Vol. 01, No. 04 (2023) 163-176, doi: 10.61552/JEMIT.2023.04.002 - http://jemit.aspur.rs

EVALUATING SCOR METRICS OF SUPPLY CHAIN PERFORMANCE BASED ON INVENTORY MANAGEMENT

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Received 11.03.2023.
Revised 05.07.2023.
Accepted 21.08.2023.

Keywords:

Supply Chain Performance, Inventory Management, SCOR, FAHP.

Original research

A B S T R A C T

Because Supply Chain Performance coordinates Inventory Management under the SCOR Metrics paradigm; this research was performed to evaluate the SCOR Metrics of Supply Chain Performance based on Inventory Management at Shiraz Petrochemical Company of Iran. Performance indicators, as Alternatives; and Inventory Management factors, as criteria; were extracted from the research literature. The research method was descriptive-analytical, employing a hybrid FAHP-SCOR approach. Consequently, after weighing the criteria, the five alternatives have been prioritized. The results of this study lead to two deductions: firstly, the type of production is the most important factor in Inventory Management. Secondly, companies with a complex supply chain need to carry out processes to strike the right balance between the size of their inventory. The findings of this study can be applied to all petrochemical industries as a strategic plan.

1. INTRODUCTION

In today's global situation, despite the challenges in supply chain management (SCM), including competition, changing markets, globalization, and balancing supply and demand (Ben-Daya et al., 2022), it is necessary to provide a variety of products according to customer demand. The customer's demand for high-quality service has faced company challenges. Consequently, in today's competitive market, economic, manufacturing, and service enterprises, in addition to managing internal resources, have found themselves in need of managing and monitoring resources and elements outside the organization. This approach is to gain a competitive advantage that companies intend to gain a larger share of the target market (Sigh et al., 2018; Solke et al., 2022; Subramanian & Suresh, 2022). Accordingly, activities such as dynamic supply and demand planning, material procurement, production planning, logistics, inventory management, distribution, delivery, and just-in-time customer service, which were previously performed at the company level, are now transferred to the value chain level. The basic point in a supply chain is the management and coordination of all these activities. It is such that customers can receive quality products and lean services in the shortest time and at the lowest cost (Tan and Sidhu, 2022).

Many studies have been done on different dimensions of the supply chain inventory (Daryanto & Wee, 2020). Multiple models have been introduced to appraise the supply chain performance. In 1996, the Supply Chain Association introduced the Supply Chain Operations Reference (SCOR) model, which is presented as a standard reference for SCM. It helps companies increase their supply chain's effectiveness and provides a process-oriented approach to SCM (Huan et al., 2004; Wang et al., 2010)). As companies move toward SCM, evaluating Supply Chain Performance seems more necessary. Notably, traditional evaluation methods are less related to SCM because the scope they examine is much more limited than examining a wide range of evaluation activities (Ricardianto et al., 2022; Rodríguez Mañay et al., 2022).

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From the establishment of Shiraz Petrochemical Company in 1959 until now, the National Iranian Petrochemical Company (NPC), as one of the country's main industries in creating added value from oil and gas resources, has been a pioneering and value-creating industry. This industry plays a crucial role in Iran's financial and economic prosperity, sustainability in development, localization of technology acceptance, growth and development of downstream industries, and creation of full employment. The main advantage of this industry in Iran is the variety of feedstock resources, access to the high seas, and specialized human resources (National Iranian Petrochemical Company, n.d.).

Shiraz Petrochemical Company, the first production unit of NPC, produces nitrogen fertilizers. The company started with the operation of four production units for ammonia, urea, nitric acid, and ammonium nitrate, as well as a unit for providing ancillary services (water, electricity, steam, and compressed air). At present, the effort and importance of the company's management and employees to improve the quality of the work environment have led to obtaining certificates in quality assurance management, environmental management, and professional occupational health and safety management (Shiraz Petrochemical Company, n.d.).

Therefore; in the current unfavorable economic conditions of the country, with the proper knowledge of the market and with the help of proper SCM, from the purchase of raw materials to sales and after-sales services, and paying attention to the Inventory Management approach of smoothing the supply chain processes (Ben-Daya et al., 2022), it is possible to help the continuity of production and sales in the market. In this field, much research has been done so far, but comprehensive research that deals with the performance of SCM, identifying and ranking essential indicators, and applying a comprehensive approach to performance evaluation in Shiraz Chemical Company has not been done, which adds to the importance and necessity of this research.

Accordingly, in the present research, we intend to evaluate the indicators of Supply Chain Performance based on Inventory Management at Shiraz Petrochemical Company. This research aims to combine FAHP and SCOR in evaluating SCM indicators based on Inventory Management at Shiraz Petrochemical Company of Iran.

2. LITERATURE REVIEW

2.1 Supply chain management

Today, SCM is considered one of the infrastructure bases for implementing electronic business worldwide. In today's global competition, various products should be made available according to the customer's demand (Richey et al., 2022). A short definition of the supply chain is that supply chain management includes all physical and informational activities related to the flow and transformation of products, from raw material extraction to final product delivery (Mentzer et al., 2001). The main processes of sustainable supply chain operation are as follows: information management, logistics management, and communication management.

2.2. Information management

Today, the role and position of information are clear to everyone. The correct circulation and transmission of information makes coordinating activities and processes more effective and efficient and simplifies their management (Anand & Goyal, 2009). Correct information management leads to greater coordination in the supply chain. So that more and more appropriate information coordination between partners and different work departments greatly affects speed, accuracy, quality, and other effective aspects. (Yang and Fan, 2016).

