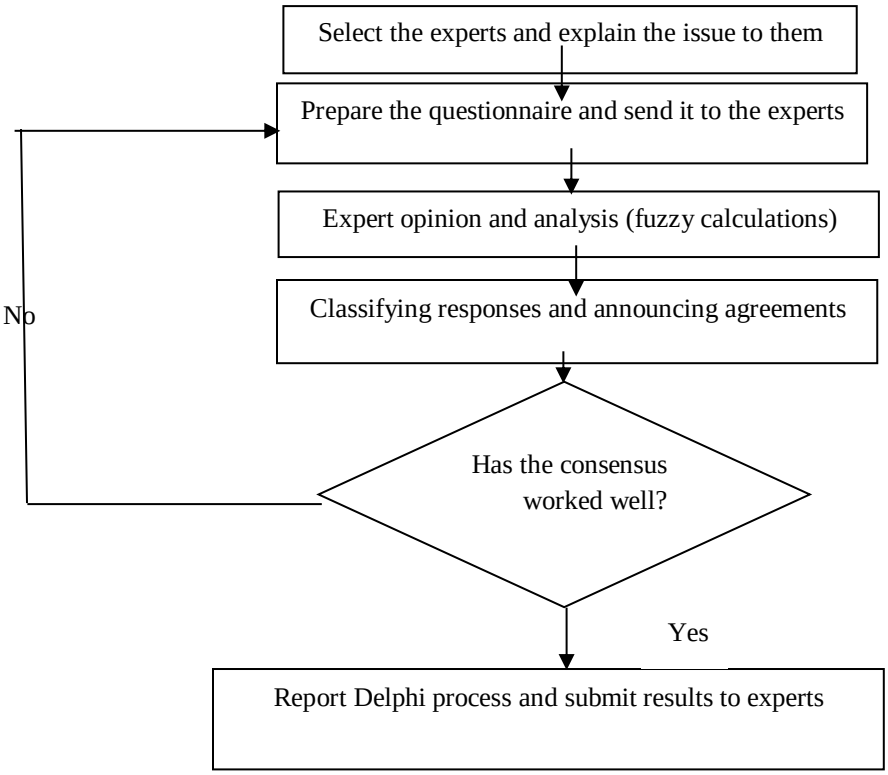

Figure 2. Fuzzy Delphi method implementation algorithm

The most important differences of the fuzzy Delphi method are that, in the fuzzy Delphi technique, the experts usually present their theories in terms of verbal variables, then to obtain average of experts̀ opinion regarding numbers presented and difference in opinion of each expert, the average is calculated and the information is updated. Subsequently, each expert will submit a review or amend his / her previous opinion based on the information from previous step, continuing until mean of fuzzy numbers is sufficiently stable. Therefore, it is also

necessary to study under supervision of groups of experts. That is, one can identify the views of experts on the basis of fuzzy relationships in similar groups by calculating distance between triple numbers and sending their information to target experts.

Research Findings

In addition to reviewing the literature, fuzzy Delphi technique was used to extract indicators and formulate conceptual model as follows:

A) Definition of Linguistic Variables

Formula (1). Minkowski's formula: $X = m + \frac{\beta - \alpha}{4}$

This research questionnaire was designed to gain experts' opinion about the degree of their agreement with the dimensions and components of the model. Since different characteristics of individuals influence their subjective interpretations of qualitative variables, therefore by defining the scope of qualitative variables, experts with the same mentality have answered the questions. Variables were defined as triangular fuzzy numbers according to Table (3) and Figure (3). In Table (3), the fuzzy numbers were calculated using the Minkowski formula as follows:

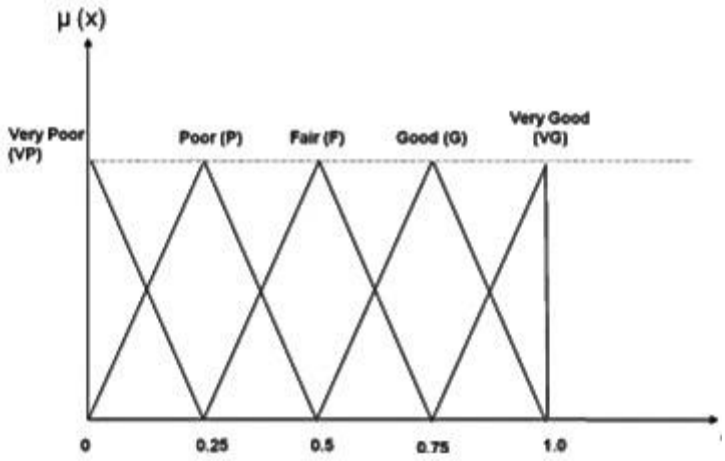

Figure 3.Defining linguistic variables

Table 3. Triangular fuzzy numbers of linguistic variables

Linguistic term	Triangular fuzzy number
Very Good(VG)	(0.75,1,1)
Good(G)	(0.5,0.75,1)
Fair(F)	(0.25,0.5,0.75)
Poor(P)	(0,0.25,0.5)
Very Poor(VP)	(0,0,0.25)

B) First Step Survey

At this stage, presented conceptual model was sent to the experts along with description of the dimensions, components, and criteria, and the degree of agreement with each component was obtained. Considering suggested options and linguistic variables defined in the questionnaire, results of the survey responses are presented in Table 4.

