PROCUREMENT MANAGEMENT WITH THE DECISION SUPPORT SYSTEM

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Abstract: Every decision support system is an application developed to meet the needs of users, but the fact that must be taken into account when considering these systems is that decision support systems are primarily aimed at supporting, not replacing, decision makers. Such systems are used at different management and organizational levels. The main benefits of using a decision support system in management processes are related to increasing the efficiency of work in terms of giving better basis to managers as well as shortening the time needed to verify corrective actions. Each decision support system consists of at least three subsystems: a database that is part of a decision support system in which the input and output of an organization is stored; model bases that represent a component of a decision support system that consists of business decision models. In the research conducted for the purposes of this paper, when analyzing 120 procurement classified into three categories, in 14 there was a situation that a large number of bidders had the same sum of weights when evaluating their criteria. It is then necessary to make the right decision, but the question arises on what basis? The proposal of the next system is to enable management to make the right decision. The basic prerequisite is to understand the importance of the financial capacity of the tenderer in the implementation of procurement. Therefore, it is necessary to mention in the competition that in case of an equal number of weights, the financial capacity of the bidder will be decided. By applying the mode among 14 procurements, in which the tenderers have the same sum of weights, the procurement with the highest value was selected. Delphi methods were used to collect the opinions of a panel of experts (four experts from academic institutions, three from industry and two from scientific institutions) who reviewed the questionnaire. Subsequently, 12 experts (who had at least five years of work experience in public procurement) completed the questionnaires. The criteria for selecting the optimal bidder are: Liquidity Indicators (S1), Business Activity Indicators (S2), Debt Management Indicators (S3), Profitability Indicators (S4), Market Value Indicators (S5), and Economic Indicators (S6). By applying the DEMATEL (Decision-Making Trial and Evaluation Laboratory) and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) methods, by determining the significance of the criteria in the procurement procurement in the research, we have proved the conclusion that by looking at the bidders' accounting indicators from the structure of the financial statements to arrive at the selection of the bidder in a situation where the amounts of weighted quantities are the same.
Keywords: management, procurements, decision support systems.

The paper is a part of research within the project no. III 46006 - Sustainable agriculture and rural development in the function of accomplishing strategic objectives of the Republic of Serbia in the Danube region, financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

1. INTRODUCTION

Decision support systems emphasize the managerial orientation of implementation across organizations. Every decision support system is an application developed to satisfy the needs of users, but the fact that must be taken into consideration when considering these systems is that decision support systems are primarily aimed to support, not to replace decision makers. Such systems are used at different management and organizational levels.

The main benefits of using a decision support system in management processes are related to increasing the work efficiency in terms of giving better basis to managers as well as shortening the time needed to verify corrective actions.

The results of decision support are to increase the consistency and accuracy of the made decision, as well as to save time, but also to be expeditious in solving problems in such a way that managers can directly answer the questions and look at multiple alternatives at the same time.

Management, the concept of a decision support system, involves giving relevant information to managers when making business decisions. In our work, the subject of the research is defined through the application of decision

support systems in the field of procurement by public users. In this context, procurement is contingent on legal provisions, which makes it necessary to establish certain procedures that, as a result, often impose the need for decision-making as a result of choosing multiple alternatives.
Each model solves a particular problem in the observed business process. Their task is to generate, on the basis of input data and decision-making models, output information on which managers as decision makers can make decisions, and by using modern systems as a user interface enables easier communication between decision support systems and users.

