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Method and system for Multi-Attribute Market Value Assessment in analysis of construction and retrofit projects

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ABSTRACT

Multi-Attribute Decision-Making (MADM) methods prioritize the alternatives of comparative projects quite accurately. Problems arise when there is a need to determine the utility degrees and market values of the project alternatives. This becomes especially important for establishing the market value of real estate property in tender offers. However, the available MADM methods cannot accomplish this. Thus the authors of this article developed the MAMVA method, which permits determining the utility degrees and market values of project alternatives, and also developed a system on the basis of this developed method. This article presents the proposed Multi-Attribute Market Value Assessment (MAMVA) Method and the Decision Support System for Construction and Retrofit Projects (DSS-CRP). It also presents a case study to demonstrate the effectiveness of this method and system. The application of the MAMVA Method and DSS-CRP System for prioritizing and for determining the utility degrees and market values of construction and retrofit projects under consideration for financing by the European Economic Area (EEA) and Norway Financial Mechanism Grant made it possible to decrease the amount of requested support.

This article also presents the analysis and comprehensive assessment of the noted construction and retrofit projects. These were performed in consideration of the entire life cycle of a project and of needs satisfaction relevant to all the groups interested in a project. The developed MAMVA Method and DSS-CRP System permit assessing the appropriateness of projects under analysis in conceptual and qualitative forms. This method and system automatically submit the values of the project alternatives.

1. Introduction

More and more Decision Support Systems (DSS) are being developed for application in various areas over recent years (Asghar, 2008; Gao, Zhang, & Lu, 2009; Henriksen & Palocsay, 2008; Ramaseshan, Achuathan, & Collinson, 2008; Rigopoulos, Askounis, & Metaxiotis, 2010; Tchangani, 2009). Decision support systems for construction have been developed by Adeli (1988), Rodriguez-Martinez, Lopez-Arevalo, Banares-Alcantara, and Aldea (2004), Hajdasz (2008a, 2008b), Dedieu, Pibouleau, Azzaro-Pantel, and Domenech (2003), Alanne (2004), Zhao, Wu, and Zhu (2009), Pohekar and Ramachandran (2004), Roulet et al. (2002), Flourentzou and Roulet (2002), Mroz (2008), Diakaki, Grigoroudis, and Kolokotsa (2008) and Juan, Kimb, Roperc, and Castro-Lacouturec (2009). In Lithuania Zavadskas, Raslanas, Kaklauskas (2008), Kaklauskas, Gulbinas, Naimavičienė, and Kanapeckienė (2006), and Kaklauskas, Zavadskas, and Trinkunas (2007) have developed a number of multi-attribute decision support systems for use in construction.

Dedieu et al. (2003) addresses the development of a two-stage methodology for multi-objective batch plant design and retrofit according to multiple criteria. At the upper level (master problem), the Multi-Objective Genetic Algorithm (MOGA), which proposes several plant structures, is implemented for managing design or retrofit problems. At the inner level (slave problem), the Discrete Event Simulator (DES) evaluates the technical feasibility of the proposed configurations. First, basic DES principles are recalled. Then the following section develops MOGA based on the combined, single objective, genetic algorithm (SOGA) and Pareto Sort (PS) procedure. Finally a didactic example related to manufacturing four products using three types of equipment of discrete sizes illustrates this approach. Next, two criteria, investment cost and number of different plant unit sizes, are considered for designing a workshop. Then, starting from the best solution in terms of investment cost found in the design phase, a plant is retrofitted for double manufacturing. Finally the workshop is redesigned under the assumption of double production at the design phase. In terms of investment cost, this new solution yields a significant saving compared with what the retrofitted plant yields. In fact redesigning a new plant may challenge the retrofitting choice. Secondly an additional criterion is introduced concerning the number of production

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campaigns for reaching the steady-state or oscillatory regime, and the same approach (designing, retrofitting and redesigning) is performed which leads to the same conclusion as the bi-criteria case does.

Alanne (2004) proposed a multi-criteria "knapsack" model to help designers select the most feasible renovation actions during the conceptual phase of a renovation project. A case analysis concerning a real, Finnish apartment building was also presented. The primary aim of this case study was to test the applicability and functionality of the "knapsack" model in the context of these types of problems and to demonstrate the new model. For these reasons, as well as to avoid confusion, the simplified approach was applied. The results allowed to conclude that the method worked as had been expected. The analysis of this building case study led to the recommendation to adjust the radiator network by installing thermostatic valves. The most controversial factors regarding the evaluation of the model were the subjectivity feature of the multi-criteria assessment as well as the additive process of the model.

Based on the multi-index comprehensive evaluation method combined with the Life Cycle Assessment (LCA) Theory, Analytical Hierarchy Process (AHP) Method, post-evaluation thought and the successful degree evaluation method, a three-grade check and evaluation system was established on the heat metering and energy efficiency retrofit of existing residential buildings in northern heating areas of China. Zhao et al. (2009) also created a set of mathematical methods to evaluate the circumstances for implementing the heat metering and energy efficiency retrofit of these same buildings systematically, scientifically, comprehensively and objectively.

