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Research Paper

Identifying and Prioritizing Supply Chain Sustainability Indicators for Perishable Products Via Grounded Theory and Fuzzy Hierarchical Analysis Approach

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Abstract **Supply chain coordination from supplier selection stages to customer delivery is among the issues creating the most challenges for supply chain management, especially for short-lived and perishable foodstuffs. The current study aims to identify and rank the factors involved in sustainable supply chain in the dairy industry. In this qualitative research, by reviewing the theoretical literature and surveying specialists and experts, the factors affecting supply chain sustainability and the sustainable supply chain dimensions (i.e., economic, social, and environmental) were identified. The determined factors were then ranked. To this end, the analytic hierarchy process (AHP) was used as a decision-making technique and the targeted snowball sampling method was used for sampling. In the qualitative stage, factors were extracted from open interviews with 15 academic experts active in the field of sustainable development and experts in the dairy industry. The social dimension with a weight of 0.493 was recognized as the most**

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important dimension of the sustainable supply chain according to the researchers and experts in the dairy industry. After that, the economic dimension with a weight of 0.314 was in the second rank, and finally, the environmental dimension with a weight of 0.193 was third in rank.

Keywords *Dairy Industry, Fuzzy Decision-Making Techniques, Sustainable Development, Sustainable Supply Chain*

Introduction

Due to the increasing importance of the environmental effects of industrialization, which can harm the quality of human life and the environment, sustainability has become the focus of many organizations (Aydiner, Sen, Koseoglu-Imer, & Dogan, 2016; Soltani, 2018). Green production aims to increase product compatibility with the environment without affecting performance or the quality of the product. The concept of a sustainable supply chain in the 1990s focused mainly on suppliers and green purchases. In the late 1990s, sustainable supply chain management (SCM) expanded to include concepts such as reverse logistics, internal environmental management of supply chain, environmental design, and customer engagement with environmental concerns (Zhu, Feng, & Choi, 2017). Supply chain management, which includes all activities related to the flow of goods and services from raw materials to final consumer delivery in parallel with the flow of information throughout the supply chain, has a significant impact on the environment (Seuring & Müller, 2008). Sustainable SCM as an approach that involves management of materials, information, capital flow, and cooperation between supply chain companies is considered through the optimal fit between objectives (economic, environmental and social) (Brandenburg & Rebs, 2015; Touboulic & Walker, 2015; Tseng, Lim, & Wong, 2015), which leads to the profitability of organizations via improving competitive advantage, reducing supply chain risk, lowering

production risks, increasing revenue, improving customer service and inventory level, and promoting customer satisfaction (Mangla, Kumar, & Barua, 2015; Panigrahi, Bahinipati, & Jain, 2019; Rostamzadeh, Ghorabaee, Govindan, Esmaeili, & Nobar, 2018; Tseng et al., 2015). Numerous studies have shown that companies are moving towards sustainability strategies and sustainable SCM methods (Sgarbossa & Russo, 2017). Sustainable supply chain for short-lived and perishable goods has always been one of the most essential and challenging management issues of all times (Ehsani & Mehrmanesh, 2021). Short-lived goods, especially dairy products, pose the greatest challenges to SCM. These obstacles are mostly due to diversity in the number of these goods, special need for tracking the flow of goods during the short supply chain of food products, and the need to control the temperature in the supply chain. Furthermore, the high volume of goods that move through the supply chain makes it an obligation to decide on the most efficient processes. Consequently, efficient SCM is of paramount importance for short-lived goods, especially foodstuffs. Since increasing the rate of return on capital is one of the main goals of any industry, creating continuity and consequently, rapid movement in the chain is one of the most basic needs of the food supply chain (Jakhar, 2014). Unlike other products, the quality of products that have a short life, such as perishable dairy products, is constantly reduced during supply chain activities. One of the main goals in the distribution of perishable products, especially in the dairy supply chain, is their on-time delivery to the customer. This issue has a direct impact on the responsiveness of the supply chain network. In this regard, choosing a profitable distribution network is a key factor in managing the procurement system. In the supply chain of perishable materials, more focus should be placed on the quality of goods and minimizing shipping time or maximizing product quality at the time of delivery. In addition to transportation costs and

accountability in the optimization of the logistics system, the stability of the supply chain should also be considered (Musavi & Bozorgi-Amiri, 2017). Fars Province plays an important role in the production of numerous agricultural products, and 14% of the province's industries are formed by the conversion and complementary industries of the agricultural sector. The dairy sector accounts for a significant percentage of the total agricultural production in Fars Province. Considering the important position of the dairy industry in Iran, the current study inspects the issue of sustainability in the supply chain as one of the most important concerns of senior managers of the dairy industry. The dairy industry supply chain is one of the most sensitive supply chains because it is directly related to human health and the society. Since supply chain network design, sustainable supply chain network design, and sustainable food supply chain network design have already been assessed in the literature, this study is limited to perishable products. Although stability of the supply chain in the food industry is very important, especially in Fars Province due to the traditional structure of food and dairy production, studies in this field are few and there is a wide information gap in this regard. This study aimed to identifying and prioritizing supply chain sustainability indicators for perishable products via grounded theory and fuzzy hierarchical analysis approach.

