Solving the suppliers selection problem in the supply chain by using Analytical Hierarchy Process :A case study

Seyed Ali Ahmadi[1] – Mohammad Nasr Azadani[2*]

[1]*Master of science student , Department of Industrial Engineering Azad university, Najafabad brach, Iran*
[2]*Master of science student , Department of Industrial Engineering Isfahan University of Technology, Iran*

m.nasr@in.iut.ac.ir

Abstract

Today, organizations and companies have found that they cannot meet the needs of their customers due to the rapid changes in their needs without a supply chain approach. In this paper, a general framework for supplier selection in the supply chain is addressed. First, a series of important measures that the consensus of experts in the supplier evaluation process is defined and then, to assess them, a few quantitative sub-criteria have been used that the scores earned by each of the evaluation criteria. Also by performing paired judgments using the hierarchical analysis process (AHP), the weights of these criteria and sub-criteria are determined and ultimately, based on the rates obtained the best supplier can be selected. A case study in Iran has been done to choose the final decision to supply each raw material by suppliers.

1.   Introduction

Today, various factors, such as the diverse methods of manufacturing and manufacturing, the need for large investments and the lack of access to the necessary technical knowledge has led manufacturers to increasingly relying on suppliers and trying to work with best suppliers. On the other hand, the industrial units have found that their long-term profitability is in the balance and integrity of the components and the proper functioning of the supply chain, and other choices of suppliers on the basis of the proposed price is not a remedy and the need to measure the performance of suppliers with competitive and Identify and improve their weaknesses. However, the bulk of the cost of products is limited to the cost of purchasing raw materials. As a result, it is clear that the performance of suppliers first and foremost has a fundamental effect on the success or failure of a chain, and then plays a major role in the success or failure of the whole organization at a later stage. Therefore, the supplier's choice is known as a strategic task, which requires a lot of data and information, and in this decision, there may be no chance to try and error [1].

Choosing a supplier as an important decision in supply chain management in the manufacturing industry Known And, d. Raw materials and parts, usually the highest costs in the Da aphids and units Order an important role in reducing the cost of purchasing and supplier selection of appropriate plays. On the other hand, manufacturers increasingly tend to produce timely and mass production have found. These issues require suppliers to supply the raw materials and ordered parts at an appropriate time, in an appropriate and sustainable manner [2]. So, manufacturers, suppliers require that the system is effective in the management of production and quality control. Supplier selection is a matter of a few criteria that encompasses qualitative and quantitative factors. To select the best supplier, you need to make a deduction from the quantitative and qualitative factors that may conflict. Capacity constraints appear when the problem becomes more complex. In this article and the second section presents the theoretical foundations. In the third part of the previous research is reviewed. In Section 4, the proposed framework is presented and in Section 5 it describes the results and is presented in the sixth part of the conclusion [3].

2. Methodology

This section attempts to explain the principles used in the paper briefly.

2.1. Supply Chain Management

Supply chain management means synchronizing production, inventory, location, and transportation between members of a supply chain in order to achieve the best combination of responses. The goal of managing the supply chain is to increase the sales of products and services to the final customer while reducing the cost of inventory and operations. The philosophy of supply chain management is that a company has the right products at the right place at the right price at the right time and in the right place [4].