Within the framework of the European Joule-Thermie OFFICE Project, Roulet et al. (2002) developed the multi-criteria rating methodology based on a rating method that uses principal component analysis and a ranking method that uses a partial aggregation technique. This methodology rates or ranks office buildings and retrofit scenarios of that same building according to an extended list of parameters including energy usage for heating, cooling and other appliances, impact on the external environment, indoor environment quality and cost.

Flourentzou and Roulet (2002) described a systematic method based on multi-criteria analysis and a constructivist approach which helps an expert to design retrofit scenarios. This approach includes several steps that follow an iterative process. The associated computer tool takes charge of the tedious tasks such as calculating the associated costs, performing an energy balance and checking for coherence between actions and then it presents various viewpoints to an expert. It also helps the user by creating various scenarios quickly. The expert can then interact with this information and make the decision for selecting the final scenario. This interactive approach brings together expert intuition and rational systematic verification.

Mroz (2008) presented a new approach to community heating systems modernization and development planning process. It is based on the algorithm that aids general decision-making. The proposed algorithm takes into account both the demand and the supply side of the market for community heating modernization and development. To make the planning process more transparent and to increase the influence of decision-makers on the planning process, the ELECTRE III method was chosen as the tool to aid decision-making. The ELECTRE III method is based on the construction of an outranking relation and definition of a pseudo-criterion. The iteration mode of method application allows the decision-maker and analyst to investigate the sensitivity of the final solution to the changing preference model.

Diakaki et al. (2008) investigated the feasibility of applying multi-objective optimization techniques to the problem of energy efficiency improvement in buildings in order to consider the maximum number of possible alternative solutions and energy efficiency measures.

Juan et al. (2009) presented the Genetic, algorithm-based, online decision support system (DSS) to help residents easily conduct a housing condition assessment and offer optimal refurbishment actions considering the trade-off between cost and quality. Two refurbishment models were developed to explore the relationships among the life cycle cost, restoration cost and improved quality. The proposed DSS solves the problems arising from asymmetric information and conflicting interests between residents and contractors as well as improves the traditional housing condition assessment to be more effective and efficient.

Pohekar and Ramachandran (2004) reviewed the application of multi-criteria decision-making on sustainable energy planning. A review of more than 90 published papers was presented to analyze the applicability of the various methods discussed. The presented classification of application areas and the year of application highlighted the trends. One observation was that the Analytical Hierarchy Process is the most popular technique followed by the PROMETHEE and ELECTRE outranking techniques. Validation of results with multiple methods, development of interactive decision support systems and application of fuzzy methods to tackle uncertainties in the data were examined in the published literature.

Zavadskas et al. (2008) considered some of the problems associated with assessing the retrofit effectiveness of apartment buildings in urban areas. The retrofit of houses should be followed by the amelioration of their surroundings. The priority order of districts to be renovated depends on the condition of the buildings in a district and on strategic urban development programs. To determine the profitability of investments in housing retrofit, a number of retrofit scenarios need to be developed. The authors of this paper offer a new approach to determine the retrofit effectiveness of houses based both on expected energy savings and the increase in the market value of the renovated buildings. Retrofit scenarios for apartment buildings in Vilnius were developed in line with the proposed approach; i.e., retrofit investment packages for various districts were prepared and arranged in priority order for their application according to the geographical analysis method suggested by the authors.

Other authors applied the Method of Multiple Criteria Complex Proportional Evaluation (COPRAS) for various retrofit tasks (Kaklauskas, Zavadskas, & Raslanas, 2005; Kaklauskas et al., 2006; Zavadskas, Kaklauskas, Turskis, & Kalibatas, 2009 and others).

Upon analyzing the aforementioned scientific works, it can be asserted that those studies did not comprehensively analyze construction and retrofit project assessments since they did not take into consideration the entire life cycle of a project nor did they include all the groups interested in a project and their needs satisfaction.

Research shows that various scientists have specialized in depth the different and very important areas of multicriteria methodology and systems (Amiri, 2010; Dymova, Sevastianov, & Bartosiewicz, 2010; Fasanghari & Montazer, 2010; Kahraman & Kaya, 2010; Montazer, Saremi, & Ramezani, 2009; Xidonas et al., 2009). However, the current multicriteria methods and systems cannot to determine a utility degree and market value of alternatives (projects). In order to find what price will make a project being valuated competitive on the market a Method and System for Multi-Attribute Market Value Assessment determining the utility degree and market value of projects based on the complex analysis of all their benefits and drawbacks were developed by authors of the paper. According to this method the projects utility degree and the market value of a project being estimated are directly proportional to the system of the criteria adequately describing them and the values and weights of these criteria.

The structure of this paper is as follows: Section 2, which follows this introduction, presents Multi-Attribute Market Value Assessment

Method. Section 3 provides a description of the Decision Support System for Construction and Retrofit Projects and Section 4—a Case Study. Certain concluding remarks appear in Section 5.

