REVIEW ON

SUPPLIER SELECTION USING FUZZY LOGIC APPROACH

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ABSTRACT

Supplier selection is a process of selecting a supplier adopted by any industry for the proper functioning of the firm and to sustain in the industrial market. In a virtual organization, the main function of the company is to make the core of the system and depend on a large network of suppliers for the rest sub-assemblies needed for building the system. Thus there should always be a good partnership between the industry and the supplier. In this paper, the various works done by a number of researchers on supplier selection process were studied. An overview is given in this paper about the various supply selection methods and principles using fuzzy logic approach were discussed. The various techniques implemented for this process were studied in detail and the various results after implementing the techniques were also discussed.

KEYWORDS: Supplier selection process, fuzzy logic, Supply chain risk management.

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INTRODUCTION

The supplier selection is a process that gives a solution to problems that involves in the selecting a supplier for an industry. It is a multiple objective problem solving technique involving both qualitative and quantitative factors. The supplier should be selected based on their technological capabilities and their ability to deliver as per schedule. The success of an industry depends on the product cost optimization and the success mainly depends on supply selection process and its efficiency. However there many research done on supply selection process but research on supplier selection under risk circumstances are not that popular and are in need to be researched. The fuzzy method is broadly employed in the supplier selection process."Fuzzy logic is an approach to computing based on degrees of truth rather than the usual true or false". It is similar to that of the Boolean logic.

The fuzzy logic was first proposed by Dr. Lotfi Zadeh of the University of California in 1960's.Many types of fuzzy logic system were proposed some the types are fuzzy neural network (FNN), fuzzy cognitive map (FCM), fuzzy analytical network process (FANP), fuzzy TOPSIS, fuzzy clustering method , etc..,

Thus many methods of fuzzy are used in supplier selection process and methodologies are discussed in the next sections of this paper.

DIFFERENT CONCEPTS USED IN FUZZY:

According to R.J. Kuo, S.Y.Hong, Y.C.Huang (2010) [1], their study was to develop a decision support system which considers both quantitative and qualitative factors. The Fuzzy Neural Network (FNN) and Artificial Neural Network (ANN) techniques were discussed. The system proposed, composed of collection for factors qualitatively, FNN method is used for handling qualitative data and a decision integration method. The Artificial intelligence (AI) model yields promising results in areas like forecasting. One of the AI techniques is Artificial neural network (ANN) .Quality, finance, location, productivity, deadline, price are some of the quantitative factors. Many supplier evaluation methods and supplier selection methods like supplier evaluation criteria, Data envelopment analysis (DEA), Clustering methods, Linear

weighting models and Mathematical programming models are discussed. The Particle swarm optimization (PSO) is a computation technique which is used to solve problems using optimum particles. The PSO consists of a population of solutions for various problems. It keeps track of the overall best value, and its location, obtained by the particles in the population. The ANN method which is also proposed in this paper is applied only to problems regarding quantitative factors hence the author integrates FNN method with PSO to develop a decision support system for the supplier selection process. The steps involved in this process are: to decide the factor that affects most of the selection process, to collect qualitative and quantitative data, to set the fuzzy numbers to the degrees of qualitative factors that affect the process, utilize the PSO to obtain the best value and to train and develop the integrated neural network. Thus in this paper the Fuzzy neural network along with PSO is used to evaluate the supplier selection process thus helping the industries to make a precise judgment.

Supplier selection is one of the key aspects of supply chain that ensures long time commitment and performances of an industry. An industry with a well structured supplier selection process can affect an increase in profit, reduction in time and maintenance costs, etc.. A research was done Malay Niraj and Prof. Shalendra kumar (2011) [2] on fuzzy logic system. After the research they proposed four components in the fuzzy system. The four components were: Fuzzifier, Knowledge base, Inference engine and Defuzzifier. The fuzzifier measures the input variables such as input signals and real variables, scale mapping and fuzzification i.e. transformation.

The fuzzification process is done for price, quality and service which are important factors in the selection process. The calculations are solved using MATLAB which acts as a tool in solving fuzzy related problems. This system generates results based on the knowledge provided by the operator in the form of conditions. Defuzzification is a process of converting the fuzzy results into crisp form using MATLAB. The results of this fuzzy system are suitable to supplier selection process.