2.2. Supplier Assessment Process and Selection Process

The main objective of the evaluation process of supply, reducing the risk of the buyer and the buyer is to maximize the total value [5]. A buyer should choose suppliers who can meet the usual performance requirements with the buyer's expectations and be able to continuously improve. A company should only evaluate those suppliers who have a good chance of qualifying for a purchase contract. Figure 1 show the activities and major decisions in the evaluation process and supplier selection.
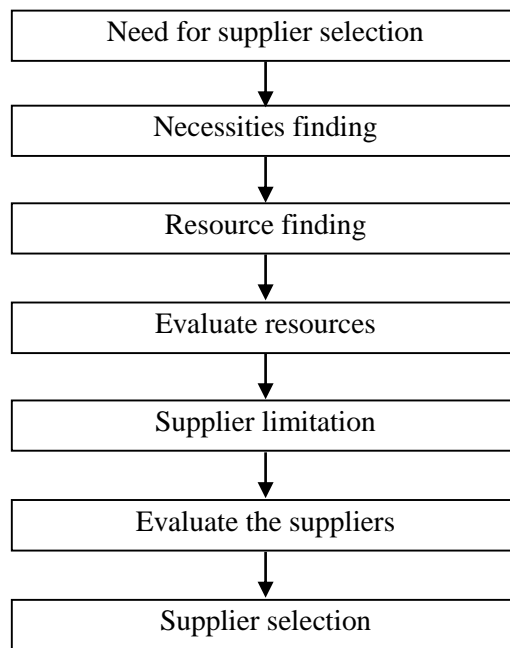
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┌─────────────────────────────────┐
│     Need for supplier selection  │
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Fig. 1. Supplier Assessment and Selection Process [6].

2.3. Evaluation and selection of different criteria for choosing the supplier

One of the most important steps in the supplier assessment process is the selection of criteria for assessing suppliers. The purpose of the supplier's choice is to identify the suppliers with the highest potential to meet the company's needs consistently and at an acceptable cost. The selection includes an extensive comparison of suppliers using a common set of criteria and indicators is. Though, the level of detail required to examine potential suppliers may vary depending on the needs of the organization. For selecting potential suppliers, capable of provisioning using the selection criteria and appropriate indicators estimates. Criteria and indicators should be chosen in such a way that all suppliers that are studied, used and moreover should reflect the needs of business and technology strategy and supply company [7].

Generally, supplier selection decisions, two issues are of particular importance. One is what criteria should be used and what methods should be used to compare suppliers. The analysis of these issues are considered by many academics in supplier selection and purchasing managers from the late 1960s have attracted.

2.4. Decision Making

The decision to choose the right supplier can be briefly extended this issue, in general, can be a variety of decision-making with regard to space, two spaces for decision-making "Continuous" And "Discrete" divided. Single or multi-criteria decision-making criteria may also be. In addition, these measures could be quantitative, qualitative or a combination of both (multi-criteria) that, in each of these cases, the decision is different. Figure 2 shows the types of decision making.
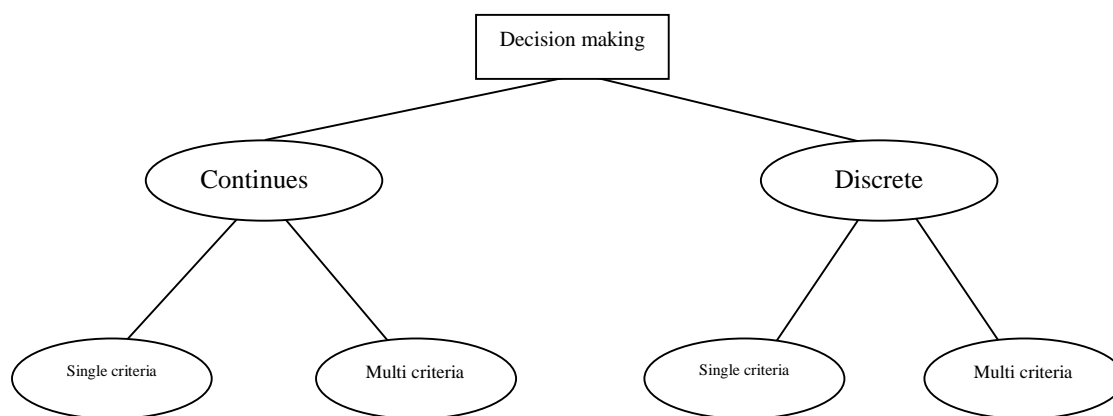
Fig. 2. Different moods decision [8].

