



Evaluating and Prioritizing the Sustainable Supply Chain Management Practices in Food Industry

Shaymaa Abdulqader Mansoor *

Department Of Industrial Management
College of Administration and Economics
Iraq University of Baghdad,

shaimaa.abd2105m@coadec.uoba_ghdad.edu.iq

*Corresponding author

Harith Yarub Maan

Department Of Industrial Management
College of Administration and Economics
University of Baghdad, Iraq

harithmaan@coadec.uobaghdad.edu.iq

Received:15/6/2023

Accepted: 20/8/2023

Published Online First: 30 /6/ 2024



This work is licensed under a [Creative Commons Attribution-NonCommercial 4.0 International \(CC BY-NC 4.0\)](https://creativecommons.org/licenses/by-nc/4.0/)

Abstract:

The companies are now aiming to integrate the concept of Sustainability Supply Chain Management (SSCM) into their work to improve operational and financial performance. The current study seeks to present and define the concept of the Supply Chain (SC) importance. The problem of this research it's to determine the importance of sustainability criteria is that most companies face. A fuzzy Analytic Hierarch Process (FAHP) was used to find the relative importance of the main and sub-criteria for sustainability by establishing a program on Microsoft office Excel (MSEXCEL) to find the results and determine the importance of the main and sub-criteria based on the binary comparison list that was done by the five experts in The General Company for Food Products and Al-Mamoun Factory affiliated to the Ministry of Industry and Minerals in Iraq. The main objective of this study is to arrange the importance of the main criteria the economic, environmental, and social, thirteen sub-criteria distributed main criteria. The study concluded that the economic criterion came at (73%), followed by the environmental criterion at (16.2%), and the social criterion in third place at (10.8%), and this shows the extent of priority followed by the company in economic matters. In addition, the sub-criterion net profit was (29%), and interest in purchasing friendly materials at (8%) was in the environmental dimension, while the sub-criterion of employee satisfaction received (4%) from the criteria of the social dimension which helps the decision-maker to take the appropriate decision and improve the development of sustainable supply chains and their applicability.

Paper type: Research Paper

Keywords: Sustainable Supply Chain Management, Evaluating Sustainable, Fuzzy, FAHP, Supply Chain, Prioritizing Sustainable Criteria.

1.Introduction:

Evaluating the performance of sustainable supply chains in industrial companies requires identifying the main and subsidiary criteria and integrating supply chain elements. In this competitive environment, every business is part of a SC that efficiently moves products or services from suppliers to customers through manufacturers, distributors, and retailers. A typical supply chain includes many companies, resources as well as people, technologies, and information to purchase, manufacture, distribute, store, and sell products. When designing sustainable supply chains, these criteria should be considered because they enable competitiveness and performance evaluation of supply chains and their impact on the effectiveness and efficiency of the company and involve different stages of production and each stage on the sustainability of the final product and that over time raises increasing concern to avoid any negative effects that could harm the reputation of companies. Therefore, industrial companies need to identify those main criteria and various criteria-sub for the sustainability of supply chain operations and therefore, need to follow effective strategies to overcome any barriers that prevent achieving sustainability. The research aims to determine the relative importance of each of the main and sub-criteria of sustainability that help in decision-making by the administration, using the fuzzy analysis hierarchical process, and then determine the priority of those criteria. (Prepared by the researcher)

Literature Review:

There are several studies on sustainable supply chains (SSC). Al-Barazi (2012) conducted a study to identify the impact of supply chain performance on industrial companies. The study aimed to identify the views of senior management managers and the positive and negative aspects of supply chain management. Moreover, it identifies the extent to which the management of the supply chain corresponds with the theoretical framework in this field. The results of the study indicated that there is an impact of supply chain management on the performance of the Kuwaiti industrial companies listed on the Kuwait Stock Exchange, from manager's perspective in higher management. This effect was at a high level, and the effect of the relationship with intermediaries and distributors came in the first place. Then the effect of the relationship with customers came second and finally, the effect of the relationship with suppliers.

Mathivathanan et al (2017) published research on sustainable supply chain management (SSCM) practices in the Indian automotive industry. Their aim to give a better understanding of the interrelated effects of SSCM practices with a special view of the automotive industry. Our research provides prespecified management managers and activities from many stakeholders, including administrators, environmental, community, and government associations. The main problem was identifying the most beneficial sustainability practices and learning how these practices affect each other. The study mainly focused on the extreme case, considering private sectors where the management is fully responsible for the company's action to implement the rules and regulations proposed by the government, but our findings are also applicable to the public automotive sectors. In a country like India, most of the automotive sectors are owned by private organizations, hence it is evident that the results of the present study can be generally applied to all sectors of the Indian automobile.

Kumar and Garg (2017) aimed to identify, prioritize, and evaluate sustainable supply chain indicators so that organizations can develop strategies for implementation. The problem with adopting sustainable supply chains is the lack of required resources, management capabilities, and sustainability. The most important findings are that reducing emissions and improving working conditions are among the most important indicators for achieving sustainability and that a good understanding of the indicators by management can achieve sustainability.

