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Vendor Selection in Construction Projects

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Abstract
The aim of the present paper is to model the vendor selection problem in construction projects using a proposed approach based on a multicriteria selection technique. The applied approach is a multicriteria rating technique, which used for calculating a normalised economic bid for the alternatives (i.e., vendors) by determining a proposed multiplier coefficient. This technique uses procurement criteria and weights according to the relevant legislative framework for government procurement in order to provide a multicriteria value score for each vendor. The application of the proposed approach is demonstrated through an illustrative example concerning the procurement of earthmoving equipment (i.e. bulldozer). The primary advantage of this approach is that it incorporates a degree of subjectivity into the evaluation process as it is outlined into the existing legislative framework.

Keywords
Procurement, Greek legislation framework, vendor selection, award criteria.

1. Introduction

The purchasing function is central to the supply chain management operations. The critical processes of the purchasing function include supplier (vendor) selection, negotiation of supply contracts, monitoring supplier performance, and acting as an interface between an organization and its suppliers (Talluri and Sarkis 2002). Within these core processes of purchasing, this paper narrows its scope to focus upon the supplier selection process based on the legislative framework concerning government procurement in Greece.
While price has been traditionally considered as the single most important factor in evaluating suppliers, it has been agreed upon that the evaluation process needs to include and other important factors such as quality, delivery and flexibility (Talluri and Sarkis 2002). Moreover, suppliers should be selected on the

basis of how well they meet a variety of specific requirements (criteria) that do not depend solely on price (Li et al. 1997). Given this evolving business competitiveness environment, the contribution of this research is two fold. First, it applies a multicriteria evaluation approach for supplier selection in earthmoving equipment procurement by considering various criteria in compliance with the relevant legislative framework in Greece and second, the application of this approach serves as a monitoring and control mechanism for the vendor evaluation by eliminating subjectivity. The relevant model and its application are demonstrated through an illustrative case example.

2. Background

2.1 Vendor selection process

The vendor selection process is a stage of the procurement process, which is directly related with the definition of procurement approach (i.e. specification of requirements) and the tender evaluation (i.e. bids evaluation and confirmation of successful supplier; for more about the procurement process see Improvement and Development Agency for Local Government 2003).

In Greece national legislation on procurement refers only to public procurement compatible with Community law. The existing legislative framework offers possibilities to integrate environmental considerations into public (i.e. government) purchases, notably when defining the technical specifications, the selection criteria and the award criteria of a contract (e.g. Directive 93/96-14-4-1993 and Presidential Decree 370/1995, Presidential Decree 394/1996; for more on the legislative framework in Greece see Karanastasis 1998).

2.2 Vendor evaluation methodologies

Methodologies for vendor evaluation can be categorized into conceptual, empirical, and modeling approaches. The conceptual research in this area mainly focused on the strategic importance of vendor evaluation and the trade-off among cost, quality, and delivery performance, though the empirical research focused on studying the relative importance of various vendor attributes (i.e. price, quality, and delivery performance) (Talluri and Narasimhan 2003).

The research on developing models for vendor evaluation have ranged from simple weighted techniques to more advanced methodologies. Some of the simple techniques for vendor evaluation include categorical, weighted point, and cost ratio approaches. In the categorical method, buyer rates each vendor as being preferred, unsatisfactory, or neutral on all equally weighted attributes considered in the evaluation process. The weighted point method assigns weights in an objective manner to each attribute and evaluates the sum-product of the weights and attribute scores for each alternative by standardising all the attribute units. The cost ratio method is based on cost accounting systems and evaluates the cost of each factor as a percentage of total purchases for the vendor (Talluri and Narasimhan 2003)..

The more advanced methodologies have ranged from multi-criteria evaluation techniques to more complex mathematical programming and statistical methods such as Mixed integer programming, Multi-objective programming, Data envelopment analysis, Analytical hierarchy process and Principal component analysis (see also Talluri and Narasimhan 2003).

3. Proposed approach for vendor evaluation

The concept behind the proposed approach is the existing national legislative framework on procurement in Greece concerning the evaluation of bids.

The choice of the winning bid is in principle simple: the best value for money, most economically advantageous offer that it responds to all the requirements of the bid package is awarded to the contract. Factors other than price to be used in the award criteria should be expressed, to the extent practicable, quantitatively.

