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Application of Analytic Hierarchy Process (AHP) for prioritizing the personnel in India

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Abstract
This study presents an evaluation of suppliers in an Indian corporate environment using Multi Criteria Decision Model (MCDM). This research indicates the supplier performance measurement criteria like Service, Reliability, Quality and Price, which must be evaluated before selecting the suppliers, in context of different Indian industries. In general studies, quality is the most important criterion in the organization. In this study the suppliers are ranked according to their performance based on above mentioned criterion and the research methodology was combined with AHP. Total 4 criteria have been observed most feasible for assessing the seven suppliers. Analytic Hierarchy Process (AHP) is implemented as a tool for leveling the personnel. From The outcome of AHP has concluded that the seventh supplier (S7) as the best supplier for an Indian manufacturing organization.

Keywords: Supplier; AHP; Priority.

1. Introduction

A supply chain is a set of connections of departments, which is mixed up in the manufacturing of a product from the procuring of raw materials to the delivery of the final goods to the end customer. Organization management is divided in operative functions such as marketing, purchasing, finance, planning, production, etc. Supply chain is a process of integrating these vivid functions for creating a strategic plan for the organization, to satisfy the service policy, for maintaining the lowest possible cost level due the implausible competition environment that they are dealing [12].

An evolution in structure of the purchasing task has been observed around 1990s. The purchasing task received great weightage in the supply chain management because of globalization, increased value added in supply, and rapid changes in technology. Purchasing includes buying the raw materials, components and supplies, for the running need of organization [13]. The activities along with it includes selecting supplier, qualifying and rating supplier performance, negotiating and counseling contracts, comparing price, service and quality, sourcing goods and service, in time purchases, selling terms, evaluation of the value received, forecasting price and service, demand changes, specifying the terms in which goods are to be received, etc.

The most prominent process of the purchasing activity is the selection of efficient suppliers, because it introduces significant savings for the organization. The purpose of the supplier selection process is to minimize risk and maximize the overall value for the buyer, and it includes considering a series of strategic parameters like time frame of the association with suppliers, the options availability between domestic and international suppliers, the supplier's number for selecting between single or multiple suppliers and the type of product [14].

Some authors have cited different parameters for supplier selection e.g. historical supplier performance, net price, service, delivery, capacity, quality, communication systems, geographic location etc. [5-6]. These parameters are significant in the supplier filtration process as it measures the performance level of the suppliers. This research focuses on providing an empirical evidence of the criteria and the measures for the supplier selection process used in various corporate cultures.

While making a decision of supplier selection a number of parameters and criterion are there on which basis the best or optimum supplier is selected for the particular organization. The right supplier at the right time with the right quality and quantity to a firm proves to bring better business opportunities and growth [2]. Apart of it, supplier selection should be based on logic and concepts, hence based on important factors, a strategy or formula needs to be developed to seek out the best possible supplier among the presence of various potential suppliers [11].

Suppliers also play an important role in following fields, Defense related areas, Medical fields, Marine, Education industry, Manufacturing fields and many more wherever the selection processes are required [9]. The objective of this research is the selection and evaluation of potential suppliers.

2. Review Literature

Selection of supplier is a tactical judgment in the course of supply chain management (SCM) and depends on the sourcing approach of the company. It helps for the optimization of supply chain and therefore raising the effectiveness of the supply chain. An inappropriate supplier assortment can create a huge confusion in entire supply chain. The supplier selection decision in a supply chain (SC) does not depend exclusively on cost or quality measures, but also on various criteria [4].