2. Multi-Attribute Market Value Assessment (MAMVA) Method

The COPRAS method developed by Zavadskas and Kaklauskas (1999) has justified itself and it is used considerably in practice (Datta, Beriha, Patnaik, & Mahapatra, 2009; Ginevičius & Podvezko, 2008a, 2008b, 2009; Ginevičius et al., 2008; Jakimavičius & Burinskienė, 2009; Karbassi, Abduli, & Neshastehriz, 2008; Mazumdar, 2009; Schieg, 2009; Šliogerienė, Kaklauskas, Zavadskas, Bivainis, & Seniut, 2009; Zavadskas, Kaklauskas, Turskis, & Tamosaitiene, 2009). This method is applied in construction (Banaitiene, Banaitis, Kaklauskas, & Zavadskas, 2008; Kaklauskas et al., 2006; Lepkova, Kaklauskas, & Zavadskas, 2008; Mickaityte et al., 2008; Tupėnaitė et al., 2008; Zavadskas, Kaklauskas, Turskis, & Tamosaitiene, 2008; Zavadskas, Kaklauskas, & Vilutienė, 2009). Systems have also been developed on its basis (Kaklauskas et al., 2007; Urbanavičienė, Kaklauskas, Zavadskas, & Seniut, 2009). The MAMVA method, which permits establishing the utility degree and market value of construction and retrofit project alternatives, was developed on the basis of the COPRAS method.

The MAMVA method assumes that the versions under investigation directly and proportionally depend by significance and priority on a system of criteria adequately describing the alternatives and on the values and weights of those criteria. A system of criteria is determined, and experts calculate the values and initial weights of those criteria. All this information can be adjusted by interested parties (customers, users, others) considering their goal pursuits and existing capabilities. Hence the results of the assessment of alternatives fully reflect the initial project data that was jointly submitted by experts and by interested parties.

The results obtained by the comparative analysis of projects are presented as a grouped, decision-making matrix where the columns contain n alternative projects. All the pertinent quantitative and conceptual information are found in Table 1. Any alternative that has a poorer criterion value than the required value is rejected. To perform a complete study of a project, a complex assessment is needed of its economic, qualitative, technical, technological, ecological, climatic and social conditions along with the traditions and requirements for better customer satisfaction. Quantitative and conceptual descriptions provide this information. The diversity of aspects being assessed should include a variety of data presented as needed for decision-making. Therefore the necessary conceptual information may be presented in numerical, textual, graphical (schemes, graphs, diagrams, drawings) or equation formats and as audio or videotapes. An analysis should include all the criteria used for conceptual descriptions, their definitions and the reasons for the choice of a criteria system as well as the values and weights of those criteria.

The determination of the significance, priority and market value of alternatives is performed in nine stages.

Stage 1: The weighted, normalized decision-making matrix D is formed. The purpose of this stage is to receive dimensionless, weighted values from the comparative indexes. When the dimensionless values of the indexes are known, all criteria originally having different dimensions can be compared. The following formula is used for this purpose:

$$d_{ij} = \frac{x_{ij} \cdot q_i}{\sum_{j=1}^{n} x_{ij}}, \quad i = \overline{1,m};\ j = \overline{1,n}. \tag{1}$$

where x_{ij} = the value of the ith criterion in the jth alternative of a solution, m = the number of criteria, n = the number of alternatives compared, and q_i = weight of the ith criterion.

Table 1
Grouped decision-making matrix of a multi-attribute analysis of projects.

Quantitative information about the projects									
Analyzed criteria	[a]	Weights	Units	Analyzed projects					
				1	2	...	j	...	n
Quantitative criteria	v_1	q_1	m_1	x_{11}	x_{12}	...	x_{1j}	...	x_{1n}
	v_2	q_2	m_2	x_{21}	x_{22}	...	x_{2j}	...	x_{2n}
	...	...	...	...	...	...	...	...	...
	v_i	q_i	m_i	x_{i1}	x_{i2}	...	x_{ij}	...	x_{in}
	...	...	...	...	...	...	...	...	...
	v_t	q_t	m_t	x_{t1}	x_{t2}	...	x_{tj}	...	x_{tn}
Qualitative criteria	v_{t+1}	q_{t+1}	m_{t+1}	x_{t+11}	x_{t+12}	...	x_{t+1j}	...	x_{t+1n}
	v_{t+2}	q_{t+2}	m_{t+2}	x_{t+21}	x_{t+22}	...	x_{t+2j}	...	x_{t+2n}
	...	...	...	...	...	...	...	...	...
	v_i	q_i	m_i	x_{i1}	x_{i2}	...	x_{ij}	...	x_{in}
	...	...	...	...	...	...	...	...	...
	v_m	q_m	m_m	x_{m1}	x_{m2}	...	x_{mj}	...	x_{mn}
Conceptual information about the projects (text, drawings, charts, video tapes)									
K_k	K_v	K_q	K_m	K_1	K_2	...	K_j	...	K_n

[a] Sign v_i (+/−) shows, respectively, the better/poorer value of a criterion relevant to better needs satisfaction for a project contributor.

