فصلنامه پژوهش های علوم مدیریت
سال سوم، شماره ۶، بهار ۱۴۰۰
ISSN: ۲۷۱۷-۱۳۶۱
www.jomsr.ir

Ranking of factors affecting the performance of supply chain performance and reducing logistics costs in the petrochemical industry by using the IPA method

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abstract

Objective: With increasing and diversifying customer demand, advances in recent information systems technology, global competition, and increasing public awareness, industries need to focus more on supply chain management. Due to the high value of petrochemical products, supply chain management is of great importance in the petrochemical industry. In general, supply chain performance evaluation is an essential element in effective planning, control, and decision-making. In this regard, the aim of this study is to rank the factors influencing the performance of the supply chain and reduce its costs in the petrochemical industry. Method: The approach used is Importance performance analysis matrix (IPA). The statistical population of the study consists of experts in the petrochemical industry. Data collection method, questionnaire and in the first half of 2021 has been done. Results: In this study, two questions were answered; What are the factors influencing the performance of the supply chain in the petrochemical industry? And according to the above factors, which factor is the first priority? Finally, the factors influencing the performance of supply chain performance in the importance-performance matrix have been established and suggestions have been made to improve the company's situation. Conclusion: Based on the results, the performance of the petrochemical industry supply chain is affected by factors such as quality and variety of products and services, flexibility in meeting customer needs, bill delivery speed and program schedule effectiveness and order cycle time. Using these results, through the matrix analysis of performance-importance matrix using Excel software, these factors were ranked in order to improve the supply chain and increase competitiveness. Findings show that in terms of importance, the factors affecting the performance of the supply chain are process, flexibility, supplier, satisfaction and time, respectively. The results of this research can help continuous monitoring, increase production, create and maintain competitive position in industries.

Keywords: supply chain; Supply chain performance; Reduce logistics costs; Petrochemical industry, IPA method.

Introduction

The term supply chain management was first coined in 1982 by Oliver and Webber (Oliver Webber, 1982). This concept was originally used mainly to explain the benefits of integrating the internal functional areas of an organization, such as melody, production, logistics, and marketing. But the history of its emergence dates back to the 1950s and 1960s, and today is a potential way to maintain a competitive advantage and improve performance. In this way, there is no longer competition between organizations, but between supply chains, and it is shown that more efficient supply chain performance improves organizational performance. This makes employees more focused on important business activities (Li, Rao, Ragu Nathan, Ragu Nathan, 2005). This chain seeks effective ways to create more value for the customer. For example, a supply chain leads to value creation for the customer through innovation and continuous improvement, system integration, and reform at industry-profitable levels (pyke, 2009).

The main goal of supply chain management activities is to satisfy customer demand, so that it can deliver the desired product to customers with maximum quality, minimum price and at the desired time. In the supply chain, in order to optimize the internal processes of the chain, each member must coordinate with the other members of the chain (Manthou, Vlachopoulou, Folinas, 2004). Assessing supply chain performance provides feedback and information to managers about supply chain activities in terms of meeting customer expectations and achieving strategic goals (Chan, 2003 & Olugu, 2009). Despite the growth of supply chain performance appraisals in recent years, many have failed to meet performance standards at the operational, tactical, and strategic levels (Gunasekaran, 2001 & Hudson, 2001). Special criteria for evaluating supply chain performance are classified into four areas: quality, time, cost, and flexibility. In addition, they are classified based on quantity or quality, cost or non-cost, and focus on technical, operational, strategic, and supply chain processes (Cai et al, 2009).

So far, various studies have been conducted on the supply chain, but evaluating this issue in the Iranian petrochemical industry still requires more work and study. Accordingly, the purpose of this study is to rank the factors influencing the performance of the supply chain and reduce logistics costs in the industry. Real-world problems are complex in supply chain management, and experts and decision makers often do not know the exact values of the parameters (Cheng et al, 2013).