2.3. Logistics management

In analyzing production and service systems, the logistics issue includes the physical part of the supply chain. This stage includes all physical activities that start from the stage of preparation of raw materials and continue until the delivery of final products. The most important of these activities include production planning, transportation, storage, etcetera, which account for a relatively large part of the effective activities in the supply chain (Soni & Gupta, 2020). This means that the concept of logistics is not only the flow of materials and products but also includes all activities of the supply chain; To the extent that practical information is one of the logistics support tools to improve the activities of that organization (Stock & Lambert, 2001; Buurman, 2002; Durach & Kembro, 2021).

2.4. Relationship management:

It is a factor that leads us to the conclusion of literature and discussion. The most important part of SCM in terms of its structure and form is relationship management in the supply chain. Relationship management strongly affects all levels and functional dimensions of the supply chain (Hingley, 2011). The information systems and technology needed for SCM operations are often easily accessible, and they may be completed and deployed in a rather short amount of time. However, many of the initial failures in the supply chain are due to the lack of optimal planning in the definition and deployment of the chain (Sutthachaidee et al., 2022). In addition, the most important factor for SCM's success is having reliable mutual communication between chain partners. In short, in developing an integrated supply chain, trust and confidence between partners are critical factors for success (Cox, 2004; Meng, 2012).

2.5. Inventory Management in the supply chain

Inventory Management in the supply chain is very important in various production and service areas.

Among the material flows, which are: financial, informational, and material; Materials are of great importance (Cachon & Fisher, 2000; Singh & Verma, most of Iran's manufacturing and industrial units, the traditional point of view is still used for supply, production, and distribution planning so that each of these plans their activities independently. For this reason, it primarily increases the total costs of the supply chains (Manzouri et al., 2010; Valmohammadi, 2014; Bazaz et al., 2022). In today's daily life, with the increase in the issue of purchasing, the importance of decisions related to purchasing has increased. In most industries, raw materials and utilized parts are the major part of product costs. So more than 50% of the total cost of the products includes purchased materials and services. Therefore, decisions related to adopting strategies in the purchasing chain determine profitability (Van Weele, 2018). Inventory Management by the seller is a new way of integrating the supply chain, where the supplier is responsible for controlling and replenishing the retailer's inventory (Sui et al., 2010; Lotfi et al., 2022). The three main criteria of Inventory Management, with their concepts and attributes, based on Eissa and Rashed (2020), Farmaciawaty et al. (2020), are determined as follows:

- Product with relevant factors (standard product, duplicate product, low demand changes for the product, clarity of the forecasted demand and inventory levels)
- Company with relevant factors (the stability of the company's annual income, high purchase transaction costs, good communication and information systems, sharing forecasted inventory information with the company's suppliers)
- Supplier with relevant factors (high level of trust and long-term relationship with the supplier, benefits of Vendor-Managed Inventory (VMI) implementation for the company and the supplier, key suppliers that have a high percentage of purchase orders, the company's information system association with suppliers)

This article considers an inventory model in a two-level supply chain under the VMI system, including a manufacturer and retailer. This model is formulated to optimize pricing decisions, replenishment amount, and frequency simultaneously to maximize supply chain profits. The retailer's market demand is price-dependent, and the manufacturer sends the manufactured stock to the retailer in several smaller batches to meet the demand. In real production conditions, generally, in addition to non-defective items, defective items are also produced. In this model, the production process is incomplete, and the shortage is not allowed.

2.6. SCOR model

The model of SCOR is a reference model and provides a standard and comprehensive model and framework for specifying efficient and effective activities along the supply chain; the main advantage of performance evaluation by this model compared to previous models is the process-oriented perspective of this model (Hasibuan et al., 2018). The SCOR model creates a balance between horizontal (inter-process) and vertical (hierarchy between processes) perspectives, and its use allows organizations to play an important and effective role in improving the overall performance of the chain by using common terminology and standard processes (Poluha, 2007; Kusrini et al., 2019). As a result of this process-oriented view, a hierarchical and structured body of evaluations and criteria is created, which gives a general view of the supply chain to all supply chain managers. Since the SCOR model is one of the suitable examples of process-oriented performance evaluation systems and is a comprehensive and standard model in this field, this research, based on the model and the indicators presented in the first level of the model and research techniques in operations, a model has been presented to evaluate the performance of SCM (Bolstorff & Rosenbaum, 2007; Lockamy & McCormack 2004). In the following, the five factors of Supply Chain Performance are explained:

Supply Chain Reliability: The performance of the supply chain considers the delivery of the necessary products, at the best possible place and time, with optimal conditions, in the necessary quantity, and according to the right documentation to the desired customer (Rombe and Hadi, 2022).

Supply Chain Responsiveness: It is the average actual time spent to satisfy the demand (SCOR11:2012).

Agility of the supply chain: the agility and flexibility of the supply chain in responding to market changes to maintain or increase competitive advantages (SCOR11:2012).

Total supply chain costs: total supply chain costs spent on delivering products and services to customers (SCOR11:2012).

The efficiency of asset management: the use of an organization in asset management to support the satisfaction of demand; this feature includes the management of fixed and variable assets (SCOR11:2012).