Literature has provided a lot key insights and models for the assessment and assortment of suppliers. There are several techniques available in literatures for choosing a personnel like; Analytical Hierarchical Process, Fuzzy Goal Programming, Fuzzy Programming Model, Interpretive Structural Modeling, Particle Swarm Optimization and Simulation Optimization Approach [1-3]. The AHP method is proposed to solve this problem and divided into two major categories, subjective approaches and quantitative approaches. Research has analyzed that in present scenario's economy, outsourcing has become a standard rather than an exception, thus it is essential to recognize the suitable supplier to outsource. Suitable Supplier selection is a critical function

performed by the purchasing subdivision [8]. Selecting a suitable supplier is a multi-criterion problem; it includes the qualitative as well as quantitative factors. The company and its supplier formed a critical relationship and companies usually create a set for evaluation criteria to be used to evaluate possible sources [1-7].

To understand this approach better, it is noteworthy that suppliers may be categorized as manufacturer, distributors, craftsmen and import links [10]. The cost-ratio is an additional method that relates all individual purchasing costs to the monetary value of the goods received from vendors. The categorical method relies deeply on the experience and capability of the individual buyer, People in charge of purchasing, quality, fabrication, and sale; all state their opinions about the supplier's concert on the basis of criteria which are vital to them. The weight for each attribute is then multiplied by the performance score that is assigned [4-15].

3. Methodology

3.1. Supplier selection process

Fig 1: Process of Supplier Selection (Source: [12])

Step 1: Product Analysis; A product analysis usually includes; labor contents, cost saving potential, purchase volume, demand pattern and product.

Step 2: Supplier Identification; this process utilize all means available, including trade directions, trade association, trade exhibition, logistic operation and cyberspace.

Step 3: Supplier Evaluation; this is the step to shorten the long list of potential suppliers based on information collected. It is an important phase for both the ends (buyers and suppliers) to develop a beneficial relationship towards each other and to have a more realistic picture for a possible long-term business relationship.

Step 4: Supplier Selection; the final step is to make the selection based on the data collected and audited during the supplier evaluation process. Both selecting the evaluation criteria and implementing an effective selection method are crucial parts to successfully prefer right suppliers.

3.2. Criteria for supplier selection

Supplier selection usually needs more than one evaluation criteria. Suppliers usually have dissimilar performance for dissimilar criteria. Throughout the past decades, supplier evaluation criteria embraces increasingly complex factors: price, quality, delivery, service, capacity, financial performance, communication systems, geographic location, historical supplier performance, and perceived risks including environmental, social, economic and political **[12]**. The main evaluation criteria are: quality, price, reliability and service selected for applying the methodology.

Figure 2 shows the 3 layer hierarchy of the AHP approach for the case company. The first level is the goal, the second levels are criteria, and third level is the alternatives.

Fig 2: An Illustrative Decision Hierarchy for Supplier Selection

3.3. Supplier selection

Analytic Hierarchy Process (AHP) is one of the most widely used multiple criteria decision making tools". The AHP method made it possible to weight both qualitative and quantitative data in the supplier evaluation process. There are six major steps in implementing AHP in supplier selection process:

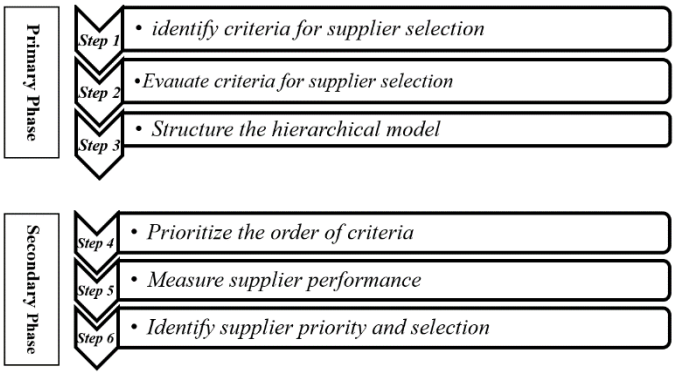

Fig 3: Two phase procedure of proposed methodology

To prioritize the alternatives pair-wise comparisons performed, It needs to compare two elements at a time. This method tries to construct the relative importance matrix of the various criteria using the nine-point scale developed by Saaty.