Given the role of the petrochemical industry in Iran's economy, improving the performance of the petrochemical industry supply chain could be an important step towards achieving the country's macroeconomic goals, that in this regard, documenting the review of literature and research background, These questions will be answered in the research:

What are the factors influencing the performance of the supply chain and the factors influencing the reduction of logistics costs in the petrochemical industry? And according to the above factors, which factor is the first priority?

The results of the present study have several stakeholders, including the government, the National Iranian Oil Company, oil industry contractors, oil consulting engineers in improving performance, managers and supervisors of supply chain management, educational institutions holding oil industry courses and supply chain and ...

In order to determine some of the literature used in the research, a brief description of these terms is provided below.

Research background

۱. Theoretical background

Supply chain

A supply chain is a chain that includes all activities related to the flow of goods and the conversion of materials from the raw material stage to the final product delivery stage to the consumer. In addition to the flow of goods, there are two other streams, one is the flow of information and the other is the flow of financial resources and credit (McCormack, Bronzo Ladeira & Paulo Valadares de Oliveira, 2008).

This chain includes a network of participants and different operational channels from within and outside the organization that affect the desirability of supply chain headquarters (Eng, 2006). In general, a supply chain consists of a variety of activities, including procurement, inventory, resource acquisition and purchasing, production planning, inter-organizational relationships, and performance measurement (Arshinder & Arun, 2008). The definition of global supply chain management (GSCF) is developed as follows: "Supply chain management is the integration of key business processes of the end user through the main suppliers that create products, services and information that add value to customers and other stakeholders. They do, it provides "(Rimienė, 2011).

Supply chain performance

Performance appraisal as an essential management tool provides the necessary assistance to improve performance in the direction of supply chain excellence; Although supply chain management has become a common practice at the industry level and a range of topics related to supply chain management theories and practices have been published, supply chain performance evaluation has not received much attention (Chan et al, 2003). To achieve the expected performance of supply chains, the company needs to monitor and control its operations on a daily basis (Sajadie et al, 2009). Bhatnagar and Ssohal consider supply chain performance criteria to be time delay, inventory, market access time, quality, customer service, and flexibility (Bhatnagar Ssohal, 2005).

Performance criteria are classified into quantitative and qualitative criteria. Some examples of quality metrics include customer satisfaction, flexibility, information and material flow integration, effective risk management, and supplier performance.

Some of the quantitative criteria are also (Chan et al, 2003):

(1) Cost-based criteria such as minimizing costs, minimizing investment in inventories, maximizing profits, and maximizing return on investment;
(2) Customer-based criteria such as maximizing the percentage of customer satisfaction (supply rate), minimizing delays in product delivery, minimizing customer response time, minimizing LT (time between receiving and delivering an order) and minimizing Resetting tasks;
(3) Productivity-based criteria such as maximizing the use of convenience and resource utilization.

Reduce logistics costs

Logistics activities can be considered the main factor in creating a supply chain. Without these activities, the chains will not actually form. Some have considered logistics to be the planning and control of material flow and related information (Ghiani, 2004). Every activity in the field of logistics comes with a cost. Various authorities have categorized logistics costs in various ways. One of these categories is presented by Inger et al. In a report on logistics costs in Norway (Inger et al, 2010) Which include: Transportation costs, warehousing costs, investment costs, packaging costs, insurance costs, waste costs and obsolescence, logistics administrative costs.

Petrochemical industry

The petrochemical industry has a significant impact on a country's economy and is known as the mother industry in every country; Because their output will be the main supplier of consumables in most industries, including chemical, electronics, textile, medical, automotive, home appliances, etc. (Kadambur Kotecha, 2015). Optimal and sustainable development in the petrochemical industry depends on effective attention to all complementary links in the petrochemical supply chain and the provision of general and specialized infrastructure related to this industry (Lababidi et al, 2019).

IPA method(Importance-Performance Analysis Matrix)

Martila and James first used the importance-performance analysis method in 1977 to analyze the performance of the automotive industry, but today, the importance-performance analysis has become a well-known management tool and is widely used to identify weaknesses and Strengthening business

identities, products, services and prioritizing opportunities for improvement is used in a variety of industries (Raymond, Choi, T, 2000).
This model consists of two main components of importance and characteristic performance. The combination of these two components forms a four-house matrix that contributes significantly to the classification of the studied characteristics. Figure 1 shows the structure of an IPA matrix.