2.7. The theoretical framework of research

SCM indicators were presented in the 1990s by the Supply Chain Council, based on which SCM was examined in five indicators: Reliability, Responsiveness, Agility, Cost, and Asset (Putra et al., 2022; Rodríguez Mañay et al., 2022). The model, which was designed based on the business process, examines all supply chain activities according to the five mentioned indicators (Thunberg & Persson, 2014; Maestrini et al., 2015; Balfaqih et al., 2016).

Moreover, as stated in paragraph 2.2 of the research literature; the factors of Inventory Management (Eissa and Rashed, 2020; Farmaciawaty et al., 2020) have been determined by the following three factors:

- Product with a number of sub-criteria.
- Company with a number of sub-criteria.
- Supplier with a number of sub-criteria.

The present research will examine SCM criteria based on the five main criteria of the SCOR model, presented in Figure 1.

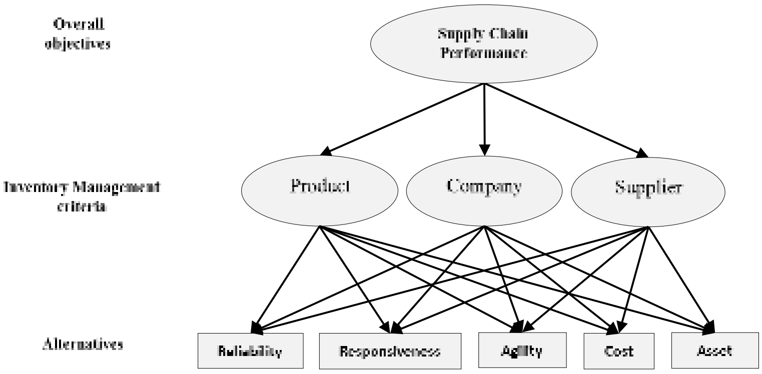

Figure 1. Proposed FAHP Model for SCOR Metrics of SCP based on Inventory Management

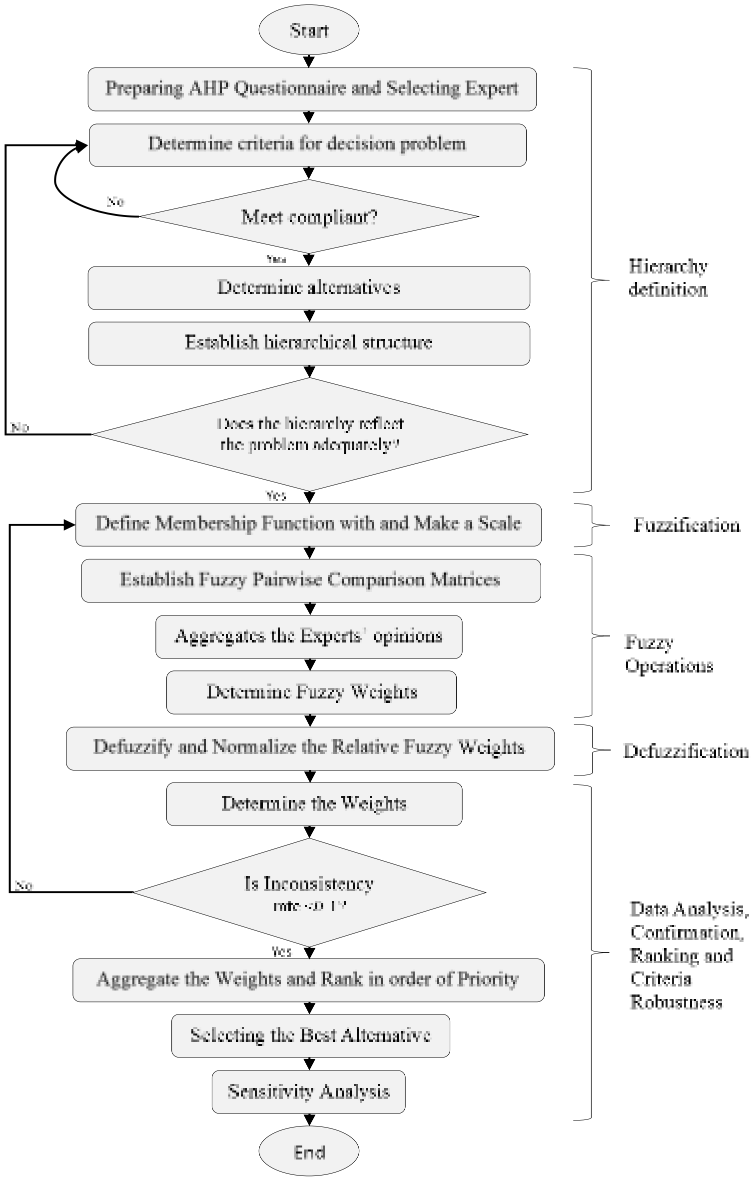

Figure 2. Fuzzy AHP flowchart

3. RESEARCH METHOD

A descriptive-analytical research method was used to evaluate SCM indicators based on Inventory Management with the combined approach of SCOR and FAHP. Based on the SCOR model, the indicators are divided into five alternatives: Reliability, Responsiveness, Agility, Cost, and Asset. \
Three criteria of product, supplier, and company were considered for Inventory Management, and the results were analyzed based on the pairwise comparison questionnaire provided to 15 experts. After data collection, the research's reliability was checked, consistent, and suitable for analysis. In the following, during quantitative operations, Inventory Management factors as criteria; and Supply Chain Performance factors as alternatives; are ranked. A schematic diagram of the steps mentioned above is shown in Figure 2.

