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A multi-criteria approach to bid selection in public procurement[5]

Abstract*: Business forms such as the goods and services sales to state-owned enterprises, due to its secure billing, are extremely attractive for private businesses and as such are susceptible to possible misuse. When there is the possibility of corruption, regardless of whether it takes place, not only the protection of the procurers' rights must be discussed, but also the protection of all parties involved in public procurement processes. The aim of this paper is to give a possible multi-criteria methodology for selecting the optimal of the submitted bids within the public procurement tender. According to the Public Procurement Law in Serbia, the procurement contracting authority is required to define the criteria for the winning tender with valued weights. The contribution of this paper lies within the new methodology which enables procurator to use transparent, unique and, by Public Procurement Law, correct way of choosing the best one from bids submitted within public procurement tender.*

Keywords*: Public procurement, Public procurement Legislation, Multi-criteria analysis.*

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Jedan višekriterijumski pristup izboru najbolje ponude u javnim nabavkama

Apstrakt*: Oblici poslovanja, kao što je prodaja roba i usluga državnim preduzećima, izrazito su atraktivni za privatna preduzeća zbog sigurne naplate i kao takvi, podložni su mogućim zloupotrebama. Tamo gde ima mogućnosti za korupciju bez obzira da li ista postoji ili ne, mora se govoriti i o zaštiti prava naručilaca, ali i svih učesnika u postupcima javnih nabvki. Cilj ovog rada je prikaz jedne moguće višekriterijumske metodologije za izbor najbolje od prijavljenih ponuda u konkursu za javnu nabavku. Prema Zakonu o javnim nabavkama u Republici Srbiji naručilac javne nabavke je dužan da definiše kriterijume za dodelu ugovora po konkursu i da ih vrednuje ponderima. Doprinos ovog rada je prikaz nove metodologije koja pruža mogućnost naručiocu javne nabavke da na transparentan, jedinstven i po važećem Zakonu o javnim nabavkama ispravan način izabere najbolju od prijavljenih ponuda u okviru konkursa javne nabavke.*

Ključne reči*: Javne nabavke, zakonska regulativa, višekriterijumska analiza.*

1. Introduction

Every capitalist economy has companies and institutions funded by government budget, but in their day-to-day operations, these corporations are procuring goods and services from privately held companies. Known as public procurement, this manner of selling goods and services to government authorities is very attractive for privately held companies because of secure payment, but, as a result, it is the subject to potential misuse.'

The aim of this paper is to analyse the small, but significant segment which addresses the procedure of bid choosing because, in general, the choice is a multi-criteria decision (and the grading criteria is defined in the Public Procurement Law). It should be noted that the Public Procurement Law provides the possibility to procure only by the price criterion. Those model of public procurement isusually not economically justified so the legislation, in principle, recommends a multi-criteria approach to public procurement.

In practice, the most commonly used method, especially in small value public procurement (as defined in the Public Procurement Law), is the lexicographical method of multi-criteria analysis (Živković, Milosavljević, Žižović, 2016) where purchasing price is considered, while other criteria given in order of importance are irrelevant. The second criterion only plays a role if the same price is offered (which is unlikely), and the third criterion is only relevant if the two or more bids are the same after the first two criteria (which is even less likely). Other authors also give preference to multi-criteria

analysis (Turskis, 2008), (Holt, Olomolaiye, Harris, 1994), (French, Simpson, Atherton, Pearman, 1998) and emphasize that such approach in modern economies is becoming more and more relevant.

With regards to innovation, a public procurement can be divided into two types: a purchase of standard products like paper or paperclips, i.e. involving no innovation, and public technology procurement, i.e. the purchase of new technologies and innovative products and services. The latter category is referred to if a government announces its intention to foster public procurement as an innovation policy instrument. (Aschhoff, Sofka, 2009) Public procurement is only one of many innovation policy instruments. Regulations, R&D subsidies and the scientific and technological infrastructure have also been identified as other main types of public innovation policy which are designed to improve industrial innovativeness (Rothwell, Zegveld, 1981) (Geroski, 1990). Public procurement accounts for a significant proportion of overall demand for goods and services and is increasingly seen as an attractive and feasible instrument for furthering the goals of innovation policy (Uyarra, Flanagan, 2010). Demand is a major potential source of innovation yet the critical role of demand as a key driver of innovation has still to be recognised in government policy. (Edler, Georghiou, 2007). However, public procurement is already expected to address a wide range of social goals. Public procurement is concerned with how public sector organizations spend tax payers' money on goods and services. It is guided by principles of transparency, accountability, and achieving value for money (Walker, Brammer, 2009) for citizens and tax payers.

