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

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Abstract

The function of the Supplier selection is one of the most important managerial functions to goal achievement in industrial companies. The main objective of supplier selection function is to evaluate firms with the best performance in providing raw sources on the best real- time procedure. Many studies illustrated that producers were needed to a good raw material in their processes, but lag time of this can caused to waste and cost in manufacturing goods, and customers. In this reason evaluate and selection of appropriative supplier is one of the critical tasks in every manufactures. Several approaches exist in the literature to objectively evaluate suppliers, including analytic hierarchy process (AHP), total cost of Owner ship (TCO) and FUZZY. In this paper, they compare focus on their features. In addition, the paper explains AHP for a framework with multiple criteria situations involving supplier selection, the " TCO" as a methodology for looking the best price of a purchasing to better understand and manage costs in selecting and maintaining relationships with suppliers and FUZZY method has duty to contribute in the problem solution with representing fussy data. In many studies those techniques explain as three ways to assessment of suppliers in best possible performance that use by companies in the process of selection that we compare them by reviewing the literature for finding the better clarify with their formula .Consequently, the paper shows a model to combination of AHP and FUZZY as FUZZY AHP method as optimal method to evaluation of suppliers.

***Key words**: Supplier Selection- AHP -TCO- AHP FUZZY-Optimal use. Literature Review*

Introduction & Background

The main objective of supplier selection processes is to identify better supplier with the highest potential for meeting a firm's needs perfect and at a lowest cost. The selection process is a predetermined comparison of suppliers using a common collection of the criteria and situations. Then, we confront to the level of this function for examining best suppliers may depending on a firm's needs. Kahraman (2003) argued that the overall goal of selection is to identify high potential of the specified supplier. In the other discussion, Choy and lee (2002) provide a good case-based supplier management tool (CBSMT) using the case-based reasoning (CBR) technique in the areas of intelligent supplier selection and management that will improve the performance as a good comparison to using the traditional approach. They believed that in today's changing global economy, using of just-in-time (JIT) in the processes of manufacturing can produce the value-added and focused on the best production methods. There is an increasing need to

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change this mutual relationship to one of cooperation and other aspect of that. So using this approach can optimize the power of the company in utilizing important factors in select of the partner companies.

The JIT requires the vendor to manufacture and deliver to the company the good extent and good quality of raw things at the best time. Thus the performance of the supplier becomes a key element in a company's success or failure. In the other hand many companies in order to achievement to their goals on the circumstance of low cost, preservation of the high quality, flexibility and quick response have increasingly considered better supplier selection approaches (Vonderembse and Tracey, 1999). Masson (1986) discussed that these methods require working together to consider the costs, benefits, expertise, and efforts to understand each other's strengths and weaknesses, which in turn will enhance the ability to evaluate the provider with long-term partnerships.

In this section we mention to those methods briefly. One of the well known methods is the analytic hierarchy process (AHP) as an expert choice easy method for formulating and analyzing decisions. It was developed to define a method to any specific class of problems that involves prioritization of potential alternate solutions. This is achieved by examining its criteria and elements through a series of clever comparisons (Bhutta and Huq study, 2000). The hierarchical well-known method as AHP has been used in many decision-making problems since this method was introduced. Delphi is one of the first methods used to obtain and collect group judgments and is widely used in hierarchical methods. The Delphi method was developed by the RAND Corporation in the 1960's.In its method, we generally used a forecasting technique. Also, group decision making problems are easily formulated by the Expert choice software that is will-known for AHP. This helps the decision maker to extract mathematical tools as weight or priorities rather than using a specific method. Mathematical averaging is a good principle for binary evaluation of individual judgments to obtain multiplayer judgments for subtle comparisons. Here the decision maker considers the sub-elements in the hierarchy as part of the total choices. The second approach is total cost of ownership; TCO is a methodology and approach, which looks the best price of a purchasing to include many other purchase-related costs. This approach has well known for increasingly important, as organization look for methods to understand and manage their costs management 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. Every decision makers usually find that it is more confident to give best judgments than fixed value views. This is because usually he/she is unable to explicit about his/her preferences due to the fuzzy nature of the comparison process. The last research in fuzzy approach published by Van Laarhoven and Pedrycz (1983), which compared fuzzy

method described by triangular membership function. In the Buckley study in 1985, he determines fuzzy approach to compare ratios that the function geometric. Stam et al. (1996) explains that the how we can develop the artificial intelligence techniques 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 preferred judgments on false or fuzzy scale.