2. RESEARCH METHODS

Each decision support system consists of at least three subsystems (Suknović & Delibašić, 2010): a database that is part of a decision support system in which the input and output of an organization is stored; model bases that are a component of a decision support system that consists of business decision models.
The implementation of an appropriate decision support system (Božanić, Pamučar, & Karović, 2016) in public procurement procedures when reviewing the bidders' accounting data comprises three basic parts. The first part of the database subsystem will contain the relevant data obtained from the analysis of the bidders' experts and financial statements in the procurement process conducted. In the second part, the subsystem of the model database will involve the use of a combination of two DEMATEL (Decision-Making Trial and Evaluation Laboratory) and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) multi-criteria methods, resulting in a single combined decision model characteristic of the observed problem (Radović et al, 2011). According to Turban (2003), these systems support different decision-making processes and styles. In the third part, the user interface subsystem would include a program created in Microsoft Excel that would allow for automatic calculation and display of analysis results, which would greatly facilitate the use of this system by the user.
We present the problem in a general sense by choosing one of *m* alternatives ($A_i, i = 1, 2, ..., m$),which are evaluated and compared among themselves based on *n* criteria (X_j , $j = 1, 2, ..., n$) whose values are known to us. Alternatives are presented by vectors $x_{i,j}$, wherein $x_{i,j}$ the value of the *i* - th alternative by the *j* criterion. Because the criteria affect the final grades of alternatives to a different extent, we assign a weighting factor to each criterion $w_{j,}\ j = 1, 2, ...n$ (wherein $\sum_{j=1}^{n} w_j = 1$) which reflects its relative importance in evaluating alternatives (Kashi & Franek, 2014).

3. SAMPLE AND RESULTS OF RESEARCH

Budget allocations for public procurement implemented by budget users, as well as the need to ensure security of procurement in order to ensure environmental protection, impose the need to increase the efficiency of public procurement implementation (Vasilev, Cvetković, & Grgur, 2019). In order to achieve this, it is necessary to support public procurement procedures by applying modern decision support systems (Stanojević, Đorđević, & Volf, 2017). The practice of conducting procurement of environmental assets (Simeunović, 2016) has shown that there are specific situations where a decision should be made in limited circumstances. Of particular importance is the training and education of employees (Slavković & Slavković, 2019).
In the research conducted for the purposes of this paper, when analyzing 120 procurement classified into three categories, in 14 there was a situation that a large number of bidders had the same sum of weights when evaluating their criteria. It is then necessary to make the right decision, but the question arises on what basis? The proposal of the following system is to enable management to make an appropriate decision (Čajka & Jovanović, 2017). The basic prerequisite is to understand the importance of the financial capacity of the tenderer in the implementation of procurement. Therefore, it is necessary to mention in the competition that in case of an equal number of weights, the financial capacity of the bidder will be decided. By applying the mode among 14 procurements, in which the tenderers have the same sum of weights, the procure- ment with the highest value was selected.
Using the Delphi method, the opinions of a group of experts (four experts from academic institutions, three from the industrial sector and two from scientific institutions) were collected and reviewed the questionnaire. Subsequently, 12 experts (who had at least five years of work experience in public procurement) completed the questionnaires.
The criteria for selecting the optimal bidder are: Liquidity Indicators (S1), Business Activity Indicators (S2), Debt Management Indicators (S3), Profitability Indicators (S4), Market Value Indicators (S5), and Economic Indicators (S6) (Ivanova, Barjaktarović, & Ivanov, 2018).

In the selected procurement procedure, five bidders had the same sum of weights. Ten experts participated in the model testing process. Expert decisions were used to derive the criterion weights. Weight coefficients were obtained using the DEMATEL method.

Testing was performed through two phases. In the first phase, the criteria were selected and the weights of the criteria were defined using the DEMATEL method. In the second phase, the TOPSIS method selected the optimal bidder.

In the first step of the DEMATEL method, Saaty's scale was used to compare the criteria. We used this scale to obtain matrices for the set criteria.

Since ten experts participated in the study, after obtaining expert opinion, a total of ten criteria matrices were obtained.

