VOLUME - 12, ISSUE - 02, FEBRUARY - 2023 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Medical Science

EVALUATION AND SELECTION OF SUPPLIER IN A HEALTHCARE SUPPLY CHAIN USING ANALYTIC HIERARCHY PROCESS UNDER CRISP ENVIRONMENT

Trupti Bhosale Krishna Institute of Medical Sciences, Deemed to Be University, Karad - 415110, India.

Hemant Umap Department of Statistics, Yashvantrao Chavan Institute of Science, Satara - 415001, India.

ABSTRACT The objective of supplier selection process is to minimize risk in purchasing, enhance overall profit of the customer, and build the long lasting and close relations between suppliers and buyers. Supplier selection process is one of the main key processes of the supply chain management. So, selection of a supplier has become an important issue for development of a proper supply chain system. Here, we have provided a case study for supplier selection using Analytical Hierarchy Process (AHP) one of the widely used Multi Criteria Decision Making (MCDM) technique. We have explained it using crisp data. In this study, we evaluated four suppliers using crisp AHP. The proposed method is useful when selection is to be done from a large set of suppliers in limited time. It also helps to choose the supplier that best suits the Pharmacist's requirements. It also provided comprehensive literature review of multi criteria decision making problems. In spite of the no. of studies on supplier selection, the evaluation and selection of suppliers using the specific measures of the healthcare sector are less investigated. In order to fill this gap, this research proposed a guide for supplier selection of baby hygiene product.

KEYWORDS : supplier, AHP, crisp, pairwise, matrix

INTRODUCTION:

The objective of supplier selection process is to minimize risk in purchasing, enhance overall profit of the purchaser, and build the close and long term relationships between suppliers and buyers Supplier selection process is one of the main key processes of the supply chain management. So, selection of a supplier has become an important issue for development of a proper supply chain system.

The main objective Supply Chain Management (SCM) is to enrich the operational productivity, profitability and competitive positions of SCM partners (Bhosale and Umap 2020). Main challenge of any retailer is to balance both satisfaction of customer and profit. Finding out the best supplier that fulfills all the needs of retailer under different criteria makes overall benefits to retailer.

Supply chain management and supplier selection have recently attracted a lot of attention in the business literature. To boost their management performance and competi tiveness, several sellers strive to interact with their suppliers. As a result, once a provider becomes a member of a well-established supply chain, its influence on the overall supply chain's success. As a result, selecting a supplier has become a critical issue in the establishment of an effective supply chain system. The major purpose of the supplier selection process is to reduce purchase risk, increase total profit, and develop close, long-term relationships between the buyer and the supplier. (Monczka, R., Trent, R., Handfield, R., 1998).

Choosing a right supplier is a decision-making activity that decides which alternative to choose from the available list of alternatives. For selection of a supplier, criteria can consider quantitative and qualitative dimensions as well. (Choi and Hartley, 1996; Dowlatshahi, 2000; Verma and Pullman, 1998; Weber et al., 1991, 1998). More than one decision-makers may be there in the decision process of supplier selection (Boer, Wegen, Telgen., 1998). In general, it can be inferred that supplier selection incorporates a variety of criteria, numerous combinations of decision-making models, group decisions, and various levels of uncertainty. There are numerous different types of supplier selection problems to deal with SCM, different methods can be used to solve different types of problems (Mustafa 2013). Finding the ideal technique to evaluate suppliers is tough, and the seller might utilize a variety of methods to do it.

The Analytic Hierarchy Process (AHP) is a structured technique for organizing and analyzing complex decisions based on Mathematics and Psychology. (Saaty, 1970). It was developed by Thomas L. Saaty in 1970s who partnered with Ernest Forman to develop Expert Choice in 1983 and has been extensively studied and refined since then.

It represents an accurate approach for qualifying the weights of the decision criteria. Individual expert's experiences are utilized to estimate the relative magnitudes of factors through pair wise comparisons. Each of the respondents has to compare the relative importance between the two items under special designed questionnaire (Note that while most of the surveys adopted five point LIKERT scale, AHP's questionnaire is 9 to 1 (Aktepe, A. & Ersoz, 2011)

AHP has particular application in group decision making (Saaty, Peniwati 2008) and is used around the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare, shipbuilding and education (Salem, Salman, Ghorai 2017). (Ho, Xu and Dey 2010) used most popular integrated approach is AHP–GP. And stated that instead of price or cost, quality is the widely used criterion for evaluation of suppliers.