Formula (2):

$$A_1 = (a_1^{(i)}, a_2^{(i)}, a_3^{(i)}), i = 1,2,3,...n$$

Formula (3):

$$A_{ave} = (m_1, m_2, m_3) = (\frac{1}{n}\sum_{i=1}^{n} a_1^{(i)}, \frac{1}{n}\sum_{i=1}^{n} a_2^{(i)}, \frac{1}{n}\sum_{i=1}^{n} a_3^{(i)})$$

In this respect, A_i represents experts' views of i, and A_{ave} represents average views of the experts. Results of these calculations are as follows. Triangular fuzzy mean was calculated using Formula (2), and then was decomposed using Formula (1) (Azar and Faraji, 2001).

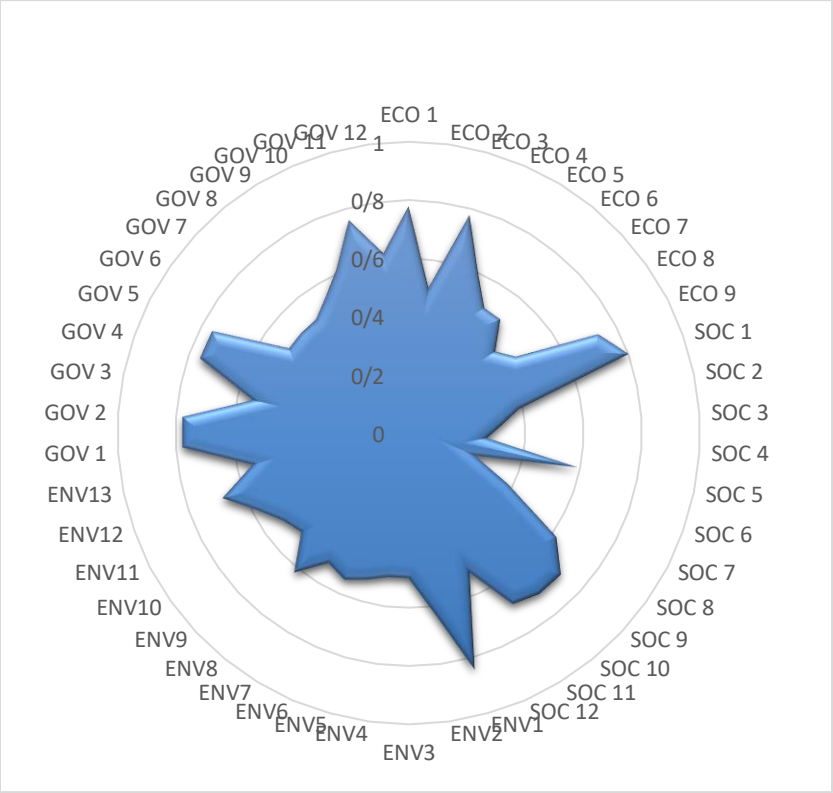

Figure 4. Results of the first phase of the expert survey.

Due to the high volume of fuzzy calculations the tables related to the results of the counting of survey responses, the average views of experts from the survey have been omitted, and the final answer is plotted. As shown in Figure (4), most experts agreed with indicators including trained staff, amount of non-renewable energy use, financial performance and market share, product quality and safety, stakeholder engagement, and value creation for shareholders. Beneficiaries with their least endorsement of entrepreneurship culture can support charities and nonprofit organizations, as well as employing local suppliers, managing staff with an emphasis on social welfare, and hiring local staff. In addition to closed-ended questions in the questionnaire, the experts' views were obtained in form of open-ended questions; and then indicators of the conceptual model were modified.

C): Second Step Survey

At this stage, while making necessary changes in the components, a second questionnaire was prepared and was sent back to the expert group along with previous point of view of each individual and the extent of their disagreement with the viewpoints of other experts. At this stage, the experts again responded to the questions presented with regard to the views of the other members of the group as well as to the changes made to the components, results of which are presented in Figure (5). According to the views presented in the first step and compared with results of this step, if difference between the two steps is less than the threshold (0.1), then polling process stops.