Table 1 - Initial Decision Matrix

	S1	**S2**	**S3**	**S4**	**S5**	**S6**
A1	2,11	3,03	0,42	0,22	0,20	1,05
A2	1,83	2,87	0,33	0,28	0,16	1,20
A3	2,60	4,11	0,51	0,15	0,08	0,92
A4	1,68	2,43	0,23	0,30	0,22	1,53
A5	2,23	2,75	0,47	0,17	0,11	1,13
w_i	0,173	0,204	0,128	0,134	0,156	0,205

Source: authors calculation

After calculating the weighting coefficients of the criterion, the conditions for evaluation and selection of the optimal alternative were obtained using the TOPSIS method.

Table 2 - Final ranking of alternatives

	S_i^+	S_i^-	Q_i	**Rank**
A1	0,0581	0,0661	0,5321	2
A2	0,0642	0,0564	0,4679	3
A3	0,0858	0,0717	0,4555	4
A4	0,0717	0,0858	0,5445	1
A5	0,0784	0,0458	0,3686	5

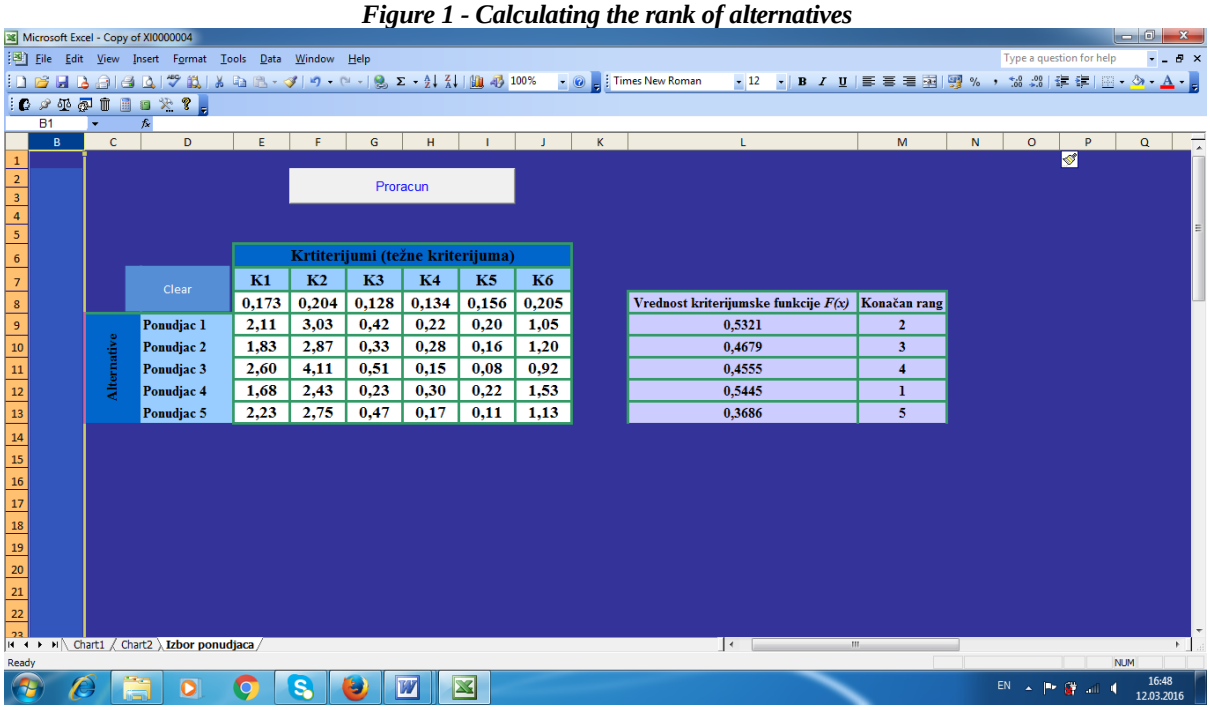
Source: authors calculation

By applying the combination of DEMATEL and TOPSIS method, the obtained solution is that the safest bidder is the ordinal number 4, which has the highest ranking among all the alternatives, that is, the tenderers who participated in the observed procurement procedure (Cvijanović, Matijašević-Obradović, & Škorić, 2017). However, it should be emphasized that in this way the result obtained is only a possible variant, since the application of multicriteria optimization does not mean a rigorous solution (Ignjatijević, Čavlin, & Vapa-Tankosić, 2017), but a possibility that can only be verified by the comparison of several different methods and scales of assessment. Multicriteria-based decision making is safer and more reliable (Bogdanović & Hadžić, 2019).