Faris (2020) evaluated the performance of the Green Supply Chain in a Hazy Environment - case studies in the Coronary Gas Filling Company and the Battery Factory. The sample of the research was the General Motors Company and the Gas Filling Factory in Taji in Iraq, where the study aimed to find the relationship and influence between green supply chain practices, identify the most important practices, as well as to evaluate the impact of applying those practices and improving the performance of the researched companies. The most important findings were to determine the relationship between green practices in the company and performance measures, and the possibility of applying these green practices.

Mussa (2021) improved the efficiency of the supply chain through chain management with modern techniques in most joints of the chain of the dairy factory, College of Agriculture, University of Baghdad, which consists of (5) main aspects and (13) sub-criteria in the evaluation and improvement process, the fuzzy analysis hierarchy process (FAHP) was used to know the relative importance of these criteria the most important results, which crystallized in the fact that the laboratory pays attention to the financial aspect, and considers the quality of the raw material (raw cow's milk) to be the major influence on the overall performance of the supply chain.

Magoti et al (2022) the study aimed to achieve cooperation, training, and sustainability in the Norwegian fishing industry. The most important finding is that cooperation for food supply chain (FSC) sustainability is related to capabilities and mentality categorized into four main factors (1) knowledge development, (2) organizational response (3) reflexive control, and (4) awareness of sustainability. In Part Two we explore how laws, regulations, and standards strengthen the relationship between collaboration and FSC sustainability performance. Finally, we define reasonable funds, conflicts of interest, and company size as diluting factors.

2. Materials and Methods:

To evaluate the performance of sustainable supply chains for the factory using the integration of the Fuzzy analytical hierarchy process (FAHP) to extract the relative importance of the main sustainability criteria (economic, social, and environmental), which contain sub-criteria such as achieving financial savings and profits and reducing or preserving its resources and satisfaction of workers and customers, in addition to an environment concerned with reducing pollution and waste.

2.1 Sustainable supply chain:

2.1.1 The Beginning of a sustainable supply chain:

Building on the emergence of many ideas in environmental science, in 1987 the Brundtland Commission of the United Nations published a report titled "Our Common Future" in which the term "sustainable" was mentioned and first defined as "a development that meets the needs of the present without compromising the ability of future generations." McGill (2020) Several concepts of sustainability and sustainable development have emerged and appeared in various research fields and literature sources. Humans must use natural resources with environmental awareness as sustainability not only focuses on protecting the environment but also takes care of other factors such as social and economic dimensions as mentioned (McGill, 2020) Sustainability seeks economic growth and interest in society and culture without causing negative effects on the environment. Saeed and Ali (2018) defined the supply chain as a network of activities and facilities, as the network consists of several links connected and linked with each other, and each link is affected by the previous link and influences the next link, which gives real value to the concept of the supply chain.

2.1.2 Advantages of Sustainability:

The main advantages of a sustainability-oriented approach (Sanders, 2012) can be identified.

- Financial gains are associated with the possibility of reduction in terms of work costs, administrative costs, and invested capital, and on the other hand, increasing returns and market appreciation.
- Consumer-related payments are linked to the ability to increase customer satisfaction, market share, reputation and development, product innovation, and new business development.
- Operational gains associated with innovation in operations increase productivity and return of the resources used, reduce process times, and reduce waste.
- Improvements to organizational gains derived from increased employee satisfaction, stakeholder relationships, reduced risk, and regulatory agency interventions, and increased organizational learning (Belvedere and Grando, 2017).

2.1.3 Sustainable Supply Chain Performance Measurement:

In 2012 a framework for sustainability was defined by The Global Reporting Initiative (GRI) is an international independent standards organization that helps businesses, governments, and other organizations understand and communicate their impacts on issues such as climate change, human rights, and corruption. Criteria are more appropriate for measuring the sustainability performance of individual supply chain members rather than the supply chain (Sopadang and Wichaisri, 2017). Sustainability criteria that are usually viewed as economic, social, and environmental are evaluated in the framework of a performance measurement presentation. The criteria used to assess the sustainability of organizations in the supply chain are given, including the criteria for sustainable economic performance. These are created by revenue, supplier partnerships, total sales, number of shareholders, costs, new investment promotion, new business opportunities, flexibility, quality, and total taxes paid (Yusf, 2018). Standards of sustainable social performance, including the sub-criteria of the performance management system that is used to evaluate sustainable social performance at the time of training, application of innovative ideas generated by employees, employee turnover rate, recordable incidents, complaints, customer complaints, part of the total sales to be invested in social projects, management effectiveness as well as discipline of employees, participation in decision-making. Sustainable environmental performance standards and waste reduction, a number of developed ISO standards, part of the facilities that use renewable energy, reverse logistics system, environmental resources, energy, and use of recycled materials (Uysal, 2012).

