

Zoran Nešić<sup>1)</sup>  
Jasmina Vesić Vasović<sup>1)</sup>  
Miroslav Radojčić<sup>1)</sup>

1) University of Kragujevac,  
Technical faculty, Čačak,  
Svetog Save 65, Serbia, mail:  
zornes2002@ yahoo.com,  
jasmina.vesic@ gmail.com,  
miroslav.radojicic@  
yahoo.com

## DEVELOPMENT OF MULTI-CRITERIA APPROACH IN THE DESIGN OF INFORMATION SYSTEMS

**Abstract:** In this paper is considered a multi-criteria approach in the design of information systems. Application of this methodology is another approach in support to the design of information systems. This paper presents a model of multi-criteria approach and its impact on improving the quality of information systems.

**Keywords:** Information Systems, Multi-Criteria Approach, Quality

### 1. INTRODUCTION

This paper presents an analysis of the possibility for implementation of multi-criteria analysis, as a support to the development of information systems, in terms of improvement of their quality. In addition to computer technology, it is undisputed that the development of information system relates to other organizational measures, the organization of material, human and other resources.

Methodology of development of information systems is considered by many authors, explaining in details:

- Principles of Information Systems [1]
- The modern organization in the global, Web-based environment [2]
- Organizational Information [3]
- Business Information Systems [4]
- Strategic planning for information systems [5], [6]
- Managing and using information systems [7]

Principles and methods of developing information systems experience constant improvements with many aspects:

- Strategic information systems planning [8]

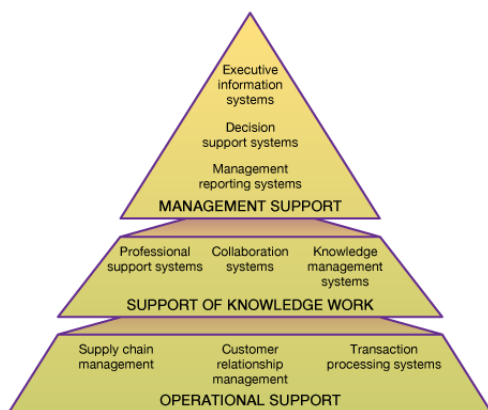
- A multilevel approach to information system [9]
- Information systems strategic planning [10]
- Large business information system development [11]

This paper presents possibilities of multi-criteria decision in the process of information system analysis. We analyzed the most important steps and issues with which the decision maker faces in applying these methods. The discussion relates to the analysis of a number of criteria by which would some projects of information system able to rank according to importance of the formation and implementation in Management information systems. The paper is primarily based on metodological aspects of the application of multi-criteria analysis for this problem.

Management information systems are primarily intended to support management in obtaining informations in accordance with their specific needs. On such a conception are based many theoretical considerations of Management information systems [12], focusing on the importance of constantly changing demands of using information [13].

This is why the same information system can be seen in the following way

[14]: „Information systems consist of three layers: operational support, support of knowledge work, and management support. Operational support forms the base of an information system and contains various transaction processing systems for designing, marketing, producing, and delivering products and services. Support of knowledge work forms the middle layer; it contains subsystems for sharing information within an organization. Management support, forming the top layer, contains subsystems for managing and evaluating an organization’s resources and goals.“, Figure 1.



**Figure 1.** Structure of organizational information systems [14]

Parker C. and Thomas C. (2003) emphasize that higher levels of management have [15]:

- less structured problems and decisions
- a greater need for summarized information
- a greater need for external information

This paper aims to show the methodology of multi-criteria optimization in the process of analyzing of information system, in terms for implementation of Management information systems. For this reason must be taken into account important characteristics of Management information systems in defining the criteria

for selection of alternative solutions.

## 2. MULTI-CRITERIA APPROACH TO THE ANALYSIS OF INFORMATION SYSTEMS

Application of multi-criteria optimization in any context, as well as in the analysis information systems has its specific characteristics. Selection of the best of a number of alternatives, and the formation of their rank, requires selection of own primarily alternatives. Criteria optimization can represent only an assistance in their ranking.