The sum of the dimensionless weighted index value d_{ij} for each criterion xi is always equal to the weight q_i of this criterion:

$$q_i = \sum_{j=1}^{n} d_{ij}, \quad i = \overline{1,m};\ j = \overline{1,n} \tag{2}$$

In other words, the value of weight q_i of the criterion under investigation is proportionally distributed among all alternative versions a_j according to their values x_{ij}.

Stage 2: The sums of weighted, standardized indexes describing the jth version are calculated. The versions are described by minimizing indexes S_{-j} and maximizing indexes S_{+j}. The lower value of minimized indexes is better, whereas the greater value of maximized indexes is better. The sums are calculated according to the formula:

$$S_{+j} = \sum_{i=1}^{m} d_{+ij}; \quad S_{-j} = \sum_{i=1}^{m} d_{-ij}, \quad i = \overline{1,m};\ j = \overline{1,n}. \tag{3}$$

In this case, the values S_{+j} (the greater this value is [project "pluses"], the more satisfied the interested parties are) and S_{-j} (the lower this value is [project "minuses"], the better the goal attainment by the interested parties) express the degree of goals attained by the interested parties for each alternative project. In any case, the sums of "pluses" S_{+j} and "minuses" S_{-j} of all alternatives are always, respectively, equal to all sums of the weights of maximized and minimized criteria:

$$\begin{aligned} S_{+} &= \sum_{j=1}^{n} S_{+j} = \sum_{i=1}^{m} \sum_{j=1}^{n} d_{+ij}, \\ S_{-} &= \sum_{j=1}^{n} S_{-j} = \sum_{i=1}^{m} \sum_{j=1}^{n} d_{-ij}, \quad i = \overline{1,m};\ j = \overline{1,n} \end{aligned} \tag{4}$$

Stage 3: The significance (efficiency) of the compared versions is determined by describing the characteristics of positive alternatives ("pluses") and negative alternatives ("minuses"). The relative significance Q_j of each alternative a_j is found according to the formula:

$$Q_j = S_{+j} + \frac{S_{-\min} \cdot \sum_{j=1}^{n} S_{-j}}{S_{-j} \cdot \sum_{j=1}^{n} \frac{S_{-\min}}{S_{-j}}}, \quad j = \overline{1,n}. \tag{5}$$

Stage 4: The priorities of the alternatives are determined. The greater the Q_j is, the higher the efficiency (priority) of the project alternative is.

The analysis of the method presented permits asserting that this method may be easily applied for assessing projects and selecting the most efficient of them while, by the same, being fully aware of the physical meaning of the process. Moreover it allows formulating a reduced criterion Q_j which is directly proportional to the relative effect of the compared criteria values x_{ij} and the end result weights q_i.

The significance Q_j of project a_j indicates the degree of satisfaction of demands and goals pursued by the interested parties, where the greater the Q_j is, the higher the efficiency of the project is (see Table 2).

Stage 5: The degree of project utility directly associates with its relevant quantitative and conceptual information. If one project is characterized as offering the best comfort, aesthetics and price indexes, while another is shown with better maintenance and facilities management characteristics, both will have obtained the same significance values as a result of the multiple criteria assessment; this means their utility degree is also the same. With an increase (decrease) in the significance of the project under analysis, the project's degree of utility also increases (decreases). The degree of project utility is determined by comparing the project under analysis with the most efficient project. In this case, all the utility degree values related to the project under analysis will range from 0 to 100. This facilitates a visual assessment of the project's efficiency.

The formula used for calculating alternative a_j utility degree N_j is the following:

$$N_j = (Q_j : Q_{\max}) \cdot 100\% \tag{6}$$

Table 2
Results of the multi-attribute project analysis.

Quantitative projects information									
Analyzed criteria	[a]	Weights	Units	Analyzed projects					
				1	2	...	j	...	n
X_1	v_1	q_1	m_1	d_{11}	d_{12}	...	d_{1j}	...	d_{1n}
X_2	v_2	q_2	m_2	d_{21}	d_{22}	...	d_{2j}	...	d_{2n}
X_3	v_3	q_3	m_3	d_{31}	d_{32}	...	d_{3j}	...	d_{3n}
...	...	...	...	...	...	...	...	...	...
X_i	v_i	q_i	m_i	d_{i1}	d_{i2}	...	d_{ij}	...	d_{in}
...	...	...	...	...	...	...	...	...	...
X_m	v_m	q_m	m_m	d_{m1}	d_{m2}	...	d_{mj}	...	d_{mn}
Sum of maximizing the standardized, rated indicators (project advantages)				S_{+1}	S_{+2}	...	S_{+j}	...	S_{+n}
Sum of minimizing the standardized rated indicators (project disadvantages)				S_{-1}	S_{-2}	...	S_{-j}	...	S_{-n}
Significance of the project alternative				Q_1	Q_2	...	Q_j	...	Q_n
Priority of the project alternative				P_1	P_2	...	P_j	...	P_n
Project's utility degree				N_1	N_2	...	N_j	...	N_n

[a] Sign v_i (+/−) shows, respectively, the better/poorer value of the criterion relevant to better needs satisfaction for a project contributor.