Award criteria except for economic criteria (i.e. price, methods of payment, cost of installation, opeartion and maintenance) include technical specifications and quality criteria (i.e. compliance the buyer's criteria) and technical support criteria (i.e. warranty, after sales service and support, experience and specialisation of supplier, delivery time).
Technical specifications and quality criteria are assigned a weight up to 80% and technical support criteria a weight up to 30%; the sum of both weights should be 100%.
Each sub-criterion of both the above categories are assigned a weight by the buyer; the sum of all weights should be 100%.
Once the criteria have been rank-ordered, points should be assigned to each criterion. A point of 100 is assigned to a criterion if there is full compliance. The point of 100 can be increased up to 120 if the offer exceeds the minimum value of the criterion and it can be decreased up to 80 if the offer does not fulfil the minimum requirements of the criterion.
In order to introduce subjectivity into that procedure we propose the following formula for deriving the range of the multiplier coefficient from 80-120 for each criterion.

$$Bn=100+20(2/2_n-1)$$

where n= value of criterion according to the offer/optimum value of the criterion

The optimum value for each criterion is defined endogenously by the set of all the offers.
Then, an overall weighted multiplier coefficient is estimated as a weighted sum of pre-selected weights for each criterion and the multiplier coefficients for each criterion.
Finally, each economic bid is multiplied with the above coefficient and a normalised economic bid is derived according to which the better candidate is selected.

4. Case illustration

A set of three vendors is considered in the evaluation process. The vendor data concerning the procurement of a bulldozer are hypothetical. The operational unit (buyer) considered in this case is a division of a public organisation. Management has considered product price, capacity, noise, consumption, delivery time, days for service and length of warranty as the most important factors in evaluating alternative vendors (Table 1).

Table 1. Vendor data

Vendors	A	B	Γ
Price	120000 €	118000 €	120000 €
Capacity	10tn/hr	9tn/hr	9tn/hr
Noise	50db	40db	50db
Consumption	0.1lt/HP/hr	0.15lt/HP/hr	0.1lt/HP/hr
Lead time	3 months	2 months	2 months
Days for service	1 day	2 days	3 days
Warranty	2yrs	3yrs	2yrs

Table 2 depicts the criteria weights determined by the buyer.

Table 2. Criteria weights determined by the buyer

	Criteria weights determined by the buyer
Capacity	0.20
Noise	0.10
Consumption	0.40

Lead time	0.06
Days for service	0.12
Warranty	0.12

The results of the proposed approach are presented in tables 3, 4, and 5.

Table 3
Transformed vendor data/calculation of multiplier coefficients

Vendors	A	B	C
Capacity	117.32	100.00	100.00
Noise	100.00	114.82	100.00
Consumption	111.75	100.00	111.75
Lead time	100.00	111.75	111.75
Days for service	108.28	100.00	92.00
Warranty	100.00	117.75	100.00

Source: Table 1

Table 4
Transformed vendor data/calculation of weighted multiplier coefficients, calculation of overall weighted multiplier coefficient

Vendors, criteria weights	A	B	C
Capacity	23.46	20.00	20.00
Noise	10.00	11.48	10.00
Consumption	44.70	40.00	44.70
Lead time	6.00	6.70	6.70
Days for service	12.99	12.00	11.04
Warranty	12.00	14.13	12.00
Overall multiplier coefficient (OMC)	109.15	104.31	104.44

Sources: Table 2, Table 3
OMC_A= 23.46+10+44.7+6+12.99+12

Table 5
Results of vendor evaluation/ Calculation of normalised economic bid

Vendors	A	B	Γ
Price; economic bid, €	120000	118000	120000
OMC	109.15	104.31	104.44
Normalized economic bid = 100 economic bid /OMC, €	109940	113124	114898

From table 5 it is evident that vendor A is selected.

5. Conclusions

This paper proposed an approach for vendor selection by incorporating a degree of subjectivity into the evaluation process as it is outlined into the existing legislative framework. The approach for vendor selection presented in this paper allows for comprehensive evaluation of vendor performance by calculating a normalised economic bid for each vendor with the aid of a proposed multiplier coefficient.

The application of this method in a real world setting had some satisfactory results, but it is worth noticing that the identification of buyer targets is highly critical because of their impact on the calculation of the multiplier coefficient and the whole decision making process. Therefore, managers must carefully evaluate and select the factors that best represent the organisation's goals and objectives and should incorporate them into the various stages of the procurement process.

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