Chang (1996) introduces a new approach for doing the fuzzy method. His study mentioned the use of triangular fuzzy numbers for pair comparison scale, and the use of the extent analysis method for the extent values of the acceptable comparisons.

Discussion

The supplier selection process

The recent researches focused on relationship between buyers and suppliers; however, in the past few years a positive and repeatedly change has been observed in this relationship. The most useable way to define the life of product, such as shortened product life cycles, increased rates of technological change, and external sourcing, have given enhance to improved communication and cooperation between buyers and suppliers, with implications on management practices, such as single source obtaining.

As previously stated the supplier selection is a difficult and time-consuming process. Suppliers are evaluated on several criteria such as pricing suggestions, delivery (time and costs), product quality, service, communications, delivery commitment, honesty and etc.

So we can point out some of the important variables in the exchanges between the companies involved in this issue .For example , one supplier may offer inexpensive parts of below average quality, while another supplier may offer higher quality parts , with uncertain delivery. In other words, one supplier delivers the right goods with delay, and one supplier delivers the defective goods at the right time. This creates a fundamental problem in decision making and confuses managers. 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, extent.), while others are qualitative (service, flexibility, honesty.). Thus, a technique is needed that can help the decision maker’s attitude toward the importance of each criterion and incorporates both qualitative and quantitative factor.

The Comparison of the methods

In the last section we compared approaches on many criteria. The comparison is presented in Table I. The integrated supply chain management confront to all activities related to a continuous process and convert of the specific outputs as a good/services from the Basic raw materials to the time of delivery where the final consumer deliver take place. To achieve competitive advantages firm need to use some outsourcing alternative method that can create value to

the supply chain. A good supplier is a major component of this value creation, the firm can make supplier selection decision. The practices of both approaches go beyond looking at the obvious and integrating several issues into the selection process. But the TCO tends to focus more on pricing issues and manage the many quality problems, the power of which is to use the same model to evaluate suppliers and identify the "best supplier" at the lowest transaction cost and can more achievably to use for supplier evaluation as supplier selection(Vonderembse, M.A.,Tracey, 1999; Kahraman, et al; 2003; Kahraman et al 2007; Bhutta and Huq study, 2000). However, in today's world of quality consciousness, JIT delivery , flexibility , and vendor – supported industries, etc. , AHP provides a tool to help combine and compare apparently on comparable issues and forces company management to make the required commercial decision to select the optimal supplier.

The AHP method is more a way of selection and is useful in some alternative decision making, where both quantitative and qualitative factors must be taken into account, while the TCO is in an environment where subjective evaluations and judgments are compared to sub-factors. It gets harder. The TCO method 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 favorable model for supplier selection and evaluation, the TCO focuses less on an ongoing issue of what is important, and the selection / evaluation outcome can coincide with the eligible suppliers and even use. Of that, it has. There is also a part of the supplier approval process in this regard. Therefore, all supplier metering tools are compatible and work together.

Table 1 Main features of the methods (Regard to Bhutta and Huq study, 2000)

Salient	AHP	TCO	FUZZY
Procedure	Binary scales using scales relative to the sum of criteria and then using pair comparison and final combination for optimal decision making	Based on the "transaction cost" view, economists seem to be more concerned with price and buying costs.	The classification of continuous elements that It defines such a set with specific members
Decision-making situations	Grading decision making with invisible factors, along with visual, qualitative, quantitative and logical aspects	Supplier selection as well as supplier evaluation	This method is systematic focusing to the alternative evaluation and justification problem by using the root of fuzzy.
Advantages	In this way, benchmarks are compared and two-dimensional aspects that managers can use in business	Provides a clear quantitative evaluation and selection rule Changes focus from purchase cost to total cost Helps find costs that may be invisible because it introduces the requirements for supplier evaluation	It is a very useful method for multi-criteria analysis by examining examples and solving ambiguous problems with mathematical programming.
Disadvantages	Need to calculate all elements. Managers need to be very involved in resolving existing business issues.	Requires extensive tracking and maintenance of cost data	Very complex need to intelligent tools and expert system and such as artificial systems.
Categories of supplier evaluation	Performance , capability , business , quality system and expert choosing	Easily, Cost-Benefit approach, Managerial	Need to unknown situation analysis system, managerial such as AHP method.
Applications	Multiple goal conflicts, supplier selection several	Supplier evaluation as well as	Multi criteria, supplier

	aspect of the factors when price alone is not the determining factor of supplier selection. The other thing such as expert decisions are important.	selection , when cost is the most important thing	selection and all of problems that need to rank factors base on analyzing them regardless one to one factor as main aspect