2.5. Analytical Hierarchy Process

Analytic Hierarchy Process, which was presented by Mr. El-hour in 1980, a decision-making tool that can deal with decisions unstructured and semi-structured. However, one of the most comprehensive systems designed for decision making with multiple criteria [9]. This technique allows for the formulation of the problem as a hierarchy provides a qualitative and quantitative criterion, as well as the possibility of taking on the issue. The decision-making process at the different options and possible sensitivity analysis on its criteria and sub-criteria [10]. In addition, based on paired comparisons has been established that this judgment and facilitate calculations. Also, the compatibility or incompatibility decision shows that the benefits of this technique in the multi-criteria decision is privileged. In addition, it has a strong theoretical base and is based on obvious principles. AHP also was known as Operations Research techniques can be combined to control the more difficult issues. This method in making decisions including ratings, selection, evaluation, and optimization and forecasting are used [11].

3. Literature review

Demirtas and Üstün [6] presented a multi-objective model for selecting suppliers and assigning orders to the supplier. In this research, they argue that in order to solve a model that involves both the selection of suppliers and the assignment of orders, it requires tangible factors. To determine these factors in this research, a network analysis approach is used. To test the performance of the model, real-world data has been used to analyze the results.

Jadidi et al. [10] conducted a study to provide an ideal planning model for selecting suppliers. The objective functions used in this research are price, delivery time. Also, in this research, we have used interval ideals to consider uncertainty. To test the effectiveness of this research, real-world data has been used to solve the presented problem

Laar et al. [13] reviewed the corporate performance and customer orientation of green supply chain management. In this research, efforts have been made to examine the effect of green supply chain management on corporate performance and customer orientation. For this, the data of 100 companies was used. The method of data analysis in this research is the analysis of structural equations. The results show that green supply chain management improves the environmental performance of organizations, as well as a collaborative approach with customers, is the key to improving financial performance.

Jabbour et al. [21] reviewed supply chain management and corporate performance. In this research, efforts have been made to explore the potential relationships existing in green supply chain management and the role of green resources in the performance of organizations from an environmental point of view. They have used research from Brazilian companies. The results of this research show that internal environmental management has a strong and positive impact on environmental performance indicators in organizations. The customer relationship factor also has a huge impact on the performance of organizations.

Fahimnia et al. [8] investigated a balanced equilibrium model in green supply chain planning. In this model, an effort has been made to create a balance between being pure and green. Lean management seeks to reduce waste and increase economic efficiency, while supply chain management seeks to reduce emissions and less attention to economic criteria. They have studied the multi-criteria decision-making approach. The results of this research are a model that focuses on both the economic and environmental dimensions of supply chain management.

Jayaram and Avittathur [12] investigated the prospects for green supply chain management in emerging economies. They have been collecting data on a model for communicating between different sectors of supply chain management. These components include government environmental policies, customer activities, and corporate sustainability strategies. Also, greenhouse gas supply chain management strategies such as green design, product recycling, and reverse logistics have been explored in this research. They analyzed the emerging economies of India. In this research, the Delphi technique is used to examine the most important factors involved in supply chain management in India.

Tognetti et al. [19] investigated the optimization of the green supply chain. They sought to engage in economic goals and environmental goals. In this research, the automotive industry has been analyzed. The proposed problem modeling is a two-objective math planning model that seeks to minimize gas emissions CO_2 and increase profitability in the supply chain.

Wu and Chang [20] investigated a multi-criteria decision approach to identify key factors in green supply chain management. In their research, they used the Dematel approach. In this study, data on green supply chains in Taiwan have been analyzed and analyzed. The results of this study show that organizational conflicts are the most important factor affecting supply chain management in Taiwan.

Mathiyazhagan et al. [15] presented a hierarchical analysis model for assessing the pressure to implement green supply chain management. It has been argued that adaptation to environmental management is vital for organizations today and organizations should try to adapt to new conditions. In many countries, governments are seeking to force companies to comply with environmental regulations through laws and regulations. Using a hierarchical analysis approach, these pressures have been identified in Indian organizations. The results of this research rank the stressors for the implementation of supply chain management in India.

