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An Approach to Selecting a Suitable Supplier

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Abstract. Supplier performance measurement has attracted much attention from researchers. In the supply chain concept, supplier performance measurement results reveal the effects of methods and potential opportunities for selection improvement. Performance measurement is an indispensable management tool. This paper presents a fuzzy decision making approach to supplier selection problem. Many quantitative and qualitative factors such as quality, and flexibility and delivery performance must be considered to determine suitable suppliers. In this paper, linguistic values are used to assess the weights for these factors. Evaluations have been carried out to assess particularly the effects of suitable suppliers on the supply chain service. An approach to improve suitable supplier performance in an unsuitable environment has been analyzed.

Keywords: Fuzzy logic; supplier; supply chain.

1. Introduction

The supplier selection process has received considerable attention in the business literature. Performance measurement is an indispensable management tool and the vehicle to achieve supplier success. A supply chain is generally viewed as a network of facilities that performs the procurement of raw material, its transformation to intermediate and end-products, distribution and selling of the end-products to end customers. The subsystems in a supply chain, explicitly recognizable,

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including a raw material inventory, production facilities, in-process and end-products stocks and selling point inventories, are coupled and interrelated in such a way that the control of one subsystem affects the performance of others. In supply chains, coordination between a manufacturer and suppliers is typically a difficult and important link in the channel of distribution. Many models have been developed for supplier selection decisions are based on rather simplistic perceptions of decision-making process [1-4]. Most of these methods do not seem to address the complex and unstructured nature and context of many present day purchasing decisions [5-6]. In fact, many existing decision models only quantities criteria are considered for supplier selection. However, several influence factors are often not taken into account in the decision making process, such as incomplete information, additional qualitative criteria and imprecision preferences. According to the vast literature on supplier selection [1,2,4], we conclude that some properties are worth considering when solving the decision-making problem for supplier selection. First, the qualitative dimensions [7-9]. In general, these objectives among these criteria are conflicted. A strategic approach towards supplier selection may further emphasize the need to consider multiple criteria [10-11]. Second, several decision-makers are very often involved in the decision process for supplier selection [12].

Under many conditions, crisp data are inadequate to model real-life situations. Since human judgements including preferences are often vague and cannot estimate his preference with an exact numerical value. A more realistic approach may be to use linguistic assessments instead of numerical values. In other words, the ratings and weights of the criteria in the problem are assessed by means of linguistic variables [13-15]. This paper is organized as follows. In Section 2, assumptions and proposed approach are presented. The evaluation is presented in Section 3. Conclusions are presented in Section 4.

2. Assumptions and Proposed Approach

Sometimes, all facilities in a supplier may be under the roof of one company. However, parts of the suppliers or even each facility in the supply chains may belong to a different company. Then, the succeeding facility in the supply chain may be viewed as its customer and the preceding facility in the supply chain as its external supplier. Assumptions concerning supplier processes considered in this paper are the following [10]:

(a) Customer demand is confined to a single product.

(b) Each inventory in the supply chain is controlled based on a periodic review policy.

(c) External demand is fulfilled from the end-product inventory. When demand exceeds the end product stock, unmet demand is backordered and delivered as soon as it becomes available on the stock.

(d) Each production facility replenishes the succeeding inventory and places orders periodically on the preceding inventory in the supply chain. If the order exceeds the stock of the preceding inventory, the order is only partially filled and unmet quantity is backordered. When the backordered quantity becomes available in stock, it is sent to the production facility with the first next delivery.

(e) The raw material inventory is supplied from external market.

(f)The production facilities have unlimited capacities.

(g) Replenishment quantities for each inventory are received with a planned deterministic lead time.The lead time includes the time necessary for order processing, the production time and/or transportation time. Fuzzy set theory provides a systematic calculus to deal with such information linguistically and it performs numerical computation by using linguistic labels stipulated by membership functions. Fuzzy set theory provides a framework for handling the uncertainties [13].

Fuzzy concepts could help system designers to cope with the fuzzy nature of real-world situations. As shown in Fig. 1, each number in a fuzzy set is not a crisp inflexible one, but is a member of the fuzzy set with a defined membership function [14].