2.1.4 Dimensions of Sustainability:

The dimensions of sustainability are used and most popular. These dimensions are divided into three main dimensions that are predominantly used economic, social, and environmental, and are the most widely accepted for sustainability research (Seghezze, 2009). Moreover, attention to these dimensions works to achieve the organization's goals, which are the achievement of economic, social, and environmental goals (Elkington, 1994). The economic, environmental and social dimensions are the basic dimensions defined in the concept of the triple bottom line (TBL) which refers to the three elements: profit, people and the environment. Based on the TBL framework, the successful performance of an organization is evaluated not only by financial benefits, but also by environmental awareness and ethical values. Many studies define TBL as a file to help organizations maintain their long-term viability, organizations may lose the interests of customers if they focus only on the economy and its development, neglecting positive activities, social issues, and the environment (Rausch-Phan and Siegfried, 2022) and paying attention to these dimensions works to achieve the goals of the organization, which are the achievement of economic, social and environmental goals. Figure 1 of the three main dimensions of the sustainable supply chain.

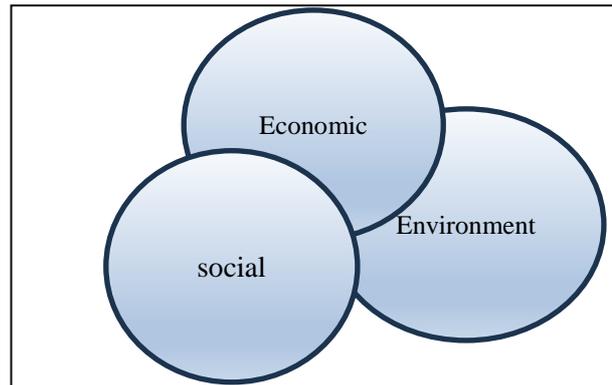


Figure 1: Main dimensions of the sustainable supply chain prepared by the researcher.

2.1.4.1 Economic dimension:

The economic dimension is a major dimension in performance appraisal. These economic criteria aim to assess organizational capacity. The most common economic sub-criteria are net profit, costs, elasticity, productivity, quality, and employment (Gunasekaran et al, 2004). Economic criteria can be classified into financial and non-financial criteria.

2.1.4.2 Environmental Dimension

The environmental dimension can be defined as the organization's ability to use resources, reduce emissions, and waste, and reduce harmful substances and waste effectively. The environmental supply chain primarily includes activities that affect the environment. The dimensions and activities related to the environmental sustainability of the supply chain that organizations adopt to increase the sustainability of the supply chain. All environmental supply chain standards are related to reducing the number of materials used in the production process, addressing emissions and waste, reducing energy use as well as searching for alternative input materials and recycling, and designing products accordingly. Environmental friendliness, reverse logistics, product disposal, and packaging optimization. The use of technology, renewable energy sources, and green procurement are also important standards to consider (Kumar and Garg, 2017).

2.1.4.3 Social Dimension

It is the responsibility of industrial companies to provide and create a healthy work environment, occupational safety standards, participation, and commitment, in addition to developing and training human resources. The social dimension evaluates the members of the supply chain (such as communities, employees, and customers) within four main criteria: customer satisfaction, employee satisfaction, noise pollution, and health and safety as indicated by (Gunasekaran, et al., 2004) Customer complaint is a measure used to measure customer satisfaction. Moreover, employee satisfaction falls within The field of human resource management that affects business activities.

2.2 Fuzzy Analytic Hierarchy Process (FAHP)

The introduction of fuzzy logic began in the thirties of the last century by the world (Jan Lukasiwicz, 1920), a scientist of Finnish origin, who introduced terms such as age, temperature, weight, etc. with mathematical logic, and at that time it was presented in a way (True or False) right or wrong, as this world expanded the work with this logic and working on the use of numbers (1 & 0). In 1937, the scientist (Max Black) published research on vagueness (Vagueness an exercise in logical analyses), through which the first group of vague processes was identified. (Negnevitsky, 2005) Several years later, specifically in the year 1965, the scientist Lutfi Zadeh, head of the Electrical Engineering Department in the United States of America, published the theory of fuzzy groups, which was adopted in the fuzzy theory and the application of linguistic terminology in it.

The fuzzy hierarchical analysis has been used in many types of research and at all levels of scientific and literary topics. There are several studies and research that have used the tool for decision-making and determining the relative importance of criteria for the work of various production or service organizations.

It is worth noting that the decision process in the industrial field is more complex than other fields due to the complexity of standards, restrictions, and objectives in the industrial decision-making process. This led to the merging of two theories, namely, the fuzzy theory and the hierarchical analysis process, to produce very effective management in multi-criteria decision-making, which is the fuzzy hierarchical process(Al-Hkeem and Dawood,2021).

2.2.1 The concept of fuzzy theory:

The method of the nature of human thinking when dealing with semi-confirmed, approximate, and uncertain information to obtain the decisions that he wants to take, which facilitated dealing with quantitative and qualitative data and information that need to distinguish between them and know the relative importance of each specific criterion and make the decision through bilateral comparisons between those Standards and fuzzy hierarchical analysis. At the first level, the relative importance (local weight) is determined for each of the three main criteria relative to the objective, and the relative importance of the second level is evaluated for the sub-criteria for each main criterion, and the third level is finding the general weight (global weight) for each sub-criterion and arranging the criteria according to priority (Basheer and Yarub ,2020).