Literature Review

The surging consumption of fossil fuels and underground resources and damage to the environment have created a trend that, if continued, will lead to unsustainable growth and development. Industrial activities is the main factor in propelling the economic cycle. Due to the nature of their technologies, industries are a potential cause of environmental pollution, and owing to their connection with the society for the supply of raw materials,

labor, and customers of goods, they cause many social problems. Because supply chain start from the processing of raw materials to delivery to the customer and sometimes vice versa (reverse logistics), focusing on the supply chain in a sustainable development environment will be a step forward for the broader adaptation of the production environment to sustainable development. Changes in production policies force both manufacturers and researchers to strive to improve operations in terms of supply chain development (Arampantzi & Minis, 2017). So far, numerous studies have assessed the applicability of support system for fresh food supply chain management (Dellino, Laudadio, Mari, Mastronardi, & Meloni, 2018). Zhao proposed relatively comprehensive frameworks of indicators to identify sustainable performance in the industry and examine the methods of sustainable development of the dairy supply chain in Italy to improve sustainable development practices in the industry. Based on the obtained results, indicators were identified as the most significant factors affecting sustainability, among which social activities was the most essential in the dairy industry and purchasing, while the requirements for greenhouse gas emissions were the least important (Zhao, Liu, Zhang, & Huang, 2017). In another study, Mathivathanan et al. inspected the dynamic capabilities of companies' sustainable supply chain performance using a hierarchical structure. The results revealed that the dynamic capabilities of companies can have a positive effect on the supply chain sustainability performance of Indian industrial companies (Mathivathanan, Govindan, & Haq, 2017).In one study by Chung and Kwon, an integrated supply chain management model was assessed for perishable pharmaceutical items (Chung & Kwon, 2016). In another study, food supply chain model was applied for shelf life of products on smart logistic units (La Scalia, Nasca, Corona, Settanni, & Micale, 2017). The role of perishable food supply chain was highlighted by

Hiassat et al. for solving inventory routing location-allocation model optimization (Hiassat, Diabat, & Rahwan, 2017). Jouzdani et al. designed a multi-objective mathematical programming model to optimize the cost and energy consumption of supply chain operations. They concluded that decision-makers need to decrease the environmental and social problems of the supply chain without compromising the economic aspects (Jouzdani & Govindan, 2021).The literature on sustainable supply chain network design was reviewed by Eskandarpour et al. (Eskandarpour, Dejax, Miemczyk, & Péton, 2015). In this regard, sustainable food supply chain network design problem is a more limited topic, which was addressed in a book chapter by Bloemhof and Soysal and in a review by Zhu et al. (Bloemhof & Soysal, 2017; Smith, Nachtmann, & Pohl, 2012). A non-linear mathematical programming model was suggested by Dutta and Shrivastava for the perishable food supply chain network design problem, which followed a scenario-based approach (Dutta & Shrivastava, 2020). The robustness and resilience of agricultural supply chains was assessed by Behzadi et al. (2017), who developed a two-stage stochastic programming model in the aforementioned study for assessing the perishability of products as an exponential random variable (Behzadi, O'Sullivan, Olsen, Scrimgeour, & Zhang, 2017). The location-allocation problem for the design of cold chains was assessed in Singh et al. study, which showed perishability was related to the deterioration of product value. In the aforementioned study, a single-objective model was suggested for cost minimizations (Behzadi et al., 2017). To our knowledge, temperature should be considered as one of the most key characteristics of perishable food supply chain network. Based on one study, perishability rate of baby food is higher than 10%, accordingly the net present value of the chain may become negative (Kovačić, Hontoria, Ros-McDonnell, & Bogataj, 2015). Manouchehri et al. applied a single-objective

mathematical programming model for the production-routing of perishable products, which showed a remarkable potential for decreasing the costs related to optimized inventory levels and temperatures (Manouchehri, Nookabadi, & Kadivar, 2020). Perishability of products is a main factor affecting decision-making processes. In this regard, interest rate and perishability should be considered in the literature. Based on previous studies, temperature as an important factor in the design and planning of perishable food supply chain design should be given special attention (Jouzdani & Govindan, 2021). Product perishability plays a remarkable role in the strategies and decisions regarding the perishable food supply chain network design (Hiassat et al., 2017). In this regard, the perishability of food products should be considered as a stochastic process. On the other hand, the conditions under which products are transported play an important role in the deterioration of products; however, there is a lack of studies on perishable supply chain networks in the literature. Moreover, the multiple periods of time in the planning horizon and the impact of temperature changes in different time periods should be addressed (Jouzdani & Govindan, 2021). Amiri and Mousavi (2017) designed a linear programming model for the sustainable supply chain of perishable materials. The main advantage of the model is its application in the sustainable supply chain of perishable products, such as foods, fruits, vegetables, dairy, and other sensitive products. They showed that the network response with increasing the number of vehicles increases and the carbon dioxide emissions are affected by the number of vehicles and shelf life (Musavi & Bozorgi-Amiri, 2017). Another study designed a two-tier supply chain model with two manufacturers and two retailers to develop a competitive structure (Ehsani & Mehrmanesh, 2021). Regarding identifying supply chain sustainability indicators and introducing the frameworks and models presented for it,

Hadizadeh Andvari (2015) identified a set of sustainability indicators affecting the supply chain of the dairy industry. Their findings indicated that Kaleh Company had the best performance in terms of supply chain stability among the four selected companies and Saleh, Gola, and Dosheh companies were in the next ranks (Hadizadeh Andvari, 2015). Supply chain sustainability as a new and highly influential issue has recently attracted the attention of researchers in the field of SCM (Safaei Ghadikolaei, 2015). Evaluation, which includes aspects of sustainability, is different from traditional and business-oriented performance evaluations. When dimensions of sustainability are considered, the scope of assessment should be expanded. Sustainable development includes not only the economic dimension, but also the environmental and social dimensions. An industry is considered sustainable when it produces goods and services in such a way that while fully estimating the needs of the current generation, it does not limit the future capabilities in meeting the potential needs (Khaledi, 2016).

Method

This applied qualitative research was performed among academic experts active in the field of sustainable development and experts in the food industry and dairy production. The members of this community are people who have executive or research expertise related to the dimensions of sustainability in the field of supply chain in the dairy industry. The data collection tool included a questionnaire designed based on structured interviews. The validity of this study was confirmed through interviews with several experts. In this approach, the phenomena were examined in their natural condition based on the grounded theory.