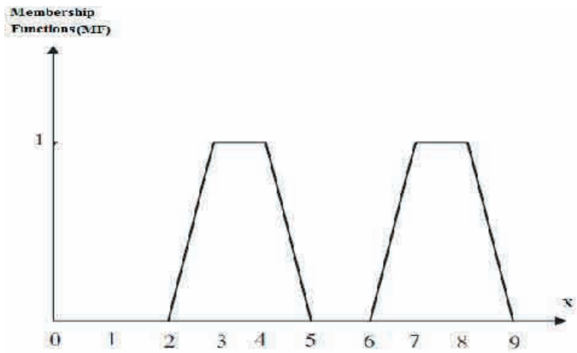

Figure. 1 Trapezoidal fuzzy numbers for x: (2, 3, 4, 5) and (6, 7, 8, 9)

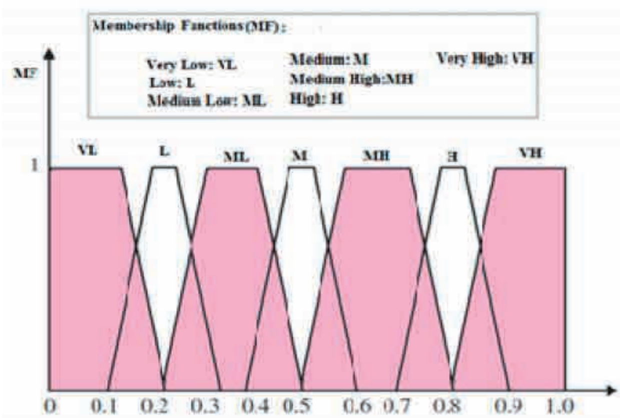

Figure. 2. Linguistic variables for criterions

The membership function is:

$$\mu(x) = \begin{cases} -2 + .1x & o.2 < x < 0.3 \\ 1 & 0.3 < x < 0.4 \\ 5 - .1x & 0.4 < x < 0.5 \end{cases} \quad (1)$$

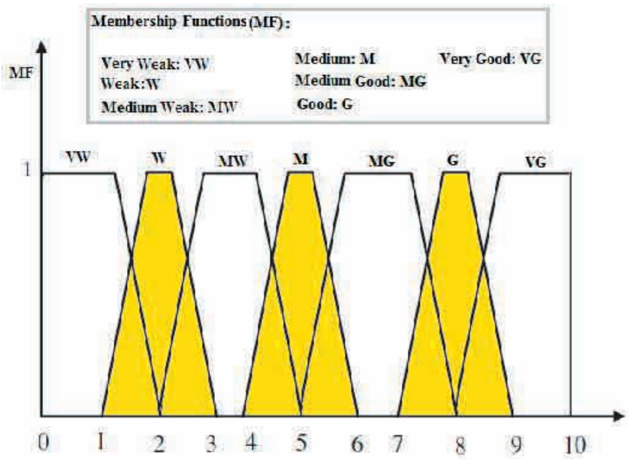

Figure. 3. Linguistic variables for ratings

The linguistic variable "Medium Good (MG)" can be represented as (5,6,7,8), the membership function of which is

$$\mu(x) = \begin{cases} 0 & x < 5 \\ x - 5 & 5 < x < 6 \\ 1 & 6 < x < 7 \end{cases} \qquad (2)$$

Uncertain customer demand causes uncertainty of internal demand along an supply chain. Customer and internal demand are derived as a sum of fuzzy and/or crisp values. A membership function of fuzzy customer demand can be derived either from subjective manager belief, if it exists [7]. Supply of raw material and supply deliveries from one to the succeeding facility in an supply chain are considered as sources of uncertainty, too. Uncertainty is always inherent in the market and, consequently, the quantity and quality of raw material delivered from an external supplier may differ from that requested. Supply delivery along the supply chain may also be unreliable in the sense that not all the replenishment quantities ordered by an inventory can be received from the preceding facility in the supply chain [7].