Here, in this paper we have applied AHP to crisp data which is described as below:

Crisp Analytic Hierarchy Process (Crisp-AHP)

The measure used in AHP is to construct a matrix which expresses the relative values of a set of attributes. The number assigned to each attribute corresponds to its size and relative importance, with more important attributes being larger than less important one (Yadav, Jayswal, 2013).

Table 1.1: Saaty's table for intensity of importance

Scale	Numerical Rating	Reciprocal
Extremely preferred	9	1/9
Very strong to extremely	8	1/8
Very strongly preferred	7	1/7
Strongly to very strongly	6	1/6
Strongly preferred	5	1/5
Moderately to strongly	4	1/4
Moderately preferred	3	1/3

Equally to moderately	2	1/2
Equally preferred	1	1

Saaty's Scale of Relative Importance [Saaty 2005]

Intensity of Importance:

It is common to always use odd numbers from the table above to make sure that there is a reasonable distinction among the measurement points. The use of even numbers should only be adopted if there is a need for negotiation between the evaluators. When a natural consensus cannot be reached, it raises the need to determine a middle point as the negotiated solution (compromise) (Saaty 1980).

Basic assumption:

- A basic but very reasonable assumption is that if attribute A is absolutely more important than attribute B and is rated at 9, then B must be absolutely less important than A and is valued at 1/9.
- These pairwise comparisons are carried out for all factors to be considered, usually not more than 7, and the matrix is completed. The matrix is of a very particular form which neatly supports the calculations which then ensue.

Steps involved:

Consider n elements to be compared C_1, C_2, …C_n and denote the relative weight (or priority or significance) of C_i with respect to C_j by a_{ij} and form a square matrix $A=(a_{ij})$ of order n with the constraints that,

$a_{ij} = \frac{1}{a_{ji}}$ for all i ≠ j and $a_{ii} = 1$ for all i.

Such a matrix is said to be a reciprocal matrix. The weights are consistent if they are transitive i.e.

$$a_{ik} = a_{ij}a_{jk} \text{ for all i, j and k}$$

Such a matrix might exist if the are calculated from exactly measured data. Then find a vector of order 'n' such that

$Aw = \lambda w$

For such a matrix, w is said to be an Eigen vector (of order n).

Judgment:

If the consistency ratio (CR) is much in excess of 0.1, the judgments are untrustworthy because they are too close for comfort of randomness and the exercise is valueless or must be repeated. It is easy to make a minimum number of judgments after which the rest can be calculated to enforce a perhaps unrealistically perfect consistency

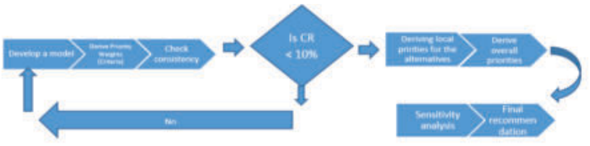
Consistency ratio (CR) $= \frac{\lambda_{max} - n}{n-1}$

Consistency Index (CI) $= \frac{CR}{CI}$

Table 1.2: Consistency index table:

Sample size n	1	2	3	4	5	6	7	8
CI value	0	0	0.58	0.90	1.12	1.24	1.32	1.41

AHP is one of the main mathematical models currently available to support the decision theory.



Flow Diagram 3.1.1: Steps involved in AHP (Crisp data)

To make methodology clear and understand its applicability in real life situation, a case study for choosing a good baby diaper is studied below:

Numerical Example of Crisp -AHP:

It's no secret that changing diapers isn't fun. It's smelly and sometimes messy. Disposable diapers help parents minimize the stress and struggles of changing their babies by keeping the process quick. It is of one-time use. Disposable diapers are designed to be thrown away. That's their biggest selling point for most parents. Instead of having to clean and wash a reusable diaper or rely on a diaper service, you can just wrap a disposable diaper up, put it in the diaper pail, and stop thinking about it. It's convenient because one you can toss out used diapers if they're short on time. The washing process takes time, and storing soiled reusable diapers when you're running errands is complicated and messy. Disposable diapers can get thrown away and you can move on with your day. It is potentially more sanitary. It is travel friendly also.

There are plenty varieties of diaper brands available in the market. The pharmacist wants to select its supplier for baby diapers. To achieve this target, demand, quality, profit and service are considered as criteria's.