The effectiveness degree E_{ji} is calculated by the money invested into project a_j. It shows by percentage how much better (worse) it is to invest money into project a_j as compared to investing in project a_i. E_{ji} is established by the interrelationship when comparing the utility degrees of the projects under consideration as follows:

$$E_{ji} = N_j - N_i \tag{7}$$

The obtained results are submitted in the form of a matrix which clearly shows the differences in the utility levels of the objects (see Table 3).Stage 6: The degree of utility N_j for project a_j is calculated at an average deviation k_j when comparing it with other $(n-1)$ projects:

$$k_j = \sum_{i=1}^{n} E_{ji} : (n-1) \tag{8}$$

Stage 7: The grouped, decision-making matrix of the multi-attribute analyses of construction and retrofit projects is compiled. First the grouped decision-making matrix is compiled (see Table 4) where the primary criterion consists of the prices of projects under comparison and the value of the project under assessment. The starting value of the project under assessment is determined by the next formula:

$$x_{11} = \sum_{j=2}^{n} x_{1j} : (n-1) \tag{9}$$

The market value (x_{11-R}) of project a1 under assessment must be established in this matrix. The amounts of the support requests ($x_{12} - x_{1n}$) from projects ($a_2 - a_n$) under comparison are known. Furthermore all the other meanings and significances of the criteria defining the projects are also known (see Table 4).

The following calculations are performed based on the grouped decision-making matrix (see Table 4).

Stage 8: The adjusted value x_{11-p} of the project under assessment is calculated as:

$$x_{11-p} = x_{11} * (1 + k_1 : 100) \tag{10}$$

It is determined whether or not the adjusted value x_{11-p} of project a_1 under assessment is calculated sufficiently accurately:

$$|k_1| < s \tag{11}$$

Here s is the desired level of accuracy by percentage in the calculation of the market value x_{11-R} of project a_1. For example, when $s = 0.5\%$, there will be fewer cycles for calculating the approximation than when $s = 0.1\%$.

Stage 9: The market value x_{11-R} of project a_1 under assessment is established. If the inequality in (11) is satisfactory, then the market value of the object under assessment is established by:

$$x_{11-R} = x_{11-p} \tag{12}$$

If the inequality in (11) is unsatisfactory, then the value of the project under assessment is still not calculated to a sufficient level of

Table 3
Average deviation in the degree of object utility calculation.

Projects under consideration	Difference in the utility of the project under consideration as compared to other objects (%)					Average deviation k_j in the utility degree N_j of project a_j as compared to other $(n-1)$ projects (%)
	a_1	a_2	a_3	a_i	a_n	
a_1	0	E_{12}	E_{13}	...	E_{1n}	k_1
a_2	E_{21}	0 E_{32}	E_{23}	...	E_{2n}	k_2
a_3	E_{31}	...	0	...	E_{3n}	k_3
...	...	E_{j2}	...	...	...	...
a_j	E_{j1}	...	E_{j3}	...	E_{jn}	k_j
...	...	E_{n2}	...	...	...	...
a_n	E_{n1}		E_{n3}	...	0	k_n

Table 4
Grouped decision-making matrix of a multi-attribute analysis of projects.

Criteria defining projects under consideration	[a]	Significance	Unit of measure	Project under assessment as compared to other construction and retrofit projects					
				a_1	a_2	...	a_j	...	a_n
1. Value of the project under assessment a_1 and the sum of requested support by the projects under comparison $(a_2 - a_n)$	v_1	q_1	m_1	x_{11}	x_{12}	...	x_{1j}	...	x_{1n}
	v_2	q_2	m_2	x_{21}	x_{22}	...	x_{2j}	...	x_{2n}
	...	...	...	...	...	...	...	...	...
Quantitative criteria	v_i	q_i	m_i	x_{i1}	x_{i2}	...	x_{ij}	...	x_{in}
	...	...	...	...	...	...	...	...	...
	v_t	q_t	m_t	x_{t1}	x_{t2}	...	x_{tj}	...	x_{tn}
Qualitative criteria	v_{t+1}	q_{t+1}	m_{t+1}	x_{t+11}	x_{t+12}	...	x_{t+1j}	...	x_{t+1n}
	v_{t+2}	q_{t+2}	m_{t+2}	x_{t+21}	x_{t+22}	...	x_{t+2j}	...	x_{t+2n}
	...	...	...	...	...	...	...	...	...
	v_i	q_i	m_i	x_{i1}	x_{i2}	...	x_{ij}	...	x_{in}
	...	...	...	...	...	...	...	...	...
	v_m	q_m	m_m	x_{m1}	x_{m2}	...	x_{mj}	...	x_{mn}

[a] Sign v_i (+/−) shows, respectively, the better/poorer the significance of the criterion relevant to the requirements of a project contributor.