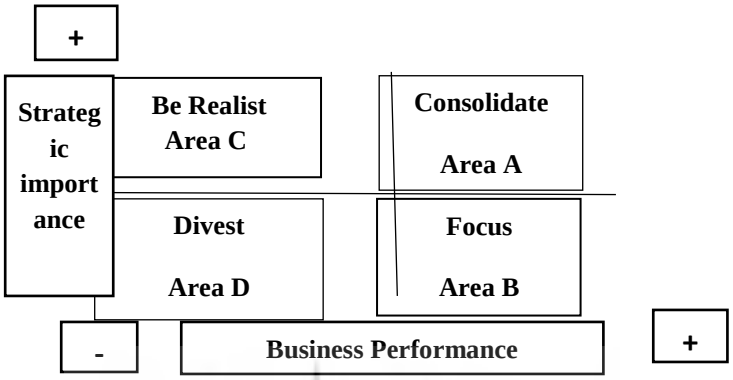


Figure 1: Importance performance matrix

The concept of each of the four areas of this matrix is as follows (Raymond, Choi, T, 2000):

- ≠ Area A: is a differentiating business that can be labeled Consolidate with the concept of consolidation and maximum utilization. Respondents evaluate the indicators as very important, but the level of performance of these indicators is relatively low, so efforts to improve and develop in this area should be focused.
- ≠ Area B: is a forgotten business that can be a potential differentiator, and the Focus label is used to focus on finding opportunities for further growth and exploitation (for example, by looking for synergistic opportunities). Respondents evaluate the indicators as very important, and the organization performs very well on these indicators, so it is important to act on these indicators as before.
- ≠ Area C: is a business that has received too much attention and can be labeled Be Realist with the concept of the need for realism. Indicators are at a low level in terms of importance and performance, and limited resources should be allocated to this area by the company.
- ≠ Area D: is an unimportant business that is neither functionally nor strategically valuable and can be labeled Divest. The indicators that are used in this area are not very important from the respondents' point of view, but they have a relatively high performance. Outsiders are pleased with the organization's high performance on these indicators, but managers must severely limit their current efforts to these features.

۲. Experimental background

In this section, we have examined the research conducted in the field of supply chain performance evaluation, the summary of the results is presented in Table 1.