Meanwhile, doing a consistency check is an essential step of implementing the AHP method. It verifies the consistency, thus the acceptance, of priority judgments. It measures how consistent the judgments have been comparing to large samples of purely random judgments.

The consistency ratio (CR) computation formula is: $CR = \frac{CI}{RI}$

Where CI stands for Consistency Index and RI for Random Consistency Index. As $A_x = \lambda_{max} X$, where A is denoted as the pair-wise comparison matrix and X as row averages, CI can be calculated by:

$CI = \frac{\lambda \max - n}{n-1}$ (n represents the number of criteria)

Then the corresponding value of RI is found in the Saaty's table below: (Table 1)

Table 1: Average Random Consistency: (developed by Saaty)

Size of Matrix	1	2	3	4	5	6	7	8	9	10
Random Consistency	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Using the responding RI found in the above table, we can receive the consistency ratio CR = CI/RI. If the CR value is less than 0.1, then we say the judgments are consistent and acceptable.

Criteria evaluation

Table 2: Pair-Wise Comparison of the Selected Criteria

Criteria	Price	Quality	Reliability	Service
Price	1	0.33	0.33	0.5
Quality	3	1	3	2
Reliability	3	0.33	1	2
Service	2	0.5	0.5	1
Total	9	2.16	4.83	5.5

As can be seen from the table, according to the case company features and the goal, the author has given preference values to each element. The preference value (1/2) of the service criterion to the quality criterion means the author gave moderate importance to quality criterion than price. The normalization calculation was done by dividing the figures of one column by the total of that column. Table 3 presents the results of normalization as well as calculated row averages and sum.

Table 3: Normalized Matrix of Paired Comparisons

Criteria	Price	Quality	Reliability	Service	Priority Vector	Sum
Price	0.11	0.17	0.07	0.08	0.106	0.425
Quality	0.33	0.5	0.6	0.33	0.442	1.767
Reliability	0.33	0.17	0.2	0.33	0.258	1.032
Service	0.22	0.25	0.1	0.17	0.185	0.739
	1	1	1	1	1	

As an example of the normalization calculations, Can be derived from the above table, the quality (0.442) was the most preferred criterion, the second was reliability (0.258), and service (0.185) and price (0.106) were the third and fourth ranked criterion.

Moreover, as stated in AHP theory, checking the consistency ratio (CR) is an essential step to determine the acceptance of the priority weighting. Below is the computation of CR:

Dividing all entities of the weighted matrices by their priority vectors and manipulating the average:

λmax= {[(0.425/0.106) + (1.767/0.442) + (1.032/0.258) + (0.739/0.185)]/4**}**

λmax= 4

CI = [λmax-n]/(n-1) = [4-4]/(4-1) = 0

Taking the random consistency ratio (RI) from Saaty (Table 1) for a matrix size of four, RI = 0.9. Calculating the consistency ratio:

$$CR=\frac{CI}{RI}=\frac{0}{0.9}=0$$

As CR value is much less than 0.1, the pair-wise comparison evaluations are consistent, and thus acceptable.

4. Suppliers evaluation on the basis of different criteria

The author assigned values to criteria under each supplier based on suppliers' qualitative and quantitative information. The assignment of values with respect to all criteria (that satisfied the CR in all cases) can be seen in appendix 1.

