# USING ELECTRE METHOD FOR A COMPUTER ASSISTED DECISION IN THE FIELD OF PUBLIC ACQUISITION IN ROMANIA

**Mariana Nagy, Prof., PhD, "Aurel Vlaicu" University of Arad and Adina Negruşa, Associate Professor, PhDm "Babeș-Bolyai" University of Cluj-Napoca**

*Abstract: Public acquisitions are performed according to well defined procedures and legal regulations. Nevertheless, the result is often subject to discussions, especially when big financial values are involved. The paper deals with offering scientific support to decision makers in order to make the best possible decision. If multiple criteria are considered, one of the MCDM methods can be chosen. A simplified decisional situation is presented, deriving of the real case of deciding the winner of the bid for implementing the 112 Emergency Service in Romania. For deciding between a number of 9 bidders - all well known IT companies, a set of criteria was defined, concerning both with the expertise, the technical capability and the structure of the company. The evaluation targeted the design, implementation, maintenance and reliability of the system. Importance of each criterion was evaluated by allocation of specialists. For assisting the decision, Electre method and the appropriate software can be used. On the basis of the decisional matrix, the software builds-up a hierarchy - the top of alternatives. The decisional process ends by assigning the work to one of the 9 bidder companies - the one that proved to best fulfill the criteria. In the specific case of the considered acquisition, the IT system is implemented by the company denoted by A6 and the decision of the public authority is supported by the results of applying the Electre method.*

*Keywords: computer assisted decision making, public acquisition, Electre method.*

## 1. Introduction

Decision making is a common task for managers at all levels. Decisional situations are characterized by different complex and changing criteria and various decision methods can lead to a better or worse solution. Computer applications are often used to support decision making, whatever the method chosen. [6]

The paper deals with a simplified decisional situation, deriving of the real case of deciding the winner of the bid for implementing the 112 Emergency Service in Romania. For supporting the decision and helping the decision making, a team of specialists was asked to give scientific support to the process. [9]. Being a typical Multicriterial decision makig (MCDM) problem, specialists decided to handle it with specific methods and using a computer application in order to solve the model. Thus, the subjective and emotional aspects of the decision making can be reduced and a real, useful decision can be made. [11]

## 2. The data

In the frame of a public acquisition procedure, a number of 9 bidders made their technical and financial offers. All of the bidders were well-known IT companies, local firms or foreign direct investments, representing the 9 alternatives or candidate solutions. Aiming to minimize the risk of non-accomplishment of the contract due to the lack of professional and technical capacity of the winner, the team of specialists assisting the decision, set-up the following elements of the process:

### 2.1. The criteria

The set of criteria established for the decisional process were selected to give a correct measure of the capacity of the companies to implement and integrate the new IT system. The

considered criteria evaluate the expertise, the technical capability and the structure of the company. Therefore, the following quantitative and qualitative criteria were used [9]:

- C1 - Capacity of integrating and implementing IT systems. The evaluation for this criterion is based on the financing conditions, access to IT&C resources, availability of suppliers, innovation capacity. Possible values are: unsatisfactory, satisfactory, good, very good, outstanding.
- C2 - Number of previous implementations. It is a numeric criterion counting the number of previously implemented IT systems. The criterion is relevant as it offers the proof of previous expertise for performing professional IT services.
- C3 - Number of external specialists needed. It is a numeric criterion; the smaller the figure is, the firm bears with internal specialists trained for implementing the new IT System.
- C4 - Dimensions and geographical deployment of the firm. It is evaluated as: local, county level, regional, national, international.
- C5 - Fault response time. As any technical device, the future IT system can't have 100% reliability. After installing and commissioning the system, the company will assure the maintenance and will take all necessary action for fixing any system failure, as soon as possible. This is a numeric criterion, expressed as the number of hours between the happening and the removal of the faults.
- C6 - Structure and quality of the firm management. According to the project management capacity of the bidder and the expertise of the project managers, this criterion may have the following values: weak, satisfactory, functional and dynamic. [7]
- C7 - Number of personnel needed for system administration. This numeric criterion refers to the personnel needed for operating the system; the smaller the figure is, the lower are the operating costs paid by the beneficiary.
- C8 - Quality and reliability of the system. It measures, in percentage, the level of the reliability of the new system while integrated to the existing structure.
- C9 - Information security issues. This criterion, expressed in percentage, gives the measure of information security, both for protection of personal data and defense against the specific IT attacks, such as viruses, hackers, etc.

### 2.2. Weighting the criteria

The evaluation of the companies for accomplishing the above presented criteria targeted the design, implementation, maintenance and reliability of the system. Importance of each criterion was evaluated by allocation of specialists. Thus, specialists in the field were asked to express their opinion on how important is each criterion, as a percentage of 100%.