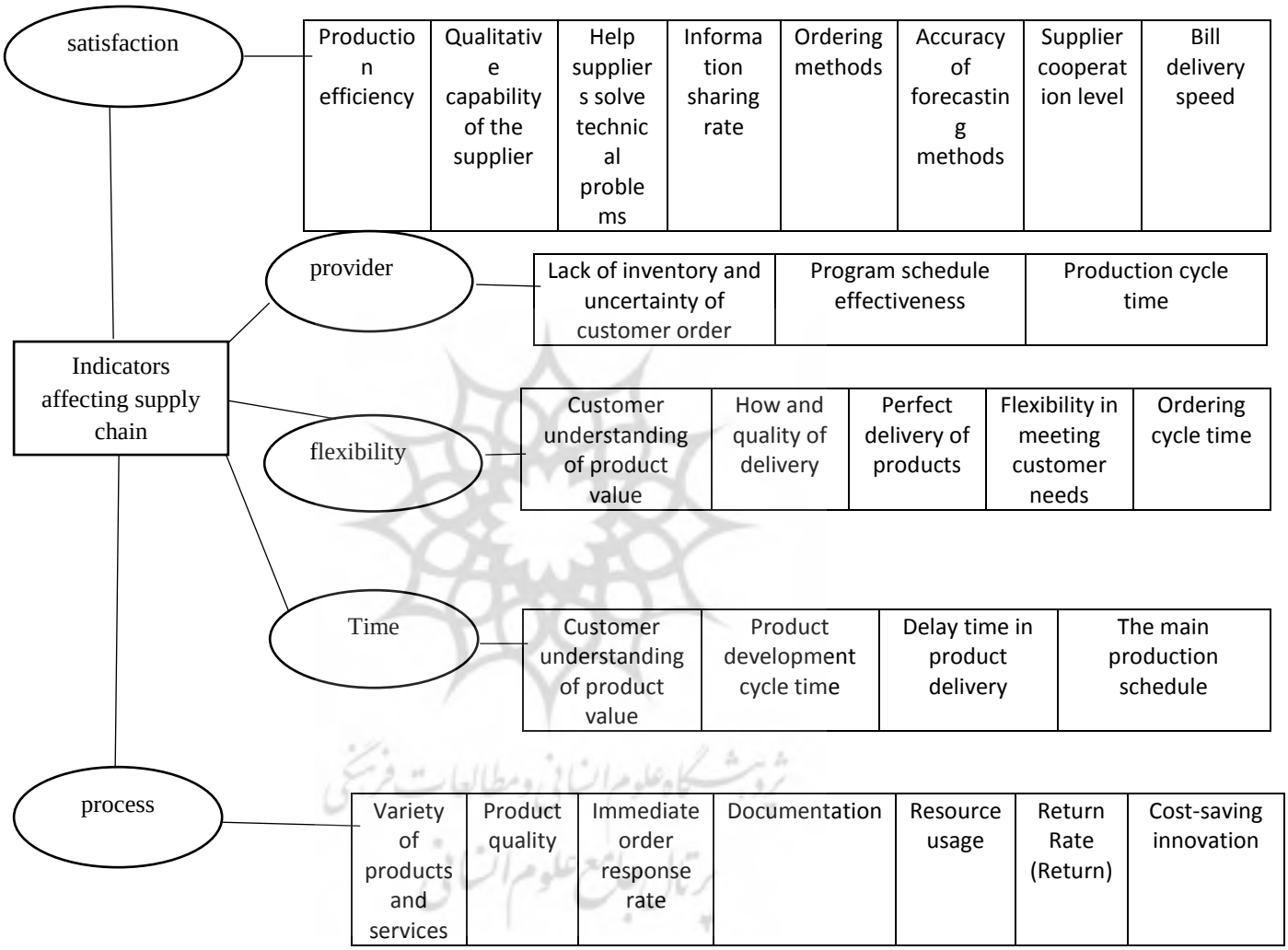
"Table 1: Research on Supply Chain Performance Evaluation"

Row	Researcher	Year of publication	Research title	Summary of research
1	Lababidi et al	2019	Optimizing the supply chain of petrochemical products under operational and uncertain economical conditions.	Provide an optimization model for the supply chain under operational and economic uncertainty conditions
2	Siwi et al	2018	Optimal Strategic Planning of Integrated Petroleum and Petrochemical Supply Chain.	Optimizing strategic planning at the upstream, middle and downstream levels of oil and petrochemical supply chains
3	Azadeh et al	2017	Optimum Integrated Design of Crude Oil Supply Chain by a Unique Mixed Integer Nonlinear Programming Model.	Provide a nonlinear programming model of the correct number for simultaneous optimization in the upper and middle parts of the crude oil supply supply chain.
4	Sah et al	2014	A Review of Structural Relationship Between Supply Chain Management and Organizational Performance.	The direct impact of supply chain management operations on organizational performance
5	Cabral et al	2012	A decision-making model for Lean, Agile, Resilient and Green supply chain management.	Provide two models to support decisions about supply chain management practices
6	Soni & Kodali	2010	Internal benchmarking for assessment of supply chain performance.	Provide methods to reduce variability in supply chain performance using PVA technique
7	Bigliardi & Bottani	2010	Performance measurement in the food supply chain.	Propose a BSC model to evaluate supply chain performance in the food industry
8	Chia, Goh, Hum	2009	Performance measurement in supply chain entities.	Introducing 15 general criteria for evaluating supply chain performance in BSC model
9	Bhagwat &Sharma	2007	Performance measurement of supply chain management.	The level of performance at the strategic level is more important than the tactical and operational levels, and the customer is the most important perspective in supply chain evaluation
10	Gunasekaran et al	2004	A framework for supply chain performance measurement.	Provide criteria based on the four main supply chain processes (planning, resource finding, production and delivery) and three levels: strategic, tactical and operational.
11	Gunasekaran et al	2001	A framework for supply chain performance measurement.	. Division of supply chain performance evaluation criteria according to two financial and non-financial dimensions and at three levels: strategic, tactical and operational