3.1. Analytical Hierarchy Process

Analytic Hierarchy Process (AHP) is a measurement method used to prioritize homogeneous elements through pairwise comparisons and heterogeneous elements through clustering (Saaty, 1994), which helps the decision maker to make decisions with subjective and conflicting criteria. AHP is mainly used in the following cases; when the problem analysis shows that it should be broken into its constituent elements and When there is a hierarchy of constituent elements about the goal (Saaty, 1988).

3.2. Fuzzy AHP (FAHP)

The hierarchical analysis process method deals with hierarchically prioritizing options. However, many researchers have created ambiguities in the correctness of this method and have stated that this method cannot correctly show the decision maker's opinion and considering it is not certain that pairwise comparisons are made subjectively. For this reason, decision-makers can use fuzzy numbers instead of definite numbers in pairwise comparisons. Fuzzy numbers are used in the fuzzy hierarchical analysis process to perform pairwise comparisons (Sun et al., 2010; Chan et al., 2019).

Step 1 - Construct the hierarchy structure model

At this stage, decision-makers with relevant knowledge and experience are selected to assist in the work process, like preparing a standard questionnaire and determining criteria and alternatives to construct a hierarchical process.

Step 2 - Fuzzification

In the current study, Triangular Fuzzy Numbers (TFNs) were used to decrease ambiguity and uncertainty for pairwise comparison. In triangular fuzzy, numbers are represented with three points in the interval (0,1) $\widetilde{A} = (l, m, u)$, represented in Figure 3. Where a and c represent the smallest and largest number of the set and b is the mid-value. Equation (1) shows the membership function of TFNs.

$$\mu(\widetilde{A}) = \begin{cases} \frac{x-l}{m-l} & l \le x \le m \\ \frac{u-x}{u-m} & m \le x \le u \\ 0 & \text{Otherwise} \end{cases} \quad (1)$$

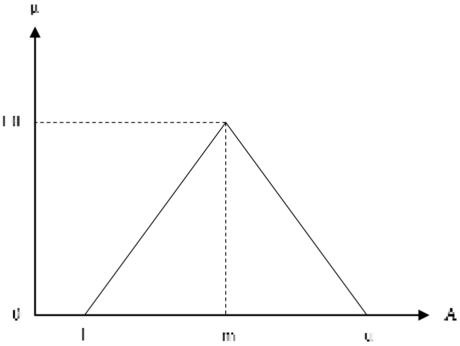

Figure 3. The membership function of TFNs

Step 3 - Fuzzy Operations

In this article, 9-point TFNs $(\tilde{1},\tilde{2},\tilde{3},\ldots,\tilde{9})$ are used for constructing a pairwise comparison matrix. The 9 TFNs are defined with the related triangular fuzzy sets, as shown in Figure 4 and Table 1 (Saaty, 2000).

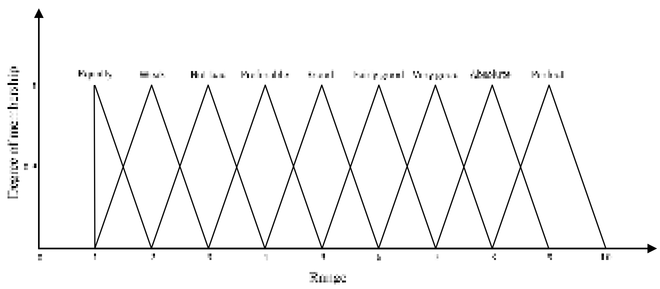

Figure 4. The membership functions of TFNs (linguistic values) $(\tilde{1},\tilde{2},\tilde{3},\ldots,\tilde{9})$

Next, the Fuzzy reciprocal judgment matrix, using TFNs, is established as Equation (2):

$$\widetilde{A} = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \cdots & 1 \end{bmatrix} \quad (2)$$

After aggregating experts' opinions, geometric mean was used to determine the fuzzy weights of matrices. Equations (3) and (4) are suggested by Buckley (1985) to use fuzzy geometric mean and fuzzy weight, respectively.

$$\tilde{r}_i = \left(\prod_{i=1}^{n} \tilde{a}_{ij}\right)^{\frac{1}{n}} \quad (3)$$

$$w_i = \tilde{r}_i / (\tilde{r}_1 + \cdots + \tilde{r}_n)^{-1} \quad (4)$$

Table 1. Definition and membership function of Linguistic Terms

Intensity of importance	Fuzzy number	Definition	Explanation	Scale of Fuzzy number	Inverse Fuzzy equivalent
1	$\tilde{1}$	Equally important	Two attributes contribute equally	(1, 1, 1)	(1, 1, 1)
2	$\tilde{2}$	Weak advantage	Equally to moderately more important	(1, 2, 3)	(0.333, 0.5, 1)
3	$\tilde{3}$	Not bad	Experience and judgment slightly favor one activity over another	(2, 3, 4)	(0.25, 0.333, 0.5)
4	$\tilde{4}$	Preferable	Moderately to strongly important	(3, 4, 5)	(0.2, 0.25, 0.333)
5	$\tilde{5}$	Good	Experience and judgment strongly favor one activity over another	(4, 5, 6)	(0.166, 0.2, 0.25)
6	$\tilde{6}$	Fairly good	Strongly to very strongly more important	(5, 6, 7)	(0.142, 0.16, 0.2)
7	$\tilde{7}$	Very good	An activity is favored very strongly over another; its dominance demonstrated in practice	(6, 7, 8)	(0.125, 0.142, 0.166)
8	$\tilde{8}$	Absolute	Very strongly to extremely more important	(7, 8, 9)	(0.111, 0.125, 0.142)
9	$\tilde{9}$	Perfect	The strongest potential order of affirmation exists for indicating that one activity is preferable to another.	(8, 9, 10)	(0.1, 0.111, 0.125)
Reciprocals			Reciprocals for inverse comparison		

