Survey the Optimal Use of three methods: AHP, FUZZY and TCO, in the process of Supplier Selection

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Abstract

Supplier evaluation and selection is arguably one of the most critical functions for the success of an organization. The main goal of supplier selection plan is to identify vendors with the best efficiency in delivering material on a real and just time. Many studies illustrated that producers were strongly needed to high quality materials in the time of producing, but lag time of deliver caused to delay in manufacturing goods, and customers lost .Thus, evaluating and selecting appropriate supplier is one of the critical tasksfor all of the manufactures. Several approaches exist in the literature to evaluate suppliers objectively, including analytic hierarchy process (AHP), total cost of Owner ship (TCO) and FUZZY. In this paper, they are compared by concentrating on their features. In addition, the paper explains AHP for a framework to cope with multiple criteria situations involving supplier selection, the " TCO" as a methodology and philosophy, which look beyond just the price of a purchase to better understanding and managing costs in selecting and maintaining relationships with suppliers and FUZZY method has a duty to contribute in the problem solution with representing vague data. In many studies those techniques are explained as three ways of assessing of suppliers in the best possible performance used by companies in the process of selection. We compare them for better enlighten with their formula .Consequently, the paper shows a model to combine AHP and FUZZY as FUZZY AHP method as an optimal method to evaluate suppliers.

Key words: *supplier selection- AHP -TCO- AHP FUZZY-Optimal use.*

Introduction & Background

The objective of supplier selection is to identify suppliers with the highest potential for meeting a firm's needs consistently and at an acceptable cost. Selection is a broad comparison of suppliers using a common set of criteria and measures. However, the level of detail used for examining potential suppliers may vary depending on a firm's needs. The overall goal of selection is to identify high potential 1 supplier. (Kahraman 2003) Choy and lee (2002) propose a case-based supplier management tool (CBSMT) using the case-based reasoning (CBR) technique in the areas of intelligent supplier selection and management that will enhance performance as compared to using the traditional approach.In today's global economy of just-in-time (JIT) manufacturing and value-added focus, there is a heightened need to change this adversarial relationship to one of cooperation and seamless integration.JIT requires the vendor to manufacture and deliver to the company the precise quantity and quality of material at the

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required time. Thus the performance of the supplier becomes a key element in a company's success or failure. Companies in order to attain the goals of low cost, consistent high quality, flexibility and quick response have increasingly considered better supplier selection approaches (Vonderembse and Tracey, 1999). These approaches require cooperation in sharing costs, benefits, expertise and in attempting to understand one another's strengths and weaknesses, which in turn leads to single sourcing, supplier and long-term partnerships (Masson, 1986,) now, in this section we mention to those methods briefly. One of the well known methods is the analytic hierarchy process (AHP) as an intuitively easy method for formulating and analyzing decisions. It was developed to solve a specific class of problems that involves prioritization of potential alternate solutions. This is achieved by evaluation of criteria elements and sub-criteria elements through a series of pair wise comparisons. Numerous applications of the AHP have been made since its development and it has been applied to many types of decision problems. Together with the AHP, the Delphi process represents one of the first formalized methods for systematically obtaining and aggregating group judgments. The Delphi method was developed by the RAND Corporation in the 1960's. The method is generally used as a forecasting technique. Also, group decision making problems are easily formulated by the Expert choice software package. This allows the decision – maker to derive geometric means as weights or priorities instead of using an eigenvector method. The geometric mean is an appropriate rule for combining individual judgments to obtain the group judgments for each pair wise comparison. Here the decision maker is considering the sub-nodes in the hierarchy as part of the whole. The second approach is total cost of ownership; TCO is a methodology and philosophy, which looks beyond the price of a purchase to include many other purchase-related costs. This approach has become increasingly important, as organization look for ways to understand and manage their costs better. The TCO models are further by usage: supplier selection and supplier evaluation (Ellram.1993).The third way for supplier detection in this paper is FUZZY method, there are many fuzzy methods proposed by various authors. These methods are systematic approaches to the alternative selection and justification problem by using the concepts of fuzzy set theory and hierarchical structure analysis. Decision makers usually find that it is more confident to give interval judgments than fixed value judgments. This is because usually he/she is unable to explicit about his/her preferences due to the fuzzy nature of the comparison process. The earliest work in fuzzy appeared by Van Laarhoven and Pedrycz (1983), which compared fuzzy ration described by triangular membership function. Buckley (1985) determines fuzzy priorities of comparison ratios whose membership function trapezoidal. Stam et al. (1996) explore how recently developed artificial intelligence techniques can be used to determine or approximate the preference ratings in that way. They conclude that the feed-forward neural network formulation appears to be a powerful tool for analyzing discrete alternative multi criteria decision problems with imprecise or fuzzy ratio-scale preference judgments.

