



# Supplier selection model for commodities procurement. Optimised assessment using a fuzzy decision support system

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## ABSTRACT

The selection of the most suitable supplier for a procurement process has a markedly strategic aspect for a company. Within this ambit, the literature review shows a lack of uniformity in the terms used to define the phases or components of a procurement process as well as in the election of the critical variables used to select the most suitable supplier. Furthermore, this literature shows a wide variety of individual and integrated methodologies that have been developed so far in an attempt to optimise such a selection.

This work proposes a new suppliers' evaluation-and-selection model. The model homogenises the terminology involved in such processes and fulfils three main goals. First, it allows the joint assessment and comparison among new and historical suppliers, identifying the key evaluation factors in each case. Second, it allows the inherent knowledge about evaluation to be flexibly adapted to the type of product to be purchased – in this paper “basic products” – according to Kraljic's terminology (a major issue in procurement management and not taken into account by any of the models proposed so far). Finally, a FDSS is proposed to make the model operational. The proposed method is robust enough to improve the main shortcomings of more simplistic methods (e.g. those based on weights) and eases the comprehension of the embedded knowledge within the supplier evaluation processes. Simultaneously, this method avoids the complexity of real-life implementation that many of some more sophisticated hybrid methods proposed in recent times – not free of certain additional disadvantages. Finally, the practical usefulness of the proposed method is ascertained through an empirical test in a specific business environment.

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## 1. Introduction

Ever more frequently companies opt for the strategy of focusing their “core business” in the out-collection of products that they had previously internally manufactured as well as outsourcing activities. This way, companies are starting to be understood as an actual supply chain, thus transforming procurement management into a determining function. Besides, purchase budgets tend to grow intensively and an important part of business success depends on managing adequately these budgets. That is way it is essential to ensure the availability of suppliers that contribute to achieve the basic targets of a purchase (for instance, delivery deadlines fulfilment, product availability, purchased product quality) as well as intensifying the relationships with those suppliers. Therefore, the

analysis, evaluation and selection of good suppliers is a keystone to success [1,2].

A review of the literature regarding the selection of suppliers in the procurement process [3–6] allows to make, among others, the following considerations: (a) the possibility of obtaining a preferential order of suppliers or a comparative score on which the “supply-base reduction decision” can be based [7], (b) identification of the main influential criteria for evaluating and selecting suppliers, (c) the use of information obtained in previous procurement processes to: standardise supplier selection decisions [8], develop appropriate partnerships [9] and identify potential actions for benchmarking [10].

However, problems such as the following appear in actual implementation: (a) the lack of consensus both in the terminology used to refer to the “evaluation” and “selection” of suppliers as well as in defining and quantifying the key variables (dealing with models that vary from the simpler ones with little exactness to the most complex models with difficult implementation); (b) the difficulty of simultaneously evaluating both new and historical suppliers; (c) the difficulty of processing the uncertainty associated with scoring certain variables involved in the selection of suppliers; (d) the difficulty of establishing appropriate criteria for scoring the bids from suppliers based on the type of product to be purchased.

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In the present paper a model is designed to select the most suitable supplier in a basic product procurement process. The model combines the scores of the bids that have been submitted and the features of the supplier that tries to be awarded the contract. Therefore, according to literature, the most relevant variables to be included are identified in the process of scoring the bids as well as in the process of obtaining a final evaluation for the supplier itself. In the same way, two calculation methodologies are to be applied on the model to evaluate both processes. The first one is based on weighting the importance of the variables: the “weighted-point evaluation” method. The second method proposes the development of a fuzzy decision support system – FDSS. This system improves the performance of the model by using linguistic treatment of the variables involved and by including the necessary knowledge (as rules) to make optimal decisions in the process of assigning purchases of basic products.

This article is divided into five sections. After this introductory section, in Section 2, there is a review of the literature so one can standardise the terminology used in selecting suppliers and in identifying the variables and methods that are most commonly employed. Section 3 describes the design of the proposed model showing its operational logic, it includes the definition of the variables chosen and engaged in the scoring of bids, and finally, it rates each supplier and the determining criteria that are considered by companies in the process of buying basic products. Section 4 proposes two assessing methods for running the model, analysing them with examples and shows the results that are obtained. Finally, the conclusions and other possible uses of the proposed model are presented for procurement processes with other types of products.