Step - 3 Defuzzification

At this stage, the obtained weight has been converted into a crisp real number. Several methods are available, e.g., mean of maximum, center of area, cut method, and Sugeno defuzzification method (Zhao and Govind, 1991; Guney and Sarikaya, 2009). In this present study, Sugeno defuzzification method is used to obtain output crisp real numbers. In order to obtain a crisp value, each input is multiplied by a constant and added up to the result to make equations called 'rules of strength' or 'degree of applicability' and finally mathematically combine these equations, which is the weighted average of all rule outputs (Sugeno and Tanaka, 1991; Mendis et al., 2020). The defuzzified value of the fuzzy number is computed using Equation (5).

$$W_{crisp} = \frac{\sum_{i=1}^{n} w_i z_i}{\sum_{i=1}^{n} w_i} \quad (5)$$

Step - 4 Data Analysis, confirmation, ranking, and criteria Robustness

Normalization of crisp real numbers is conducted using Equation (6).

$$n_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (6)$$

The consistency of the decision problem is examined in two aspects; 1) The variables and criteria that are compared should be related and of the same type, and 2) The consistency ratio of pairwise comparison judgments is investigated. The inconsistency index (II) and inconsistency rate (IR) are calculated using Equations (7) and (8), respectively. Where λmax is the largest eigenvalue of the comparison matrix, n is the dimension of the matrix, and the inconsistency index of the random matrix (IIR) is selected from Table 2 (Saaty, 1994; Saaty, 2000; Kwong & Bai, 2010).

$$II = \frac{\lambda_{max} - n}{n-1} \quad (7)$$

$$IR = \frac{II}{IIR} \quad (8)$$

Table 2. Inconsistency index of the random matrix

N	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
IIR	0	0	0.52	0.39	1.11	1.25	1.35	1.40	1.45	1.49

If the IIR value is less than 0.1, the comparisons are acceptable, and variables can be ranked; otherwise, decision-makers must revise the original values in a pairwise comparison matrix. At last, to investigate the robustness of the criteria, sensitive analysis is applied by switching the weight of the criteria.

3.3. Data Analysis

This research aimed to evaluate Supply Chain Performance based on Inventory Management. Data analysis has been done in two stages: the first stage, Pairwise comparisons of the triple factors of Inventory Management, and the second stage, Pairwise comparisons of five SCOR indices based on Inventory Management criteria.

Step 1 - Pairwise comparisons of the three criteria of Inventory Management (product, company, supplier).

After preparing the pairwise comparison questionnaire and obtaining SCOR through 15 experts in the industry, Aggregation of questionnaires (using the geometric mean method) and fuzzy transformation were done (Table 3).

Table 3. Aggregation of experts' opinions of criteria (geometric mean)

Inventory Management	**Product (C1)**			**Company (C2)**			**Supplier (C3)**		
Supplier (C3)	1.00	1.00	1.00	1.70	2.80	3.85	0.71	1.07	1.65
Supplier (C3)	0.25	0.33	0.52	1.00	1.00	1.00	0.43	0.63	0.83
Supplier (C3)	0.66	1.05	1.68	1.52	2.15	3.14	1.00	1.00	1.00

As evident in Table 3, all the fuzzy numbers of the aggregated questionnaire of the experts in the pairwise comparison of Inventory Management factors have been calculated through the geometric mean. The fuzzy weights of Inventory Management factors are shown in Table 4.

As evident in Table 3, all the fuzzy numbers of the aggregated questionnaire of the experts in the pairwise comparison of Inventory Management factors have been calculated through the geometric mean. The fuzzy weights of Inventory Management factors are shown in Table 4.

Based on Table 4, in pairwise comparisons of Inventory Management criteria, the product criterion with the highest weight, is in the first place, and supplier and company criteria are ranked second and third, respectively.

Table 4. Final weights of Inventory Management factors

Criteria	**Final weight**	**Normal weight**	**Rank**
Product	0.4587	0.427	1
Company	0.1905	0.177	3
Supplier	0.4248	0.396	2

Step 2 - Pairwise comparisons of SCM indicators. The SCOR ranking (Reliability, Responsiveness, Agility, Cost, and Asset) is based on the criteria of Inventory Management (product, company, supplier) presented in Table 5.

Table 5. SCOR factors (alternatives) ranking based on Inventory Management criteria

Criteria	**Reliability (A1)**	**Responsiveness (A2)**	**Agility (A3)**	**Cost (A4)**	**Asset (A5)**
Reliability (A1)					
Responsiveness (A2)					
Agility (A3)					
Cost (A4)					
Asset (A5)					

Based on this model, pairwise comparisons of 5 alternatives (Supply Chain Performance indicators) are performed in three stages based on three Inventory Management criteria (product, company, supplier) separately. Carrying out this process for each of the criteria is in four steps:

1. Pairwise comparisons alternatives based on criteria
2. Geometric mean of Alternatives based on criteria
3. Fuzzy weights of Alternatives based on criteria
4. Final weights of Alternatives based on criteria

Ranking alternatives based on product: Criteria Aggregated experts' opinions of pairwise comparison of alternatives based on product criteria (geometric mean) are shown in Table 6.