Table 1.3: The pairwise comparison matrix

Criteria	Demand	Quality	Service	Profit
Demand	1	1/2	1/2	1
Quality	2	1	3	5
Service	2	1/3	1	2
Profit	1	1/5	1/2	1
Sum	6	2.033	5	9

Divide each element of the matrix with sum of its column, to get normalized relative weight. Then normalized Eigen vector is obtained by taking average of rows.

Table 1.4: Calculation of Eigen vector

Criteria	Demand	Quality	Service	Profit	Eigen vector
Demand	0.166667	0.245902	0.1	0.111111	0.15592
Quality	0.333333	0.491803	0.6	0.555556	0.495173
Service	0.333333	0.163934	0.2	0.222222	0.229873
Profit	0.166667	0.098361	0.1	0.111111	0.119035

The Eigen vector or the relative importance or value of demand, quality, service, and profit is (0.15592, 0.495173, 0.229873, and 0.11903). Thus quality is most valuable, service and demand are behind and profit is very much less significant.

Check consistency (calculation of λ_{max}):

The next stage is to calculate λ_{max} so as to lead to the consistency index and consistency ratio.

Table 1.5: Calculation of λ_{max}

Criteria	Demand	Quality	Service	Profit
Eigen vector	0.15592	0.495173	0.229873	0.119035
Total sum	6	2.033333	5	9

$\lambda_{max} = \sum_{i=1}^{4}(\prod_{i=1}^{4} Eigen\ vector * Total\ sum) = 4.163045$

Decision:

Consistency Index 0.054348

Table 1.6: Random Consistency Index Table:

Sample size n	1	2	3	4	5	6	7	8
C. I. value	0	0	0.58	0.90	1.12	1.24	1.32	1.41

Random Consistency Index (©. I.) = 0.90 from table above

Consistency Ratio $= \frac{CI}{RI} = \frac{0.054348}{0.90} = 0.060387 < 0.1$

Thus, Pharmacists subjective evaluation about his preference to criteria's is consistent. Now, we will derive Eigen vectors for all alternatives using the same methodology

Table 1.7: Eigen vectors for all alternatives

	Demand	Quality	Service	Profit
Supplier 1	0.307067	0.270617	0.276902	0.237194
Supplier 2	0.21889	0.177279	0.183999	0.263037
Supplier 3	0.307067	0.292356	0.291608	0.263037

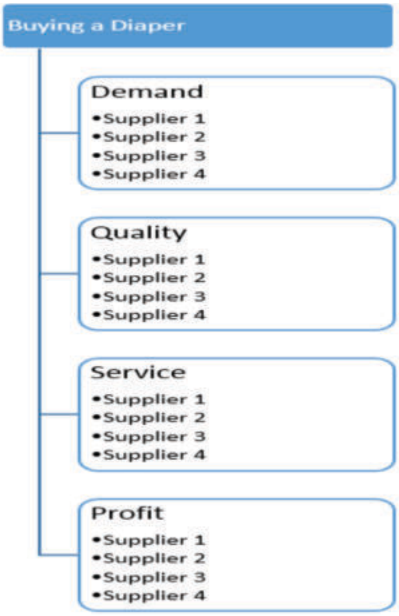
Supplier 4	0.181172	0.259748	0.247491	0.236733
Criteria weights	0.15592	0.495173	0.229873	0.119035

After multiplication of criteria weights with corresponding Eigen vectors for all alternatives and adding it we get overall priorities for all the suppliers.

Table 1.8: Calculation of overall priorities for all the suppliers

	Demand	Quality	Service	Profit	Overall Priorities
Supplier 1	0.047878	0.134002	0.063652	0.028234	0.273767 (Rank 2)
Supplier 2	0.034129	0.087784	0.042296	0.031311	0.19552 (Rank 4)
Supplier 3	0.047878	0.144767	0.067033	0.031311	0.290988 (Rank 1)
Supplier 4	0.028248	0.12862	0.056891	0.02818	0.241939 (Rank 3)

It shows that supplier 3 is better than supplier 1 followed by supplier 4 and supplier 2 is behind.



Flow Diagram 1.2: Hierarchy of Criteria and the alternatives

RESULTS AND DISCUSSIONS:

Selection of supplier is one of the most important task of pharmaceuticals in healthcare as most criteria's conflict each other, suppliers should be examined properly. Supplier selection comes under MCDM problem and it plays crucial role in SCM. Here, AHP technique is used.