Supplier selection problem which is considered as a multi criteria decision making (MCDM) is one of the key issues for all firms. Zhi Xiao,Weijie Chen and Lingling Li (2012) [3] discussed about the integration of fuzzy cognitive map (FCM) and fuzzy soft set model to solve supplier selection problems. This system not only considers dependent and feedback effects but also

uncertainties that may arise while making a decision. This also takes risks that need to be taken while implementing the system. The Supply chain risk management (SCRM) is an effective approach to identify, asses, analyze and to treat the areas under risk. It is important to have an well structured SCRM to improve the performance of the firm. The major advantage of combining FCM and fuzzy soft set is evaluation accounts for interdependency of criteria and uncertainties in decision making problem. The FCM is a soft computing tool, which combines the elements of fuzzy neural network (FNN) and fuzzy logic. The fuzzy soft set is a mathematical tool that can deal with uncertainties that arise during solving problem. This was proposed by Molodtsov. The FCM consists of the following steps:1) To Compare the important criteria among the different criteria to derive the local weight vector 2) To depict the FCM to indicate the criteria 3) To train FCM using PSO algorithm. The fuzzy soft set is used to construct the resultant values and to select the best supplier.

Thus in this approach solutions for problems which involves risks can be obtained using SCRM. This also helps the industry to select the supplier that is optimal to their management. This method can also be used to analyze the evaluation process because of the integration of the FCM and fuzzy soft set method.

The supplier selection depends on various criteria's such as price, quality, time of delivery, reputation etc. A study was done by Yueh-Hsiang Chen and Ru-Jen Chao (2012) [4] they came up with an idea called Consistent fuzzy preference relations (CFPR) to make a decision on the suppliers. This used criteria structure of Analytic hierarchy process (AHP). The CFPR is efficient and is consistent and the computation can be done in Excel or by a simple computer program. Many methods were employed and used for supplier selection but all had some assumptions. In this method, the criteria were solved in AHP method and the CFPR was used to perform the supplier rating.

Supplier selection is a process of selecting the suppliers based on the criteria that are suitable for an industry's condition. Samrand Khaleie, Mehdi Fasanghari and Ensi Tavassoli (2012) [5] discussed about the clustering method in supplier selection process which is used solve group decision making problems. Intuitionist fuzzy value (IFV) shows the preferences of the decision maker. This method is based on IFS clustering technique to choose the best alternate supplier.

The evaluation is based on four criteria, they are – quality, cost and price, delivery and company and technology ability.

Francisco Rodrigues Lima Junior, Lauro Osiro, Luiz Cesar R.Carpinetti (2013) [6] discussed about fuzzy inference that integrates two types of approaches, they are – a non compensatory rule for qualification processes and a compensatory rule for ranking the suppliers. The supplier performance is considered for qualifying stages. The performances of the suppliers were represented in fuzzy numbers. This is used to classify the suppliers.   This method brings flexibility in selection process and also allows the company to choose the suppliers to their strategy. This method is based on if-then scenarios. Defuzzification is also used in this method.

M.H.Fazel Zarandi and R.Gamasaee (2013) [7] discussed about the evaluation and the reduction of bullwhip effect in the fuzzy system. They introduced a type-2 fuzzy method to reduce the bullwhip effect in the supplier chain. Fuzzy Disjunctive Normal Forms (FDNF) and Fuzzy Conjunctive Normal Forms (FCNF) is used in this system for aggregation of antecedents. The reasons of bullwhip effect are discussed they are: demand forecasting, order batching, price fluctuation, rationing and short age gaming, and non zero lead time. The steps in the system are: fuzzification, aggregation of antecedents and defuzzification.

The selection strategic suppliers are one of the critical factors for the purchasing managers. In a system proposed by Ash Aksoy, Eric Sucky and Nursel Ozturk (2013) [8], the fuzzy logic is based on dynamic strategic supplier system. All the organizations are dependent on their suppliers hence any poor decision made in the selection process would result in critical consequences either directly or indirectly. The characteristics of the model are the problem has multi period planning horizon and has many alternate suppliers. The switching from one supplier to another should consider the costs as a major factor before switching. The main objective of this paper is to develop a supplier selection model under stochastic demand conditions with total cost optimized constraint. In the previous proposals many mathematical programming models were implemented for dynamic supplier selection process. Thus the results yielded from this method are more promising and the buyer can select the supplier more effectively and simply using fuzzy logic and well suited for working in uncertain parameters and is best suited for selecting the supplier.