There were involved specialists for the following roles: project manager, IT architecture designer, network administrator, IT&C expert, communication expert, hardware and service expert. The average of the opinion given by the specialists was then written in a table as a set of decimal numbers whose sum is 1. Each element of the table corresponds to a specific criterion and expresses the importance given to that criterion. [3]

For the considered decisional situation, the weight for each criterion is included in the last numeric row of the decisional matrix (Figure 1)

### 2.3. The decisional matrix

Most MCDM methods are based on processing algorithms applied to the elements of the decisional matrix. [2] This consists of a table that includes [4]:

- The consequences of each criterion on the result - the values of the criteria for each candidate solution;

- The importance of each considered criterion - the weights containing the opinion of the specialists;
- The type of criteria - the need of obtaining an as high as possible value or an as low as possible value for the consequences of criteria.

The decisional matrix for the considered problem was built-up by evaluating the consequences for the 9 criteria on each of the 9 candidate alternatives. The matrix is presented in Figure 1.

| | Capacity of integrating and implementing IT systems | Number of previous implementations | Number of external specialists needed | Dimensions and geographical deployment of the firm | Fault response time | Structure and quality of the firm management | Number of personnel needed for system administration | Quality and reliability of the system | Information security issues |
|---|---|---|---|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 |
| F1 | Good | 12 | 11 | Local | 4 | Satisfactory | 65 | 95 | 94 |
| F2 | Very good | 17 | 10 | Regional | 8 | Dynamic | 64 | 95 | 92 |
| F3 | Good | 14 | 12 | National | 12 | Satisfactory | 60 | 94 | 97 |
| F4 | Satisfactory | 11 | 13 | International | 8 | Weak | 64 | 97 | 96 |
| F5 | Satisfactory | 10 | 14 | International | 10 | Satisfactory | 56 | 96 | 100 |
| F6 | Good | 15 | 11 | International | 6 | Functional | 57 | 99 | 100 |
| F7 | Outstanding | 22 | 9 | National | 12 | Dynamic | 63 | 98 | 95 |
| F8 | Unsatisfactory | 10 | 14 | County level | 14 | Weak | 60 | 98 | 97 |
| F9 | Very good | 13 | 10 | International | 7 | Dynamic | 62 | 97 | 98 |
| Weight | 0,16 | 0,1 | 0,08 | 0,07 | 0,09 | 0,11 | 0,12 | 0,14 | 0,13 |
| Type | Max | Max | min | Max | min | Max | min | Max | Max |

Figure 1 - The decisional matrix [9]

**3. The method**

The decisional situation was handled as a typical MCDM situation. At the first stage, the ELECTRE method was applied and the resulting model was solved by using a computer application.

Data input for Electre method is the decisional matrix built-up in the above presented manner. The method consists of an algorithm - a set of mathematical operations applied to matrixes. The mathematical basis of the Electre method is well known and it computes the following matrixes [4, 10]:

- The matrix of utilities - a linear interpolation applied to the element of the matrix of consequences;
- The concordance matrix - showing at what extent an alternative is better than another alternative, relative to the considered criteria;
- The discordance matrix - showing how an alternative is worse than another one;
- The surclassing matrix - built-up according to a median ranking rule.

The output of the process is a top of preference obtained by sorting the given alternatives in descending order of their positive effects that is, the decisional alternatives are sorted in the order that better satisfies the goals.

For computing the matrixes, a computer assisted solution was chosen. At "Aurel Vlaicu" University of Arad, a dedicated software was created in order to solve a large variety of decisional models. The program bears with a user friendly interface, permits conversational data input, offers a quantitative evaluation for qualitative criteria and an advanced graphical data output. Moreover, the program can be used both as a decision support system and as a didactical software, as it includes an option for step by step visualization. [5]

The Electre data input menu and the Step by step visualization are presented in Figure 2 and Figure 3. [8] For the considered decisional problem, Figure 4 presents the data,

after the first processing, namely with after the quantitative transformation of all qualitative criteria.