Appendix 1: Pair-wise comparisons of suppliers on the basis of Price

Pair wise comparison								Normalized Values							Priority Vector	Sum
	S1	S2	S3	S4	S5	S6	S7	S1	S2	S3	S4	S5	S6	S7		
S1	1	0.5	0.2	0.33	0.5	0.5	0.13	0.020	0.012	0.008	0.021	0.057	0.013	0.023	0.022	0.154
S2	2	1	0.25	0.5	0.13	0.5	0.33	0.039	0.023	0.010	0.032	0.014	0.013	0.062	0.028	0.194
S3	5	4	1	0.25	0.5	2	0.33	0.098	0.093	0.041	0.016	0.057	0.053	0.062	0.060	0.419
S4	3	2	4	1	0.25	3	0.5	0.059	0.047	0.165	0.064	0.028	0.079	0.093	0.076	0.534
S5	2	8	2	4	1	5	0.5	0.039	0.186	0.082	0.255	0.113	0.132	0.093	0.129	0.900
S6	2	2	0.5	0.33	0.2	1	0.13	0.039	0.047	0.021	0.021	0.023	0.026	0.023	0.029	0.200
S7	8	3	3	2	2	8	1	0.157	0.070	0.124	0.127	0.226	0.211	0.186	0.157	1.100
Total	28	22.5	13.3	7.28	4.26	18	2.47	1	1	1	1	1	1	1		

Pair-wise comparisons of suppliers on the basis of Quality

Pair wise comparison								Normalized Values							Priority Vector	SUM
	S1	S2	S3	S4	S5	S6	S7	S1	S2	S3	S4	S5	S6	S7		
S1	1	0.2	0.25	0.13	0.5	2	0.33	0.043	0.010	0.014	0.013	0.047	0.167	0.116	0.058	0.409
S2	5	1	0.25	0.5	0.13	0.5	0.33	0.213	0.050	0.014	0.051	0.012	0.042	0.116	0.071	0.497
S3	4	4	1	0.13	0.5	0.5	0.25	0.170	0.198	0.057	0.013	0.047	0.042	0.087	0.088	0.614
S4	8	2	8	1	0.25	2	0.5	0.340	0.099	0.457	0.103	0.023	0.167	0.174	0.195	1.363
S5	2	8	2	4	1	3	0.13	0.085	0.396	0.114	0.410	0.093	0.250	0.043	0.199	1.393
S6	0.5	2	2	2	0.33	1	0.33	0.021	0.099	0.114	0.205	0.031	0.083	0.116	0.096	0.670
S7	3	3	4	2	8	3	1	0.128	0.149	0.229	0.205	0.747	0.250	0.348	0.294	2.055
Total	23.5	20.2	17.5	9.75	10.7	12	2.87	1	1	1	1	1	1	1		

Pair-wise comparisons of suppliers on the basis of Reliability

Pair wise comparison								Normalized Values							Priority Vector	SUM
	S1	S2	S3	S4	S5	S6	S7	S1	S2	S3	S4	S5	S6	S7		
S1	1	0.5	0.25	3	0.5	2	5	0.100	0.032	0.031	0.231	0.047	0.182	0.386	0.144	1.008
S2	2	1	2	0.5	0.13	2	0.33	0.199	0.065	0.250	0.038	0.012	0.182	0.026	0.1102	0.772
S3	4	0.5	1	2	0.5	0.5	4	0.399	0.032	0.125	0.154	0.047	0.045	0.309	0.1587	1.111
S4	0.33	2	0.5	1	0.25	2	0.5	0.033	0.129	0.063	0.077	0.023	0.182	0.039	0.0779	0.545
S5	2	8	2	4	1	3	0.13	0.199	0.516	0.250	0.308	0.093	0.273	0.010	0.2356	1.649
S6	0.5	0.5	2	0.5	0.33	1	2	0.050	0.032	0.250	0.038	0.031	0.091	0.154	0.0924	0.647
S7	0.2	3	0.25	2	8	0.5	1	0.020	0.194	0.031	0.154	0.747	0.045	0.077	0.1812	1.268
Total	10	15.5	8	13	10.7	11	13	1	1	1	1	1	1	1		