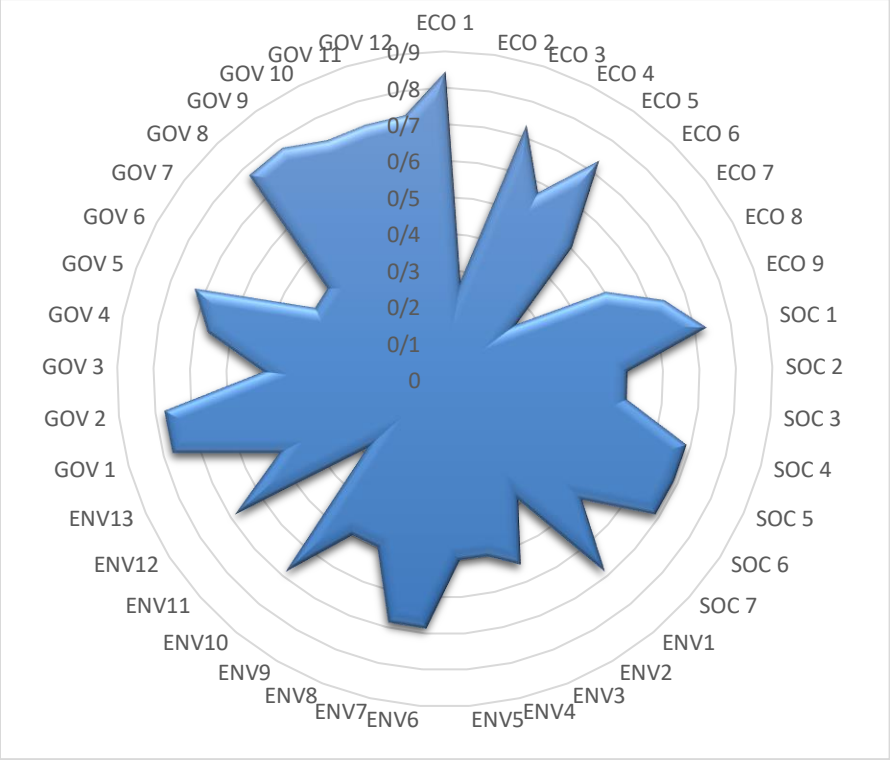

Figure 5. Results of the second phase of the expert survey

Formula (4):

$$s(A_{m2}, A_{m1}) = \left| \frac{1}{3} \left[(a_{m21} + a_{m22} + a_{m23}) - (a_{m11} + a_{m12} + a_{m13}) \right] \right|$$

Table 4. Experts' opinion differences in stage I and II surveys

Row	Dimension	Indicators Code	differences in stage I and II
1	Economic	ECO 1	0.06875
2		ECO 2	**0.23125**
3		ECO 3	0.04375
4		ECO 4	0.03125
5		ECO 5	**0.23125**
6		ECO 6	0
7		ECO 7	**0.1625**
8		ECO 8	0.05
9		ECO 9	0.09375
10	Social	SOC 1	0.06875
11		SOC 2	0.09375
12		SOC 3	**0.11875**
13		SOC 4	0.025
14		SOC 5	0.025
15		SOC 6	0
16		SOC 7	0.025
17	Environmental	ENV1	**0.15625**
18		ENV2	**0.28125**
19		ENV3	0.05
20		ENV4	0
21		ENV5	0.025
22		ENV6	**0.1375**
23		ENV7	**0.1625**
24		ENV8	**0.1195**
25		ENV9	0
26		ENV10	**0.1625**
27		ENV11	**0.29375**
28		ENV12	0.0125
29		ENV13	0.04375
30	Governance	GOV 1	0
31		GOV 2	0
32		GOV 3	0.04375
33		GOV 4	0.09375
34		GOV 5	0.025
35		GOV 6	0.09375
36		GOV 7	0.09375
37		GOV 8	0.275
38		GOV 9	**0.23125**
39		GOV 10	**0.11875**
40		GOV 11	0.025
41		GOV 12	**0.1125**

D): Third Step Survey

According to the above table and considering that the difference between the two stages is less than (0.1) (using formula 4), experts have reached a consensus. Otherwise, the survey to the next step continues, so the survey continues with 13 indicators.