Conceptual Model

Reviewing the literature to be able to more accurately evaluate the indicators and in response to the first question, the factors influencing the performance of the supply chain and the factors influencing the reduction of logistics costs in the petrochemical industry, according to the conceptual research model in 5 criteria and 21 indicators are shown in Figure 2.

Figure 2: Conceptual research model



Research method

This research is causal in terms of the scope of application at the level of applied research and in terms of methodology. Due to the thematic nature of the research and relying on the literature, the community available for this research includes senior managers with 10 to 20 years of experience in supply chain management as well as managers and supervisors with more than 10 years of experience in the petrochemical industry. The people in question are selected from production, sales, warehousing, foreign trade, procurement, finance, quality control and planning units. And. It should be noted that all members of the statistical population were questioned. Field method and questionnaire tools have been used to collect research data. The research was conducted in two stages. In the first stage, the factors influencing the performance of supply chain performance were determined by

studying the background of research and consulting experts. Based on the conceptual model of the research, 27 factors were extracted as effective factors in improving the performance of the supply chain and then analyzed and analyzed with the opinion of experts. Then, among them, the factors that were repetitive, or overlapping, or combinable in one factor were identified, and finally the final 15 factors were determined. At this stage, the research community was the supply chain management experts.

Research findings

Based on previous studies, for each of the factors and their sub-branches, their importance is determined according to the factor load of each index. The findings of the confirmatory factor analysis of the research variables are given in the table below.

Step1: Identify the qualitative characteristics

Table 2: Qualitative characteristics

Code	Characteristic name	Abbreviation symbol
1	Speed of delivery of the invoice and the effectiveness of the program schedule and order cycle time	A
2	The level of cooperation and qualitative ability and the help of suppliers in solving technical problems	B
3	Accuracy of forecasting methods and amount of information sharing	C
4	Ordering methods and the rate of response to instant order	D
5	Lack of inventory and uncertainty of customer order	E
6	Flexibility in meeting customer needs	F
7	Delivery rate of products without defects and how and quality of delivery	G
8	Customer understanding of product value	H
9	The main production schedule	I
10	Time delay in product delivery and production cycle time and product development	J
11	Cost-saving innovation	K
12	Return Rate (Return)	L
13	Resource usage	M
14	Documentation	N
15	Product quality and variety of products and services	O

Step2: Determine the importance of the quality and performance characteristics of the industry in those characteristics, according to the opinion of 7 senior managers in the field of supply chain management in the petrochemical industry. The respondents, who were the senior managers of the petrochemical industry, answered the following questions based on the following seven options:

۲: Totally agree ۱: Totally disagree

۷ ٦ ٥ ٤ ۳ ۲ ۱

Table 3: Importance and performance of qualitative characteristics in the petrochemical industry

performance							Importance							Characteristic name	Code
7	6	5	4	3	2	1	7	6	5	4	3	2	1		
3	3	6	5	4	4	3	6	3	4	5	5	4	6	A	1
6	3	4	7	5	7	4	5	6	3	7	4	5	5	B	2
3	5	4	3	5	4	4	5	2	2	4	2	3	3	C	3
5	4	6	7	4	6	7	6	4	6	5	7	5	5	D	4
4	6	4	4	5	3	4	3	5	6	5	4	4	7	E	5
٤	٤	٦	٥	٣	٤	٥	٧	٤	٥	٥	٥	٦	٤	F	6
6	7	5	6	6	5	4	6	5	5	5	6	7	7	G	7
4	5	4	4	5	6	5	7	4	4	6	5	4	5	H	8
4	4	5	4	6	5	6	4	6	5	5	4	5	5	I	9
5	4	4	7	6	6	4	4	3	4	7	5	5	6	J	10
7	5	7	5	5	5	5	6	7	6	5	4	7	7	K	11
6	4	5	3	3	4	6	5	4	5	5	5	4	5	L	12
4	5	5	6	7	3	5	5	3	4	6	5	5	5	M	13
6	7	4	5	5	3	4	7	6	4	3	6	4	4	N	14
7	6	5	6	6	7	7	5	6	5	5	5	7	6	O	15

Step3: Obtain the value of the significance and performance of the qualitative characteristics using the geometric mean.