Also, Mukherjee [16] reviewed and evaluated a variety of math models related to the selection of suppliers. In a study of bugs in mathematical models, there is a lack of the ranking mechanism for suppliers. For this reason, the use of multi-criteria decision-making methods has been proposed in the ranking.

4. Proposed Research Framework

The investigation into the two main raw material manufacturing company "Persian motifs" Is done in this research. These two primary ingredients, "Molasses of Beetroot" and "Molasses

of Nashkari" They are called. In this paper, information is analyzed by applying the process analysis process of the dynamics. According to the explanations provided, to review and select the appropriate supplier from each of these two suppliers (Sugar beets and sugar beet molasses) Require Da criteria and sub-criteria that we can easily apply this Indicators little, evaluated and compared our suppliers. For this reason, the criteria defined for this purpose and for at least the better of them, sub-criteria for each of the criteria defined in the group of ten, and then use the AHP technique, practice weight Going to the criteria and then What to do sub-criteria and ultimately with the use of the data problem, the score for each of the sub-criteria as well as the criteria used to calculate the appropriate choice among all suppliers of finance Let's take a look.

4.2. Criteria and Their Weights

The interpretation of these studies in the selection criteria in the selection of preferred suppliers and based on interviews with senior managers and technical experts, three quality criteria, price, and shipping, are set for this review. These three criteria are among the most important criteria for reviewing the suppliers of materials in the company, each of them having different weights, depending on their importance.

According to the information available and the views of the managers and experts of the company, the evaluation criteria are judged using the technique of the hierarchical analysis process of the group, and then weigh each of the three criteria of the price Quality and transportation for both types of beet and sugar cane molasses are as follows The calculation has been calculated. Since sugar beet molasses are more expensive in terms of price, it will be more effective in comparisons. The population of the judging panel, managing director, deputy managing director, commercial director and technical director of the company. Also worth noting is that in order to ensure the correct judgments, consistency ratio (CR). The calculations obtained for the value less than 0.1 of CR state that the judgment is valid (Figures 3 and 4).
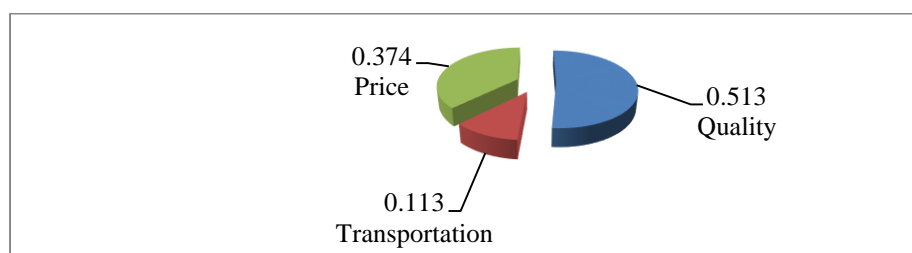

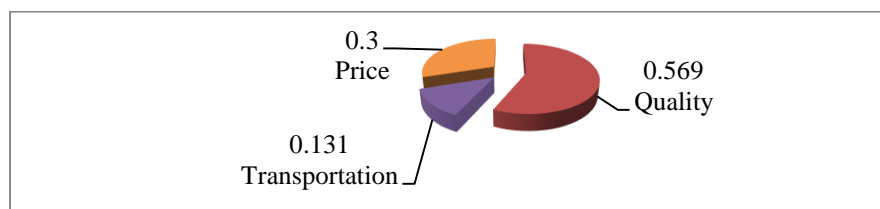**Fig. 3**. Weights of quality, transportation and price criteria.

Fig. 4. Weights of quality, transportation and price criteria.

4.3. Criteria Evaluation

One of the best ways to measure each criterion, having a low definition of that scoring is the least of it. So you have to try to do this to criteria of every possible way to be low. One of the most reasonable approaches for this Determine a series of small sub-criteria that are easily measured and scored. To achieve this purpose, interviews with managers and expert cited in

the study, and with the agreement of their First, a series of small sub measurable criteria of price and quality and shipment to third in Table 1 it is stated.