Chang (1996) introduces a new approach for handling fuzzy, with the use of triangular fuzzy numbers for pair wise comparison scale of fuzzy, and the use of the extent analysis method for the synthetic extent values of the pair wise comparisons.

Discussion

The supplier selection process

Historically, an antagonistic relationship has often existed between buyers and suppliers; however, in the past few years a positive change has been observed in this relationship.

Trends, such as shortened product life cycles, increased rates of technological change, and foreign sourcing, have given rise to improved communication and cooperation between buyers and suppliers, with implications on management practices, such as single source procurement.

Supplier selection is generally a lengthy evaluation process. Suppliers are evaluated on several criteria such as pricing structure, delivery (timeliness and costs), product quality,

and service (i.e. personnel, facilities, research and development, capability, etc.).

Frequently, these evaluation criteria involve trade-offs. For example , one supplier may offer inexpensive parts of slightly below average quality, while another supplier may offer higher quality parts , with uncertain delivery, thus setting up trade-offs. In addition, the importance of each criterion varies from one purchase to the next and is complicated further by the fact that some criteria are quantitative (price, quality, etc.), while others are qualitative (service, flexibility, etc.). Thus, a technique is needed that can adjust for the decision maker's attitude toward the importance of each criterion and incorporates both qualitative and quantitative factors.

The Comparison of the methods

Those approaches were compared on several criteria. The comparison is presented in Table I.

Integrated supply chain management encompasses all activities associated with the flow and transformation of products from the raw materials stage through delivery to the final consumer. To achieve competitive advantages firm need to emphasize outsourcing in a way that adds value to the supply chain as a whole. A good supplier is a major component of this value creation, hence making supplier selection decision critical.The procedures of both approaches go further than just looking at the obvious and integrate multiple issues into the selection process. However, TCO tends to focus more on the pricing issues and ignores qualitative issues, its strength being the ability to use the same model to evaluate suppliers across the board and identify the "best supplier" based on lowest transaction costs, and can be used effectively for supplier evaluation along with supplier selection. However, in today's world of quality consciousness, JIT delivery , flexibility , and vendor – supported industries, etc. , AHP provides a tool to help integrate and compare seemingly un comparable issues and forces company management to make the required trade-offs to select the optimal supplier.

AHP is more of a selection tool and is appropriate in decision – making situations, where both quantitative and quality factors have to be considered, whereas TCO is difficult to use in an environment where subjective assessment and judgments have to be used in comparing factors.

TCO provides a consistent supplier evaluation tool, improving the value of supplier performance comparisons among suppliers and over time. It helps clarify and define supplier performance expectation for both the buyer and the supplier. Using a common model for both supplier selection and evaluation , TCO provides focus and a consistent message about what is important , creates less work , and the outcome of selection/evaluation can be used directly to pre-qualify suppliers, qualify suppliers, and even be part of the supplier certification process. Thus, all the firm's supplier measurement tools will be linked and consistent.

A fuzzy set is a class of objects with a continuum of grades of membership. Such a set is characterized by a membership (characteristic) function, which assigns to each object a grade of membership ranging between zero and one. A tilde "~ "will be placed above a symbol if the symbol represents a fuzzy set. Therefore p, r, n are all fuzzy sets. The membership functions for these fuzzy sets will be denoted by μ (x\p), and μ (x\n) respectively.

A triangular fuzzy number (TFN), M, is shown in figure 1. A TFN is denoted simply as (m1/m2, m2/m3) or (m1, m2 , m3). The parameters m1, m2 and m3 respectively denote the smallest possible value, the most promising value , and the largest possible value that describe a fuzzy event .