## 2. A review of the literature

### 2.1. Terminology issues

Although studies on the topic of supplier evaluation have existed for some time (e.g. [11]), we will focus on the period that begins in the sixties, when a more formalised supplier evaluation can be found.

The review of the literature has allowed, first off, to point out the lack of uniformity in matters of terminology relating to the concepts of sourcing strategy, supplier evaluation, types of assessment, how often it is to be carried out or the processes that establish the selection of suppliers for a purchase.

Supplier evaluation is one valuable tool used to manage suppliers, which serves at gathering the buying organization's perceptions of the supplier's capabilities and, when possible, performance [12]. For the buying organisation, supplier evaluations can be used for supplier selection [8] among other objectives.

In the reviewed literature, there is a lack of uniformity of the concepts that identify the processes of assessment and the selection of suppliers due to the many tasks that are either seen as independent or not independent processes.

Lee et al. [13] seems to take the evaluation process as a mere step within the process of selection which in turn takes part of the more general supplier management system. Chan [14] is aligned with this idea since he includes the evaluation within his proposed Interactive selection model (ISM). Chen and Paulraj [15] also include the selection process as a subprocess of supply management, even though they do not explicitly analyse the evaluation process. In contrast, Carr and Pearson [16] do delve deeper into this concept by studying the relationships of strategic purchasing, the buyer-supplier relationships, the supplier evaluation system, and the performance outcomes.

In addition, Tracey and Tan [17], understand the evaluation of suppliers as a sub process within the broader process of deciding what the ideal purchase is for a company.

However, Goffin et al. [18] consider the evaluation and ideal purchasing decision to be two separate processes, just as Kwong et al. [19] and Schorr [20] do. The last one, Schorr, also proposes repeating the assessment process each time a purchase is made.

The type of supplier that is analysed may condition the evaluation or scoring process. Thus, Chui [21] proposed a supplier certification system that would distinguish two types of evaluation: a supplier visit evaluation report for new suppliers, and an annual report for existing suppliers. This distinction coincides with the one that is already provided by Dickson [22] regarding the initial evaluation of each new or potential supplier (in order to be able to require minimum guarantees for future trade relations) and for an additional assessment – related to the observed behaviour – for suppliers that the company have already worked with.

This article works off of the proposal by Dickson, as far as evaluation is concerned, by distinguishing between two basic types. First, an initial assessment, applicable to new suppliers, which is hereinafter called “a priori” – and which will determine the level of assurance of the supplier to meet the buying needs of the company and it will provide a rating that will allow to include them in the list of approved suppliers with which future business relations will be established. The second type of evaluation, which Dickson called “complementary” and hereinafter is referred to as an “a posteriori” evaluation, completes the “a priori” analysis with the supplier's behaviour, by providing a score for those that have already supplied an order to the purchasing company (this score is obtained on the basis of their behaviour in the business relationship with the purchasing company that is maintained over a period of time). Both assessments should be taken into account when deciding which one the appropriate supplier is that should be awarded the deal in what we will call the “Purchasing process” (see Fig. 1).

Since the goal of the purchasing process is to determine which is the perfect supplier to which allocate the purchase, in order to make this decision we will accomplish the sub-process of supplier evaluation by means of an analysis or scoring of the bids that have been submitted by each supplier that opt to be awarded the purchase. This way we obtain the most suitable supplier as a function of the two mentioned sub processes.

### 2.2. Principal variables and methodologies used in the models of supplier selection

Extensive multi-criteria decision making approaches have been proposed for supplier evaluation and selection, such as the analytic hierarchy process (AHP), analytic network process (ANP), case-based reasoning (CBR), data envelopment analysis (DEA), fuzzy set theory, genetic algorithm (GA), mathematical programming, simple multi-attribute rating technique (SMART), and their hybrids. Among these, the final assessment of the supplier is a function of the ratings assigned to a set of variables that are considered to be influential. These variables can be both quantitative and qualitative, with both being required in order to ensure the robustness of the analysis [3].

There are at least four journal articles reviewing the literature regarding supplier evaluation and selection models [4,23,24,25]. It was decided not to include bibliographic details of these variables and methods, referring readers to these papers, if necessary.

The most up-to-date revision paper [25] analyses the mention of different variables that influence the evaluation and selection of suppliers and the most frequently used methods in these processes between the years 2000 and 2008. Table 1a shows the ranking of variables mentioned in the previous analysis while Table 1b shows

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