4. INTERPRETATION OF RESEARCH RESULTS

The third part of the decision support system is the user interface, which provides communication between users and the system in the simplest way. For the purpose of this work, a program was created in Visula Basic for Applications, which provides an easy way to get solutions and rank alternatives after entering the database.

Figure 1 - Calculating the rank of alternatives



The stability of the obtained solution in case of change of criteria can be performed by the sensitivity analysis procedure. This analysis is also software-supported in Visual Basic for Applications. Figure 2 shows the impact of the criteria on each bidder or alternative, with a simultaneous graphical representation of these implications (Figure 3) in the domain of selecting the bidder for the procurement of environmental assets (Aleksić, Lukinović, & Jovanović , 2018).

Figure 2 - Effect of changes in the criterion weight coefficients on the value of the criterion function

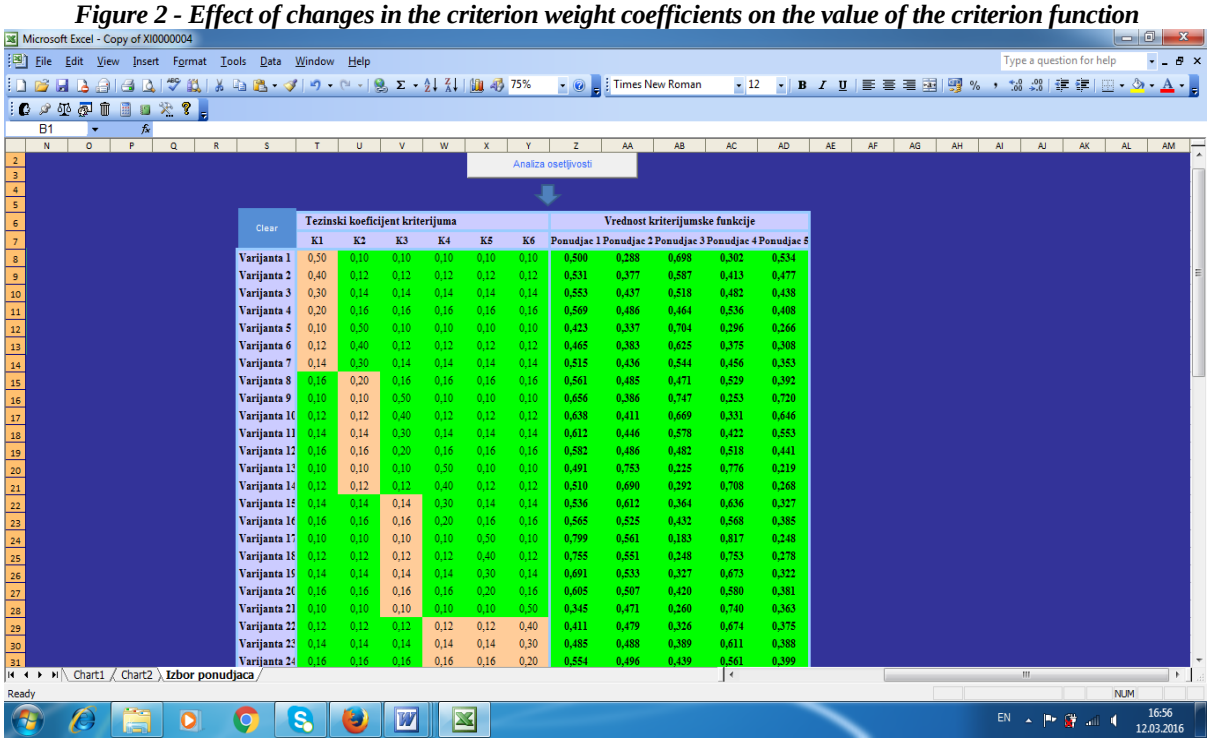
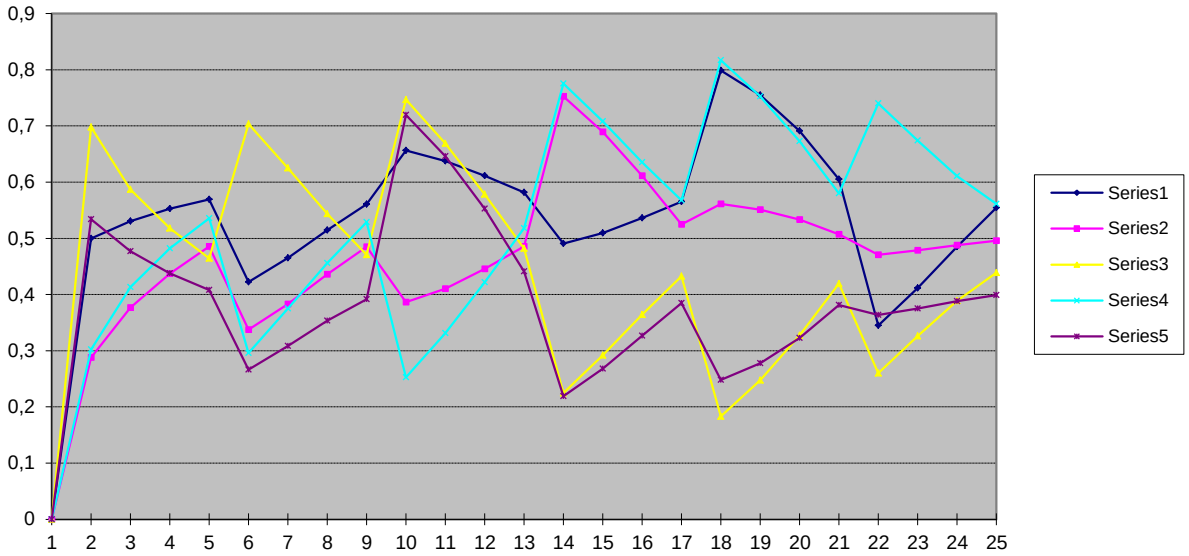