Findings

First, a list of supply chain sustainability indicators in the dairy industry of Fars Province was prepared. The theoretical basis of this study is to provide a model of supply chain sustainability in the dairy industry in Fars Province. For this purpose, Pegah, Ramek, Mani Mass, Dietif Shandiz, and Arjan companies were selected. To achieve a rich description of the experiences, attitudes, and perceptions of the interviewees to identify the indicators of supply chain sustainability, qualitative research methods, and in particular the strategy of Strauss and Corbin, the grounded theory, have been used. The interviewees included 15 experienced specialists, with whom in-depth interviews were conducted to recognize the main characteristics and criteria of supply chain sustainability. These concepts included environmental, social, and economic dimensions in the discussion of sustainability. Due to the large number of questions asked, on the one hand, and the specialization of the questions, on the other, the questionnaire was completed only for experts active in the field of dairy industry. Consequently, academic experts, food and trade experts of Fars Province, and experts of the dairy industry were among the statistical population of the study. According to the minimum and maximum sample size required for completing the supplementary questionnaires, 15 individuals from this community were selected as the statistical sample. From a statistical sample of 15 individuals, six university experts, three experts from the food and trade department of Fars province, and six experts from the dairy industry were selected using the targeted and snowball sampling method. To form the basic system (data collection), brainstorming (interviews with experts) and reviewing the related documents and the long-term trend of variables were performed. The average time for each interview was 50 minutes. Theoretical sampling continued until the categories reached theoretical saturation. The

interview questions were open-ended and, based on the dimensions of the grounded theory, we explored all the dimensions and criteria of supply chain sustainability in three dimensions to clarify the phenomenon based the data obtained from the interviews. All the interviews were recorded with the permission of the interviewees. To analyze the data, the method of microscopic analysis of data (microanalysis) was used. Data were then analyzed through a coding process based on the systematic design of Strauss and Corbin's grounded theory (Corbin & Strauss, 2014).

Open Coding and Concept Extraction: The data were analyzed line by line and presented in the form of concepts. Coding at this stage was performed in two ways using the words of the interviewees and based on the concepts in the data (Tables 1-3).

Table 1.
Open Coding of Interview Data in the Economic Dimension

Economic dimension			
Code	**Concept**	**Code**	**Concept**
1	The economic value of dairy products in supply centers	12	Fluctuations in livestock and animal feed prices
2	Granting subsidies to farmers	13	The amount of milk source control
3	Product return rates	14	Manipulation of milk quality by farmers
4	Productivity rate	15	Invest in long-term growth
5	Number of product supply markets	16	Strengthen the brand name
6	Raw milk quality	17	Coverage of retirement plans
7	Dairy quality and safety	18	The time horizon of product demand

Economic dimension			
Code	**Concept**	**Code**	**Concept**
8	Risk management and economic opportunities	19	The time horizon of product production in the market
9	Geographical focus with suppliers and the number of raw milk suppliers	20	Concluding contracts with suppliers to purchase raw milk
10	Purchase cost from local suppliers	21	Diverse investment in the dairy industry
11	Cost of transportation and storage of milk and products between production and market centers	22	Cost of testing and inspection of products and milk

Table 2.

Open Coding of Interview Data in the Environmental Dimension

Environmental dimension			
Code	**Concept**	**Code**	**Concept**
1	Time and place interval between dairy supply and market and optimization of delivery and supply routes	12	Train staff to get involved in the waste reduction process
2	The capacity of the vehicle used to transport raw milk and products	13	Air pollution
3	Temperature circulation in refrigerators and machinery transporting products	14	Implementation and improvement of the company's wastewater treatment system
4	Energy consumption and renewable resources throughout the supply chain	15	Design / modify products/packaging to reduce energy and water consumption at all stages of the product life cycle
5	Company measures to reduce greenhouse gas emissions (ammonia vapor, methane, ozone-depleting drains, etc.) along the supply chain	16	Design / modify products/packaging to reduce the production of pollutants into the air, water, and soil at all stages of the product operation cycle

6	Design / modify products/packaging to reduce energy and water consumption at all stages of the product life cycle	17	Distinguish the design of products and services of the company's products from the main competitors
7	Use of Saiphoo method in use in materials	18	Water consumption
8	Receive the required raw materials on time	19	The use of purified water in the production process
9	Recycling and reuse of materials	20	Eliminate over-packaged materials and transport and optimize the load of vehicles
10	Number of endangered species of the company's operations	21	Assistance in habitat protection
11	Ethical use of livestock and animals	22	Forage and animal productivity

Table 3.

Open Coding of Interview Data in the Social Ddimension

Social dimension			
Code	**Concept**	**Code**	**Concept**
1	Frequency of dairy safety accidents	21	Non-discrimination based on gender in employment, remuneration, education, promotion, and retirement
2	Occupational health insurance	22	Anti-competitive behavior
3	Average hours of training and capability per year per employee	23	The average score of employee performance appraisal
4	Implementation of subsidized milk distribution plan in schools	24	Periodic examinations and evaluation of workplace cycles
5	Compliance with the standards and laws and regulations of the society (Labor Law - Trade Law)	25	Number of workplace health and safety control committees

Social dimension			
Code	**Concept**	**Code**	**Concept**
6	Use mechanized systems to receive orders from customers	26	Make periodic calls to customers and receive feedback from them
7	Employee participation in decision making	27	No ethnic, racial, religious discrimination in employment, rewards, education, promotion, and retirement
8	Novelty and variety of products	28	Implications for supply chain labor practices
9	Observance of ethical principles and equality of employees	29	Product description and provide appropriate information
10	The level of support for sustainable employment	30	Establish sales agents in different areas
11	Producing low fat and low salt diet products	31	Considering customer demands in product packaging
12	Fast delivery time and response	32	Increase advertising and personal sales
13	Improving public knowledge and community culture about the benefits of dairy	33	Production of ultrasonic products to increase the body's immunity
14	Total number of business units to analyze corruption risks	34	Staff overtime rates
15	Handling employee complaints, evaluated opinions in the company.	35	Serious employment rate and labor turnover
16	Paying attention to the nutrition and consumption pattern of the community	36	Standard working hours

Social dimension			
Code	**Concept**	**Code**	**Concept**
17	The amount of protein, fat, vitamins, lactose, calcium in milk	37	Compensation for proper staff services
18	No wage gap between working groups with similar work	38	Produce attractive children's products such as flavored milk and cheese
19	Consider labor standards to screen suppliers	39	Having ethical codes
20	Labor force composition by gender (female, male)	40	Informing and educating about anti-corruption practices and policies and the percentage of trained staff

Axial coding and category extraction: At this stage, the extracted concepts were compared with each other and their relationships were determined. Then, similar concepts were placed in one category. Thus, at this stage, extensive classes and subclasses were described (Table 4).