Public procurement has received much attention in recent discussions on favorable innovation policy options, both at the European level, such as in the Barcelona Strategy (European Commission, 2003) and the Aho-Report presented to European leaders at their Spring summit in 2006 (European Commission, 2006). Statistics showing EU procurement four times less than the US in civilian sectors and two times less when defence is taken into account (Directors Forum, 2006) The importance of this process becomes evident after considering the fact that in Serbia public procurement accounts for some 7.27% of gross domestic product (GDP), that in the EU it approximates to 19% of GDP (European Commission, 2012) and that public procurement represents around 15% of the world's GDP. (Bobar, Mandic, Suknovic, 2015)

2. New methodology for bids evaluation

According to the Public Procurement Law, the procurement contracting authority is required to define the criteria for the winning tender with valued

weights (the total sum of the weights on all the criteria should be 100). It should be noted that the law recommends some possible criteria (all of this is found in Articles 84 and 85 of the Public Procurement Law).

In Article 92 of the law, it is written that unusually low bid prices may be rejected immediately or eventually upheld with additional explanations, however it's a little unclear what to do with other offers while making this clarification. Therefore, it can be concluded that the legislature was not completely correct when it came to the application of this particular article.

Bid opening is regulated in Articles 103 and 104 of the Public Procurement Law.

Bids which were submitted on time and were prepared in accordance with tender documents are (following the rules of multi-criteria analysis) alternatives, and the criteria for the selection of the best bid are the same criteria as the multi-criteria model, while the weights are the same weights as the criteria in the multi-criteria model with a little modification.

So, here the following multi-criteria model is presented:

$$A_1, \dots, A_m \text{ - alternatives} \tag{1}$$

$$K_1, \dots, K_n \text{ - criteria} \tag{2}$$

$$W_1, \dots, W_n \text{ - weighting coefficient} \tag{3}$$

The multi-criteria model defined above with certain alternative values, according to the criteria after bid opening, is presented in the following matrix:

Table 1. The multi-criteria model presented in the matrix

	C_1	C_2	...	C_n
A_1	a_{11}	a_{11}	...	a_{1n}
A_2	a_{21}	a_{22}	...	a_{2n}
...	...	...	...	...
A_m	a_{m1}	a_{m2}	...	a_{mn}

Source: author

With the weight coefficients criteria

$$W_1, \dots W_n \tag{4}$$

Wi (weights coefficients) which corresponds to Ci criteria with a total sum 1

$$\sum_{i=1}^{n} W_i = 1 \qquad (5)$$

from the weights is easily obtained by dividing the corresponding weights by 100.

Now the problem can be approached by problem solving following the next steps:

STEP 1

For every C_i criterion, zero or limit values g_i are defined for bids (alternatives). Below (above) these values, the bids are negative or will be rejected based on the criteria for minimum or maximum type.

STEP 2

Criteria for which the zero or limit values are the reason for the bid rejection should be specified. Also, other criteria for which specific bids could be accepted below (above) limit values without rejection should be specified.

STEP 3

Using the previously mentioned multi-criteria table comprised of bids accepted, a new table can be made in which the value of aij is replaced with the value qij, which is calculated by the following equation:

$$q_{ij} = \frac{\left(a_{ij} - g_j\right)}{\left(max\{a_{ij} - g_j\}\right)} \qquad (6)$$

for maximisation type or

$$q_{ij} = \frac{\left(g_j - a_{ij}\right)}{\left(max\{g_j - a_{ij}\}\right)} \qquad (7)$$

for minimisation type.

The following table is the result:

Table 2. The new matrix with replaced values

	C_1	C_2	...	C_n
A_1	q_{11}	q_{12}	...	q_{1n}
A_2	q_{21}	q_{22}	...	q_{2n}
...	...	...	...	...
A_m	q_{m1}	q_{m2}	...	q_{mn}

Source: author

STEP 4

The values in the table in Step 3 are then transformed in a new table where the values of p_{ij} are obtained by multiplying the elements of the columns from the previous matrix with the corresponding weight coefficients.

$$p_{ij} = w_j q_{ij} \tag{8}$$

The following table demonstrates this:

Table 3. New table created by multiplying the elements of the columns with the corresponding weight coefficients

	C_1	C_2	...	C_n
A_1	p_{11}	p_{12}	...	p_{1n}
A_2	p_{21}	p_{22}	...	p_{2n}
...	...	...	...	...
A_m	p_{m1}	p_{m2}	...	p_{mn}

Source: author

Adding the values of this matrix by type, the numerical values on the right side are calculated. Using these values, in this step the order of bids based on the amount of the sum on the right side can be determined.