<div align="center">Table 1. Sub criteria of each criterion.</div>

Criterion	under the criteria	Measurement section
Quality	Brix (BRIX)	Latest information
	sugar Loaf	Latest information
	PH (Acidity)	Latest information
	Flower	Latest information
Transportation	Shipping cost	Latest information
	Timely delivery	Latest information
	Realization of the order	Latest information
	Healthy delivery	Latest information
price	Percentage difference of price with the target price	Latest information

For the price criterion, as well as just a sub- criterion "Percentage of price difference" is defined, so the weight of this sub-criterion is 1. Finally, the triple points for each criterion for each of the suppliers surveyed, with attention to the weight of each of the sub and also earn points by each of these sub-criteria calculated.

In Tables 2 and 3, information on potential suppliers and the obtained scores for each criterion according to the raw material (1) and (2) beet molasses sugar cane molasses are presented and explained. It should be noted that all suppliers have the ability to produce each and every raw material.

<div align="center">Table 2. Amount obtained from suppliers for the preparation of raw sugar molasses.</div>

Total Score	Sub weight	Weight of criteria	Criteria	Potential suppliers
0.595	0.4	0.56	Quality	1
	0.1	0.61	Shipped	
	0.5	0.62	Price	
0.678	0.4	0.64	Quality	2
	0.1	0.57	Shipped	
	0.5	0.73	Price	
0.607	0.4	0.72	Quality	3
	0.1	0.84	Shipped	
	0.5	0.47	Price	

Total Score Supplier	Sub weight	Weight of criteria	Criteria	Potential suppliers
	0.4	0.49	Quality	
0.55	0.1	0.54	Shipped	4
	0.5	0.6	Price	

Table 3. Score obtained for suppliers for the preparation of raw molasses Nashkari.

Total Score Supplier	Sub weight	Weight of criteria	Criteria	Potential suppliers
	0.4	0.66	Quality	
0.56	0.1	0.71	Shipped	1
	0.5	0.45	Price	
	0.4	0.51	Quality	
0.583	0.1	0.34	Shipped	2
	0.5	0.69	Price	
	0.4	0.78	Quality	
0.545	0.1	0.88	Shipped	3
	0.5	0.29	Price	
	0.4	0.75	Quality	
0.636	0.1	0.91	Shipped	4
	0.5	0.49	Price	

The optimal decision-making process is presented in Tables 4 and 5, which is based on the ranking of suppliers for each raw material.

Table 4. Suppliers ranking for the production of raw material for sugar beet molasses.

Ranking	Supplier
3	1
1	2
2	3
4	4

Table 5. Ranking of suppliers for the preparation of Nashkari Molasses.

Ranking	Supplier
3	1
2	2
4	3
1	4

So optimal policy obtained indicate that company to supply raw material beet molasses from suppliers third purchase, and to supply the raw material sugar cane molasses from suppliers

quarter of the purchase and the lack of capacity of each of the suppliers or any Another problem can be bought from suppliers with a second priority.

5. Conclusion

In this paper, a multi-criteria decision-making approach was used to plan the supply through the selection of supply chain suppliers. In this regard, by means of a hierarchical analysis method, the most important indicators affecting the selection of suppliers are quality, transportation, and price. It can, therefore, be verified that relative importance and exchange of criteria are considered in the evaluation process. Also, given that for each evaluation criterion, a number of quantitative sub-criteria are defined that, by definition, the scores obtained by each of the criteria are obtained from the sum of the points of each of these sub-criteria according to their weights, hence the effect Personal judgments in the evaluation process have been reduced. As well as the use of group pair judgments through the application of the hierarchical analysis process technique, each of the criteria and sub-criteria has been weighed, hence the accuracy of the evaluation process has increased. In order to evaluate the applicability of the proposed methodology, two primary materials of an Iranian company were studied and ultimately the optimal policy was provided to provide each supplier with raw materials. In order to develop this research, network analysis can be used instead of hierarchical analysis, and it is possible to provide a mathematical model to determine the volume of orders in each pay period.