Table 4.
Axial Coding

Economic dimension	
The main criterion	**Sub-criteria**
Economic performance	**The economic value of dairy products in supply centers** **Risk management and economic opportunities** **Productivity rate** **Coverage of retirement plans**
Procurement procedures	**Purchase cost from local suppliers** **Cost of transportation and storage of milk and products between production centers and markets** **Cost of testing and inspection of products and milk**

Economic dimension		
The main criterion		**Sub-criteria**
Vulnerability		**Manipulation of milk quality by farmers** **The amount of milk source control** **Number of product supply markets** **The time horizon of product production in the market** **The time horizon of product demand** **Fluctuations in livestock and animal feed prices**
Investment		**Diverse investment in the dairy industry** **Invest in long-term growth**
Product safety and quality		**Raw milk quality** **Product return rates** **Dairy quality and safety**
Presence in the market		**Granting subsidies to farmers** **Concluding contracts with suppliers to purchase raw milk** **Geographical focus with suppliers and the number of raw milk suppliers** **Strengthen the brand**
Environmental dimension		
The main criterion		**Sub-criteria**
Green production	Materials and energy	**Energy consumption and renewable resources throughout the supply chain** **Recycling and reuse of materials** **Train staff to get involved in the waste reduction process**
	Water	**Water consumption** **The use of purified water in the production process**
	Atmosphere	**Air pollution** **Company actions to reduce greenhouse gases (ammonia vapor, methane, ozone-depleting particles ...) throughout the supply chain** **Implementation and improvement of the company's wastewater treatment system**

Economic dimension	
The main criterion	**Sub-criteria**
Biodiversity	**Assistance in habitat protection** **Number of endangered species of the company's operations**
Green logistics (Transportation and warehousing)	**Time and place interval between dairy supply and market and optimization of delivery and supply routes** **The capacity of the vehicle used to transport raw milk and products** **Receive the required raw materials on time** **Using Saiphoo method in using materials** **Temperature circulation in refrigerators and machinery transporting products** **Eliminate over-packaged materials and transport and optimize the load of vehicles**
Green design	**Product/product design/packaging to reduce the production of pollutants into the air, water and soil at all stages of the product life cycle** **Design / modify products/packaging to reduce energy and water consumption at all stages of the product life cycle** **Design / modify products/packaging to reduce raw material consumption during all stages of the product life cycle** **Distinguish the design of products and services of the company's products from the main competitors**
Green Strategy	**Forage and animal productivity** **Ethical use of livestock and animals**
Animal welfare	
Staff Recruitment	**Serious employment rate and labor turnover** **The level of support for sustainable employment** **Standard working hours** **Staff overtime rates** **Compensation for proper staff services**

Economic dimension		
The main criterion		**Sub-criteria**
	Occupational safety and health	**Frequency of dairy safety accidents** **Number of workplace health and safety control committees** **Occupational health insurance** **Periodic examinations and evaluation of workplace cycles**
	Education	**Average hours of training and capability per year per employee**
		Employee participation in decision making **The average score of employee performance appraisal**
	Equal opportunity	**Labor force composition by gender (female, male)** **Observance of ethical principles and equality of employees**
	Non-discrimination and meritocracy	**No wage gap between working groups with similar work** **Non-discrimination based on gender in employment, remuneration, education, promotion, and retirement** **No ethnic, racial, religious discrimination in employment, rewards, education, promotion, and retirement**
	Grievance Mechanisms of Community Workforce Procedures	**Handling employee complaints, evaluated opinions in the company.**
	essing suppliers without labor practices	**Consider labor standards to screen suppliers** **Implications for supply chain labor practices**

Economic dimension		
The main criterion		**Sub-criteria**
Customers	Product and service labeling	**Novelty and variety of products** **Use mechanized systems to receive orders from customers** **Make periodic calls to customers and receive feedback from them** **Establish sales agents in different areas** **Product description and provide appropriate information** **Fast delivery time and response** **Considering customer demands in product packaging**
	Consumer safety and health	**The amount of protein, fat, vitamins, lactose, calcium present in milk** **Production of low fat and low salt diet products** **Production of ultrasound products to increase the body's immunity** **Produce attractive children's products such as flavored milk and cheese**
	Marketing Communications	**Increase advertising and personal sales** **Implementation of subsidized milk distribution plan in schools**
Society	Local communities	**Improving public knowledge and community culture about the benefits of dairy** **Paying attention to improving nutrition and community consumption patterns** **Having ethical codes**
	Compliance with the rules	**Compliance with the standards, laws, and regulations of the society (Labor Law-Commercial Law)**
	Anti-competitive behavior	**Anti-competitive behavior**
	Fight against corruption	**Total number of business units to analyze corruption risks**
		Informing and educating about anti-corruption practices and policies and the percentage of trained staff