We have explained it using crisp data. The priorities of all the suppliers were like supplier 3 was first, supplier 1 was second, supplier 4 was third and supplier 2 was last using crisp AHP.

CONCLUSION:

Despite the availability of no. of researches on supplier's assessment, selection and assessment and selection of suppliers with precise criteria's of baby hygiene related product are less studied. To address this gap, this research was conducted Depending on varied criteria, selection of supplier is one among the foremost vital tasks for companies. Since most of those criteria conflict one another, the choice suppliers ought to be inspected effectively. So some techniques like TOPSIS, ELECTRE, PROMETHEE, DEMATEL, ANP, etc., are developed for the same. During this study AHP technique is employed. Hence AHP model is utilized to solve the supplier selection problem of a baby hygiene related product, which should determine the best supplier among 4 alternatives.

In this paper, we presented methodology to rank the suppliers and also choosing of best supplier on the basis of four criteria's namely demand, quality, service and profit using AHP. In crisp AHP method, Supplier 3> Supplier 1> Supplier 4> Supplier 2 in the decreasing order of preference. The result of AHP framework is able to assist decision makers to examine the rankings of the suppliers as well as strength and weaknesses of suppliers. However, efficacy of evaluation at the initial levels depends on the accuracy and the value of the judgment provided by them.

The proposed methodology can be utilized for selecting alternative decisions related to production planning decisions, product development process, order production, logistic management and site selection etc.

REFERENCES:

1. Aktepe, A. & Ersoz, S. (2011). A Fuzzy Analytic Hierarchy Process Model for Supplier Selection and a Case Study. International Journal of Engineering Research and Development, 3 (1), 33-36.
2. Anupma Yadav, Dr. S.C Jayswal, 2013, Using Geometric Mean Method of Analytical Hierarchy Process for Decision Making in Functional Layout, International Journal of Engineering Research & Technology (IJERT) Volume 02, Issue 10 (October 2013)
3. Choi, T.Y., Hartley, J.L., 1996. An exploration of supplier selection practices across the supply chain. Journal of Operations Management 14, 333–343.
4. De Boer, L., van der Wegen, L., Telgen, J., 1998. Outranking methods in support of supplier selection. European Journal of Purchasing & Supply Management 4, 109–118.
5. Dowlatshahi, S., 2000. Design–buyer–supplier interface: Theory versus practice. International Journal of Production Economics 63, 111–130.
6. Ho, W., Xu, X. and Dey, P.K. (2010) 'Multi-criteria decision making approaches for supplier evaluation and selection: a literature review', European Journal of Operational Research, Vol. 202, No. 1, pp.16–24.
7. Monczka, R., Trent, R., Handfield, R., 1998. Purchasing and Supply Chain Management. South-Western College Publishing, New York.
8. Mustafa Batuhan AYHAN (2013) A Fuzzy AHP approach for supplier selection problem: A case study in a gearmotor company, International Journal of Managing Value and Supply Chains (IJMVSC) Vol.4, No. 3
9. Salem, O., Salman, B. and Ghorai, S. (2017) Accelerating Construction of Roadway Bridges Using Alternative Techniques and Procurement Methods. Transport, 33, 567-579.
10. Saaty, T. L. (1970). How to Make a Decision: The Analytic Hierarchy Process. European Journal of Operational Research, 48, 9-26.
11. Saaty, T. L (1980). The Analytic Hierarchy Process. New York: McGraw-Hill International.
12. Saaty T. L. (2005) Analytic Heirarchy Process, Wiley Online Library
13. Saaty, T.L. and Peniwati, K. (2008) Group Decision Making: Drawing out and Reconciling Differences. RWS Publications, Pittsburgh.
14. Trupti Bhosale and Hemant Umap (2020). Fuzzy Supply Chain Management Model for Healthcare Sector. International Journal of Agricultural and Statistical Sciences Vol. 16, No.2, pp. 825-829, 2020
15. Verma, R., Pullman, M.E., 1998. An analysis of the supplier selection process. Omega 26, 739–750.
16. Weber, C.A., Current, J.R., Benton, W.C., 1991. Vendor selection criteria and methods. European Journal of Operational Research 50, 2–18.