In this paper is applied methodology of The PROMETHEE method for multiple criteria decision making [16]. The specificity of this method lies in the great possibilities that can be used to express some preference criteria. The specificity of this method is the expression of preferences in the form of preferential functions. They provide a sophisticated expression of preferences in the form of functions, and their diagrammatic representation. This feature is very important for their graphical display. This way provides a visual interpretation of complex preferences to certain criteria. Further improvement of PROMETHEE method enabled the formation of a universal model of preferential functions. This allows the preferential formation of an unlimited number of functions. This methodology represents the initial criteria optimization theory of multi-criteria decision making model that was used in this paper.

In the first step of creating model of multi-criteria can be noticed great importance of a decision maker in the definition of alternatives. The example in this paper concerns on the analysis of a large number of potential projects, in terms of information relevant to their implementation in the Management information system. Therefore the first

step is the selection of own alternatives. The starting point in determining the most important possible information projects, may represent the most important processes for a typical manufacturing business organization, Table 1.

**Table 1 The most important processes for a typical manufacturing business organization [17]**

<p><b>Planning</b></p> <ul style="list-style-type: none"> <li>• Strategic planning</li> <li>• Market research</li> <li>• Economic analysis</li> <li>• Predictions</li> <li>• Resource planning</li> </ul>	<p><b>Production</b></p> <ul style="list-style-type: none"> <li>• Scheduling launch</li> <li>• Stock management</li> <li>• Production management</li> <li>• Packaging</li> <li>• Maintenance</li> <li>• Quality control</li> <li>• Shipping</li> </ul>
<p><b>Product development</b></p> <ul style="list-style-type: none"> <li>• Research</li> <li>• Licence</li> <li>• Design</li> </ul>	<p><b>Finances</b></p> <ul style="list-style-type: none"> <li>• Financial planning</li> <li>• Financial analysis</li> <li>• Accounting</li> <li>• Personal salaries</li> </ul>
<p><b>Marketing</b></p> <ul style="list-style-type: none"> <li>• Sales forecast</li> <li>• Advertising</li> <li>• Pricing</li> <li>• Contracting</li> <li>• Sales</li> <li>• Analysis of sales</li> </ul>	<p><b>Administration</b></p> <ul style="list-style-type: none"> <li>• Personnel function</li> <li>• Acts, records and other documentation</li> <li>• Information</li> </ul>

Also, the decision makers is placed another significant problem, which is another important feature of methods of multi-criteria optimization. This problem relates to the selection of criteria and defining their relative importance. As with the selection of alternatives, defining of criteria primarily is left to the decision maker.

In the analysis of information systems,

and criteria by which projects would be able to rank according to importance of the formation and implementation in Management information systems, it is necessary to take as a starting point same basic characteristics of Management information systems. In addition to the above-mentioned basic characteristics in terms of less structured problems, greater need for summarized and external information, may be accepted following criteria of efficiency and effectiveness of MIS [18]:

- Relevance of information for the effective performance of jobs and tasks
- The adequacy of the distribution of right information to the right organizational segments and rights of individuals – customers
- Timeliness of obtaining information
- Suitability of information forms
- Adequacy of the amount of information for customers needs
- The availability of ad hoc required information

Based on the above described basic feature of the Management information system, can be distinguished the following typical processes for production and business organization, with a more important significance for the implementation in Management information system:

1. Strategic planning
2. Predictions
3. Resource planning
4. Financial planning
5. Sales forecast
6. Contracting

These processes may represent important elements in designing information system intended for TOP management. In this consideration, they can be regarded as alternatives which preferential ranking functions can be analyzed.