Selective coding and central category extraction: The coded sentences were reassembled to make the relationship between them understandable, and then a diagram was drawn. The main trajectory of the story and the relationship between the main category and other categories were determined. In the selective coding stage, common areas were identified and by integrating the categories, 22 indicators in the economic dimension, 22 indicators in the environmental dimension, and 40 indicators in the social dimension were identified. To assess the validity of the present study, the final report of the first stage of the analysis process and the obtained categories, along with the statements extracted from the interviews and the transcripts of the interviews were sent to three interviewees and their suggestions were applied in open and axial coding. Also, in line with the codes and the relationships between them, studies, conducted in this field were used to develop a model. To conduct accurate and precise interviews, we first conducted two experimental interviews and after the initial analysis, the obtained results were compared with the research objectives and questions, and to increase the accuracy of the research tool, the questions were modified and prioritized. In the conceptual model presented in Figure 1, the main and sub-criteria in the economic, social, and environmental dimensions are the factors of supply chain sustainability in the dairy industry (Fars province). Economic factors in this model include economic performance, supply procedures, vulnerability, investment, safety, quality of products, and market presence. Environmental factors presented in this model consist of green production, green logistics, green design, and green strategy. The green production section includes materials, energy, water, atmosphere, and biodiversity, and the green strategy section includes animal welfare, each of which has specific criteria. The social sector in this study also includes the three sub-sectors of employees, customers, and society. In

the field of staff, employment, safety, occupational health, education, equal opportunity, non-discrimination and meritocracy, grievance mechanisms about community labor practices, and supplier evaluation for workforce procedures were classified as the main criteria. The customer segment included product and service labeling, consumer safety and health, and marketing communications, and finally, the community segment entailed local community standards, compliance, anti-competitive behavior, and the fight against corruption. In the second stage of the research, the indicators and criteria extracted from the opinions of experts and specialists in the sustainable supply chain were prioritized using the hierarchical analysis procedure (AHP). The opinions of 15 experts were used for analysis.

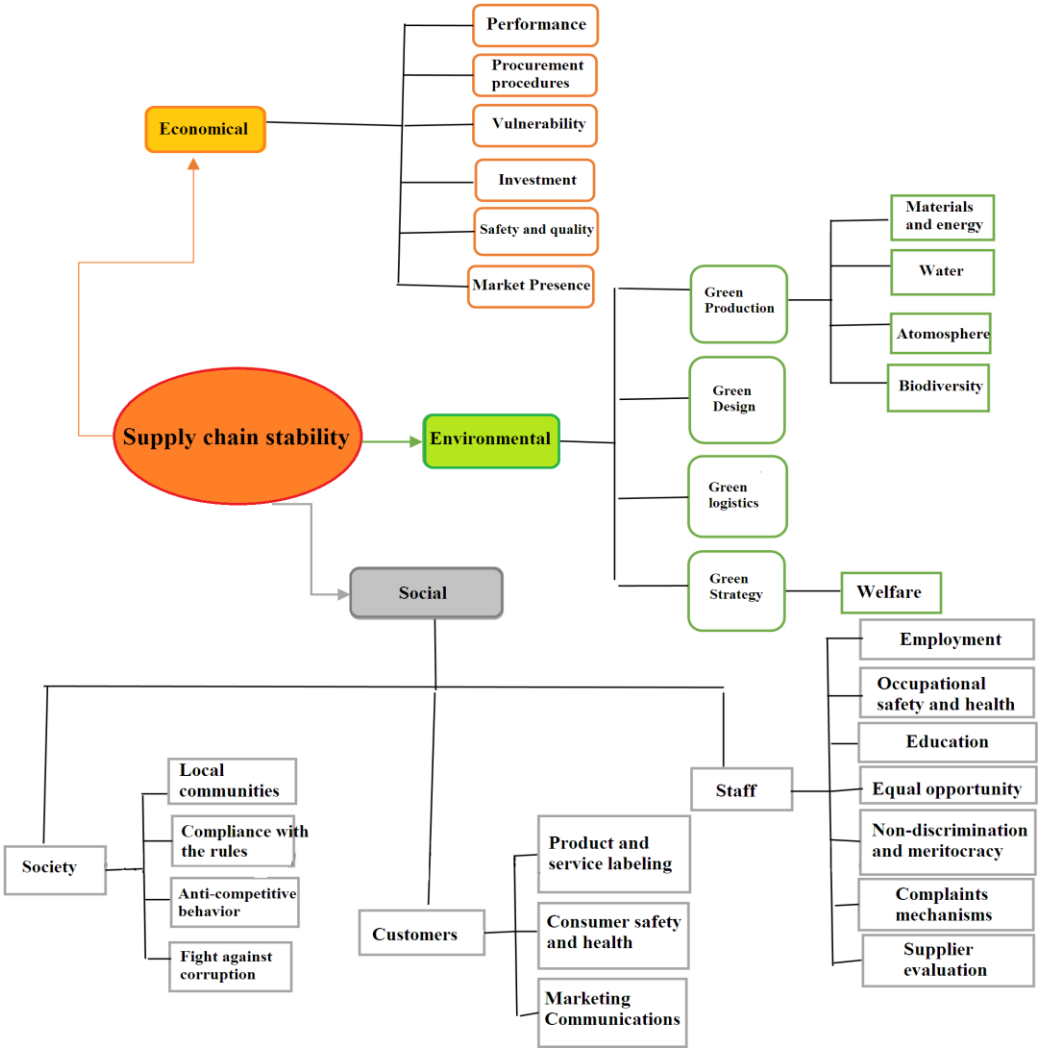

Figure 1. Selective coding. Source: Findings of conducted research and studies

After determining the research indicators, the AHP method was used to determine their importance and weight. In this study, first, pairwise comparisons of dimensions and indicators were made and provided to the experts. The number of experts in this section was 15 people. After the pairwise comparison matrices, the incompatibility rates of each were calculated, all of which were less than 0.1, which indicates the stability and compatibility of the matrices. Then, the pairwise comparisons of the experts were integrated by the geometric method and then entered to the Expert Choice software to determine the weight. The following are the results of the pairwise comparisons and weights. In this section, pairwise comparison of the three main dimensions is presented in Table 5. The inconsistency rate of these pairwise comparisons was 0.008, and because it is less than 0.1, it indicates acceptable compatibility.

Table 5.
Pairwise Comparison of Criteria with the Target

	E	**M**	**S**
E		1.577	0.657
M			0.381
S			

After entering the pairwise comparisons in the expert software, the weights of the criteria were as shown in Figure 2. According to Figure 2, the social dimension (S) with a weight of 0.493 ranked first, economic dimension (E) with a weight of 0.314 ranked second, and the environmental dimension (M) with a weight of 0.193 ranked third.