The lowest bid is ommited and a new multiple criteria table is set up using (m-1).

This procedure is repeated with the new results and at the end the lowest bid is ommited again.

The procedure ends when the lower bid from the remaining two bids is rejected.

NOTE: This procedure must be defined before the public procurement tender announcement and correspond to the Public Procurement Law, as it will be part of the tender requirements.

The methodology defined this way is, in principle, more efficient than a regular application of some of the one-way multi-criteria methods, for the following reasons:

The introduction of a new alternative in most methods of multi-criteria analysis changes the order of the previously observed alternatives.

This is further explained in the monograph (Radojičić, Žižovic, 1998), where this feature of the method for multi-criteria analysis is analyzed for the compromise programming method.

Thus, by adding fictitious alternatives, it is possible to favour one of the alternatives. This can be prevented by publishing that the procedure will eliminate extreme bid, either bids with extremely poor or extremely good characteristics that are generally not competitive for selection, but serve only to favour some of the alternatives. This publication could give the possibility for manipulation and distrust in the process, and would require additional reasoning to explain why a certain bid was eliminated (there would be a similar problem with a bid offering an extremely low price).

In multi-criteria analysis, methods exist that do not allow favouring alternatives by introducing new alternatives, but always give the same order of alternatives that have already been processed. They require a lot of new restrictions on contracting authorities which must be pre-defined under the Public Procurement Law, and this might have a negative impact on application submissions and thus reduce the competition.

3. Analysis of possible cases in a given procedure

According to the proposed procedure, some specific situations can arise which will be analysed in this report.

Situation 1. All the alternatives have the same numerical value (all are equally good or bad using the given method) after a certain step.

Which one to choose? In this situation, selection would be done according to the time of arrival of the offers. If this is not known, then it would be chosen randomly.

Situation 2. If there is more than one offer that is in last place (have the same numerical value), then they are all eliminated during that step and the next step is carried out with the remaining bids.

In paper (Živković, Milosavljević, Žižović, 2016) a public procurement case study for "Parking Service" from Belgrade is presented, using three criteria for selection by lexicographical method.

Table 4. The criteria for bid selection for "Parking Service"

	C_1	C_2	C_3
A	1,80	30	6
B	1,68	10	9
C	1,4	15	6
D	1,68	60	9

Source: author

C_1- price for one hour of work,
C_2 - deadline for execution of works,
C_3 - warranty period (the required minimum of 6 months).

The lexicographic method will obviously select bid C, while the multi-criteria analysis with appropriate weight coefficients assignment (Živković, Milosavljević, Žižović, 2016) determines that B is the best alternative. In the mentioned article, the weight coefficients take the values of

$$W_1 = 0,6 \quad W_2 = 0,1 \quad W_3 = 0,3 \tag{9}$$

and the following order of alternatives is obtained

$$B \rightarrow C \rightarrow D \rightarrow A \tag{10}$$

noting that it is economically justified to give much greater significance to the last weight coefficient.

An example of the proposed procedure.

It would be necessary to do:

1. For criteria C_1 marginal cost (above which the offers are not accepted), e.g.

$$g_1 = 2 \tag{11}$$

2. For criteria C_2 the deadline for execution of works, e.g.

$$g_2 = 60 \tag{12}$$

3. For guarantee period (which a minimum value of 6 months has already been determined), e.g.

$$g_3 = 6 \tag{13}$$

It is necessary to determine the weight coefficients and criteria, e.g.

$$W_1 = 0,5 \quad W_2 = 0,2 \quad W_3 = 0,3 \tag{14}$$

and then following the step by step procedure as described, from the initial table

Table 5. Initial table

	C_1	C_2	C_3
A	1,80	30	6
B	1,68	10	9
C	1,4	15	6
D	1,68	60	9

Source: author

the next table is created

Table 6. Mid-step table

	C_1	C_2	C_3
A	0,33	0,6	0
B	10,533	1	1
C	1	0,9	0
D	0,533	0	1

Source: author

or, after appropriate multiplication with the selected weight coefficients, the table with final step results is made

Table 7. Table with final step results

	C_1	C_2	C_3
A	0,166	0,12	0
B	0,267	0,2	0,3
C	0,5	0,18	0
D	0,267	0	0,3

Source: author

after addition by type, the values for the bids are:

$$V(A) = 0,286 \tag{15}$$
$$V(B) = 0,767 \tag{16}$$
$$V(C) = 0,680 \tag{17}$$
$$V(D) = 0,567 \tag{18}$$

which gives the order of offers as

$$B \rightarrow C \rightarrow D \rightarrow A$$

(19)

It is not difficult to see that this order does not change until the end, which definitely recommends offer B as the best in this case.