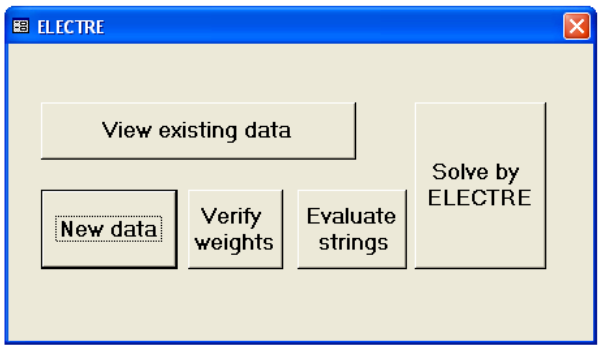


Figure 2 - The main input menu

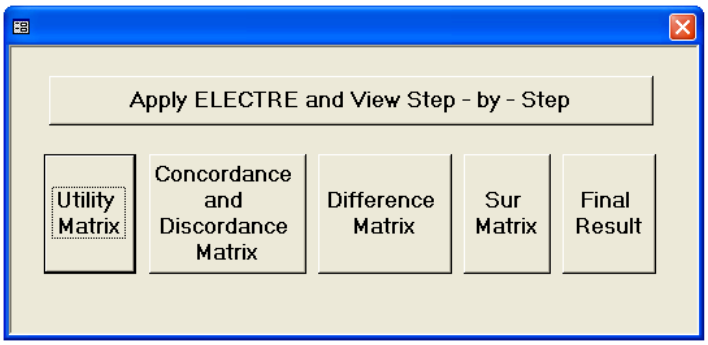


Figure 3 - The Step by step menu

Weights : Table

| xx | x1 | x2 | x3 | x4 | x5 | x6 | x7 | x8 | x9 |
|---|---|---|---|---|---|---|---|---|---|
| Importance | 0,16 | 0,1 | 0,08 | 0,07 | 0,09 | 0,11 | 0,12 | 0,14 | 0,13 |
| Best if MAX=1 / MIN=0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |

Specific_Data : Table

| Subject | x1 | x2 | x3 | x4 | x5 | x6 | x7 | x8 | x9 |
|---|---|---|---|---|---|---|---|---|---|
| F1 | 0,5 | 12 | 11 | 0 | 4 | 0,33 | 65 | 95 | 94 |
| F2 | 0,75 | 17 | 10 | 0,5 | 8 | 1 | 64 | 95 | 92 |
| F3 | 0,5 | 14 | 12 | 0,75 | 12 | 0,33 | 60 | 94 | 97 |
| F4 | 0,25 | 11 | 13 | 1 | 8 | 0 | 64 | 97 | 96 |
| F5 | 0,25 | 10 | 14 | 1 | 10 | 1,33 | 56 | 96 | 100 |
| F6 | 0,5 | 15 | 11 | 1 | 6 | 0,66 | 57 | 99 | 100 |
| F7 | 1 | 22 | 9 | 0,75 | 12 | 1 | 63 | 98 | 95 |
| F8 | 0 | 10 | 14 | 0,25 | 14 | 0 | 60 | 98 | 97 |
| F9 | 0,75 | 13 | 10 | 1 | 7 | 1 | 62 | 97 | 98 |

Figure 4 - The input data after the first, numeric transformation

**4. Results**

The program calculates successively the matrixes according to the method and output the ranking of the candidate alternative. The first is the one that better complies with the considered criteria and weights. For the considered problem, the result is presented in Figure 5.

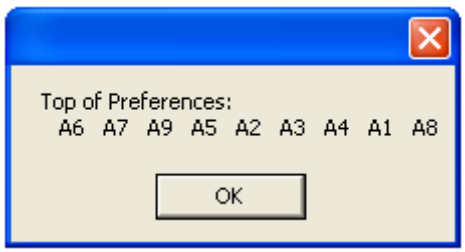

Figure 5 - The resulted ranking of the alternatives

The result gives a coherent solution and clearly recommends company F6 to win the bid, as it best fits in the framework designed by the decision maker as the ideal solution. The less acceptable is company F8.

Considering all the legal and eligibility elements and the result of ELECTRE method, the procedure of public acquisition was concluded by awarding the acquisition of the IT system to company initially denoted F6. Thus, the computer assisted process supports the decisions in the favor of an important actor on the Romanian communication market - a company bearing with an intelligent evolution, developing with real efforts from a state monopole to a private company that offers reliable, innovative and easy to use IT&C services. [9]

## 5. Conclusion and developments

For managerial decisions, one of the useful options is to build-up a mathematical model of the problem and solve the model with an appropriate software [1]. The software created at "Aurel Vlaicu" University of Arad proved to be suitable for supporting the decision making process in a lot of practical cases, including the presented situation for awarding a public acquisition in the IT sector.

The software offers coherent solutions for a various type of models and implements a couple of methods for solving incoherency. In order to rely on various models and decision methods, the authors recommended the use of other MCDM methods, such as the additive model or a fuzzy model. Could be interesting to apply different models to the same decisional situation and, eventually, to perform a sensitivity analysis.

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