3. Evaluation

The first step towards supply chain fuzzy modelling is development of a fuzzy model for an isolated single stocking point inventory control. A high-technology manufacturing company desires to select a suitable material supplier to purchase the key components of new products. After preliminary screening, five candidates (G1, G2, G3, G4, G5) remain for further evaluation. A committee of three decision-makers, d1; d2 and d3, has been formed to select the most suitable supplier. Five benefit criteria are considered: (1) profitability of supplier (S1), (2) relationship closeness (S2), (3) technological capability (S3), (4) conformance quality (S4), (5) conflict resolution (S5). The proposed method is currently applied to solve this problem, the computational procedure of which is summarized as follows:

Step 1: Three decision-makers use the linguistic weighting variables shown in Fig. 2 to assess the importance of the criteria. The importance weights of the criteria determined by these three decision makers are shown in Table 1.

Step 2: Three decision-makers use the linguistic rating variables shown in Fig. 3 to evaluate the ratings of candidates with respect to each criterion. The ratings of the five candidates by the decision makers under the various criteria are shown in Table 2.

Step 3: Then the linguistic evaluations shown in Tables1 and 2 are converted into trapezoidal fuzzy numbers to construct the fuzzy-decision matrix and determine the fuzzy weight of each criterion, as in Table 3.

Table1: Decision makers (DM) for criterions

Criteria	DM		
	d_1	d_2	d_3
S_1	High	High	High
S_2	Very High	Very High	Very High
S_3	Very High	Very High	High
S_4	High	High	High
S_5	High	High	High

Table 2: Decision makers (DM) for various ratings of candidates

Criteria	Suppliers	DM		
		d_1	d_2	d_3
S_1	G_1	Medium Good	Medium Good	Medium Good
	G_2	Good	Good	Good
	G_3	Very Good	Very Good	Good
	G_4	Good	Good	Good
	G_5	Medium Good	Medium Good	Medium Good
S_2	G_1	Medium Good	Medium Good	Very Good
	G_2	Very Good	Good	Good
	G_3	Good	Good	Medium Good
	G_4	Medium Good	Good	Good
	G_5	Good	Good	Good
S_3	G_1	Very Good	Very Good	Very Good
	G_2	Very Good	Very Good	Good
	G_3	Medium Good	Medium Good	Good
	G_4	Medium Good	Medium Good	Medium Good
	G_5	Good	Good	Good
S_4	G_1	Good	Medium Good	Medium Good
	G_2	Very Good	Very Good	Very Good
	G_3	Good	Good	Good
	G_4	Medium Good	Medium Good	Good
	G_5	Good	Good	Good
S_5	G_1	Good	Good	Good
	G_2	Very Good	Very Good	Very Good
	G_3	Good	Very Good	Good
	G_4	Good	Good	Very Good
	G_5	Medium Good	Medium Good	Medium Good

Table 3: Fuzzy decision and weights

	S_1	S_2	S_3	S_4	S_5
G_1	(2,6,7,8)	(6,7,8,10)	(5,8,8,9)	(6,8,8,9)	(5,8,8,9)
G_2	(5,8,8,9)	(7,9,10,10)	(8,9,10,10)	(7,8.7,9.3,10)	(7,9,10,10)
G_3	(5,8.7,9.3,10)	(5,8.3,8.7,10)	(3,8.7,9.3,10)	(8,9,10,10)	(7,8.3,8.7,10)
G_4	(6,8,8,9)	(5,7.3,7.7,9)	(5,6.7,7.3,9)	(7,8,8,9)	(7,8.3,8.7,10)
G_5	(6,6,7,8)	(5,7.3,7.7,9)	(5,6,7,8)	(5,6.7,7.3,9)	(5,6,7,8)
Weights	(0.6,0.8,0.8,0.9)	(0.8,0.9,1.0,1.0)	(0.7,0.87,0.93,1.0)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)

4. Conclusion

The purpose of this research is to develop an appropriate decision making model for supplier problem. This study proposes a criteria decision model in fuzzy environment for supplier selection. This is considered as one of the critical decision making process for supplier. The use of linguistic variables in decision problems is highly beneficial when performance values cannot be expressed by means of numerical values. In other words, in assessing of possible suppliers with respect to criteria and importance weights, it is appropriate to use linguistic variables instead of numerical values. The results of this study show that the factors supplier is the major criteria for selecting the best supplier. This research can be used to describe, analyze and prescribe for supplier selection.

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