Table 6. Pairwise comparison alternatives based on product criteria

Product Criteria	**A1**			**A2**			**A3**			**A4**			**A5**		
A1	1.00	1.00	1.00	0.34	0.50	0.80	0.26	0.35	0.56	2.49	3.59	4.64	1.52	2.27	3.25
A2	1.25	2.00	2.96	1.00	1.00	1.00	0.33	0.50	1.00	3.18	4.36	5.45	2.64	3.68	4.70
A3	1.78	2.86	3.90	1.00	2.00	3.00	1.00	1.00	1.00	5.16	6.21	7.24	4.08	5.10	6.12
A4	0.22	0.28	0.40	0.18	0.23	0.31	0.14	0.16	0.19	1.00	1.00	1.00	0.33	0.50	1.00
A5	0.31	0.44	0.66	0.21	0.27	0.38	0.16	0.20	0.25	1.00	2.00	3.00	1.00	1.00	1.00

As evident in Table 6, all the fuzzy numbers of the aggregated questionnaire of the experts in the pairwise comparison of the Supply Chain Performance alternatives based on the criteria of the products (inventory) have been calculated through the geometric mean, and the numbers of the main diameter are all one. The numbers below the main diameter are the inverse numbers above the main diameter. After determining the IR (less than 0.1), the questionnaires are consistent according to Table 6 and are suitable for analysis. In the following, the fuzzy weights of the Supply Chain Performance alternatives based on the product criteria are given in Tables 7 and 8.

The final weights of SCM **alternatives** based on product criteria are shown in Table 9.

Table 7. The geometric mean of Alternatives based on product criteria

Product Criteria	l	m	u
A1	0.8000	1.0732	1.4664
A2	1.2833	1.7418	2.3761
A3	2.0649	2.8293	3.4903
A4	0.2831	0.3486	0.4761
A5	0.4036	0.5425	0.7128
Sum of averages	4.8348	6.5353	8.5218
The inverse of the total	0.1173	0.1530	0.2068

Table 8. Fuzzy weights of Alternatives based on product criteria

Product Criteria	l	m	u
A1	0.09387	0.16422	0.30331
A2	0.15059	0.26651	0.49146
A3	0.24231	0.43293	0.72191
A4	0.03322	0.05333	0.09847
A5	0.04736	0.083	0.14744

Table 9. Final weights of Alternatives based on product criteria

Product Criteria	Final weight	Normal weight	Rank
A1	0.181	0.168	3
A2	0.294	0.271	2
A3	0.458	0.423	1
A4	0.060	0.055	5
A5	0.090	0.083	4

According to Table 9, the final ranking of Supply Chain Performance **alternatives** based on the criterion of the product will be as follows: 1-Agility, 2-Responsiveness, 3-Reliability, 4-Asset, 5-Cost.

Ranking alternatives based on Company: Pairwise comparisons of Supply Chain Performance **alternatives** based on the company criteria. Due to the repetition of the work steps of evaluating the alternatives based on different criteria, only the first and last tables have been given.

Based on the numbers obtained in Table 10, it is clear that all the fuzzy numbers of the aggregated questionnaire of the experts in the pairwise comparison of the Supply Chain Performance **alternatives** were calculated based on the company criteria (inventory) through the geometric mean, and the numbers below the main diameter are inversed numbers above the main diameter.

In the following, after calculating of "Geometric mean" and "Fuzzy weights" of Alternatives based on Company criteria, the Final weights of Alternatives based on Company criteria are calculated in Table 11.

In the following, after calculating the"geometric mean" and "fuzzy weight" of the alternative options based on the company criteria, the final weights of the alternatives based on the company criteria are calculated.

Table 10. Pairwise comparison alternatives based on company criteria

Company criteria	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	1.10	1.68	2.30	0.58	1.00	1.55	2.49	3.59	4.64	1.89	2.61	3.59
A2	0.44	0.59	0.91	1.00	1.00	1.00	0.30	0.43	0.76	1.43	2.57	3.65	1.52	2.55	3.57
A3	0.64	1.00	1.72	1.32	2.35	3.37	1.00	1.00	1.00	2.79	3.87	4.92	1.72	2.86	3.94
A4	0.22	0.28	0.40	0.27	0.39	0.70	0.20	0.26	0.36	1.00	1.00	1.00	0.33	0.50	1.00
A5	0.28	0.38	0.53	0.28	0.39	0.66	0.25	0.35	0.58	1.00	2.00	3.00	1.00	1.00	1.00

Table 11. Final weights of Alternatives based on Company criteria

Company criteria	Final weight	Normal weight	ran k
A1	0.325	0.293	2
A2	0.213	0.192	3
A3	0.362	0.326	1
A4	0.085	0.077	5
A5	0.124	0.112	4

According to the results from the company criteria, agility is more important, and reliability is ranked second.

Ranking alternatives based on supplier: Pairwise comparisons of Supply Chain Performance **alternatives** based on supplier criteria. Due to the repetition of the work steps of evaluating the alternatives based on different criteria, only the first and last tables have been given.

