AN ANALYTICAL MODEL FOR SUPPLIER SELECTION USING FUZZY INFERENCE SYSTEM

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Abstract - *This paper deals with selection of suppliers through Fuzzy Inference System, which is an alternative approach to handle effectively the impreciseness and uncertainty that are normally found in supplier selection processes. Fuzzy Inference System is a powerful and flexible decision making tool for supplier selection. Fuzzy Inference system reduces complex decisions into a series of one to one comparisons and then synthesizes result. When any supplier for a particular item makes changes for the parameter like quality, price, and improve its performance for the better delivery to his customer, the Fuzzy Inference System is used for arriving ranking of supplier for finding out the best supplier. This research paper also shows that the proposed decision making model is applicable to any supply chain system. Some results of the prototype system trial-run are presented in this study.*

Keywords: *Fuzzy Inference System, Supplier Selection, Supply Cain Management*

1.INTRODUCTION

Supply Chain Management is the end-to-end business activities carried out in any kind of business, irrespective whether it belongs to secondary or service sector. It involves both internal and external functions of a company that enables the value chain to produce and deliver product to ultimate consumers.Gone are the days where suppliers are selected on few parameters, after advent of information technology, more and more information are demanded to finalize right suppliers. Supplier evaluation can be defined as a permanent and objective monitoring and evaluation process of a Supplier's performance regarding specific criteria. In order to complete the supplier selection process, data required for selection are analyzed through fuzzy approach. Fuzzy Inference System is an important technique for solving many management problems. Fuzzy Inference System involves applying the fuzzy set theory, thus allowing the model to take into

account the ill-defined and undefined aspirations of an organization.

2.OBJECTIVES AND SCOPE OF THE STUDY

The main objective of this study is to evaluate supplier using Fuzzy Inference System and to develop a model using MATLAB.A Fuzzy Inference System is proposed as an alternative approach to handle effectively the impreciseness and uncertainty that are normally found in supplier selection processes. The input parameters are like source of material, manufacturing facility, turnover, income tax clearance and final criteria like price, performance, quality, delivery schedule. MATLAB Software returns the outputs values through output parameter, overall ranking of different supplier and the maximum overall ranking value can be picked, which will enable us to identify the most effective supplier. The overall objective of the supplier selection process is to reduce risk and maximize overall value of the purchaser.

4.LITERATURE REVIEW

Choy and Lee (2002), proposed a case-based management tool (CBSMT) using the case-based reasoning (CBR) technique in the areas of intelligent supplier selection and management, they also concluded that it will enhance performance, compared with the traditional approaches.

Zhu (2004), expressed that the use of the analytic hierarchy process (AHP) to deal with imprecision in vendor choice. They used the analytical hierarchical process (AHP) to generate weights for the vendor selection decision.

Shyur and Shih (2005), in this research paper they developed a hybrid method for strategic vendor selection by using both the ANP and TOPSIS techniques. For solving the measurement of qualitative items, and approach was developed using both quantitative and qualitative data for supplier selection intended to create value for the customer. They concluded that in the real world, quantitative and qualitative data approach has to be developed to handle the purchase situation which is full of uncertainty and the imprecision of human subjective judgment.

Ravisankar and Verma (2006), they developed a general framework for vendor-related issues in the context of supply chains, and the status of vendor selection decisions. They focus on how to relate uncertainty factors in vendor selection decisions, and the role of suppliers in buyer-supplier relationships in the Indian manufacturing firms. They concluded that factors such as price, lead time are highly preferred in the industry.

TarapadaBhowmick,et.al (2014), in this paper they developed an approach for fuzzy logic to transfer the experts evaluation of these factors into a value, representing probability. The graphical user interface of MATLAB is used to determine the probability of acceptance for each using fuzzy logic.

Shahvand et.al (2015), authors stated that criteria functions used for judgment process are identified through expert judgment. The system can utilize each criteria for each suppliers to attain final list.

Nazario Garcia et.al (2018), in this paper they compared weighted point method and fuzzy

inference system. The proposed FIS allows to incorporate non-linear nature model and thus making them more reliable to represent reveal evaluation. FIS also helps for easier understanding the knowledge behind the decision of supplier selection.