A hybrid model for supplier selection to cope up with the problems that arise while selecting a supplier was proposed by Giuseppe Bruno, Emilio Esposito, Andrea Genovese, Rosa Rossella Longobardo and Renato Passaro (2013) [9]. They proposed a hybrid model that combines Analytic Hierarchy process (AHP) and Fuzzy Soft Theory (FST) to cope up with the supplier selection problems. The weakness of AHP and FST when used alone for supplier selection are that AHP method suffers to show the precise ranking of the alternatives whereas FST suffers to show the precise and thorough estimations of different weight criteria. Thus by combining these two method the weight determination is done through AHP and performance assessment is done through FST. The various steps involved in this method are : identification of customer needs, Evaluation of criteria and defining the decision makers, arrangement of criteria and decision makers , determination of weights using AHP and assessment of performance using FST. The performance is evaluated by measurement of indicators associated with the criteria. The results of AHP and FST are combined to get the final rating. Defuzzification is used to get the values in crisp form. This method is time consuming but results show an improved way for selecting suppliers.

Supplier selection is one of the major factors that results to have a greater impact on the quality of goods and performance of an organization. Francisco Rodrigues Lima Junior, Lauro Osiro and Luiz Cesar Ribeiro Carpinetti (2014) [10] proposed the use of two models Fuzzy Technique for Order of Performance by Similarity to Ideal Solution (Fuzzy TOPSIS) and Fuzzy Analytic Hierarchy Process (Fuzzy AHP) to help in the supplier selection decision making process. The paper gives a comparative analysis of both the methods in the field of supplier selection. The comparative analysis is done based on many factors such as adequacy to changes of alternatives or criteria, agility in decision making, complexity in computation, adequacy in group decision making, modeling of uncertainty and the number of alternative suppliers and criteria. In order find which is the most effective method, both methods were applied for supplier selection to an automotive industry and in addition computational analysis were also performed considering the criterias. The results show that both methods are suitable for making group decision but Fuzzy TOPSIS is method is better suited for problem of supplier selection with respect to changes in alternatives and criteria and number of alternate suppliers. Thus this paper contributes in choosing more effective method for supplier selection.

Supplier selection and improvement are inherently multiple criteria decision making problems and are important to industries. Though many efforts have been to made to sort out the supplier selection problems, these efforts have assumed the criteria are independent which is actually not the case. James J.H. Liou , Yen-Ching Chuang and Gwo-Hshiung Tzeng (2014) [11] in their study proposed a novel fuzzy integral based model that address the interdependence among the criteria and employs non-addictive gap weighted analysis. The relationships between the criteria are developed using Decision Making Trial and Evaluation Laboratory (DEMATEL) and combined with a concept of Analytic Network Process (ANP) called DANP.

The fuzzy integral model uses the weights obtained from the DANP to aggregate the gaps. Thus this model addresses the shortcomings of the previous models and gives more reasonable representation of the world.

Supplier evaluation is a major activity to manage buyer-supplier relationship. Lauro Osiro, Francisco R.Lima-Junior, Luiz Cesar R. Carpinetti (2014) [12] proposed a new approach based on Fuzzy inference combined with the simple fuzzy grid method to help decision making in the supplier evaluation for development. This approach follows a procedure for pattern classification based on decision rules to categorize supplier performance according to the item category so as to determine the strengths and weakness of current suppliers, thus helping the decision makers of an industry to review supplier development action plans. This approach also helps to identity suppliers in need of attention or suppliers that should be replaced. There are two steps they are: 1) criteria formulation, the set of criteria used for item and supplier classification and the requirements posed by the buyer-supplier relationship are defined. 2) Classification is done based on the complexity of supply market and importance of items. The supplier classification is related to short term delivery performance and long term potential for partnership. One disadvantage of this approach is that an inclusion of a new criterion increases the number of rules of an inference system.

The main goal of the paper from Ahmad Dargi, Ali Anjomshoae, Masoud Rahiminezhad Galankashi, Ashkan Memari , Masine Binti Md.Tap (2014) [13] was to develop a support system for supplier selection process in an Iranian automotive industry. Though many criteria were being used for the selection of suppliers, selection of critical factors with respect to the specifications of the industry was less investigated. Nominated Group technology (NGT) was

deployed to extract the most critical performance from the initial list of suppliers. A Fuzzy Analytical Network Process (FANP) is used to weight the extracted measures and determine their importance level. The supplier selection in this method consists of certain steps, they are: 1) Identification of Criteria, 2) Recognition of the interdependence between criteria, 3) Determination of the weights of criteria, 4) Creating a check list according to criteria and 5) Gather the criteria values by auditing. According to the scores the supplier is either accepted or rejected.