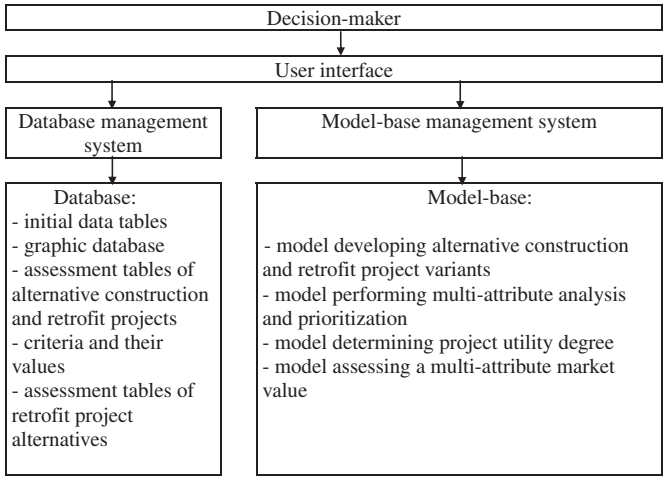


Fig. 1. DSS-CRP system components.

accuracy, and the approximation cycle must be repeated. In this case, the adjusted value $x_{11} = x_{11-p}$ of the project under assessment is placed in the grouped, decision-making matrix of the multi-attribute analyses of construction and retrofit projects, and all the calculations are repeated until the inequality in (11) is satisfactory.

To establish the market value x_{11-R} at which project a_1 under assessment would be equally competitive with the other projects $(a_2 - a_n)$ under comparison, the MAMVA method was recommended for the multi-attribute establishment of the degree of utility and market value of an object by comprehensively assessing all their positive and negative attributes. According to this method, the calculated degrees of utility and the market value of the project under consideration directly and proportionally depend on a system of criteria adequately describing the levels of meanings and significances of those criteria. The MAMVA method is further used to develop the Decision Support System for Construction and Retrofit Projects.

3. Decision Support System for Construction and Retrofit Projects (DSS-CRP)

The Decision Support System for Construction and Retrofit Projects (DSS-CRP) in presented by accessing web page: http://iti.vgtu.lt/loreta2. The system was developed based on the analysis of existing information, expertise and decision support systems to determine the most efficient versions for construction and retrofit projects. The system is developed on the basis of the proposed MAMVA methodology.

DSS-CRP consists of a database, database management system, model-base, model-base management system and user interface (see Fig. 1).

The DSS-CRP database management system allows users to analyze construction and retrofit projects in consideration of a system of criteria.

The analysis of database structures according to the type of problem solved reveals their various utilities. There are three basic types of database structures: hierarchical, network and relational. The DSS-CRP system contains a relational database structure when information is stored in the form of tables. These tables contain quantitative and conceptual information. Each table is given a name and saved in the computer's external memory as a separate file. Logically linked parts of a table comprise a relational model. The following tables form the DSS-CRP database:

- initial data tables that contain general information about the retrofit projects under consideration, action plans, project budgets and other facts;
- graphic database that contains conceptual information on the projects under consideration, i.e., object photographs, plans, and the like;
- assessment tables of alternative construction and retrofit projects that contain quantitative and conceptual information about alternative renovation solutions relevant to applicant suitability, project feasibility and such;
- criteria and their values that contain criteria group descriptions and their weights in quantitative and conceptual terms;
- assessment tables of retrofit project alternatives.

A module base allows a DSS-CRP user to select the most suitable project alternative by comparing the measures offering the greatest value to all interested persons and organizations.

Since the efficiency of a construction and retrofit project variant is often determined by considering organizational, management, technological, economic, technical, legal, social and other factors, a DSS-CRP model-base needs to include models enabling a decision-maker to perform a comprehensive analysis of the variants available and to make an appropriate choice. The following model-base models are designed to perform this function:

- model developing alternative construction and retrofit project variants;

Table 5
Visual project data.

1. Joniškis Synagogue complex	2. Agluonėnai ethnographic farmstead	3. Museum of the 1863 Revolt in Paberžė	4. Ethnographic Museum of Žemaitija (Samogitia) lands
			
5. Sculptor V. Grybas Memorial Museum	**6. Antanavas Chapel**	**7. Children's Home for Independent Living in Molėtai**	**8. Liubavas Manor Estate Watermill**
			

- model performing multi-attribute analysis and prioritization;
- model determining project utility degree;
- model assessing a multi-attribute market value.

To serve as an example, two models (for performing multi-attribute analysis and prioritization and for determining project utility degree) are described further. The model performing multi-attribute analysis and prioritization performs the multi-attribute analysis of the construction and retrofit project alternatives and sets project priorities based on weighted criteria.

The model determining project utility degree determines the degree of utility of each project under analysis.

The model assessing a multi-attribute market value permits a comprehensive determination of the market value of the projects under analysis that considers the entire life cycle of the project and includes all interested groups and an assessment of all the positive and negative attributes of the alternatives under consideration.

The developed Multi-Attribute Market Value Assessment (MAMVA) Method and Decision Support System for Construction and Retrofit Projects (DSS-CRP) have been used in practice by the authors of this article who participated in assessing projects and establishing the market values of the objects submitted in applications to the EEA and the Norwegian Financial Mechanism for support grants.