(FAHP) is a decision-making method developed by (Laarhven and Pedrycz, 1983) and it is a continuation and extension of the traditional hierarchical analysis, the Fuzzy Analytic Hierarchy Process (FAHP) that combines current AHP with fuzzy theory.

The main criteria and factors in the main levels, sub-levels, and weights are calculated by completing the pairwise comparison matrix However, unlike AHP, an arithmetic operation including a trigonometric fuzzy number, or a trapezoidal fuzzy number is used in the weight calculation process.

2.2.2 Steps in fuzzy style:

All different uses of this fuzzy method must be subject to the stages specified in the fuzzy method, as follows: (Sindhvani et al, 2021)

- 1- Fuzzification process
- 2- Fuzzy Inference Algorithms
- 3- Defuzzification

There are many ways to defuzzification from data and information from it.

1. Median method
2. Centre of gravity method
3. removes fuzziness (Convert fuzzy data into real numbers) (Faris, 2020).

2.2.3 Fuzzy arithmetic operations:

The fuzzy method is based on algebraic mathematical operations (El Alaoui, 2021), which are as follows:

Assuming that \tilde{A}_1 and \tilde{A}_2 are fuzzy, and each fuzzy number consists of three values called:

$$\tilde{A}_2 = (l_2, m_2, u_2) \quad \tilde{A}_1 = (l_1, m_1, u_1) \quad (1)$$

1-Addition fuzzy numbers

$$(l_1, m_1, u_1) \oplus (l_2, m_2, u_2) = (l_1 \oplus l_2, m_1 \oplus m_2, u_1 \oplus u_2) \quad (2)$$

2- Subtraction of fuzzy numbers

$$(l_1, m_1, u_1) \ominus (l_2, m_2, u_2) = (l_1 \ominus l_2, m_1 \ominus m_2, u_1 \ominus u_2) \quad (3)$$

3- Multiplication of fuzzy numbers

$$(l_1, m_1, u_1) \otimes (l_2, m_2, u_2) = (l_1 \otimes l_2, m_1 \otimes m_2, u_1 \otimes u_2) \quad (4)$$

4- The process of dividing fuzzy numbers

$$(l_1, m_1, u_1) \oslash (l_2, m_2, u_2) = (l_1 \oslash l_2, m_1 \oslash m_2, u_1 \oslash u_2) \quad (5)$$

5- The fuzzy value inverse process

$$(l_1, m_1, u_1)^{-1} = \left(\frac{1}{l_1}, \frac{1}{m_1}, \frac{1}{u_1}\right) \quad (6)$$

2.2.4 Processing logic in Fuzzy Analysis Hierarchy process:

The steps of the mathematical treatment of the fuzzy hierarchical analysis do not differ with the hierarchical analysis, but rather they are similar, and the difference is in the calculations due to its use of fuzzy measures that differ from the direct representation of numbers in the hierarchical analysis (Yahan, 2022).

To calculate FAHP as following:

- 1- Determine the hierarchical structure and the levels in it.
- 2- Establishing a matrix of pairwise comparisons using linguistic expressions and determining the corresponding fuzzy values.

$$\tilde{A}^k = \begin{bmatrix} \tilde{a}_{11}^k & \dots & \tilde{a}_{1j}^k & \dots & \tilde{a}_{1n}^k \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \tilde{a}_{i1}^k & \dots & \tilde{a}_{ij}^k & \dots & \tilde{a}_{in}^k \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1}^k & \dots & \tilde{a}_{nj}^k & \dots & \tilde{a}_{nn}^k \end{bmatrix} \quad (7)$$

- 3- If there is more than one decision-maker or expert in the organization, the opinions of the experts obtained from pairwise comparisons are dealt with as follows:

$$\tilde{a}_{ij} = \frac{\sum_{k=1}^K \tilde{a}_{ij}^k}{K} \quad k \text{ is the No. of experts} \quad (8)$$

- 4- Depending on that method (Bukly, 1985), the geometric mean values are extracted through the following equation:

$$\tilde{r}_i = \left(\prod_{j=1}^n \tilde{a}_{ij}\right)^{-1/n} \quad (9)$$

- n is the number of standards
- The equation can also be written in the following form:

$$\tilde{r}_i = (\tilde{a}_{i1} * \tilde{a}_{i2} * \dots * \tilde{a}_{in}) \quad (10)$$

- 5- Finding the relative importance or relative weights to know the importance of each of the criteria through the following equation:

$$\tilde{w}_i = \tilde{r}_i \otimes (\tilde{r}_1 \oplus \tilde{r}_2 \dots \oplus \tilde{r}_n)^{-1} \quad (11)$$

- 6- Next, find the weights for the standards, as these weights are still fuzzy and have a fuzzy meaning, so the fuzziness is removed (Defuzzification) through the CoA method or what is called (Centre of area)

$$w_i = \frac{lw_i + mw_i + uw_i}{3} \quad (12)$$

3. Discussion and Result :

3.1 Overview of Al-Mamoun Factory:

Al-Mamoun Factory is considered one of the ancient factories that had a major role in the Iraqi market. If its production reaches all Iraqi governorates through the Iraqi ration card, as well as the distributor's agents. The factory's products were known for their high quality, and it was difficult to compete with these products. The factory started producing vegetable oils in 1953, then a detergent filling department was added to it in 1957, and after that, it started producing cosmetics and detergents. The factory is in the Iraqi capital, Baghdad. (Prepared by the researcher)

3.2 Determine the relative importance of the criteria:

Indicators of a sustainable supply chain are determined by the decision group through experts. Review and competency of experts in the supply chain. The expert group consists of five members with more than 12 years of experience. This paper proposed a hybrid model based on supply chain prioritization. Indicators for achieving sustainability in a supply chain in the General Company for Food Products and Al-Mamoun Factory.