Figure 2. Weights of the main dimensions

The final weights of the economic dimension sub-criteria were calculated by multiplying the weight of the main criterion by the sub-criteria, which is shown in Figure 3. The sub-criterion of raw milk (1-E5) (with a weight of 0.178) ranked first among the 22 sub-criteria. Dairy quality and safety (3-E5) and various investments in the dairy industry (1-E4) with the weights of 0.090 and 0.074, respectively, ranked second and third. The sub-criterion of cost of testing and inspection of milk products (3-E2) with a weight of 0.009, ranked last.

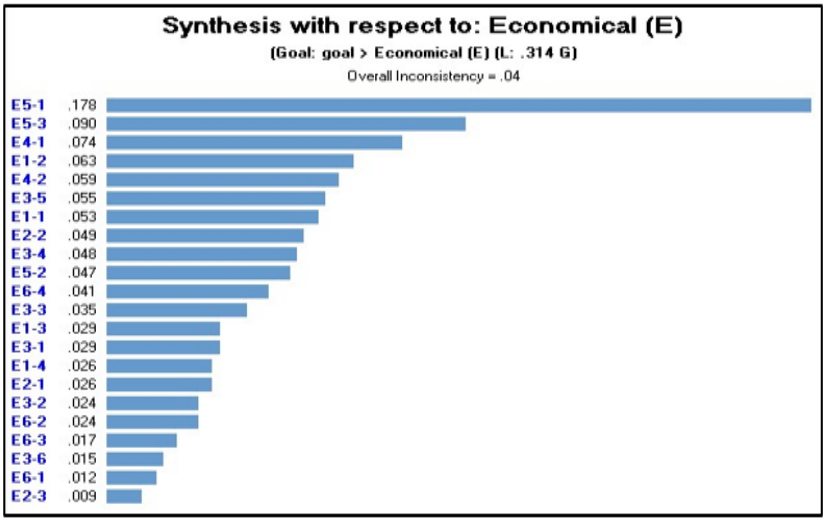

Figure 3. Final weight of economic dimension sub-criteria

The final weights of the environmental sub-criteria were obtained by multiplying the weight of the main criterion in the sub-criteria, which is shown in Figure 4. Thus, the sub-criterion of design/modification of products/packaging to reduce the consumption of raw materials during all stages of the product life cycle (M 3-3) with a weight of 0.141 ranked first among the 22 environmental sub-criteria. The use of the Saiphoo method in line with using materials (M2-4) and the ethical use of livestock and animals (M4-1-2) with the weights of 0.114 and 0.104 ranked second and third, respectively. The sub-criterion of the number of endangered species of the company's operations (M1-2-4) with the weight of 0.005 ranked last.

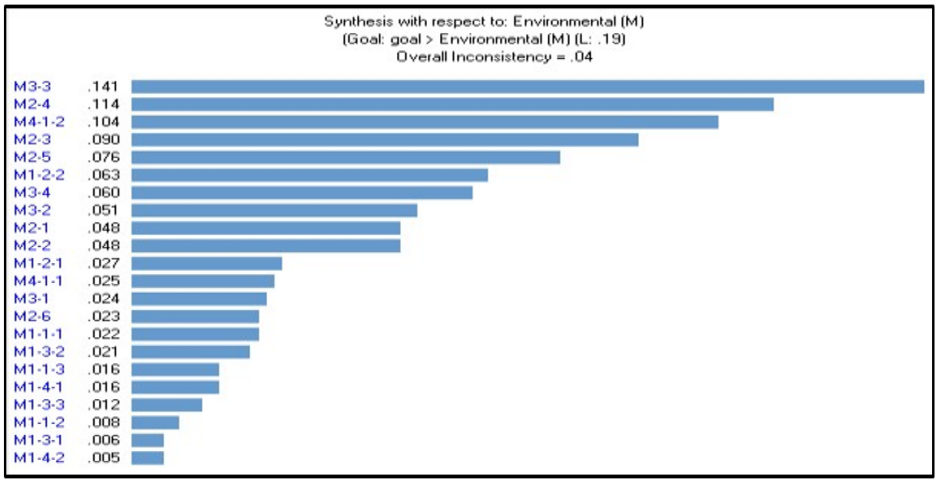

Figure 4. Final weight of sub-criteria of the environmental dimension

The final weights of the social dimension sub-criteria were obtained by multiplying weight of the main criterion in the sub-criteria, which is shown in Figure 5. The amount of protein, fat, vitamins, lactose, and calcium in milk (S2-1-2) with a weight of 0.142 gained the first rank among the social dimension sub-criteria. Production of useful products to increase immunity (S2-3-2) and increased advertising and personal selling (S2-1-3) with the weights of 0.091 and 0.064, respectively, ranked second and third. The sub-criterion of considering labor force for screening suppliers (S1-7-1) with a weight of 0.005 was the lowest in rank.