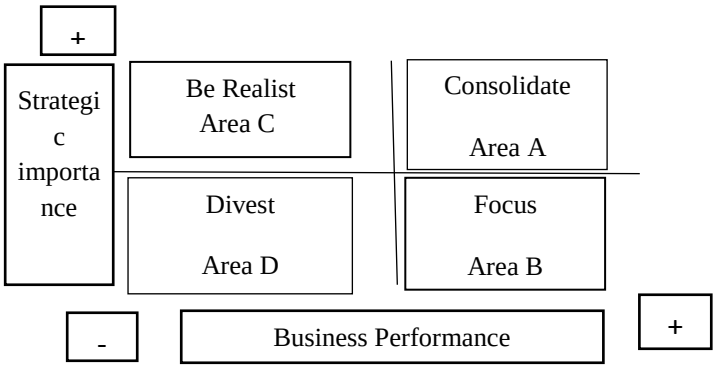
Table 4: Geometric mean importance and performance

c_j	b_j	Characteristic name	Code
٣ ٨٦	٤ ٥٩	A	1
٤ ٩٢	٤ ٨٤	B	2
٣ ٩٢	٢ ٨٢	C	3
٥ ٤٤	٥ ٣٥	D	4
٤ ١٩	٤ ٦٩	E	5
٤ ٣٣	٥ ٠٥	F	6
٥ ٤٩	٥ ٧٩	G	7
٤ ٦٦	٤ ٨٩	H	8
٤ ٧٨	٤ ٨١	I	9
٥ ٠٢	٤ ٦٩	J	10
٥ ٥٠	٥ ٨٩	K	11
٤ ٢٧	٤ ٦٩	L	12
٤ ٨٤	٤ ٦٢	M	13
٤ ٦٩	٤ ٦٦	N	14
٦ ٢٤	٥ ٥٢	O	15

Step 4: Calculate the value of the threshold of importance and the value of the threshold of performance.

$$\mu_b = \frac{٧٢.٩}{١٥} = ٤.٨٦ \qquad \mu_c = \frac{٧٢.١٥}{١٥} = ٤.٨$$

Step5: Make Importance - Performance Matrix.



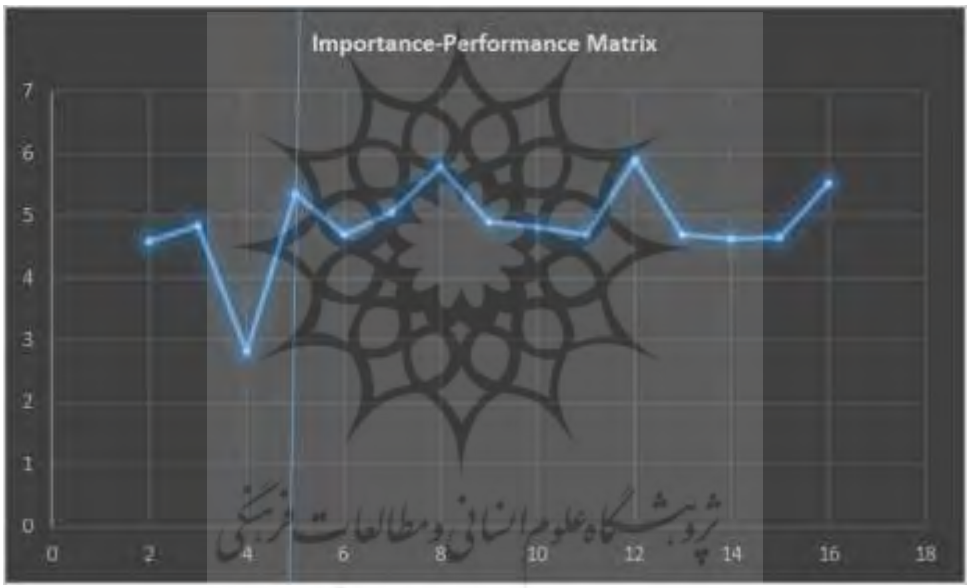


Figure 2: Performance-Importance Analysis Matrix

Step 6: Calculate (VOC)