To get a response from the expert group, it was a series of brainstorming sessions.

Organized to achieve the following study objectives:

1. Obtaining the approval of all academics and teachers on the sustainability indicators.
2. Obtaining the approval of all indicators on the relationship between the different indicators and their categories (economic, social, and environmental).
- 3- Obtaining a bilateral comparison between the main and sub-standards of sustainability by experts in the company and the factory.

The main process of FAHP is to extract the relative importance of the criteria by comparing the criteria according to the opinions of the experts. The main characteristic of FAHP is the reliance on triangular values that represent the opinion of the expert. Table 1 shows Linguistic expressions and ambiguous values used in comparing expert opinions.

Table 1: TFN matrix

Linguistic variables Allotted TFN	Fuzzy Values
Equally	(1, 1, 1)
Very Lower	(1, 2, 3)
Lower	(2, 3, 4)
Medium	(3, 4, 5)
Higher	(4, 5, 6)

Table 2 is a model answered by comparing both criteria in one row by choosing the right Linguistic expressions, and if one of the two criteria is more likely than the other, then a mark is added in the appropriate cell for the percentage of the preference of the criterion over the other. Below is the matrix of one of the matrices as an example of comparison.

Table 2: List of pairwise comparisons of main Indicators.

Absolute importance	Strong importance	Very important	Indicators		Absolute importance	Strong importance	Very important
			Social	Economics		√	
			Environmental	Economics			√
			Social	Environmental		√	

3.3 Determine the relative importance of the main criteria:

The response of the experts was divided into two phases, the first is to compare the main criteria with each other, then compare the sub-criteria for each main criterion with each other and extract the weights from the comparisons, then multiply the sub-weights for each criterion by the weight of the specified criterion and extract the total importance of each criterion. Below are the pairwise comparisons of the four experts for the main criteria, however, one expert's response was excluded due to the invalidity of the response form. The well-known spreadsheet program from Microsoft (Excel) was used to build a software environment for FAHP, based on the Visual Basic programming environment. The following steps of determining the importance percentage for the main indicators and sub-indicators:

- 1- Open the program from the main interface.
- 2- Enter and choose the appropriate matrix to work.
- 3- Choose the target matrix according to the number of criteria that the matrix of type (3x3) is to be compared.

4- After selecting the appropriate matrix, the opinion of the appointed expert is entered through the use of capital letters. The linguistic expressions used to differentiate between criteria, as the program receives preferences and automatically determines the inverse of each preference, which facilitates the input process and the absence of error by the user, and shows the consistency ratio of the matrix, and the matrix is rejected in the event that it is inconsistent.

Table 3, which shows the relative importance of each criterion highlights by using MSEXCEL program as the result of economic criterion has the greatest importance in the eyes of the administration, with the importance of (73%). This indicates that the financial outlook of the organization and the organization's interest in economic standards is great. From the researcher's opinion importance percentage of this criterion is due to the real importance of the economic criterion in achieving sustainability in a country that suffers from several problems that transform the achievement of sustainability and the application of its conditions, which means the weakness of the environmental aspect with importance of (10.8%), and more evidence of this is the low importance of the environmental criterion which defines the general framework of thought in the organization enjoyed by the management of the organization and the social criterion was third in terms of order of importance by highlighting importance of (16.2%), and the researcher believes that it is the social criterion. The importance was not high because the social sub-criteria were not achieved and if we want to raise their importance, we must work to achieve the sub-criteria of the economic and environmental criteria.

The orientation of the organization can be deduced through the importance of each criterion, which is reflected in the operations within the company. However, it can be said that the preference for a particular main criterion does not necessarily indicate the preference for the criteria belonging to it. The organization's orientation may be towards the economic standard, but this standard can be achieved by paying attention to environmental standards and governmental facilities for organizations that adopt the principle of environmental sustainability and try to introduce sustainable operations in all the joints of the supply chain. Approvals can be obtained for a specific type that is exempt from customs or tax entry, depending on whether it contributes to the sustainability of the environment, specifically in organizations that produce consumer products that affect the environment and people. The production of cleaning powders in the Al-Mamoun factory is in direct contact with humans in terms of use and the environment in general, such as production waste and the results of operating production processes or waste after use. The model of sustainable supply chains emphasizes That all operations be on a sustainable basis.

Table 3: The relative importance of the main indicators.