Pair-wise comparisons of suppliers on the basis of Service

Pair wise comparison								Normalized Values							Priority Vector	SUM
	S1	S2	S3	S4	S5	S6	S7	S1	S2	S3	S4	S5	S6	S7		
S1	1	3	2	3	4	5	8	0.365	0.383	0.250	0.250	0.353	0.286	0.449	0.334	2.335
S2	0.33	1	2	3	0.5	2	2	0.121	0.128	0.250	0.250	0.044	0.114	0.112	0.146	1.020
S3	0.5	0.5	1	2	0.5	4	4	0.182	0.064	0.125	0.167	0.044	0.229	0.224	0.148	1.035
S4	0.33	0.33	0.5	1	2	2	0.5	0.121	0.043	0.063	0.083	0.176	0.114	0.028	0.090	0.629
S5	0.25	2	2	0.5	1	3	0.33	0.091	0.255	0.250	0.042	0.088	0.171	0.019	0.131	0.917
S6	0.2	0.5	0.25	0.5	0.33	1	2	0.073	0.064	0.031	0.042	0.029	0.057	0.112	0.058	0.408
S7	0.13	0.5	0.25	2	3	0.5	1	0.046	0.064	0.031	0.167	0.265	0.029	0.056	0.094	0.657
TOTAL	2.74	7.83	8	12	11.3	17.5	17.8	1	1	1	1	1	1	1		

Table 4: Evaluation of alternatives

Alternatives	w.r.t. Q	w.r.t. R	Q'=Q*(0.441667)	R'=R*(0.257917)	Total Weight=Q'+R'	Rank
S1	0.05840	0.14405	0.0258	0.0372	0.0629	6
S2	0.07101	0.11022	0.0314	0.0284	0.0598	7
S3	0.08765	0.15866	0.0387	0.0409	0.0796	4
S4	0.19473	0.07791	0.0860	0.0201	0.1061	3
S5	0.19894	0.23556	0.0879	0.0608	0.1486	2
S6	0.09571	0.09242	0.0423	0.0238	0.0661	5
S7	0.29356	0.18119	0.1297	0.0467	0.1764	1

5. Findings

From the above tables, supplier 7 (0.1764) has the highest total score among all alternatives. Supplier 5 tightly follows supplier 7 with a total score 0.1486. Supplier 1, 2, 3, 4, 6 score 0.0629, 0.0598, 0.0796, 0.1061 and 0.0661 respectively.