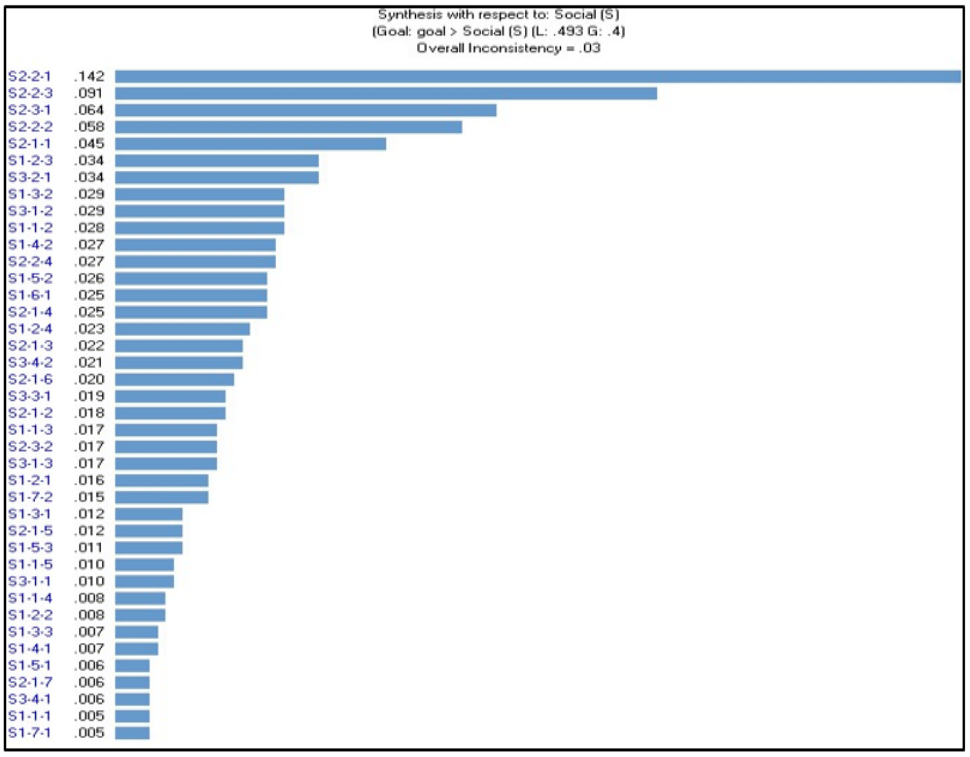

Figure 5. Final weight of social dimension sub-criteria

Conclusions

Considering the importance of the discussion of supply chain sustainability on the one hand, and the significance of dairy industry in Iran on the other, this study focused on identifying and prioritizing the supply chain sustainability indicators for perishable products based on the data analysis approach and the fuzzy multi-criteria decision-making technique. By referring to the relevant literature and interviewing senior experts from the dairy industry, indicators of business sustainability in the three dimensions of economic, social, and environmental were determined.

Twenty-two indicators in the economic dimension and 22 indicators in the environmental dimension were identified. In the social dimension, the indicators of each sector were identified separately, which were as follows: in the employee sector 20 indicators, in the community sector 7 indicators, and in the customer sector 13 indicators. Finally, a suitable model of sustainability in the dairy industry was proposed. Economic factors discussed in this model include economic performance, supply procedures, vulnerability, investment, safety, product quality, and market presence. The environmental factors presented in this model consist of four sections, namely green production, green logistics, green design, and green strategy. The green production sector includes materials, energy, water, atmosphere, and biodiversity, and the green strategy sector includes animal welfare, each of which has specific criteria. The social sector in this research also includes the three sub-sectors of employees, customers, and society. In the field of staff, the main criteria consisted of employment, occupational safety, health, education, equal opportunity, non-discrimination and meritocracy, grievance mechanisms about labor practices in the community sector, and evaluation of suppliers for labor practices. The customer sector included product and service labeling, consumer safety and health, and marketing communications. Finally, the community sector included local community standards, compliance, anti-competitive behavior, and the fight against corruption. The identified indicators were then ranked using the AHP method. According to the proposed model, it is recommended that companies have a written plan in the proposed dimensions and compile sustainability reports by evaluating their cycles. Bringing environmental and social dimensions to the mission of the organization can help the success of the organization. To improve the social dimension, much attention must be paid to improving communication and staff training. Moving from

traditional management and applying new management methods, organizational reform, paying more attention to job descriptions, providing pre-service and in-service training, as well as paying attention to knowledge management can help organizations. To improve the ecological situation, it is recommended to improve the created waste collection systems and use them to improve the economic dimension, pay attention to strategic planning, address concentration and differentiation strategies, and improve the company's cost structure. The criteria of the economic dimension held the second place in the list of priorities and play an important role in the sustainability of the sustainable supply chain. This shows that organizations have unlimited resources to spend on issues related to sustainability. Consequently, it is important for the organization to determine which area of sustainability is most important and to determine how the organization's sustainability in these areas affects its reputation, name, and relationships with key stakeholders. In other words, the effect of organizational sustainability on the effectiveness of the organization and in relation to business activities, long-term profitability and continuity of activities are identified. Such an analysis must focus on business activities for sustainability and should include measuring the impact of sustainability on employees, operations, buildings, suppliers, and customers of the organization and other related and affiliated communities. Stability analysis must be presented in numbers as much as possible. Organizations that review their supply chains have found that improving operational performance and environmental factors (i.e., waste disposal, reducing training, and materials costs) is profitable, and by developing sustainable and green policies, many benefits can be achieved. By involving green and sustainable SCM in decision-making processes, the organization will buy green resources that lead to green products through production in an

environmentally-friendly way and will create a competitive advantage and strengthen its reputation in the market and among customers. Sustainable and green thinking, given today's participatory world, also focuses on areas beyond an organization's internal boundaries, while showing a way to preserve the environment for future generations and innovate for sustainable economic growth. Sustainable supply chain leads to improving the environmental performance of dairy companies in Fars Province. Sustainable supply chain practices in these companies lead to a reduction of harmful environmental products and reduce pollution from production. For the environmental factor, energy management in the chain, use of renewable and recycled materials, management of greenhouse gas emissions, management of industrial effluents, use of recovery methods for packaging, management of environmental fines, investment to protect the environment, screening suppliers according to environmental criteria, and adopting preventive measures to prevent damage to the environment are recommended.

References

Arampantzi, C., & Minis, I. (2017). A new model for designing sustainable supply chain networks and its application to a global manufacturer. *Journal of Cleaner Production, 156*, 276-292.

Aydiner, C., Sen, U., Koseoglu-Imer, D. Y., & Dogan, E. C. (2016). Hierarchical prioritization of innovative treatment systems for sustainable dairy wastewater management. *Journal of Cleaner Production, 112*, 4605-4617.

Behzadi, G., O'Sullivan, M. J., Olsen, T. L., Scrimgeour, F., & Zhang, A. (2017). Robust and resilient strategies for managing supply disruptions in an agribusiness supply chain. *International Journal of Production Economics, 191*, 207-220.