4. Case study

The EEA and the Norwegian Financial Mechanism were established for supporting the social and economic development of the new EU member countries. The ten countries that joined in 2004 as well as Bulgaria and Rumania, which joined in 2007, had GDP levels lower than the average for the EU and they were included in the list for support grants. Financial Mechanisms always provided financial support to the more impoverished regions. The EEA and the Norwegian Financial Mechanism constantly contribute to lessening the social and economic gaps in Europe's economic sphere as an opportunity to support the integration of the new EU countries into the European Economic Area (EEA). By 2009 a total of € 1.134 billion Euros had been expended for Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia as well as for Spain, Portugal and Greece.

Eight projects were selected for analysis and assessment of those which were project applications from Lithuania for support grants from the EEA and Norwegian Financial Mechanism. The authors of this article were invited to participate in the expert project assessments. A multi-attribute analysis was performed to better explain which project would be the most effective and beneficial. The system of criteria for assessing retrofit projects was developed on the basis of the EEA Financial Mechanism and the Norwegian Financial Mechanism Appraisal Manual (2009). The values and weights of the criteria were established by the authors.

As the priority, utility and effectiveness of the submitted projects are being established, it is necessary to consider several questions such as, amongst others: Does the project correspond with a priority area for financial mechanisms that Lithuania allocates? Will the implementation of the project help the applicant to reach stated goals in the public or cultural sphere? Will implementation create new jobs? Will it serve to provide new public services?

The priority and significance of construction and retrofit projects under consideration by the multi-attribute analysis method directly and proportionately depend on a system of criteria adequately describing the levels of meanings and significances of those criteria. The eight projects submitted for analysis and assessment were: the Joniškis Synagogue complex restoration, Agluonėnai ethnographic

Table 6
Criteria descriptions and weights for project assessments.

Criteria	Weight	Description
How suitable is the applicant to implement the project?	0.8	Is the applicant sufficiently committed to implement the project in line with relevant terms and requirements?
How suitable are the partners for the project?	0.2	Any partners must be checked for background, etc. Their commitment and relevant competence/capacity must be verified
How suitable are the organizational resources/structure?	0.8	Applicant resources and competence regarding ability to manage the project must be examined. Clarity of the management structure and clear-cut roles and responsibilities must be verified. Is the institutional capacity sufficient, e.g., does the body responsible for project management and implementation have the necessary staff, experience and know-how to ensure efficient completion?
Is the publicity plan adequate for the operation?	0.7	The publicity plan given in the application must be examined and verified as corresponding to the purpose and objectives of the financial mechanisms
How justified is the project?	0.8	The background and justification of the project must be confirmed by one or more independent sources such as local or national bodies and the like
How good is the public consensus about the project?	0.9	Public opinions about the project are gathered
What is the relevance of the overall objective?	0.6	The relevance of the overall objective needs to be considered according to: (1) How the overall objective fits in with national strategic plans for the relevant sector in the beneficiary state and (2) How significant the project's potential contribution is to the overall objective
To what extent does the purpose of the project meet the needs expressed by the applicant?	0.7	The defined purpose of the project must be compared with the needs and their justification as expressed by the applicant in the background and determined to what extent the proposed project meets these needs
How does the purpose contribute from a national or regional perspective?	0.8	The purpose must be considered from local, regional and national perspectives, and an opinion importantly must be formed on how the project contributes to solving the problem or issue in the broader view
How suited is the project to catalyze other resources for the same overall objective?	0.4	The suitability of the project to catalyze other resources into the same overall objective is determined
Does the verification of compliance with EU legislation appear correct?	0.6	The project must be in accordance with EU legislation. The appraisal must evaluate such a verification
How does the project contribute to the implementation of EU legislation?	0.7	The project must be in accordance with EU legislation
How good is the proposed solution compared with alternative solutions of the same problem?	0.9	The chosen solution, methodology and/or technology must be compared to alternative ways of solving the problem. If there are other feasible ways of solving the problem which have not been considered, these should be addressed and when practical, also comparatively assessed
How does the solution stand in a best available technique (BAT) consideration, if relevant?	0.8	The choice of technology should, when relevant, be defended in a best available technique (BAT) context
How clear and feasible is the time schedule?	0.5	A realistic schedule is important for the success of the project and thus it must be considered. The proposed work program must be assessed for coherence between objectives, activities and time table
How relevant is the division into separate project activities?	0.8	The clarity of the work program must be assessed. The milestones included must be definable and measurable. They must also be appropriate and practical for monitoring, reporting, disbursement, etc.
How suitable are the proposed indicators?	0.8	The result indicators must illustrate key, direct results of a project. Ideally result indicators can also be used as progress indicators during project implementation. All the indicators of results and purpose must be quantified
Has appropriate consideration been included regarding building and human resources development in the necessary capacity?	0.8	The institutional capacities and possible needs for human resource capacity strengthening need to be considered for different types of projects. It must also be considered if there has been sufficient integration of the necessary elements of capacity building, training of existing personnel and such matters into the project
How well are the operational and maintenance requirements of post completion addressed?	0.8	The capacity to ensure the operation and maintenance of post completion is an essential element for long term success
Are the managerial risks under control?	0.6	Examples of managerial risks are lack of qualification, mismanagement, fraud and others. Managerial risks that relate to the project must be assessed
Are the technical risks under control?	0.5	Technical risks may, among other things, be related to risks of accidents, lack of technical suitability and such
Are the financial risks under control?	0.6	Examples of financial risks are lack of co-financing, lack of fiscal strength, inappropriate expenses and such
Are the legal risks under control?	0.7	Legal risks may be related to unattained but required permits, legal disputes, changing legislation and such
How suitable is the management and control of risk?	0.7	The purpose of risk management is to identify, control and minimize risk factors as well as to secure an efficient response to minimize consequences
Does the detailed budget demonstrate proportionate costs at realistic prices?	0.7	The budget must be assessed for its accuracy regarding both unit prices and number of units needed for the project
Has the revenue generating potential been assessed accurately by the applicant?	0.7	If the project has a revenue generating component, this must be evaluated. The additional benefit information must be assessed
Has the applicant secured co-financing?	0.9	Co-financing source(s) must be assessed regarding the likelihood of required financing delivery according to schedule throughout the project
How cost-effective is the project?	0.9	The cost-effectiveness of the project must be analyzed taking all relevant costs and benefits of the project into account over the lifetime of the project considering net present value. An attempt must be made to quantify all relevant effects of the project, including ecological, social and other benefits to society
Has the potential for post completion financing been utilized?	0.4	A project's economic life is related to the long-term financing of operating and maintaining the result of the project purpose after the implementation period is over. All types of projects must include the effort to stimulate economic life after project