Also, based on theoretical

considerations can be defined the most significant criteria of Management information system:

1. The need for external and ad hoc information
2. Appropriateness of forms of information, the ability to obtain summary information and their subsequent analysis by the method of business intelligence
3. Adequacy of distribution of information to the TOP management
4. Relevance of information
5. Timeliness of information

By this are extracted the most significant criteria for definition of multi-criteria approach to the analysis of Management information system. The next step is the implementation of complex possibilities of expressing preferences for particular criteria.

The need for external and ad hoc information is one of the specific characteristics of Management information systems. This feature is primarily determined by the need for managers to solve less structured and unstructured problems. Obviously this is an essential characteristic of the specific Management information systems. That is why is selected preferential function which emphasizes the importance of higher initial preferences for smallest difference in each criterion area. Figure 2 shows diagrammatic appearance of preferential function of the first criteria.

Obtaining a broad range of information from internal and external sources, establishes a requirement for criteria of suitability forms of the displayed information. In this sense, business intelligence methods are particularly important in terms of "categories of data analysis, querying, reporting, enabling the user in the business process to synthesize the vast amounts of valuable information which will be based on reasonable business decisions." [19].

By increasing the amount of information this feature is more prominent. For this reason, expression of preference of this criteria is defined by preferential function which gives a distinct preference near the border of changes of the intensity (speed) of preference (p). Figure 3 shows the diagrammatic representation of the second preferential function.

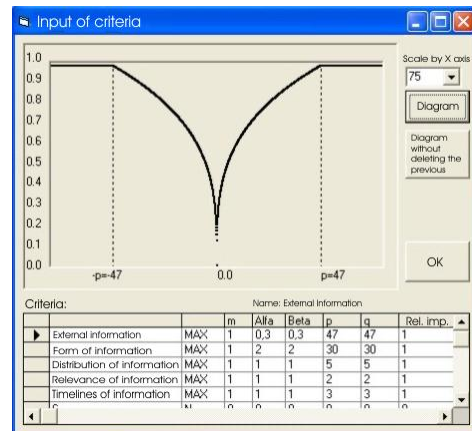


Figure 2. The first criterion function

Adequacy of distribution of information to the TOP management, the relevance of information, as well as timeliness of obtaining information are default criteria in the overall criterion space.

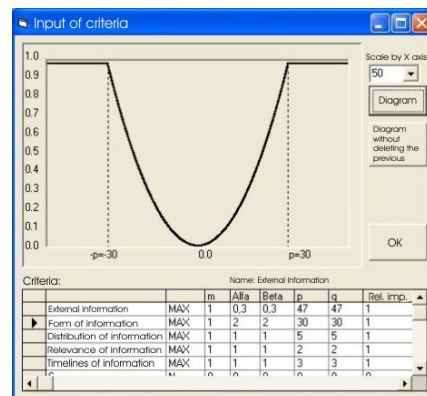


Figure 3. The second criterion function

As a result, they can express preference by a linear function. Figure 4 shows preferential function of the third criterion. Because of a similar character, preferential function of the fourth and fifth criterion is also expressed by the linear function.

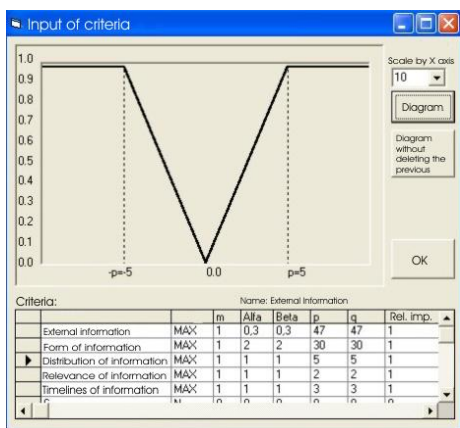


Figure 4. The third criterion function

The next step in the implementation of multi-criteria optimization is the determination of values of alternatives in relation to certain criteria, Figure 5. Assignment of values of alternatives in relation to certain criteria is possible by empirical measurements, expert analysis and estimation, based on experience of the decision-maker.