References

[1] Banaeian, N., Mobli, H., Fahimnia, B., Nielsen, IE, & Omid, M. (2018). Green supplier selection using fuzzy group decision making methods: A case study from agri-food industry. Computers & Operations Research 89, 337-347.

[2] Bhutta, K. and Huq, F. (2002), "Supply Chain Management 3 Comparison of the Total Cost of Ownership and Analytical Hierarchy Processes"

[3] Charles, A. and Ellram, M. (1993), "Supplier Selection Using Multi-Objective Programming: A Decision Support System Approach", Vol. 23, International Journal of Physical Distribution & Logistics Management

[4] Ching-Chow, Yang and Bai-Sheng, Chen (2006) "Supplier Selection Using Combined Analytical Hierarchy Process and Gray Relationship Analysis", Journal of Manufacturing Technology Management, Vol. 17

[5] Choy, KL and Lee, WB (2002), "A Generic Tool for the Selection and Management of Supplier Relationships in an Outsourced Manufacturing Environment: The Application of Case Based Reasoning", Logistics information environment, Vol. 15

[6] Demirtas, EA, & Üstün, Ö. (2008). An integrated multiobjective decision-making process for supplier selection and order allocation. Omega , 36 (1), 76-90.

[7] Ellram, LM (1990), "The Supplier Selection Decision in Strategic Partnership", Journal of Purchasing and Materials Management

[8] Fahimnia, B., Sarkis, J. & Eshragh, A. (2016). A tradeoff model for green supply chain planning: A leanness-versus-greenness analysis. Omega , 54 , 173-190.

[9] Ghodsypour, SH and Obrien, C. (1996), "A Decision Support System for Supplier Selection Using an Integrated Analytical Hierarchy Process and Linear Programming", International Journal of Production Economics .

[10] Jadidi O., Cavalieri S., & Zolfaghari S. (2015). An improved multi-choice goal programming approach for supplier selection problems. Applied Mathematical Modeling , 39 (14), 4213-4222.

[11] Jaggernath, R., & Khan, Z. (2015). Green supply chain management. World Journal of Entrepreneurship, Management and Sustainable Development, 11 (1), 37-47.

[12] Jayaram J., & Avittathur B. (2015). Green supply chains: a perspective from emerging economies. International Journal of Production Economics, 164 , 234-244.

[13] Laari, S., Töyli, J., Solakivi, T. & Ojala, L. (2016). Firm performance and customer-driven green supply chain management. Journal of cleaner production , 112 , 1960-1970.

[14] Lee, HL (2000), "Creating Value Through Supply Chain Integration," Supply chain management review, September-October

[15] Mathiyazhagan, K., Diabat, A., Al-Refaie, A., & Xu, L. (2017). Application of the analytical hierarchy process to assess the pressure to implement green supply chain management. Journal of Cleaner Production , 107 , 229-236.

[16] Mukherjee K. (2017). Modeling and Optimization of Traditional Supplier Selection. In   Supplier Selection (pp. 31-58). Springer India.

[17] Sharma, MK, & Bhagwat, R. (2007). An integrated BSC-AHP approach for supply chain management assessment. Measuring Business Excellence, 11 (3), 57-68.

[18] Sevastyanov, P. & Figat, P. (2007). Aggregation of aggregating modes in MCDM: Synthesis of Type 2 and Level 2 fuzzy sets. Omega, 35 (5), 505-523.

[19] Tognetti, A., Grosse-Ruyken, PT, & Wagner, SM (2016). Green supply chain network optimization and the trade-off between environmental and economic goals. International Journal of Production Economics , 170 , pp. 385-392.

[20] Wu, HH, & Chang, SY (2016). A case study of using the DEMATEL method to identify critical factors in green supply chain management. Applied Mathematics and Computation , 256 , 394-403.

[21] Jabbour, C. J. C., Jugend, D., de Sousa Jabbour, A. B. L., Gunasekaran, A., & Latan, H. (2015). Green product development and performance of Brazilian firms: measuring the role of human and technical aspects. Journal of Cleaner Production, 87, 442-451.