Table 12. Pairwise comparison alternatives based on supplier criteria

Supplier criteria	A1			A2			A3			A4			A5		
A1	1.00	1.00	1.00	1.32	2.35	3.37	3.32	4.34	5.35	3.57	4.57	5.58	3.44	4.48	5.50
A2	0.25	0.33	0.50	1.00	1.00	1.00	2.00	3.00	4.00	3.00	4.00	5.00	2.86	3.90	4.92
A3	0.33	0.50	1.00	1.00	2.00	3.00	1.00	1.00	1.00	1.15	2.17	3.18	0.80	1.52	2.41
A4	0.20	0.25	0.33	0.33	0.50	1.00	0.25	0.33	0.50	1.00	1.00	1.00	0.33	0.50	1.00
A5	0.25	0.33	0.50	0.25	0.33	0.50	0.33	0.50	1.00	1.00	2.00	3.00	1.00	1.00	1.00

Based on the numbers obtained in table 12, it is clear that all the fuzzy numbers of the aggregated questionnaire of the experts in the pairwise comparison of the Supply Chain Performance **alternatives** were calculated based on the criteria of the supplier (inventory) through the geometric mean, and the numbers below the main diameter are inversed numbers above the main diameter.

Table 13. Final weights of Alternatives based on Supplier criteria

Supplier criteria	Final weight	Normal weight	rank
A1	0.439	0.404	1
A2	0.265	0.244	2
A3	0.202	0.186	3
A4	0.076	0.070	5
A5	0.104	0.096	4

After determining the IR (less than 0.1), the questionnaires are consistent according to Table 12 and are suitable for analysis. In the following, after calculating the "geometric mean" and "fuzzy weight" of the alternative options based on the company criteria, the final weights of the alternatives based on the Supplier criteria are calculated in Table 13.

According to Table 13, the final ranking of the Supply Chain Performance **alternatives** based on the criteria of the supplier will be as follows: 1- Reliability 2- Responsiveness 3- Agility 4- Asset 5- Cost.

Determining the normal weights of the alternatives: The final weight of each alternative should be normalized once weights are determined based on criteria, and these weights will be taken into account when determining the final rank of each criterion.

The ranking of SCM **alternatives** based on Inventory Management is given in Table 14. After calculating the weights of SCM based on inventory **alternatives**, in the last step, the final matrix of the obtained weights should be calculated, and the final results should be considered as the final rank of each **alternative** in the SCOR model.

According to Table 15, the final ranking of alternatives based on Inventory Management will be as follows; Agility, Reliability, Responsiveness, Asset, and Cost, as illustrated in Figure 5.

Table 14. Final ranking of Alternatives based on criteria

	A1	A2	A3	A4	A5
C1	3	2	1	5	4
C2	2	3	1	5	4
C3	1	2	3	5	4

Table 15. Final ranking matrix of Alternatives

$$\begin{pmatrix} 0.427 & 0.177 & 0.396 \end{pmatrix}$$

	0.16758	**0.27138**	**0.42268**	**0.05505**	**0.08332**
	0.29314	0.19217	0.32621	0.0768	0.11167
	0.40367	0.24405	0.18628	0.07019	0.09581
	A1	**A2**	**A3**	**A4**	**A5**
Final weight	0.283	0.247	0.312	0.065	0.093
Final rank	2	3	1	5	4

Figure 5. Final ranking of alternatives based on their weights

4. SENSITIVITY ANALYSIS

Sensitivity analysis is used to determine independent parameters' effect on dependent parameters. The outcome is determined by varying the independent variables over a predetermined range (Sachan & Datta, 2005; Anand et al., 2019). Sensitivity analysis demonstrates the degree to which a result depends on a particular variable. The results are sensitive if the ranking order is altered by elevating or lowering the weight of the criteria; otherwise, it is robust (Senthil et al., 2014).

By varying the weights of two criteria, which resulted in three scenarios, various scenarios were represented to investigate the impact of weights on selecting five alternatives. The weights of criteria 1 and 2 are switched in each experiment as indicated by the C12 symbol, which denotes the weight switch. Table 16 and Figure 6 present the sensitivity analysis results, showing that A3 scored highest twice and A1 ranked first once in the three experiments. The outcome demonstrates the robustness and low sensitivity of the criteria. As a result, the decision-making process rarely responds to the weight of the criteria.

Table 16. Results of sensitivity analysis

Scenario No.	Experiment No.	A1	A2	A3	A4	A5
1	C12	0.31468576	0.22673465	0.28787291	0.07033269	0.10037149
2	C23	0.29061455	0.24568992	0.30466201	0.06536453	0.09367118
3	C13	0.25908969	0.23517543	0.34263508	0.06634278	0.09675733