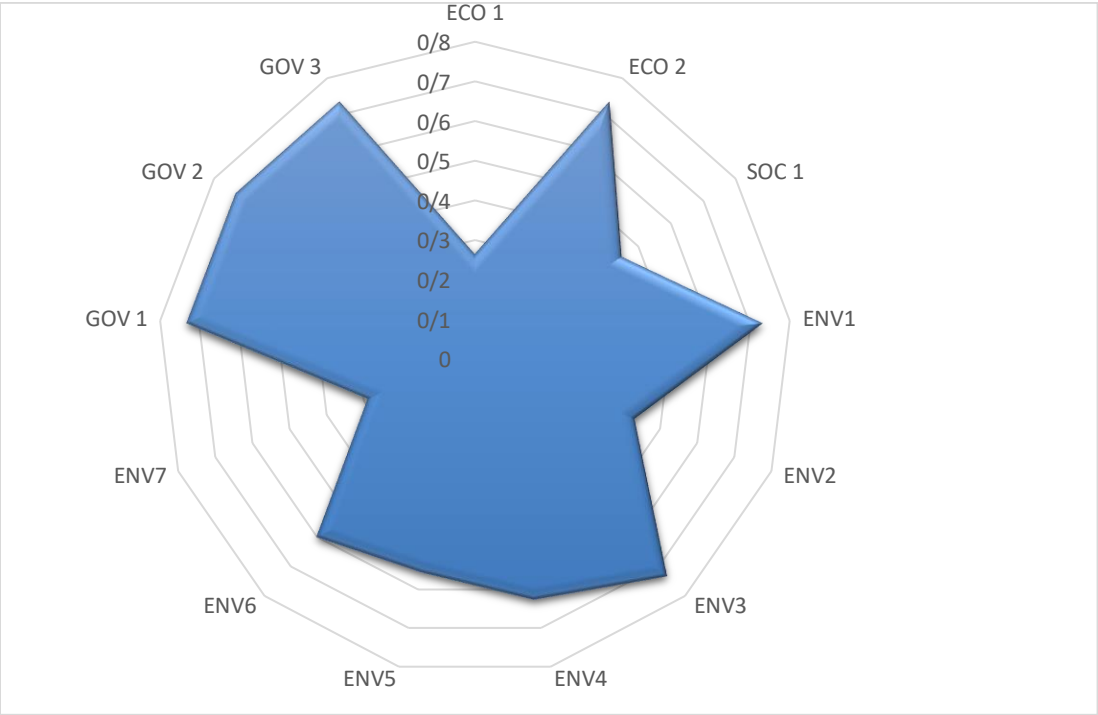

Figure 5. Results of the third phase of the expert survey

"Table (5). Experts' opinion differences in stage II and I I I surveys"

Row	Dimension	Indicators Code	differences in stage II and I I I
1	Economic	ECO 1	0.00625
2		ECO 2	0
3	Social	SOC 1	0.05
4	Environmental	ENV1	0.04375
5		ENV2	0.09375
6		ENV3	0.04375
7		ENV4	0.0625
8		ENV5	0.05
9		ENV6	0.0875
10		ENV7	0
11	Governance	GOV 1	0.04375
12		GOV 2	0
13		GOV 3	0

As noted in above table, the experts' disagreement in the second and third stages is below “the very low threshold” (0.1), so polling stops at this stage. Therefore, during the three survey phases of determining 46 indices, final conceptual model of the study had 41 indices.

Discussion and Conclusion

This study was conducted to identify supply chain sustainability factors in economic, social, environmental, and governance dimensions by applying fuzzy Delphi approach. Then, the experts were provided with fuzzy calculations and finally a final conceptual model was presented.

Regarding economic aspect, four indicators of financial performance and market share, product quality and safety, timely delivery of goods and services, and brand management were accepted as four most important indicators. Therefore, in order to sustain the supply chain, companies must take measures for each indicator. For example, financial performance index and market share need to be enhanced in order to supply products at a reasonable price to gain more market share.

In relation to environmental dimension, five indicators of non-renewable energy use, lack of energy management in transport and telecommunication technology replacement, amount of generated waste, the use of environmentally harmful raw materials, and level of air pollution were the most important indicators. It should be noted that these indicators were taken into account with respect to the problems in our country's industry. Energy management and pollution were considered as important issues.

In terms of social dimension, four indicators were accepted as important indicators by the experts such as trained staff, professional ethics, occupational health and safety, and customer satisfaction.

In regards to governance, as it has been less studied in the literature, 5 indicators of stakeholder engagement, stakeholder value creation, corporate governance principles, and compliance with laws, management systems, accountability, and power to achieve pursued goals were determined by the experts.

The indicators that have been most agreed upon by experts are: the use of non-renewable energy in the environmental dimension with a score of 0.84, the rate of employees trained in the social dimension with a score of 0.80, financial performance and market share and quality. In addition, product safety in the economic dimension with a score of 0.77 and interaction and partnership with stakeholders and value creation for shareholders and stakeholders in the governance dimension with a score of 0.77. Now, managers can increase the sustainability of the supply chain by considering these indicators in targeting and formulating the relevant strategy.

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