5.RESEARCH METHODOLOGY

5.1 Research Design: Analytical Research Design

5.2 Tools Applied: Fuzzy Inference System using MATLAB Software

6.FUZZY INFERENCE SYSTEM MODEL

To maximize supply chains, companies must ensure that they have an actualized picture of suppliers and demand issues. In the global current scenario the fuzzy logic concepts could better represents the cognitive process of supplier selection. Based on reviews, the variables selected in for the study are Technological Level, Economical Situation, Production Capacity, Market Share, Quantity Level, Delivery Rate, Cost Reduction, Part Quotation, Investment Cost, and Project time. The supplier selection decision will be based on the mentioned value factors. Mathematical representation of proper value to each component of the vector is given, using the cognitive connections. The value y of supplier selection decision as a function f of 10 independent variables, so that: y = f(x1, x2, x3, x4, x5, x6, x7, x8, x9, x10). Additionally, the 10 factors selected were collected into three different groups as intermediate variables, intermediate levels of decision, and taking in consideration the nature of factors. The group's characteristics are describes as follows:

Group 1is named as "Strategic Option" and corresponding inputs are "Technological Level", "Economical Situation", "Production Capacity", and "Market Share", named the output of the first group as Strategic Option".

Group 2 is relatedto "Supplier Performance", the inputs are "Quality Level", "Delivery Rate", and "Cost Reduction".

Group 3 analyzes the project details and supplier offers and named as "Percentage of Provision". The inputs are "Part Quotation", "Investment Cost", and "Project Time".

Group 4named as "Final Decision" process the results obtained to give a final recommendation. The inputs here are the outputs of the other three groups: "Strategic Option", "Supplier Performance", and "Percentage of Provision".

7.RESULTSAND DISCUSSION

Fuzzy Inference Systems are employed in domains where decision makers must repeatedly have to make decisions, especially in complex situations. In the study the reliability has been tested for the constructed FIS system, through a series of simulations i.e; varying the value of one or several inputs simultaneously. Using the FIS Editor software from MATLAB (Graphical User Interface) it can be seen in output graph that each variable allow the user to individually select from a range of values. The default value in each case is zero and the input changes when the scroll bar arrows are clicked. With the FIS model, it defined; the final stage was to implement these functions and made several situations. The input values for

individual vendors are fired in the constructed fuzzy inference system and the output of the individual vendors are shown in the form of graph. The values of every input were increased and decreased from almost its minimum to its maximum, for a better understanding of final output, in a wide range of values.

The following simulations deal with different input values, and the results obtained from the system are presented in numerical and linguistic formats for group-1 as shown in Table 1 below

Table 1: Result of Group-1 "Strategic Option"

Inputs				Outputs
Tech Level	**Economic Situation**	**Production Cap**	**Market Share**	**Strategic Option**
Worse (10)	Under Risk (10)	Overload (100)	Little Participation (40)	Not Recommended (16)
Average (50)	Under Risk (50)	Available (50)	Some Participation (40)	To Develop (52.06)
Average (70)	No Risk (80)	Available (20)	Some Participation (70)	Convenient (63.3)
Better (100)	No Risk (100)	Available (10)	A lot participation (100)	Recommended 91.6

For different input values, different results obtained from the system are presented in numerical formats for group-1 as shown in Figure below

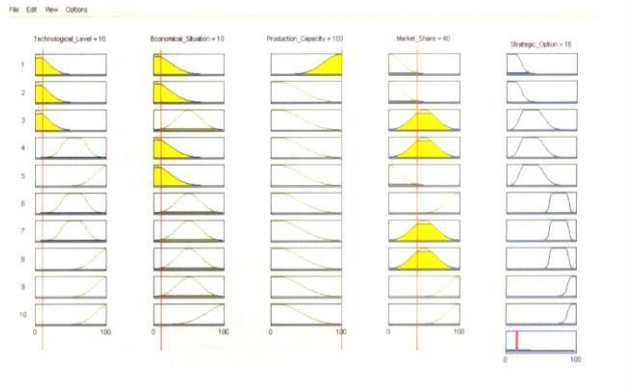

Chart 1: Output of Group-1

For different input values, different results obtained from the system are presented in numerical formats for group-2 as shown in Figure 2 below