Figure 3 - Sensitivity analysis of the impact of the change in weights of all criteria on alternatives



From the obtained graph it can be seen that the biggest change in value is achieved by alternative 4, where due to the decrease in the weight of the criterion "liquidity", the increase in the weight of other criteria only further leads to the conclusion reached by the budget for the selection of the most favorable bidder. Research can conclude that, with other alternatives, the weight of other criteria and their value is increasing due to the increase, but still insufficient to achieve greater value than alternative 4, which is particularly important alternative 1. Analyzing the results of environmental investments (Beke-Trivunac & Jovanović, 2013) we can conclude that due to the stated trend accounting systems based decision support systems must be used. Of course, the results obtained in this way must be taken with a degree of caution (Prnjat,2012) following the basic rules of logical reasoning.

5. CONCLUSION

By applying the DEMATEL (Decision-Making Trial and Evaluation Laboratory) and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) methods, by determining the significance of the criteria in the procurement procurement in the research, we have proved the conclusion that by looking at the bidders' accounting indicators from the structure of the financial statements to arrive at the selection of the bidder in a situation where the weighted amounts are the same.

Based on the data, using Visual Basic for Applications in sensitivity analysis, the same results that we have presented are presented. Suppliers that had better accounting ratios at the required level were proven to be reliable and secure, which also resulted in a high level of availability of environmental assets. We can conclude that in this research, the decision support system in procurement for the needs of the environment, in which the bidders have an equal number of weights, proved that the reliability of the bidder is correlated with its indicators of financial capacity.

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