Indicators	Importance
Economic	73%
Social	10.8%
Environmental	16.2%

3.4 Determine the relative importance of sub-criteria:

Using the same program, as shown above, extracting the relative importance of the main criteria, the relative importance of the sub-criteria was extracted, which were, according to the sequence, the sub-criteria: profits, cost, flexibility, quality, and productivity. Through the answers and the clarified forms of the relative importance of each criterion, it is clear that the financial outlook dominates the opinions of experts and the importance of the profit criterion, as its importance reached (40%) of the total importance, superior to the rest of the criteria, while the second criterion was the cost of importance amounting to (15%) with a clear indication of interest, the company costs in a limited way, so the factory needs a complete program to show the importance of costs and analyze the behavior of costs to make the most of the distribution of costs and their collection and classification centers.

As for the third criterion, flexibility, it was of almost non-existent importance, amounting to (9%). This indicates the lack of focus by the company on the issue of flexibility in terms of its requirements or changing the form of operations in proportion to the product, and this was evident in the weak importance. As for the fourth criterion (quality), its importance was (10%). Through talking with experts, it appeared that the possibility of determining the quality of products is not difficult and it is possible to rely on (ISO9001) in adopting a quality-based management approach. About the second most important criterion in the economic criteria, it was the fifth criterion (productivity) with an importance of (24%) to indicate the importance of the production rate and productivity in the researched factory, as it depends on raising production rates to sell the largest possible number of products to achieve the appropriate profit. In the same context, the relative importance of the criteria for the main criterion (social) and the main criterion (environmental) is found. Table No (4) shows the relative importance of sub-indicators.

Table 4: The relative importance of sub-indicators (Local Weight)

Main Indicators	Sub-indicators	Importance
Economic	Net profit	40%
	cost	15%
	Flexibility	9%
	quality	10%
	productivity	24%
Social	Employee satisfaction	43%
	Customer satisfaction	8%
	Health and Safety	29%
	Staff training	19%
Environmental	Use of environmentally friendly materials	47%
	green packaging	7%
	Comply with environmental regulations and standards	23%
	Environmental pollution inside the factory	21%

3.5 Finding the overall importance of the criteria:

After finding the local weight for the main and sub-criteria using fuzzy hierarchical analysis, the relative importance of each main criterion is multiplied by the sub-criteria belonging to it to find the global weight. This process gives the approved importance to each criterion. Sub-criteria and Table 4.

After extracting the total importance of all the criteria, it becomes clear that the profit criterion is preferred over the rest of the criteria with the importance of (29%), which means that profit and productivity are equivalent.

In the level of importance, the rest of the criteria combined, and this indicator shows the importance of the economic standard of the company and the factory in which the research was conducted. This is a view that must be addressed for the company to be able to deal with the modern labor market. Some may believe that the introduction of sustainability in the supply chain operations will cost the company other costs, but it can be considered a marketing opportunity for environmentally friendly products.

And table 5 shows the sub-criteria in order of importance, where the cost appears with the importance of (11%) of the experts' answers. As for the sub-criteria of the main environmental criterion, the criterion (use of environmentally friendly materials) was of (8%) importance, showing the sample's preference for this criterion is because the operations depend originally on raw materials, so using environmentally friendly materials, sustainability will be

achieved in more than one axis without relying on treating all the joints of the supply chain. Table 5 that follows shows the standards in order of importance

Table 5: The standards in order of importance (Global Weight)

Sub-indicators	Importance
Net profit	29%
Productivity	18%
Cost	11%
Use of environmentally friendly materials	8%
Quality	7%
Flexibility	7%
Employee satisfaction	4%
Comply with environmental regulations and standards	4%
Environmental pollution inside the factory	3%
Health and Safety	3%
Staff training	2%
green packaging	1%
Customer satisfaction	1%

4. Conclusion:

- 1- The company needs to define standards for sustainable supply chains at the strategic, operational, and tactical levels.
- 2- The research concluded that the overall importance is that the company and the factory attached to the economic standard is considered invaluable when paying attention to the sub-criteria of the economic standard. This is because we can work to solve the problems that stand in the way of achieving and giving importance to other standards, and this will be the same or parallel to the standards of total importance.
- 3- It is preferable that one of the company's goals is to transform manufacturing operations into a slogan (green manufacturing), even if it affects certain parts more environmentally than others.
- 4- Intensifying training courses for workers in the field of environmental sustainability and defining environmental damage to the company's products and similar products.
- 5- Certain research methodologies can be adopted in spreading environmental awareness (such as the instructions of the ISO organization and the ISO140001 publication).
- 6- Spreading the culture of cause and effect and how a specific criterion affects the rest of the aspects and introducing workers to the most influential aspects.
- 7- Applying appropriate steps in evaluating sustainable supply chains, specifically in the company to determine work priorities and clarify lines for work teams, suppliers, and customers.
- 8- Educating customers on the characteristics of sustainability and how they can affect the current and future generations.
- 9- The supply chain can be improved in a way that ensures the reconfiguration of the main interface of the chain and considers sustainability standards as its main feature.
- 10- Defining green production methods and how the green packaging process affects the progress of the process, such as what we see in the recycling of (carton) products. Solving the packaging problem by reducing dependence on plastic and slow degradation of materials or designing containers in a way that guarantees their reuse and recycling.