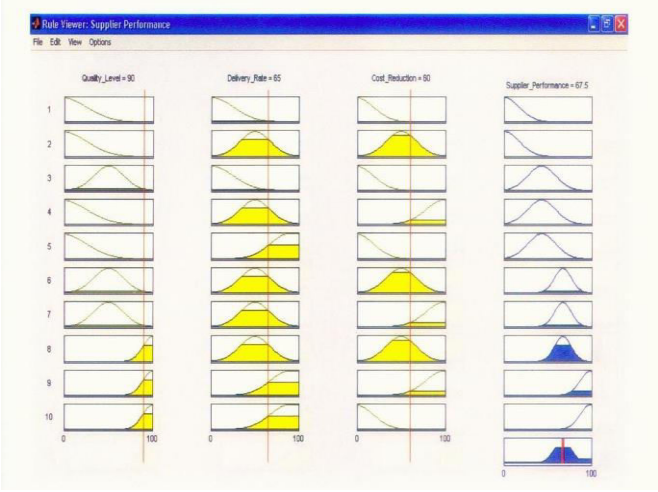

Chart 2:Output of Group-2

The following simulations deal with different input values, and the results obtained from the system are presented in numerical and linguistic formats for group-2 as shown in Table 2 below

Table 2: Result of Group-2 "Supplier Performance"

Inputs			Outputs
Quality Level	**Delivery Rate**	**Cost Reduction**	**Supplier Performance**
Poor (10)	Poor (10)	Not any (10)	Critical (5.9)
Good (50)	Good (50)	Not any (20)	Under control (46.1)
Best (90)	Good (65)	Some objective (60)	Reliable (67.5)
Best (100)	Excellent (100)	Every Objective (90)	Autonomous (91.8)

For different input values, different results obtained from the system are presented in numerical formats for group-3 as shown in Figure 3

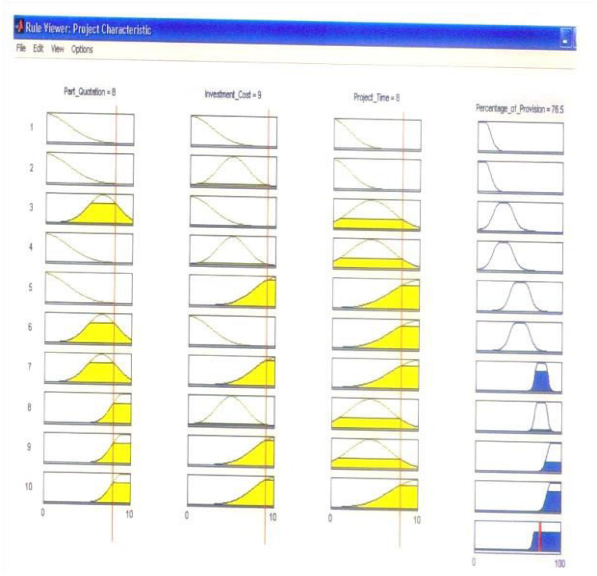

Chart3: Output of Group-3

The following simulations deal with different input values, and the results obtained from the system are presented in numerical and linguistic formats for group-3 as shown in Table below

Table 3: Result of Group-3 "Percentage of Provision"

Inputs			Outputs
Part Quotation	**Investment Cost**	**Project Time**	**Percentage Recommendation**
High (1)	High (0)	High (0)	0-10% (10.9)
Medium (4)	Medium (2)	Medium (1)	10-30% (20.02)
Medium (6)	Medium (5)	Medium (5)	30-60% (40.5)
Medium (8)	Low (9)	Low (8)	60-80% (76.5)

Mow (10)	Low (10)	Low (9)	80-100% (88.4)

The simulations for final decision are done for each individual input. It demonstrates not onlythat the system work, but also the variation in all intermediate outcomes, which are shown

Chart 4: Output of Final Decision

The following simulations deal with different input values, and the results obtained from the system are presented in numerical and linguistic formats final decision as shown in Table below

Table 4: Result of "Final Decision" group

Inputs			**Outputs**
Strategic option	**Performance**	**Percentage Recommendation**	**Final Advice**
Not Recommended	Critical (10)	0-10% (10)	Not Selected (11)
Convenient (50)	Under Consideration (50)	30-60% (60)	Second Choice (53.7)
Recommended (90)	Under Consideration (50)	60-80% (80)	Under Consideration (59.8)
Recommended (100)	Autonomous (90)	80-100% (90)	Selected (93.2)

Using the FIS Editor software from MATLAB an interface screen also developed to make the system user friendly for operator. The interface screen as shown in Figure below:

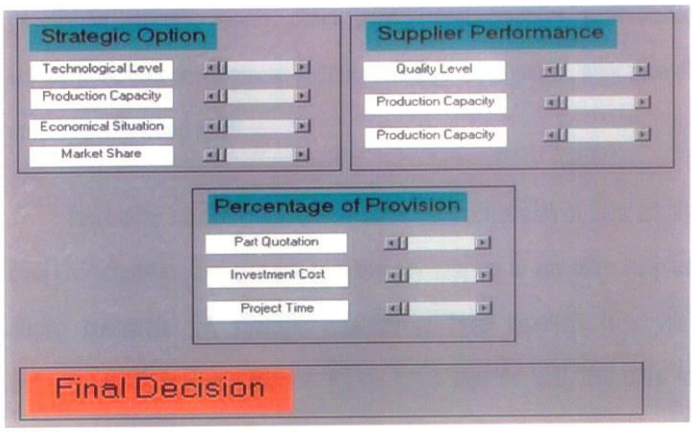

Chart5: Interface screen of FIS

CONCLUSION

This analytical research paper studied a modular Fuzzy Inference System for supplier selection. It has been also observed that fuzzy

set theory can be applied to most of the traditional areas of production research using a language to model problems, which contain fuzzy relationships. In this study specific application of the fuzzy inference theory and modular approach that can help companies to make decisions about supplier selection. Additionally, it can be used for supplier benchmark studies, negotiation process, supply chain improvement, supplier performance feedback, metrics development, supplier rankings development, allocation of order quantities, and so on. Purchasing managers and buyers can have a better idea of their supply base characteristics, and also can compare any supplier to any other supplier during quotation. A strategic commitment from suppliers is a vital determinant of business success which helps directly and indirectly to improve companies' performances and this model is beneficial as it incorporates strategic and operational measurements at the same time.It is concluded that when percentage recommendation is 80% or more than that final advice is given for selection and when it is between 60%-80% due consideration is given.

SCOPE OF THE FUTURE WORK

The study can be further extended with combination of genetic algorithm, analytical hierarchy process, goal programming etc. which will give better result. The total number of input variable shall extend which will give accurate composite output for deciding supplier rating.

REFERENCES

1. Kasilingam R G and Lee C P. (2004) 'Selection of vendors mixed- integer programming approach. Computers and Industrial Engineering, Vol. 31 No. 1 pp. 120 - 197.
2. Kumar M, Vrat P. (2004) 'A fuzzy goal programming approach for vendor selection problems in a supply chain.' Industrial Engineering, Vol. 46 No.3 pp. 69 – 85.
3. Kannan, V. and Tan, K. (2002) 'Supplier selection and assessment: Their impact on business performance.' The Journal of Supply Chain Management, Vol. 11 No.9 pp. 4 – 19.
4. Liu Baodinga and Liu Yankui. (2002) 'Expected value of fuzzy variable and fuzzy expected value model." IEEE Transactions on Fuzzy Systems, Vol. 10 No.4 pp. 445 – 450.
5. Liu Baoding (1998) 'Chance constrained programming with fuzzy parameters.' Fuzzy Sets and Systems, Vol.94 No.2 pp. 227 – 237.
6. Li Xiang and Liu Baoding. (2006) 'A sufficient and necessary condition for credibility measures.' International Journal of Uncertainty, Fuzziness & Knowledge-Bases Systems, Vol.14 No.5 pp. 527 – 535.
7. McCauley-Bell, P. (1999) 'Intelligent agent characterization and uncertainty management with fuzzy set theory.' Journal of Intelligent Manufacturing, Vol. 10 No.3 pp. 135 – 147.
8. Nazario Garcia, Javier Puente, Isabel Fernandez & Paolo Priore (2018), Suitability of a Consensual Fuzzy Inference System to Evaluate Suppliers of Strategic Products, Symmetry 2018, Vol. 10, Issue: 22, pp. 1-20.

9. Pan, A. (1997) 'Allocation of order quantities among suppliers' Journal of Purchasing and Materials Management, Vol. 25 No.3 pp. 36 - 39.
10. Sarkis, J. and Talluri, S. (2001). 'A model for strategic supplier selection. Proceedings of the third worldwide research symposium on purchasing, 'Canada. Vol. 14 No. 5 pp. 527 – 535.
11. Shahvand, Sebt&Banki (2016), Developing fuzzy expert system for supplier and sub-contractor evaluation in construction industry, ScientiaIranica Transactions: A Civil Engineering (23), pp. 842 - 855.
12. Talluri S. (2002) 'A buyer-seller game model for selection and negotiation of purchasing bids.' European Journal of Operational Research, Vol. 143 No. 1 pp. 171 – 180.
13. TarapadaBhowmick, RaiyanTahsin& Kumar Mondal (2014), A Case Study of Appropriate Supplier Selection of RFL Industry by using Fuzzy Inference System (FIS), International Conference on Mechanical, Industrial and Energy Engineering, 2014, 25 – 26th December, ICMIEE – PI – 140345.