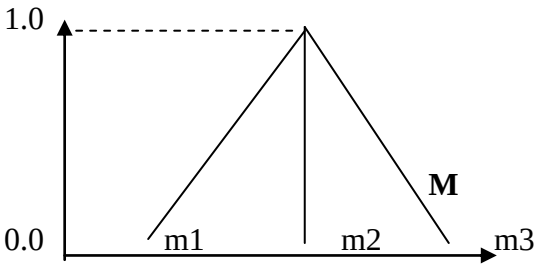
The fuzzy set of objects is a class of joining degrees. Such a set is characterized by a membership function, which assigns a membership degree between zero and one to each subject. A tilde "~ "will be placed above a symbol if the symbol represents a fuzzy set. Therefore *p, r, n* are all fuzzy sets. 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 (Vonderembse, M.A.,Tracey, 1999; Kahraman, et al; 2003; Kahraman et al 2007). A fuzzy number can always be given by its corresponding left and right representation of Each TFN has linear representations on its left and right side such that its membership function can be defined as:

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

each degree of membership: l(y) r(y) M = (M. M) = (m1 + (m2 – m1) y, m3 + (m2 – m3) y). 2)Where l(y) and r(y) denotes the left side representation and the right side representation of a fuzzy number respectively. There are many descriptive methods for numerical and mathematical calculation in the literature. These methods are the result of different classifications and theories of the methods used in graphical variations of formulas that require mathematical calculations (Figure1).

Figure 1 A triangular fuzzy number,



Many decisions cannot be understood by individuals because of their complexity. However, people have to make decisions using the uncertain science that exists and using fuzzy set theory with approximate information. So if there is not enough knowledge about a topic, people can use the fuzzy set. it was specifically designed to mathematically represent uncertainty and vagueness and provide formalized tools for dealing . Instead, traditional computing requires precision in every component. Since fuzzy sets can be interpreted better than fuzzy sets, many engineering and civil engineering

issues and decisions can be easily solved. Fuzzy set theory is very effective at spreading people's consciousness across boundaries that science has yet to find. The benefit of extending this theory and analysis methods to fuzzy techniques is develop a way in solving the complicated problems. 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. The TCO method has four main parts. It always uses these four sections to evaluate suppliers. The 4 section are shown below:
(1) Manufacturing (raw material, labor, etc.); (2) Quality (quality inspection, rework etc.);
(3) Technology (designing, engineering, etc.); and(4) After-sales service costs (Bhutta and Huq, 2000). 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. It can be seen in Table 2 that all evaluations are based on the costs that may be incurred by a supplier to us. For example, when we look at supplier 1, it is understood that it will generally cost us less, but that supplier is not productive in the machinery sector. It has a higher engineering cost than Supplier 2. In total, one is more profitable than the others at $ 820. So it can be selected. TCO's cost / benefit approach helps the company make better decisions in selecting partner companies. In this way we can get the micro-costs of the suppliers and do better in their selection. But it must be remembered that the cost criterion may not always be the best choice.

Table II Total cost of ownership (Adapted Table from Bhutta and Huq study, 2000)

	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

Consider the following example to identify an HP approach. Here are four criteria used for supplier review. Production - Quality - Technology and services provided by the supplier. For example, it is assumed that we have also received 3 bids from various companies. It can be seen in Table 3 that the

rating of each factor should be 9 degrees. This is a differentiation from the previous method. Because it has increased the decision-making power for managers. Experts can comment on the 4 factors using the 9 indices and can comment on the 3 suppliers. Now suppose we combine this method with fuzzy method. Table V contains three numbers that make it easier to make ambiguous decisions. This is illustrated in Table IX.