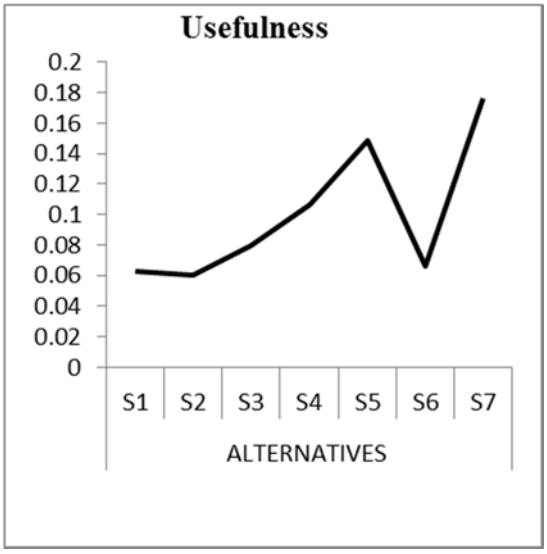

Fig 4: Scores/Relative usefulness of alternatives

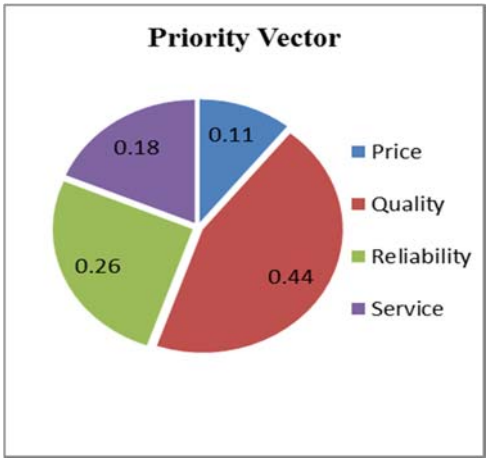

Fig 5: Relative Importance of Criteria

According to the results (Table 4) obtained in the supplier evaluation, Supplier 7 appears to be the best choice of all 7 suppliers based on its highest total score. Though S5 is second strong in quality as well as reliability criterion after supplier 7. Based on the analysis of AHP results, Supplier 7 would be the appropriate choice for the case company. Choosing S 7 meets the goal the case company and its product specification. In addition to low price, S 7 provides a high level of trustworthiness and a lower level of expected risks.

6. Conclusions

Moreover, the results found through AHP implementation were reliable as the evaluation criteria matched the case company's objectives, pair-wise comparisons were made via informed judgments and were consistent, and mathematical calculations were carefully completed and re-examined through Excel. Reacting to the difficulties, the study has successfully met its two prime goals. First, the researcher used Internet channels to locate potential suppliers as the Internet offers a great quantity of supplier information according to product category or geographic locations. The second contribution was the identification of the important evaluation criteria for the supplier selection process. Through reviewing relevant literature and research projects on supplier selection criteria, the researcher identified price, quality, reliability and service as the most important criteria for case company in selecting Indian supplier. Moreover, as proved by pair-wise comparisons, price criterion was not the most decisive factor in selecting Indian suppliers; quality and reliability were factors taken more seriously than price for the case company.

7. References

1. Azadeh A, Alem SM. A flexible deterministic, stochastic and fuzzy Data Envelopment Analysis approach for supply chain risk and vendor selection problem: Simulation analysis. Expert Systems with Applications, 2010; 37(12):7438-7448.
2. Bai C, Sarkis J, Wei X. Addressing key sustainable supply chain management issues using rough set methodology. Management Research Review, 2010; 33(12):1113–1127.
3. Chou SC. A decision support system for supplier selection based on a strategy-aligned fuzzy SMART approach. Expert Systems with Applications 2008; 34(0):2241-2253.
4. Dash D, Zhang Y, Wu D, Olson DL. Fuzzy multi-objective programming for supplier selection and risk modeling : A possibility approach. European Journal of Operational Research, 2010; 200(3):774–787.
5. Dickson. An Analysis of vendor selection systems and decisions, Journal of Purchasing, 1966, 5-17.
6. Dempsey. Vendor Selection and the Buying Process, Industrial Marketing, 1978.
7. Haleh H, Hamidi A. A fuzzy MCDM model for allocating orders to suppliers in a supply chain under uncertainty over a multi-period time horizon. Expert Systems with Applications, 2011; 38(8):9076-9083.
8. Kambiz shahrouditonekaboni SMS. Application of topsis method to supplier selection in iran auto introduction : Journal of Global Strategic Management. 2012; 12(0):123-131.
9. Matin KZSAMS. The Application of Fuzzy TOPSIS Approach to Personnel Selection for Padir Company, Iran. Journal of Management Research. 2011; 3(2):1-14.
10. Mohanty MKG. Buyer supplier relationship in manufacturing industry - findings from Indian manufacturing. Business Intelligence Journal, 2012, 5(2).
11. Ordoobadi S. Application of Taguchi loss functions for supplier selection. Supply Chain Management: An International Journal. 2009; 14(1):22-30.
12. Rajesh G, Malliga P. Supplier selection based on AHP method. Procedia Engineering 2013; 64(0):1283–1292.
13. Sawik T. Selection of a dynamic supply portfolio in make-to-order environment with risks. Computers and Operation Research 2011; 38(4):782–796.
14. Tang CS. Perspectives in supply chain risk management. Int. J Production Economics. 2006; 103(0):451-488.
15. Timmerman. An Approach to Vendor Performance Evaluation", the Journal of Supply Chain Management, 1986, 2-8.