11- Seeking to purchase environmentally friendly raw materials that contribute to preserving human health and the surrounding environment.

12- Creating a comprehensive plan for development with goals that organizes all efforts, especially the efforts of the Ministry of Industry and Minerals, the General Company for Food Products, in order to achieve sustainable supply chains.

Authors Declaration:

Conflicts of Interest: None

-We Hereby Confirm That All The Figures and Tables In The Manuscript Are Mine and Ours. Besides, The Figures and Images, Which are Not Mine, Have Been Permitted Republication and Attached to The Manuscript.

- Ethical Clearance: The Research Was Approved By The Local Ethical Committee in The University.

References:

1. Alaoui, H. M., Kacem, H. A, Fal, S., Karim M., Rhinane, H. and Maana, M., (2021) "Application of fuzzy analytical hierarchy process for assessment of desertification sensitive areas in Northwest of Morocco", *Geocarto International*, Vol. 36, No. 5, pp 563-580.
2. Buckley, J. J. (1985), Fuzzy hierarchical analysis, *Fuzzy Sets and Systems*, 17(3), 233–247.
3. Al-Brazi, D, (2012)" Supply chain management on the performance of the organization" master's thesis, College of Business, Middle East University.
4. Basheer, Y.N. and Maan, H.Y. , (2020)" Fuzzy Analytic Hierarchy Process FAHP to Prioritize The Evaluation of The Main and Subsidiary Criteria in B2B Industrial Market Sectors – Applied Research", *Journal of Economics and Administrative Sciences*, Vol.26, No.124, pp.460-480.
5. Belvedere, Valeria & Grandi, Alberto, 2017 *Sustainable Operations and Supply Chain Management*, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom.
6. Elkington, J. (1998), "Cannibals with forks: The triple bottom line of 21st century business", *Conscientious commerce*. New Society Publishers.
7. Harun, M., Mwesumo, D., Hogset, H. and Ramudhin, A., (2022), "Practicing co-competition for food supply chain sustainability: a contextual perspective in the Norwegian fishing industry", *International Journal Of Sustainability engineering* 2022, VOL. 15, NO. 1, 228–241.
8. Mathivathanan, D., Kannan, D. and Haq, A. N, (2017) *Sustainable supply chain management practices in Indian automotive industry*", A multi-stakeholder view, *Centre for Engineering Operations Management, Department of Technology and Innovation, Resources, Conservation and Recycling* 128 (2018), pp 284–305
9. Faris, H.M. and Maan, H. Y., (2020) "Evaluating the performance of the green supply chain in a foggy environment", A thesis submitted for a master's degree in industrial management / College of Administration and Economics / University of Baghdad.
10. Gunasekaran, A. Patel, C. and McGaughey, R. E. ,(2004)," A Framework for Supply Chain Performance Measurement", *International Journal of Production Economics*, Vol. 87, No. 3, PP 333-347.
11. Al-Hkeem, A.A. and Dawood, F.S., (2021)" Evaluation suppliers according to the integration of the Quality Function Deployment and the Fuzzy Analytic Hierarchy Process", *Journal of Economics and Administrative Sciences* Vol.27, No. 125, pp. 170-192.
12. Kumar, D. and Garg, P., (2017)"Evaluating sustainable supply chain indicators using Fuzzy AHP: Case of Indian automotive industry", *Benchmarking: An International Journal*, <https://doi.org/10.1108/BIJ-11-2015-0111>.
13. Lukasiewicz, L., (1920)," Fuzzy analytic hierarchy process", mathematical logic and basic research a, Warsaw University.