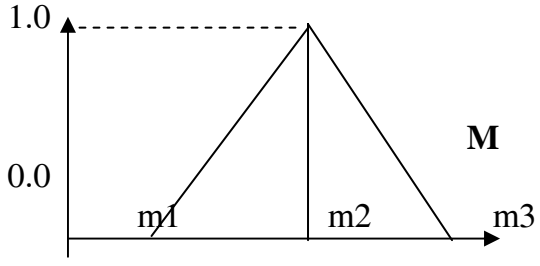
Each TFN has linear representations on its left and right side such that its membership function can be defined as:

Table 1 salient features of methods

Salient	AHP	TCO	FUZZY
Procedure	**Hierarchical and using ratio scales to integrate and then use pair-wise comparison and eventual synthesis to find "best" decision**	**Looks beyond purchase price to include all other purchase-related costs. Based on the economists "transaction cost" view**	**Classification of objects with a continuum of membership Such a set is characterized by a membership function**
Decision-making situations	**Prioritizing decision making with intangible factors, along with intuitive, qualitative , quantitative and rational aspects**	**Supplier selection as well as supplier evaluation**	**Decisions usually make from given interval judgments than fixed value judgments This method is systematic approach to the alternative selection and justification problem by using the concept of fuzzy.**
Advantages	**Use in both criteria comparison and individual aspects within each can be tackled Forces managers to make trade-off simple.**	**Provides a clear quantitative evaluation and selection rule Changes focus from purchase cost to total cost helps identify costs that otherwise may remain hidden provides consistent message to supplier as regards the requirements and evaluation criteria**	**Evaluating naval tactical missile systems by the fuzzy algorithm and the mathematics logic. Ranking objective set with fuzzy evaluation. Sampling qualities multi-criteria analysis ways Solving vague problems wit mathematical programming.**
Disadvantages	**Requires enumeration of all issues Requires intense management involvement forces trade-offs**	**Complex Requires extensive tracking and maintenance of cost data Requires cultural change Often situation – specific**	**Very complex need to intelligent tools and expert system and neural network in some cases**
Categories of supplier evaluation	**Performance , capability , business , quality system**		**Supplier financial, managerial and etc such as AHP method.**
Applications	**Multiple goal conflicts, supplier selection based on numerous, factors, when price alone is not the determining factor of supplier selection.**	**Supplier evaluation as well as selection , when cost is of high priority**	**Multi criteria, supplier selection and all of problems that need to rank factors base on analyzing them regardless one to one factor as main aspect**

manipulation requiring complex mathematical calculation. The algebraic operations with fuzzy numbers are given in Appendix 1.

Figure 1 A triangular fuzzy number,



Many decision-making and problem-solving tasks are too complex to be understood quantitatively, however, people succeed by using knowledge that is imprecise rather than precise. Fuzzy set theory resembles human

$$\mu(x\backslash M) = \begin{cases} 0 & , x<m1 \\ (x-m1)/(m2-m1) & , m1 \le x \le m2 \\ (m3-x)/(m3-m2) & m2 \le x \le m3 \\ 1 & x> m3 \end{cases}$$

A fuzzy number can always be given by its corresponding left and right representation of each degree of membership: l(y) r(y) M = (M. M) = (m1 + (m2 – m1) y, m3 + (m2 – m3) y). y ∈ [0 , 1], 2)Where l(y) and r(y) denotes the left side representation and the right side representation of a fuzzy number respectively. Many ranking methods for fuzzy numbers have been developed in the literature. These methods may give different ranking results and most methods are tedious in graphic

supplier evaluation tool, improving the value of suppliers and over time. it helps clarify and define supplier performance expectations for both the buyer and supplier .TCO also provides a focus and sets priorities regarding the areas in which supplier performance would be most beneficial (supports continuous improvement), creating major opportunities for cost savings .

Table II Total cost of ownership

	Supplier 1	Supplier 2	Supplier 3
Manufacturing			
Raw material	1,000	950	1,100
Labor	500	600	550
Machine depreciation	250	200	225
	1,750	1,750	1,875
Quality costs			
Cost of inspection	200	250	150
Rework costs	50	100	45
Cost due to delay	50	75	40
	300	425	235
Technology			
Design costs	500	450	550
Engineering costs	1,500	1,250	1,500
	2,000	1,700	2,050
After – sales service	200	350	150
Total costs	8,200	8,350	8,470
Units shipped	1,000	1,000	1,000
TCO	$ 8,20	$ 8.35	$8.47

An illustration of the AHP approach

To illustrate this approach the following example is presented. It is assumed that four criteria are used to evaluate supplier. Manufacturing –quality-technology being used and service offered

We further assume that three supplier proposals are being considered. Figure 1 depicts the hierarchy of this decision. The next step is to develop a set of pair wise comparisons to prioritize the criteria based on a measurement scale such as that shown in Table III. The AHP procedure begins with the development of a matrix that compares each criterion with the others under consideration.