Supplier selection process involves various types of uncertainty such as imprecision, fuzziness and incompleteness due to inability of proper judgment. Xinyang Deng , Yong Hu, Yong Deng and Sankaran Mahadevan (2014) [14] proposed a new method called D numbers, a D-AHP method to handle these type of uncertainties in supplier selection process which extends the classical analytic hierarchy process (AHP). Within the proposed model, D numbers extended the fuzzy preference relation has been involved to represent the decision matrix of pair wise comparisons made by the experts. D numbers is a new representation of uncertain information which is an extension of Dempster-Shafer theory. Dempster- Shafer theory is applied in many fields such as pattern recognition, risk assessment, supplier selection, etc. in mathematical representation of Dempster-Shafer, the basic probability assignment (BPA) is defined and is used to express the uncertainty in judgement.

High quality Human Resources (HR) is essential in determining the success of an industry. Renny Pradina Kusumawardani , Mayangsekar Agintiara (2015) [15] investigate the problem of human resource selection using Fuzzy AHP-TOPSIS. In this paper an investigation is done for an Indonesian telecommunication company which has a robust human resource management process, including assigning roles to its employees. The fuzzy AHP-TOPSIS method is a combination of fuzzy AHP method with Fuzzy TOPSIS method. Fuzzy AHP is used to weight the relative importance of criteria when compared with other criteria. The weighted criteria are used to assign a score to each candidate in every evaluation. Fuzzy TOPSIS is used to calculate the assigned score both for positive ideal and for negative ideal. Thus a candidate should be as near to positive ideal to be selected.

Supplier selection is a complex process in which decision makers have to deal with the optimization of issues such as price, quality and delivery time. The conventional methods for supplier selection are inadequate for dealing with vague nature of assessment. Mohsin Khan , Arvind Jayant and Veepan Kumar (2015) [16] proposed a two step approach to overcome this drawback. The steps are: 1) to identify the criteria and sub-criteria for supplier selection to design the Fuzzy analytical Hierarchy process tree structure and 2) fuzzy analytical Hierarchy process (FAHP) is used to determine the weights of criteria, sub-criteria and alternatives.

Inspite of various studies on green supplier selection, the evaluation of green supply chain performance indicators aligned with measures is less investigated. Masoud Rahiminezhad Galankashi , Ali Chegeni ,Amin Soleimanynanadeegany, Ashkan Memari ,Ali Anjomshoae , Syed Ahmad Helmi and Ahmad Dargi (2015) [17] attempted to provide an integrated step by step procedure to consider both green performance and classical performance within the supplier selection framework. Nominal Group Technology (NGT) is deployed to extract the performance measures. Fuzzy Analytical Network Process (FANP) was deployed to weight the extracted measures and determine the importance level of the supplier. The steps involved in this method are: 1) determining the criteria , 2) interdependency between the criteria , 3) weighting the Green Supplier Selection Criteria and 4) checklist development and Auditing.

The advancement of knowledge service has enabled the demanders and suppliers to find satisfied results. A good relationship between suppliers and demanders will result in continuous improvement. Xi Chen , Zhiwu Li , Zhi-Ping Fan, Xiaoyang Zhao, Xiao Zhang (2016) [18] suggested a method Fuzzy Axiomatic Design (FAD) for effectively matching the knowledge of suppliers and demanders in which the expectation levels of attributes given by demanders and suppliers are considered. Axiomatic design (AD) is used to establish a scientific and systematic basis to develop design activities by providing a theoretical knowledge on logical and rational thought processes and tools. The main objective of this method is to properly match the knowledge demanders and suppliers in knowledge service. First, the knowledge of the demander's matching satisfaction degree is maximized and then the supplier's knowledge on

matching satisfaction degree is maximized. There are two kinds of attributes considered in this method, they are benefit attributes and cost attributes. The benefit attributes includes quality which should always be high and the cost attributes such as price should be less.

CONCLUSION

Supplier selection is a key aspect for any industry to ensure proper functioning of the industry. Supplier selection is one of the major factors that results to have a greater impact on the quality of goods and performance of an organization. Supplier selection is a complex process in which decision makers have to deal with the optimization of issues such as price, quality and delivery time. Thus the understanding between the demanders and suppliers should be good for proper functioning. This paper gives the importance of supplier selection process for an industry. Supplier selection is done through various methods. This paper explains about various fuzzy techniques used for supplier selection process. In this paper, the various works done by a number of researchers on supplier selection process were studied. An overview is given in this paper about the various supply selection methods and principles using fuzzy logic approach were discussed. The various techniques implemented for this process were studied in detail and the various results after implementing the techniques were also discussed.