14. Van Laarhoven, P.J.M. and Pedrycz, W., (1983) “ consistency and ranking of alternatives in uncertain AHP”, A fuzzy extension of Saaty’s priority theory. *Fuzzy Sets and Systems*”, *Natural Science*, Vol.4, No.5, pp.229-241.
15. Mussa, A. R., (2021), “Improving the efficiency of the supply chain using artificial intelligence”, A thesis submitted for a master’s degree in industrial management / College of Administration and Economics / University of Baghdad.
16. Magoti, H., Mwesumo, D., Hogset, H. and Ramudhin, A., (2022),” Practicing coopetition for food supply chain sustainability: a contextual perspective in the Norwegian fishing industry”, *International Journal of Sustainable Engineering*, VOL. 15, NO. 1, pp 228-241.
17. Minglu Ma and Yahan Hu, (2022) “Comprehensive evaluation of navigation safety for ships sailing in polar regions”, *Seventh International Conference on Electromechanical Control Technology and Transportation Proceedings Vol 12302*, No. 7, pp 1-11.
18. Rausch-Phan, M. T. and Siegfried, P.,(2022), “Sustainable Supply Chain Management”, *Management GmbH Frankfurt am Main*, First edition, Springer, Germany.
19. Seghezze, L., (2009),” The Five Dimensions of Sustainability”, *Environmental Politics*,18:4,539 — 556.
20. Sander, A. (2012), *Report BCG in Harvard Business Review Italia*, June, pp. 10–11.
21. Sanders N.R. (2012), *Supply Chain Management: A global perspective*, Hoboken, NJ: John Wiley & Sons.
22. Sopadang, A., Wichaisri, S. and Banamyong, R., (2017) *Sustainable Supply Chain Performance Measurement A Case Study of the Sugar Industry*” Department of Industrial Engineering, Faculty of Engineering, Chiang Mai University, Chiang Mai, Thailand. *Proceedings of the International Conference on Industrial Engineering and Operations Management Rabat, Morocco*, April 11-13, 2017
23. Saeed, S. M. and Ali, A. S., (2018), *Effect of Using Quantitative Methods of Demand Forecasting In Improving Of Supply Chain Performance*", *Case Study In One Of An Industrial Organization*" *Journal of Economics and Administrative Sciences* Vol.24, No. 103, pp. 292-323.
24. Sindhvani, R., Goel, M. and Chopra, N.,(2021),” A Hybrid Approach Based on Fuzzy TOPSIS-AHP for Ranking and Classifying MOOC Key Acceptance Factors”, *International Journal of Web-Based Learning and Teaching Technologies* Volume 16 • Issue 5 • September-October 2021.
25. Uysal, Fahriye, (2012) ” An integrated model for sustainable performance measurement in Supply Chain Management”, *Assist. Prof. Dr., Akdeniz University, Ayse Sak School of Applied Sciences, Poyraz Sok. No:55, Yesilbayir, Dosemealti, 07190 Antalya, Turkey*.
26. Yusuf, N., Kalaf, B.A and Sabih, B ,(2018), “Integrated Approach for Management of Supply Chain and Relation with MRP”, *Journal of Economics and Administrative Sciences*, Vol. 18, No.66, pp. 74-100.

تقييم وتحديد أولويات ممارسات إدارة سلسلة التجهيز المستدامة في صناعة الأغذية

حارث يعرب معن
جامعة بغداد/ كلية الإدارة والاقتصاد/ قسم الإدارة الصناعية
harithmaan@coadec.uobaghdad.edu.iq

شيماء عبد القادر منصور
جامعة بغداد/ كلية الإدارة والاقتصاد/ قسم الإدارة الصناعية
shaimaa.abd2105m@coadec.uobaghdad.edu.iq

Received:15/6/2023 Accepted: 20/8/2023 Published Online First: 30 /6/ 2024

هذا العمل مرخص تحت اتفاقية المشاع الإبداعي نَسب المُصنَّف - غير تجاري - الترخيص العمومي الدولي 4.0

[Attribution-NonCommercial 4.0 International \(CC BY-NC 4.0\)](https://creativecommons.org/licenses/by-nc/4.0/)



مستخلص البحث:

تهدف الشركات الآن إلى دمج مفهوم إدارة سلسلة التجهيز المستدامة (SSCM) في عملها لتحسين الأداء التشغيلي والمالي. تسعى الدراسة الحالية إلى تقديم وتعريف مفهوم أهمية سلسلة التجهيز (SC). إن مشكلة هذا البحث المتمثل في تحديد أهمية معايير الاستدامة هي التي تواجهها معظم الشركات. تم استخدام أسلوب التحليل الهرمي الضبابي (FAHP) Analytical Hierarchy Process للعثور على الأهمية النسبية للمعايير الرئيسية والفرعية للاستدامة من خلال إنشاء برنامج على MSEXCEL للعثور على النتائج وتحديد أهمية المعايير الرئيسية والفرعية بناءً على قائمة المقارنة الثنائية التي قام بها الخبراء الخمسة في الشركة العامة للمنتجات الغذائية ومصنع المأمون التابعين لوزارة الصناعة والمعادن في العراق. الهدف الرئيسي من هذه الدراسة هو ترتيب أهمية المعايير الرئيسية الاقتصادية والبيئية والاجتماعية، وثلاثة عشر معياراً فرعياً موزعة على المعايير الرئيسية. وخلصت الدراسة إلى أن المعيار الاقتصادي جاء عند (73٪)، يليه المعيار البيئي في المرتبة الثانية (16٪)، والمعيار الاجتماعي في المرتبة الثالثة (10٪). وهذا يوضح مدى الأولوية التي تتبعها الشركة في الأمور الاقتصادية. بالإضافة إلى ذلك، بلغ المعيار الفرعي صافي الربح للمعيار الفرعي (29٪)، وكان الاهتمام بشراء مواد صديقة بنسبة (8٪) في البعد البيئي، بينما حصل المعيار الفرعي لرضا الموظفين (4٪) من المعايير الفرعية للبعد الاجتماعي. ومن خلال النتائج التي تمكن صانع القرار على اتخاذ القرار المناسب وتحسين تطوير سلاسل التجهيز المستدامة وقابليتها للتطبيق.

نوع البحث: دراسة حالة

المصطلحات الرئيسية للبحث: إدارة سلسلة التجهيز المستدامة، تقييم الاستدامة، الضبابية، FAHP، سلسلة التجهيز، الأهمية للمعايير المستدامة، ترتيب معايير الاستدامة.

*البحث مستل من رسالة ماجستير