The matrix for the four criteria considered in this illustration is given in Table IV. In general, for pair wise comparison matrix, we place 1s down the diagonal from the upper left – hand corner to the lower right-hand corner to the lower right –hand corner.

reasoning in its use of approximate information and uncertainty to generate decision. it was specifically designed to mathematically represent uncertainty and vagueness and provide formalized tools for dealing . By contrast, traditional computing demands precision down to each bit. Since knowledge can be expressed in a more natural by using fuzzy sets, many engineering and decision problems can be greatly simplified. Fuzzy set theory implements classes or groupings of data with boundaries that are not sharply defined (I . e .fuzzy) .Any methodology or theory implementing "crisp" definitions such as classical set theory, arithmetic , and programming , may be "fuzzified" by generalizing the concept of a crisp set to a fuzzy set with blurred boundaries. The benefit of extending crisp theory and analysis methods to fuzzy techniques is the strength in solving real-word problems, which inevitably entail some degree of imprecision and noise in processed for the application. Accordingly, linguistic variables are a critical aspect of some fuzzy logic applications, where general terms such a "large", "medium," and "small" are each used to capture a range of numerical values. Fuzzy set theory encompasses fuzzy logic, fuzzy arithmetic, fuzzy mathematical programming, fuzzy topology, fuzzy graph theory, and fuzzy data analysis, though the part. Their respective costs incurred on the production are detailed below (Table).

The **c**osts are broken down into four main categories:

(1) Manufacturing (raw material, labor, etc.);
(2) Quality (quality inspection, rework etc.);
(3) Technology (designing, engineering, etc.); and(4) After-sales service costs.

From Table II, it is apparent that supplier 1 has the least total cost for the given product, though, if we look at each item separately, the supplier is not the "best" in each area. Based on this evaluation and using the TCO approach, we would select "supplier 1" as our vendor.

Advantages and limitation of the TCO provides many benefits that are documented in the literature and confirmed by case studies. Some of the primary benefits of adopting a TCO approach are that it provides a consistent

Table III Measurement scale

Verbal judgment or preference	Numerical rating
Extremely preferred	9
Very strongly to extremely preferred	8
Very strongly preferred	7
Strongly to very strongly preferred	6
Strongly preferred	5
Moderately to strongly preferred	4
Moderately preferred	3
Equally to moderately preferred	2
Equally preferred	1
Source : Render and stair(2000)	

Last table overall score calculation

Manufacturing	Quality	Technology	Service	Score
Supplier 1 0.32451	+ 0.02152	+0.00688	+0.00264	= 0.35556
Supplier 2 0.16205	+ 0.06457	+0.02887	+0.03017	= 0.28566
Supplier 3 0.07916	+0.19371	+0.07221	+0.01370	= 0.35878

The below table shows combination of two methods AHP and fuzzy as a multi-attribute(evaluation method with other data)

Table the fuzzy evaluation matrix with respect to the goal

	sc	pp	sp
sc	(1,1,1)	(3/2 , 2 , 5/2)	(2/3,1,3/2)
pp	(2/5 , 1/2,2/3)	(1,1,1)	(3/2,2,5/2)
sp	(2/3,1,3/2)	(2/5,1/2,2/3)	(1,1,1)

Table summary combination of priority weights: sub-attributes of supplier criteria

	Financial	Management	Quality sys	Alternative priority weight
Weight	0.70	0.15	0.15	
Alternative				
EXB	0.66	0	0	0.46
DXR	0	0	0	0.00
FXM[1]	0.34	1	1	0.54

Table summary combination of priority weights: sub-attributes of product performance criteria

	Hand	Use in	Other	End use	Alternative priority weight
Weight	0.19	0.04	0.77	0.00	
Alternative					
EXB	0	0.87	0	0.27	0.03
DXR	0	0	0.31	0.18	0.24
FXM	1	0.13	0.69	0.55	0.73

Table summary combination of priority weights: sub-attributes of service performance criteria

	Fol-up	c.sup	c.sat	prof	Alternative priority weight
Weight	0.00	0.05	0.00	0.95	
Alternative					
EXB	1	0.05	0.72	0	0.003
DXR	0	0.64	0	0	0.032
FXM	0	0.31	0.28	1	0.965