4. Results and Discussion

Government is often the single biggest customer within a country and can potentially use this purchasing power to influence the behaviour of private sector organisations. It has been noted that public procurement can be a lever to deliver broader government objectives, such as using public money to support environmental or social objectives, and for supporting domestic markets (McCrudden, 2004). Procurement preferences are commonly interpreted as protectionist devices, similar in their effects to tariffs (Lowinger, 1976.)

Every government wants to secure the operations and activities of its institutions, partly because of continuing and prolonging control and partly to stop any possible misuse and false rumours. Therefore, public procurements are regulated under the Public Procurement Law (Zakon o javnim nabavkama, 2012) of which there are numerous supporting by-laws. These include companies' internal rule books regarding procurements, and internal plans about preventing corruption in public procurements.

There are a considerable number of "small" public procurers (contracting authorities) who reduce government allocations for this purpose - a small number of those who take a considerable part of the resources. For example, Public procurement development strategy of the Republic of Serbia for the period 2014-2018. (Strategija razvoja javnih nabavki, 2014) says that 73% of procurers made 22% of the total value of all public procurements, and 27% of procurers participated in 78% of all public procurements.

This was the reason to address the centralisation of public procurements in Strategy from 2011 (Strategija razvoja javnih nabavki u Republici Srbiji, 2011). This has not happened.

The same act discusses corruption in public procurement:

- − corruption in public procurement planning,
- − corruption in public procurement realisation and
- − corruption after concluding the contract.

"When faced with a changing or uncertain business landscape, companies cannot resolve to playing by the same rules as their competitors" (Mamula,

Popović-Pantić, 2015). As a rule, when there is the possibility of corruption, regardless of whether it takes place, not only must the protection of the procurers' rights be discussed, but also the protection of all parties involved in public procurement processes. This is due to potential litigation that could damage both the procurer and the contractor.

For example, if a contractor doesn't carry out the agreed work, the procurer is inconvenienced and can sue, however potential contractors who don't get chosen can be dissatisfied too. Another reason for litigation can be the dissatisfaction of the chosen contractor in the event of unforseen circumstances resulting in the inability to meet the project deadline.

It should be noted that the Public Procurement Law is one of the most modified and revised laws in the last 15 years. The most recent changes came into force on the 1st of January 2016.

One of the main reasons for this is that potential contractors are not yet accustomed to this way of procurement. In the previous socialist economy, the issues were resolved factiously and with only one party, all potential problems were more easily controlled. In terms of a planned economy this was even simpler.

Success and speed of transition processes in different post-socialist countries, measured by the speed and the nature of privatization and corporate restructuring, the scope and extent of liberalization and degree of macroeconomic stabilization, produced rather diverse results regarding their institutional and economic systems. (Leković, Marić, 2016), (Nikolić, Kovačević, 2014) So, the problem is not only to find the answer for here, but in all countries where capitalism was re-introduced.

5. Conclusion

Governments have interest to secure the operations and activities of its institutions, partly because of continuing and prolonging control and partly to stop any possible misuse and false rumours. Therefore, public procurements in Republic of Serbia are regulated under the Public Procurement Law and its numerous supporting by-laws. As a rule, when there is the possibility of corruption, regardless of whether it takes place, not only must the protection of the procurers' rights be discussed, but also the protection of all parties involved in public procurement processes. This is due to potential litigation that could damage both the procurer and the bidder.

The overall benefit of selecting the optimal bid can be an improvement of the overall performance. Choosing the most suitable bid for certain job influences the work quality as well as the economic progress. Especially during the

public procurement process optimal selection of bids is vital for an accurate and realistic bid proposal. This paper analysed the small but significant segment which addresses the procedure of bid choosing, because, in general, the choice is a multi-criteria decision (and the grading criteria is defined in the Public Procurement Law).

The contribution of this paper lies in the new methodology which enables procurator to use transparent, unique and by Public Procurement Law correct way to choose the best of bids within public procurement tender. Also, all participants of the tender can easily see their position between submitted bids thus avoiding the possibility of disputes. The proposed methodology is a valuable tool for making more precise decisions, considering preferences of all parties involved in public procurement processes in an uncertain environment.

The model presented in this paper is a feasible tool to aid in decision-making for right bid selection. This model can help improve the selection process and obtain the best decision on selecting a bid. The application of the model offered in this paper may reduce the risk involved in the selection of a contractor and can lead to the elimination of unqualified contractors during the bidding process. The conducted analysis shows that only the criterion of the lowest price is mostly not the optimal solution, so mathematical methods should be used in public procurement.

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