Table III Measurement scale (Adapted following Data :Vonderembse, M.A.,Tracey, 1999; Kahraman, et al; 2003; Kahraman et al 2007)

For the purpose of better understanding and because of nature of this literature study, tables of other articles have been reproduced here. A review of these data, calculated by other researchers, shows that fuzzy methods can better evaluate alternatives. The main reason is that in the real world decisions are subject to a series of uncertain data. The following tables (to IX) show that the obtained values are different from the TCO method.

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)	

Table IV. 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 V. 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 VI. Summary combination of priority weights: sub-attributes of supplier criteria

	Financial	Management	Quality sys	Alternative priority weight
Weight Alternative	0.70	0.15	0.15	
EXB	0.66	0	0	0.46

DXR	0	0	0	0.00
FXM[2]	0.34	1	1	0.54

Table VII. 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 VIII. 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

Table IX 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

[2]. Name of suppliers (EXB-DXR-FXM)

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, the supplier firms were compared using fuzzy AHP.

Nowadays, people are faced with difficult and difficult situations to make decisions. Also in other researches mentioned the humans are often busy to evaluation of the scores in AHP method regard to the literature. Apparently by explanation of the above example we perceived that the Fuzzy AHP can capture this difficulty. There are many other methods to use in comparing supplier firms.

Researchers showed these 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 use most effective selection criteria yet remain simple enough to be easily applied that can be a problem to select good supplier.

Both approaches can be used in negotiations and in helping to optimize and concentrate resources where they are most needed. It is a more useful way to help managers compete against other competitors. Because it can be consider other factors along with costs, this can defeat TCO in the field of holism.

However, AHP can help evaluate and compare supplier on different evaluation criteria and, if cost data are included as they are in TCO, AHP can provide a tool for managers to select and evaluate suppliers across the decision making processes, and enabling them to make a good selections based on both qualitative and quantitate 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 in a certain situation. The integration of Fuzzy with TCO and AHP can be extended to more complex situations, including assessment of risk behavior of supplier .During the decision-making between buyer and suppliers, the AHP process matches product characteristics with supplier characteristics. Next, brokers 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 approach and its 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 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 fulfillment time. Consequently after analyzing, it is illustrated 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 has need to intelligent tools and expert system with a rational judgment.

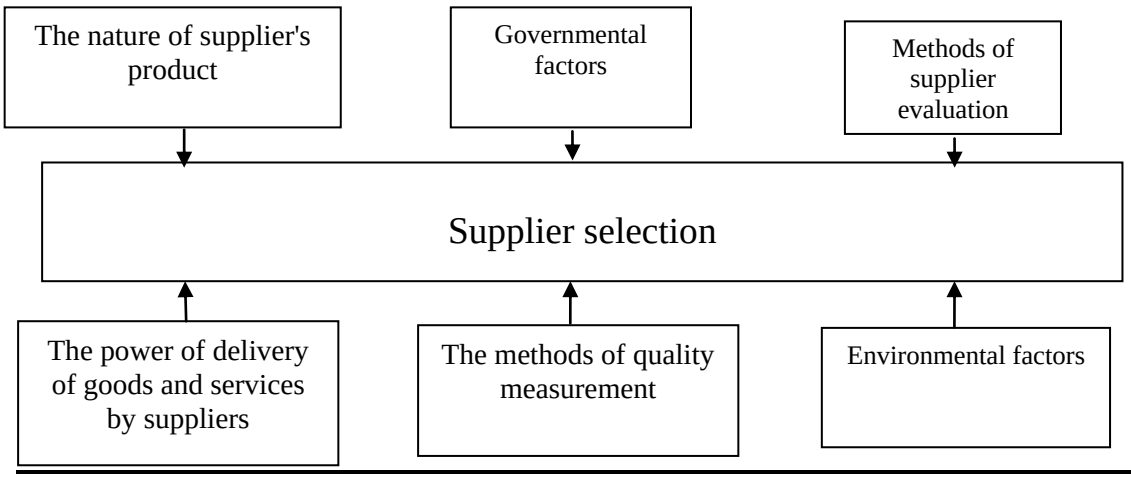


Figure III* THE EEFECTIVE FCTORS IN SUPPLIER SELECTION.

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