1. Name of suppliers (EXB-DXR-FXM)

Table summary combination of priority weights: main attributes of the goal

	Sc	Pp	Sp	Alternative priority weight
Weight	0.43	0.37	0.20	
Alternative				
EXB	0.46	0.03	0.003	0.21
DXR	0	0.24	0.032	0.10
FXM	0.54	0.73	0.965	0.69

in TCO, AHP can provide a more robust tool for managers to select and evaluate suppliers across the board, enabling them to make sound selections based on both qualitative criteria. In the FUZZY approach multi criteria, supplier selection and all of problems that need to rank factors base on analyzing them regardless one to one factor as main aspect. It is important that we know many evaluation in real world is not sure. The integration of Fuzzy with TCO and AHP can be extended to more complex situations, including assessment of risk behavior of suppliers .During the decision-making between buyer and suppliers, the AHP process matches product characteristics with supplier characteristics. Next, agents assist the user in the debate to negotiate a joint representation of the supplier chosen and automatically justify proposals with this joint representation. According to findings in this study focused on a multi-attribute negotiation mechanism including qualitative conditions, enables automated negotiation on multiple attributes. Consequently a fuzzy membership function represented the joint representation's cognition for each condition such as quantity, price, quality, and delivery for the outsourced component.

Reviews the literature and provides a structured hierarchical model for logistic information technology evaluation and selection based on the premise that the logistic information technology evaluation and selection problem can be viewed as a product of tangible benefits, intangible benefits, policy issues and resources. Defines tangible benefits as cost savings, increased revenue, and return on investment; intangible benefits as customer satisfaction, quality of information, multiple uses of information, and setting tone for future business; policy issues as risk and necessity level; resources as costs and completion time. Consequently after analyzing , it is illustrated

Conclusion

Decisions are made today in increasingly complex environments. In more and more cases the use of experts in various fields is necessary, different value systems are to be taken into account, etc. In many of such decision – making settings the theory of fuzzy decision –making can be of use. Fuzzy group decision – making can overcome this difficulty.

In general , many concepts , tool and techniques of artificial intelligence , in particular in the field of knowledge representation and reasoning , can be used to improve human consistency and implement ability of numerous models and tools in broadly perceived decision-making and operations research .In this paper , supplier firms were compared using fuzzy AHP.

Humans are often uncertain in assigning the evaluation scores in crisp AHP. Fuzzy AHP can capture this difficulty. There are many other methods to use in comparing supplier firms.

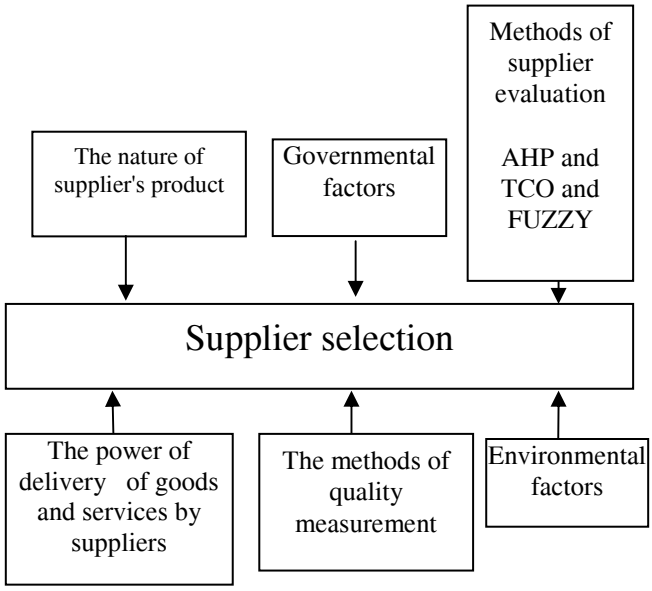
These are multi-attribute evaluation methods such as ELECTRE, DEA, and TOPSIS.

These methods have been recently developed to use in a fuzzy environment. Further research may be the application of these methods to the supplier selection problem and the comparison of the results. This paper highlighted three approaches that managers can use make effective decisions regarding supplier selection. Both these approaches are flexible to accommodate most selection criteria yet remain simple enough to be easily applied.

Both approaches can be used in negotiations and in helping to optimize and concentrate resources where they are most needed.

However, AHP can help evaluate and compare supplier on different evaluation criteria and, if cost data are included as they are

that the approach of AHP – FUZZY because of its classification and evaluation of data with an agreeable ranking can provide the best model to supplier selection regard to more one factor and compare one to one . Of course using of this method need to intelligent tools and expert system with a rational judgment.



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