Bloemhof, J. M., & Soysal, M. (2017). Sustainable food supply chain design. In *Sustainable Supply Chains* (pp. 395-412): Springer.

Brandenburg, M., & Rebs, T. (2015). Sustainable supply chain management: A modeling perspective. *Annals of Operations Research, 229*(1), 213-252.

Chung, S. H., & Kwon, C. (2016). Integrated supply chain management for perishable products: Dynamics and oligopolistic competition perspectives with application to pharmaceuticals. *International Journal of Production Economics, 179*, 117-129.

Corbin, J., & Strauss, A. (2014). *Basics of qualitative research: Techniques and procedures for developing grounded theory*: Sage publications.

Dellino, G., Laudadio, T., Mari, R., Mastronardi, N., & Meloni, C. (2018). A reliable decision support system for fresh food supply chain management. *International Journal of Production Research, 56*(4), 1458-1485.

Dutta, P., & Shrivastava, H. (2020). The design and planning of an integrated supply chain for perishable products under uncertainties. *Journal of Modelling in Management*.

Ehsani, A., & Mehrmanesh, H. (2021). A Conceptual Model for Evaluation the Impact Factors Affecting Organizational Performance in Supply Chain. *Journal of System Management, 6*(4), 269-294.

Eskandarpour, M., Dejax, P., Miemczyk, J., & Péton, O. (2015). Sustainable supply chain network design: An optimization-oriented review. *Omega, 54*, 11-32. doi:https://doi.org/10.1016/j.omega.2015.01.006

Hadizadeh Andvari, M. (2015). *Assessing the supply chain sustainability in the dairy industry in Mazandaran province.* . (Master's thesis.), Allameh Tabatabaei University, Tehran.

Hiassat, A., Diabat, A., & Rahwan, I. (2017). A genetic algorithm approach for location-inventory-routing problem with perishable products. *Journal of manufacturing systems, 42*, 93-103.

Jakhar, S. K. (2014). Designing the green supply chain performance optimisation model. *Global Journal of Flexible Systems Management, 15*(3), 235-259.

Jouzdani, J., & Govindan, K. (2021). On the sustainable perishable food supply chain network design: A dairy products case to achieve sustainable development goals. *Journal of Cleaner Production, 278*, 123060. doi:https://doi.org/10.1016/j.jclepro.2020.123060

Khaledi, M., Asgari, Neda (2016). Identify and prioritize supply issues in the Iranian dairy industry with an emphasis on logistics. *Iranian Agricultural Economics Conference. Iranian Association of Economics and Agriculture, Shahid Bahonar University of Kerman*.

Kovačić, D., Hontoria, E., Ros-McDonnell, L., & Bogataj, M. (2015). Location and lead-time perturbations in multi-level assembly systems of perishable goods

in Spanish baby food logistics. *Central European journal of operations research*, *23*(3), 607-623.

La Scalia, G., Nasca, A., Corona, O., Settanni, L., & Micale, R. (2017). An innovative shelf life model based on smart logistic unit for an efficient management of the perishable food supply chain. *Journal of Food Process Engineering*, *40*(1), e12311.

Mangla, S. K., Kumar, P., & Barua, M. K. (2015). Risk analysis in green supply chain using fuzzy AHP approach: A case study. *Resources, Conservation and Recycling*, *104*, 375-390.

Manouchehri, F., Nookabadi, A. S., & Kadivar, M. (2020). Production routing in perishable and quality degradable supply chains. *Heliyon*, *6*(2), e03376.

Mathivathanan, D., Govindan, K., & Haq, A. N. (2017). Exploring the impact of dynamic capabilities on sustainable supply chain firm's performance using Grey-Analytical Hierarchy Process. *Journal of cleaner production*, *147*, 637-653.

Musavi, M., & Bozorgi-Amiri, A. (2017). A multi-objective sustainable hub location-scheduling problem for perishable food supply chain. *Computers & Industrial Engineering*, *113*, 766-778.

Panigrahi, S. S., Bahinipati, B., & Jain, V. (2019). Sustainable supply chain management: a review of literature and implications for future research. *Management of Environmental Quality: An International Journal*.

Rostamzadeh, R., Ghorabaee, M. K., Govindan, K., Esmaeili, A., & Nobar, H. B. K. (2018). Evaluation of sustainable supply chain risk management using an integrated fuzzy TOPSIS-CRITIC approach. *Journal of Cleaner Production*, *175*, 651-669.

Safaei Ghadikolaei, A. C., Fatemeh Mohammadnejad (2015). Explain a framework for evaluating the sustainability of the food supply chain using the fuzzy network analysis process (Case study: selected companies producing meat products in Mazandaran province). *6*(3), 554-535.

Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of cleaner production*, *16*(15), 1699-1710.

Sgarbossa, F., & Russo, I. (2017). A proactive model in sustainable food supply chain: Insight from a case study. *International Journal of Production Economics*, *183*, 596-606.

Smith, B. K., Nachtmann, H., & Pohl, E. A. (2012). Improving healthcare supply chain processes via data standardization. *Engineering Management Journal*, *24*(1), 3-10.

Soltani, H. (2018). Providing a Model for Financing the Buyer and Supplier in the Supply Chain of Mehrvarzan Healthcare Products Distributor. *Journal of System Management*, *4*(2), 11-24.

Touboulic, A., & Walker, H. (2015). Theories in sustainable supply chain management: a structured literature review. *International Journal of Physical Distribution & Logistics Management*.

Tseng, M., Lim, M., & Wong, W. P. (2015). Sustainable supply chain management. *Industrial Management & Data Systems*.

Zhao, R., Liu, Y., Zhang, N., & Huang, T. (2017). An optimization model for green supply chain management by using a big data analytic approach. *Journal of Cleaner Production*, *142*, 1085-1097.

Zhu, Q., Feng, Y., & Choi, S.-B. (2017). The role of customer relational governance in environmental and economic performance improvement through green supply chain management. *Journal of Cleaner Production*, *155*, 46-53.

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