SUPPLIER EVALUATION, QUALIFICATION AND SELECTION MODEL: A PROPOSAL

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ABSTRACT

The evaluation and selection of suppliers are strategic decisions to be made by the purchasing department with long-term implications. These decisions are highly complex and the most difficult responsibility of the purchasing department. Complexity stems from a number of factors. Among others: a) different variables may be chosen from a list of 50 found in literature, b) variables may be contingent to product categories and situations, c) a gamut of different methodologies can be considered d) input information related to the various suppliers is not completely known with certainty.

In this work different interpretations have been analysed about both the supplier evaluation concept and the involved variables to be used in this evaluation. Then, a supplier evaluation and selection model is designed to obtain, on the one hand, a list of qualified suppliers and, on the other hand, a support to make the decision on the best supplier to which a specific order is to be assigned to. Finally, the uncertainty inherent to the quantification of certain variables included in the model is considered by using the fuzzy logic.

Keywords: Supplier evaluation, Supplier selection

1. INTRODUCTION

In business organization, supplier management has not played a decisive role as a key in business success in the past (Törrönen and Möller [1]). This fact started to change with the irruption of the supply chain management (SCM) concept. Thanks to SCM, companies are able to strengthen their competitive position in the markets, evaluation and selection of good suppliers becoming a key piece in the company success (Brun and Staudacher [2]). The review of the literature on the supplier evaluation-and-selection process has enabled the identification of some advantages and disadvantages (Min [3], Romero [4], De Boer et al [5], Bhutta [6]). The possibility of ranking potential suppliers, getting their comparative qualification, identifying the relevant criteria for carrying out the evaluation, or choosing the best supplier for a specific purchasing decision are, among others, some remarkable advantages. On the other hand, the lack of consensus about both the definitions used to refer to the "evaluation" and "selection" of suppliers and the variables used determining in these processes, the difficulty to evaluate simultaneously new and historical suppliers, or the complexity associated to the selection of the most suitable supplier according to the strategic importance of the product purchase object, are among the disadvantages.

This work proposes, so as to mitigate these disadvantages, in the first place, a model design that uses the "weighted-point evaluation" method to analyse the variables considered as more relevant in literature. Secondly, given the high degree of subjectivity involved in assigning the weightings, together with the impossibility to capture the relevant information related to the decision, the previously mentioned model design is improved by including the fuzzy logic. Thanks to fuzzy logic, the involved variables can be dealt with linguistically and in addition, the knowledge necessary can be inserted (in the form of rules) to take the evaluation and selection decisions.

2. LITERATURE REVIEW

Many are the works in which the terms supplier "evaluation" and "selection" are separately mentioned, as if they were two processes with their own entity. However a number of works can be found that seem to include the evaluation process as a step to carry out within the selection process (Lee et al.[7], Chan [8], Chen and Paulraj [9]).

In line with Dickson's distinction [10], this work considers two types of evaluation which fulfilment will be previous to the supplier selection analysis (see Figure 1): a) the initial or "a priori" evaluation and b) the "a posteriori" evaluation. The "a priori" evaluation will score the supplier so that the decision about its inclusion or not in the listing of qualified suppliers can be taken. The "a posteriori" evaluation adds to the "a priori" evaluation a qualification related to the behaviour of the historical suppliers according to the quality of the commercial relationship with the purchaser. The availability of both evaluations will be taken into account when taking a decision on choosing the appropriate supplier for a specific purchasing process.



Fig. 1. Steps in the purchasing process.

Most supplier-evaluation models make use of multi-criteria approaches (Weber et al. [11], Weber y Ellram [12], Muralidharan et al. [13], Bhutta and Huq [14]), with both quantitative and qualitative variables. The inclusion of both variable types guarantees the robustness of the analysis (Bhutta [6]). An extensive revision (154 scientific papers published between 1986 and 2002) of the most commonly used variables can be found in Bhutta [6]. Kwong et al. [15], Chan [8], Garfamy [16] and Pressey et al. [17] are only a sample of later publications to be consulted on the subject.

3. PROPOSED MODEL TO EVALUATE, QUALIFICATE AND SELECT SUPPLIERS IN A PURCHASING PROCESS

The proposed model consists of two successive phases. First, an evaluative phase (see Figure 2) where each supplier (new or historical) is examined and ranked; then, a selective phase (Figure 3) where the best supplier is appointed.



Fig. 2. Phase I. Supplier Evaluation



Fig. 3. Phase II. Supplier Selection

The variables "Structure", "Q_System" and "Economic", refer to organizational aspects, whereas the variables "Delivery", "Quality" and "Response", refer to the reliability of deliveries, proportion of rejected orders and flexibility and capability of answer of the supplier respectively.

According to Figure 3, given a set of bids received from new suppliers and related to a specific type of product (left branch of the graph), the model calculates a score associated to each new supplier [SCORE_New], based on its "a priori" evaluation [EVAL_Pri], the evaluation of the product to be purchased [Product], and the evaluation of the supplier's bid [Offer]. Similarly, the system will score (right hand side of the graph) historical suppliers' bids related to the same type of product [SCORE_Hist].