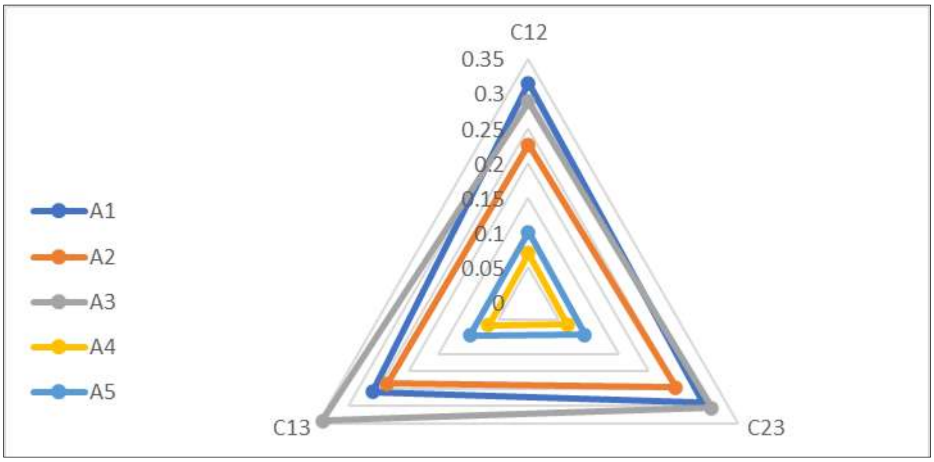

Figure 6. Sensitivity analysis in a radar chart

5. DISCUSSION AND CONCLUSION

Based on the presented model, the evaluation of **SCOR Metrics of Supply Chain Performance** indicators based on Inventory Management with the hybrid approach of FAHP and SCOR was discussed in Iran Petrochemical Company. Based on the SCOR model, the indicators are divided into five **alternatives**: Reliability, Responsiveness, Agility, Cost, and Asset, and three criteria of product, supplier, and company are considered for Inventory Management. The designed questionnaire given to 15 experts at Iran Petrochemical Company served as the basis for analyzing the results. The improved FAHP technique was initially employed as the best technique for problem-solving. The IR, based on which all 15 research questionnaires and the obtained cumulative matrices were deemed consistent and appropriate for analysis, was also checked to determine the reliability of the research. The **alternatives** and the final rank on each scale were studied further to produce the results shown below:

Ranking of Inventory Management criteria: Product-related factors received the top ranking in this comparison, followed by supplier-related factors in second place and company-related factors in third place. There has not been any comparable study in this area to compare. However, given that the product's contributing factors include: standard products (minimum customization of the products), repetitive products (small changes made by the customer), low demand changes for the products, clarity of forecasted demand, and inventory levels, it is concluded that when choosing petrochemical company products, it is important to keep the following in mind:

- Selecting the type of products produced according to the market
- Raising the standard level of the products according to foreign samples
- Proper and accurate forecasting of the target market and products demand

Based on the results obtained in this research, it seems that SCM that is based on inventory, the importance of product criteria depicts that the supply chain approach based on customer orientation and customer satisfaction is very significant and creates value for customers in manufacturing companies, creating value for customers can be the most critical function for the supply chain.

The results of the final ranking of the SCOR Metrics of Supply Chain Performance: In general, Supply Chain Performance indicators were presented by the Supply Chain Council in the 1990s, based on which SCM was evaluated based on five **alternatives** of Reliability, Responsiveness, Agility, Cost and Asset. Based on this, this model, designed based on the business process, examines all supply chain activities based on the five mentioned indicators (Sellitto et el., 2015). The following are the final rankings for SCM based on inventory management: Agility, Reliability, Responsiveness, Asset, and Cost. The most important indicator in this regard was organizational agility and reliability, and it shows that the petrochemical company should use all available tools for agility and reliability strategies.

Guritno et al. (2015), in similar research to the evaluation of supply chain factors and classification of Inventory Management at the level of fresh vegetable suppliers based on the SCOR reference model, showed that the most efficient indicator was cost. In a similar research, the results of Hasibuan et al. (2018) research in "Performance analysis of SCM" indicate the prioritization of five performance criteria of the supply chain as follows: Responsiveness, Agility, Reliability, Asset, and Cost. The above research results are precisely the same as the present research. Praharsi et al. (2021), in a research field of "Supply Chain Performance," showed that the lowest performance metric value is the cost of goods. But in Kusrini et al. (2019). "Supply Chain Performance Measurement" research, agility ranked last. The reasons for the different results can be things like: type of industry, type of organization, type of country, type of product, et cetera. Ambe's (2014) research findings showed that the reliability and quality of the final products are the most significant indicators of South Africa's light vehicle market.

Although the purpose of SCM is to ensure that the products are delivered at the right place and time through inventory optimization,it can be seen that the importance of the five factors (Reliability, Responsiveness, Agility, Cost, and Asset) is different according to the type of company. Therefore, a single result cannot be prescribed.

According to the current research results, since organizational agility and reliability are ranked first and second, prioritization results indicated that human, organizational, technical, and technological factors and strategic factors in terms of organizational agility and reliability should be prioritized for improvement and upgrade. In fact, by training and creating capable and multi-skilled employees, quick response, continuous feedback; agility, and reliability are gained to make it possible to make a decision about the appropriate amount of inventory for each of these levels and help in determining the minimum inventory needed to face uncertainty and products and supply chain problems.

- As a result; Considering the ranking and importance of agility, reliability, and responsiveness, it is recommended to observe the following points in petrochemical company:
- It is suggested that an aggregated information system be formed from suppliers, and all purchases, inputs, and outputs of the company are made based on determining the order point of stock in products and products. The advantage of this becomes essential since all the raw materials of the factory have expiration dates, and sometimes the lack of proper forecasts causes damage to materials and products;
- Developing standard products and creating forecasted demand;
- Improving the level of high trust and long-term relationship with the supplier, the connection of the company's information system with the suppliers;
- Determining critical points and solving challenges and agility obstacles in the organization;
- Defining reliability engineering in the organization and providing the appropriate policy;

Drawing a detailed process to respond to all requests (customers, market, and suppliers).

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