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A cost efficiency approach for strategic vendor selection problem under certain input prices assumption

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ABSTRACT

Strategic vendor selection problem (VSP) has been investigated in different purchasing literature during the last two decades. Indeed, senior purchasing managers always deal with such crucial decisions. Manufacturing managers in the global market are faced with challenging and complex tasks very similar to VSP. Increasing outsourcing and opportunity provided by automotive industry to the worldwide markets make these decisions, even more, complex. Various methodologies, from simple weighted scoring methods to complex mathematical programming models, are introduced to tackle the VSP.

Data envelopment analysis (DEA) is a non-parametric method in operations research and economics for evaluating the productive efficiency of decision-making units (DMUs). This study utilizes the proposed approach in Toloo and Ertay (2014) to develop a method for finding the most cost efficient DMU when the prices are fixed and known. A case study of an automotive company located in Turkey is adapted from the literature to illustrate the potential application of the suggested approach.

1. Introduction

In general, analysis of production systems is considering a variety of techniques to assess performance and efficiency evaluation. Singh et al. [24] implied three categories of performance measurement techniques: index measurement, linear programming, and econometric models. The first approach is based on the concept of total factor productivity or financial ratio while the last two categories are related to production function. The production economics approach introduced by Hackman [18] can be considered for the estimation of the frontier production function and determination on how efficiently a production system uses inputs to generate outputs. A production system is efficient if and only if it is not possible to improve any input or output without worsening some other input or output. In other words, given the same input resource, a production system is inefficient when its output levels are lower than other production systems and this situation can lead to a decrease in efficiency measures. For overall business success, effective supply chain management, simultaneous improvements in both customer service levels and the internal operating efficiencies should be considered. The success of supply chain is highly dependent on selection and arrangement of the best vendors. For that reason, productivity measurement and efficiency analysis of vendors are to assure a managerial development for the main company and should also carry out collaborative support among partners of the main company.

Moreover, vendor selection problem (VSP) is a noteworthy and common issue in operational decision making in organizations. The main purpose of this problem is to find the most suitable vendor(s) for the organizations based on

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various vendors' capabilities. VSP arises when the purchasing price is high, the purchasing power is low and also when purchasing decision making is more complex. Several researchers have addressed the strategic importance of vendor evaluation process and have mainly emphasized the impact of vendor selection decisions on different functional areas of commerce from procurement to production and delivery of the products to the customer [7,12]. Weber et al. [46] reviewed, annotated and classified 74 supplier selection articles which have been published since 1966 and concluded that there are three most frequently used criteria in VSP: net price, delivery performance, and product quality. It was also reported that geographical location, production facility, supplier capacity and financial position generated an intermediate amount of attention. It has been also explained that in highly technological companies, such as automotive industries, the cost of raw materials and components is very important and constitute up to 80% of the total production cost.

Kleinsorge et al. [21] illustrated how DEA can be used to track the performance of a selected supplier. Since DEA approach allows managers to consider not only financial and economic measures simultaneously, but also to incorporate quantitative measures of satisfaction, they utilized it for monitoring customer–supplier relationships. Weber and Desai [47] demonstrated the use of DEA for measuring vendor market performance and efficiency. The algorithm of Inselberg [19] was employed for determining alternative contraction paths, which can be used by inefficient vendors to get to the efficient frontier. In addition, the use of the parallel coordinate's graphical representation approach was revealed to be used in vendor negotiation. Weber et al. [48] combined multi-objective programming and DEA to introduce some non-cooperative negotiation strategies where the selection of one vendor results in another being left out of the solution. Liu et al. [22] formulated a new multi-objective 0–1 linear model to deal with multi-objective resource allocation problem (MRAP) which can be applied to a service-oriented public sector entity to allocate limited resources to different activities with multiple objectives. The authors implemented variable returns to scale (VRS) DEA model to measure the efficiency of decision-making units (DMUs) where each DMU presents a technological relationship between resources and objectives of MRAP. Talluri [25] dealt with multiple attributes including price, quality and delivery performance by proposing a buyer-seller game model to bid selection and utilizing effective negotiation strategies in order to make the unselected bids competitive. He also formulated an integrated 0–1 integer programming for obtaining the optimal set of vendors to be selected in meeting the demand requirements of the buyer with considering the minimum order necessities of the vendors. Talluri et al. [26] proposed a chance-constrained DEA (CCDEA) approach in the presence of uncertain multiple performance measures to evaluate vendor performance and applied it on a real dataset of a pharmaceutical company involving six vendors.

On the other hand, finding the most efficient unit is a scientific challenge and hence has been the subject of numerous studies: Ertay and Ruan [13] proposed an evaluation procedure in order to improve the discriminating power of DEA. The cross evaluation ranking method was applied for discriminating between *true efficient candidate* and *false positive candidate*. Cross efficiencies in DEA effectively used to surmount the problems associated with simple efficiency scores has been developed to discriminate between relatively efficient DMUs. Ertay et al. [14] suggested that a minimax method should consist of a parameter, which should be selected on a trial-error method in order to achieve the most efficient DMU. Karsak and Ahiska [20] and Amin et al. [2] introduced a multi-criteria decision-making DEA model in order to evaluate the best efficient DMUs in advanced manufacturing technology. Amin and Toloo [3] formulated a new integrated DEA model for finding the best CCR-efficient and illustrated its capability by applying on a real data set consisting of 19 facilities layout alternatives. Toloo and Nalchigar [29] extended the proposed model of Amin and Toloo [3] from constant returns to scale (CRS) to VRS situation. Toloo et al. [28] suggested an integrated DEA model for finding the most efficient discovered association rules from data mining and then utilized it to design an algorithm for prioritizing association rules by considering multiple criteria. An example of market basket analysis was applied to demonstrate the applicability of the proposed approach. Farzipoor [17] took non-discretionary factors and imprecise data into consideration and formulated some DEA models to find the best supplier. Toloo and Nalchigar [30] addressed some weaknesses in the proposed DEA approach of Toloo et al. [28]. Toloo [31] found some drawbacks in the integrated model of Toloo and Nalchigar [29] which might produce more than one efficient DMU, and he then formulated a mixed integer linear model (MILP) to overcome the shortcoming. The author also mathematically proved that the newly introduced model identifies only a single BCC-efficient DMU by an optimal common set of weights (CSW). Azadi and Farzipoor [5] developed a chance-constrained DEA model which selects the best supplier in the presence of undesirable outputs. Azadi et al. [6] suggested a chance-constrained method which finds the most efficient supplier with non-discretionary factors and statistical data. Toloo [33] extended a new MILP-DEA model in order to find the most efficient DMU among several efficient ones without explicit inputs. To illustrate the discriminating power of his methodology, a real data set containing 40 professional tennis players was utilized. Toloo [34] introduced a method to deal with finding and full ranking suppliers with imprecise data. Toloo [35] illustrated that if the non-Archimedean epsilon is ignored, then the DEA models can neither find the most efficient unit nor rank the extreme efficient units. In order to get rid of the problem of finding a suitable value for the non-Archimedean epsilon, Toloo [36] proposed a novel epsilon-free approach which excludes the non-Archimedean epsilon and consequently the formulated models can be solved straightforwardly. Toloo and Ertay [39] suggested a DEA approach to deal with the most cost efficient DMU with price uncertainty. Toloo and Kresta [40] suggested a method to deal with a data involving multiple inputs and without explicit output and applied it to a data containing 139 asset financing alternatives provided by the