The values of the dependent variables in previous figures, will be initially calculated by means of arithmetic weighting of the values of the variables that influence them (In both Figure 2 and 3, "Wx" denotes the weights assigned to each variable).

In the selective phase, the model is designed so that it processes information related to the product type (according to Kraljic's taxonomy [18]: strategic (1), bottleneck (2), basic (3) and non-critical or general (4)) and to the conditions of each bid. This information together with the evaluation of each supplier (obtained in the previous phase) leads to the establishment of rankings for both new and historic suppliers. Table 1 shows the weighting system used in this selective phase.

Type of Product					
Input	1, 2	3	4		Output
[Eval_Pri] / [Eval_Post]	W11	W31	W41		[Score New] / [Score Hist] Range: 0-10
[Product]	W12	W32	W42	\Rightarrow	
Offer]	W13	W33	W43		

 Table 1. Weighting system for the selection phase

The design of the proposed model has shown a) its flexibility when it comes to define the variable weightings and b) its discriminative capability in the supplier selection contingent to the type of product. As a result, a set of suppliers with similar values in the rest variables will be ranked differently according to the type of product. Nevertheless, the weighting model previously described also presents some disadvantages. In the first place, the model does not reflect certain scenarios that may be desirable to consider. Additionally, pure weighting models require a previous normalization of categories in the scoring ranges of the variables involved in the model. To follow with, the nature of the decisions to select suppliers is complex and little structured (Chen-Tung) [19] and the estimate of some quantitative and qualitative factors in such decisions is subject to high doses of uncertainty and subjectivity (Amida et al. [20]. All those reasons justify to extend the weighting model by introducing the fuzzy logic which will allow to emulate the human reasoning process and to make decisions out of vague or/and uncertain data (Bevilacqua and Petroni [21] and that mitigates the effects of the disadvantages previously described.

3.1. Model development through fuzzy inference systems

Fuzzy decision support systems are based on the theory of fuzzy sets (Zadeh [22]), and allow an uncertainty component to be incorporated into models, making them more effective in terms of approximating to reality (Lootsma [23]). This work proposes a fuzzy model implying the fulfilment of the following steps: firstly, the required transformation of the variables used in the initial weighting model into its homologous fuzzy ones; secondly, to establish the adequate sequence of fuzzy subsystems during the phases of evaluation and selection. Finally, the knowledge required to transform these processes into the form of rules is incorporated in any point of the system in which it is desired to obtain a qualification - these points are identified with [*] in Figure 2.

In the adaptation process, it has been chosen to implement the global system of fuzzy inference in the MATLAB 6.5 Fuzzy Toolbox 2.0 Mamdani Model - (Mamdani and Gains [26]). In order to design each fuzzy inference subsystem, fuzzy labels must be assigned to the variables (both input and output variables) and its base of rules needs to be defined (so that the knowledge for the decision making - in qualification terms- is incorporated). The structure of the rules is of conditional type and must allow the intuitive allocation of linguistic labels in all its variables.

Unlike the weighting model, the own configuration of the fuzzy model enables to consider a wider set of scenarios. On the other hand, the direct definition of the fuzzy labels for each variable, makes it unnecessary to standardise its ranges.

Once a fuzzy subsystem has been designed, the qualification of each supplier can be inferred as a function of the "crisp" values assigned to its input variables. Last but not least, the congruence of any supplier's global evaluation in a subsystem can be analyzed by means of the inference maps. Figures 5 globally depicts how an "a priori" evaluation of any given supplier looks. The evaluation is based on two input variables (shown in X and Y axis), being constant the third input variable which is not shown in the graphic.



Fig. 5. "A priori" evaluation map from the pair of variables Q_system & Economic, Structure being kept at low constant value (left) and high (right)

The analysis of the map profile and the qualifications assigned in Figure 5 shows the congruence of the subsystem since, for any given value of the Structure variable, the fact of having low scores in the Economic variable renders an unfavourable "a priori" evaluation (independently of Q_System). In addition, growing values in Q_System and Economic return better qualifications in Eval_Pri. This link becomes the more acute the greater the value considered for Structure. Thus, when analyzing all the variable combinations in each subsystem, it is possible to refine the knowledge enclosed in the base of rules (in case of finding some type of inconsistency), which guarantees the robustness of the model.

4. CONCLUSIONS

The model proposed in this work has incorporated the most frequently used variables in supplier evaluation-and-selection literature. Although the weighting method initially presented is characterized by great flexibility in the evaluation process among other advantages, it does not permit the analysis of certain situations very likely to happen in real business. The adaptation of the initial model is made by using the fuzzy logic inference. As a consequence, the previous disadvantages have been mitigated, resulting in a robust, versatile and congruent model for the qualification of a supplier in the different phases within the purchase process.

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