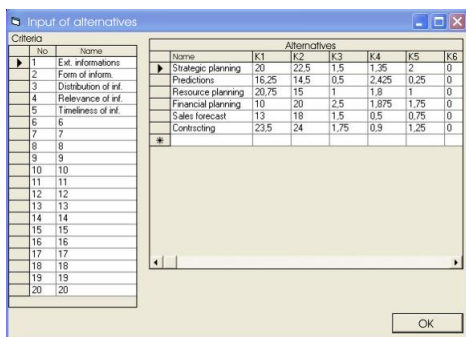


Figure 5. The values of alternatives in relation to criteria

The specific issue in this paper, which refers to importance of specific

alternatives in relation to criteria of Management information system, indicating the essential abstractness of the considered alternatives. As a consequence, it is pronounced role of a man - a decision maker in the implementation of this step of multi-criteria method. Assignment of specific values of is left to the expert analysis of each particular case.

It is necessary to point out that the application of computer technology is particularly important in the application of criteria optimization. By automating calculations are opened important opportunities for improvement of the application of criteria optimization. In addition to automation of calculations in obtaining the results, Figure 6, it is provided a simplified analysis of different alternatives of initial model, Figure 7.

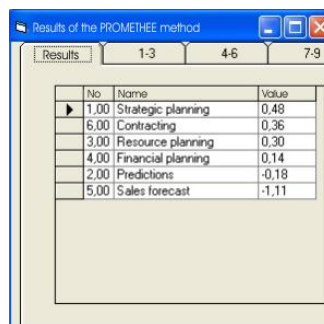


Figure 6. Results - Rank of the importance of certain alternatives

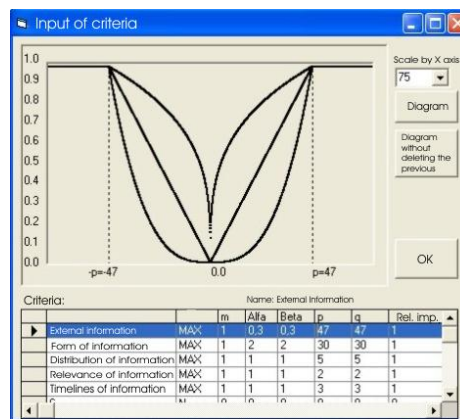


Figure 7. Visual analysis of preferential function

### 3. CONCLUSION

The paper considers the most important steps in implementation of the multi-criteria optimization method in the design of information systems. A specific example relates to determination of the level of particular importance in the formation of alternatives of a Management information system. It can be concluded that the specific discussed problem greatly emphasizes the most important features of the application of criteria optimization:

- Selection of alternatives and criteria themselves are left to a man. Their selection is primarily based on theoretical observations of a Management information system. In this way, in this paper have been made initial steps in the definition of alternatives and the criteria themselves.
- The next step was the expression of individual preferences of criteria. For these reasons, in the considered analysis is applied PROMETHEE method which allows the possibility of expressing sophisticated preferences in the form of visual display of preferential functions. Even in this step, is also highlighted the role of a man in expressing preferences of individual criteria. In this paper, the criterion for obtaining external

information is expressed by greater initial preference for each the smallest difference in the criterion space. Suitability of a form of information presents a criteria which is expressed by preferential function which gives a distinct preference near the border of changes of intensity preferences, due to increasing amounts of information. Adequacy of distribution of information to the TOP management, the relevance of information, as well as timeliness, also represent an important criteria, which can be seen as a default criteria. As a consequence, their preferences is expressed by a linear function.

- Defining the values of alternatives in relation to individual criteria also represents a key step, based primarily on expert evaluation of the specific case.
- The paper highlighted the use of software support to this method of multi-criteria optimization, which is an essential element in its implementation.

Displayed review was aimed analysis of the application of multi-criteria optimization in design of information systems, in terms of another contribution the improvement of their quality.

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