REFERENCES

[1] R.J. Kuo, S.Y.Hong, Y.C.Huang Integration of particle swarm optimization based fuzzy neural network and artificial neural network for supplier selection, Applied Mathematical Modelling 34 (2010) pg-3976–3990.

[2] Malay Niraj and Prof. Shalendra kumar, Modeling For Supplier Selection through Fuzzy Logic , International Journal of Scientific & Engineering Research Volume 2, Issue 8, Auguest-ISSN 2229-5518 2011

[3] Zhi Xiao,Weijie Chen and Lingling Li , An Integrated FCM and Fuzzy soft set for supplier selection problem based on risk evaluation, Applied Mathematical Modelling 36 (2012) Pg-1444–1454

[4] Yueh-Hsiang Chen and Ru-Jen Chao , Supplier selection using consistent fuzzy preference relations(2012), http://dx.doi.org/10.1016/j.eswa.2011.09.010.

[5] Khaleie, Mehdi Fasanghari and Ensi Tavassoli , Supplier selection using a novel intuitionist fuzzy clustering approach,(2012) dx.doi.org/10.1016/j.asoc.2012.01.017 Pg 1741-1754

[6] Francisco Rodrigues Lima Junior, Lauro Osiro, Luiz Cesar R.Carpinetti , A fuzzy inference and categorization approach for supplier selection using compensatory and non compensatory decision rules, Applied Soft Computing 13 (2013) Pg 4133–4147

[7] M.H.Fazel Zarandi and R.Gamasaee , A type-2 fuzzy system model for reducing bullwhip effects in supply, ScientiaIranica, pg 879–899 2013

[8] Ash Aksoy, Eric Sucky and Nursel Ozturk, Dynamic Strategic Supplier Selection System with Fuzzy Logic, Procedia - Social and Behavioral Sciences   109 (2014) Pg 1059 – 1063

[9] Giuseppe Bruno, Emilio Esposito, Andrea Genovese, Rosa Rossella Longobardo and Renato Passaro , Hybrid Supplier Selection Methodologies: Problems and Prespectives , International Federation of Automatic Control June 19-21, 2013

[10] Francisco Rodrigues Lima Junior, Lauro Osiro and Luiz Cesar Ribeiro Carpinetti,A comparison between Fuzzy AHP and Fuzzy TOPSIS methods to supplier selection , Applied Soft Computing 21 (2014) Pg 194–209

[11] James J.H. Liou , Yen-Ching Chuang and Gwo-Hshiung Tzeng, A fuzzy integral based model for supplier evaluation and improvement,http://dx.doi.org/10.1016/j.ins.2013.09.025.

[12] Lauro Osiro, Francisco R.Lima-Junior, Luiz Cesar R. Carpinetti , A fuzzy logic approach to supplier evaluation for development , Int. J. Production Economics 2014 Pg 95-112.

[13] Ahmad Dargi, Ali Anjomshoae, Masoud Rahiminezhad Galankashi, Ashkan Memari, Masine Binti Md.Tap , Supplier Selection A Fuzzy ANP Approach , Procedia Computer Science 31 (2014) Pg 691 – 700

[14] Xinyang Deng , Yong Hu, Yong Deng and Sankaran Mahadevan , Supplier selection using AHP methodology extended by D numbers , Expert Systems with Applications 2014 Pg 156-167

[15] Renny Pradina Kusumawardani , Mayangsekar Agintiara , Application of Fuzzy AHP-TOPSIS Method for Decision Making in Human Resource Manager Selection Process, Procedia Computer Science   72 (2015) Pg 638 – 646

[16] Mohsin Khan , Arvind Jayant and Veepan Kumar ,Multi-Criteria Supplier Selection Using Fuzzy-AHP Approach: A case study of manufacturing company , ISSN : 2249-5762 ISSN : 2249-5770 2015

[17] Masoud Rahiminezhad Galankashi , Ali Chegeni ,Amin Soleimanynanadeegany, Ashkan Memari ,Ali Anjomshoae , Syed Ahmad Helmi and Ahmad Dargi, Prioritizing Green Supplier Selection Criteria using Fuzzy Analytical Network Process, Procedia CIRP   26 (2015) Pg 689 – 694

[18] Xi Chen , Zhiwu Li , Zhi-Ping Fan, Xiaoyang Zhao, Xiao Zhang, Matching demanders and suppliers in knowledge service: A method based on fuzzy axiomatic design , Information Sciences 2016 Pg 130-145