$voice\ of\ customer(voc)$

$weight\ wu\&\ etal.$

$owj = \left|(b_j - c_j) \times b_j\right|$

$sw_j = \frac{ow_j}{\sum_{j=1}^{\mu} ow_j} \qquad 0 \leq sw_j \leq 1$

$\sum_{j=1}^{m} sw_j = 1$

Table 5: Measurement ow_j and sw_j

Preference	sw_j	ow_j	Characteristic name	Code
3	0.12	3.35	A	1
13	0.01	0.38	B	2
4	0.11	3.1	C	3
12	0.02	0.48	D	4
5	0.09	2.34	E	5
2	0.13	3.63	F	6
8	0.06	1.73	G	7
10	0.04	1.12	H	8
14	0.01	0.14	I	9
9	0.06	1.54	J	10
6	0.08	2.29	K	11
7	0.07	1.96	L	12
11	0.04	1.01	M	13
15	0.00	0.13	N	14
1	0.15	3.97	O	15

As can be seen in Table 6, the quality and variety of product and service, flexibility in meeting customer needs, bill delivery speed and program schedule effectiveness, and order cycle time are the most important components affecting supply chain performance, that they need to be given more attention. However, in general, the factors affecting the performance of the supply chain, process factor, flexibility and supplier are of great importance and need more attention, and thus the answer to the second question is clear in the table below.

Table 6: prioritization of important factors

Factor	Preference
Product quality and variety of products and services	1
Flexibility in meeting customer needs	2
Speed of delivery of the invoice and the effectiveness of the program schedule and order cycle time	3

Conclusion

Most of the issues facing system analysts in the real world are fuzzy in nature. The issue of ranking factors influencing supply chain performance is an important and serious issue that is no exception. In mathematical planning, the parameters of coefficients, values to the right, etc. can be considered as fuzzy numbers or goals that the problem can be solved in the form of mathematical planning. To solve such problems, we must first define the membership functions for the fuzzy parameters and convert them to a definite state so that the classical algorithms of the problem can be solved. The answer or set of fuzzy planning problems will always be definite. In this study, by identifying the factors affecting the performance of the supply chain based on the John and Key model and the opinion of experts and experts in the petrochemical industry, 27 indicators were extracted and identified, which are: Bill delivery speed, Supplier Cooperation Level, Accuracy of forecasting methods, Ordering method, Information sharing rate, Assistant suppliers in solving technical problems, Qualitative capability of the supplier, Production efficiency, Cost-saving innovation, Rate of return, Resource usage, Documentation, Immediate response rate, Product quality, Variety of products and services, Order cycle time, Flexibility in meeting customer needs, Perfect delivery of products, How and quality of delivery, Customer understanding of product value, The main production schedule, Delivery time for

product delivery, Product Development Cycle Time, Lack of inventory and not fulfilling the customer's order.

Then, using the performance-importance analysis matrix, the geometric mean of the views on the factors affecting the performance of the supply chain was obtained. Using this matrix, the final weight of the factors affecting the supply chain was obtained. Based on weights, the priority of the factors affecting the supply chain is as follows: Process, Flexibility, Supplier, Satisfaction and Time. In the end, the priority of all factors was determined. Product quality and variety of products and services, flexibility in meeting customer needs, bill delivery speed and program schedule effectiveness and ordering cycle time are the most important factors affecting supply chain performance in the petrochemical industry that should be given more attention. Overall, it is important to consider the factors influencing the performance of the supply chain in any industry to contribute to continuous monitoring, increased production, coordination, creation and maintenance of competitive position.

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