Table 6 (*continued*)

Criteria	Weight	Description
		completion. This appraisal must determine whether the possibilities for generating needed financing for such an economic life have been utilized effectively. It is important to determine if an applicant of a project, including capital investments, has a sound plan for funding future maintenance costs in a secure way
Are all the financial drivers of the project sustainable?	0.4	Sustainable development requirements are implemented in the financial mechanisms in different ways. Some projects will have a sustainable development focus, whereas other projects will be part of sustainable development by including sustainability aspects wherever appropriate
Will the project increase public understanding of sustainability?	0.7	Increase of public understanding of sustainability by the project is considered
Will the project influence the sustainability behaviors of citizens positively?	0.7	The positive influence of the project to the sustainability behaviors of citizens is considered
Will the project contribute to poverty reduction?	0.8	Contribution to poverty reduction of the project is considered
Does the project take into account gender specific needs and address specific gender conditions?	0.5	The project takes into account gender specific needs and addresses specific gender conditions
Does the project promote participation of women within the project?	0.6	Promotion of participation by women within the project is taken into account
Does the project contribute to gender equality awareness-raising?	0.7	Gender aspects should be reflected in all facets of a project, making the concerns and experiences of women as well as men an integral part of the planning, implementation, monitoring and evaluation of the project. The extent of a project's integration of gender equality issues must be assessed. This may include adopting an equalities strategy, having women in decision-making roles or including flexible work practices
Does the project encourage women's participation in and access to the labor market?	0.5	Equal working conditions, equal pay for equal work and equal social insurance are being provided for both men and women
Does the project promote women's rights?	0.6	Promotion of women's rights in the project is considered
Will the project contribute to better public access to information and/or improved transparency?	0.9	Contribution to better public access to information and/or improved transparency of the project is considered
Will the project improve participation of civil society into decision-making processes?	0.8	Improvement of participation of civil society into decision-making processes by the project is considered
Does the project deal with the issue of accountability to those affected by the project?	0.6	Issues of accountability in the project are included
Does the project take a proactive approach to preventing and dealing with corruption?	0.4	A proactive approach to preventing and dealing with corruption is considered in the project
How is the partnership contributing to the quality or success of the project?	0.5	A common way to contribute to bilateral relations is a partnership between the applicant and one or more partners in one or more donor country. Such partnerships must contribute to the objective of the project in an efficient way, for example, by utilization of special competence or resources possessed by the partner for the benefit of the project
Are there indications of developed and good working relations between the partners?	0.3	The relations between the partners and their quality must be assessed to guarantee successful implementation of the project
Is there a potential to develop the partnership beyond the project cooperation?	0.5	The partnership beyond the project cooperation is estimated as a complementary benefit of the project
How well are forms of bilateral relations other than partnerships identified?	0.6	The other forms of bilateral relations than partnerships should be indicated and valuated
Project duration	0.9	Duration of the project in months is determined
Project budget	1.0	Project budget in submitted in Euros

farmstead restoration, Museum of the 1863 Revolt in Paberžė reconstruction, Ethnographic Museum of Žemaitija (Samogitia) lands restoration, Sculptor V. Grybas Memorial Museum and Antanavas Chapel reconstructions, Children's Home for Independent Living in Molėtai construction and Liubavas Manor Estate Watermill restoration. The visual data of these projects appear in Table 5.

A brief description of each project follows.

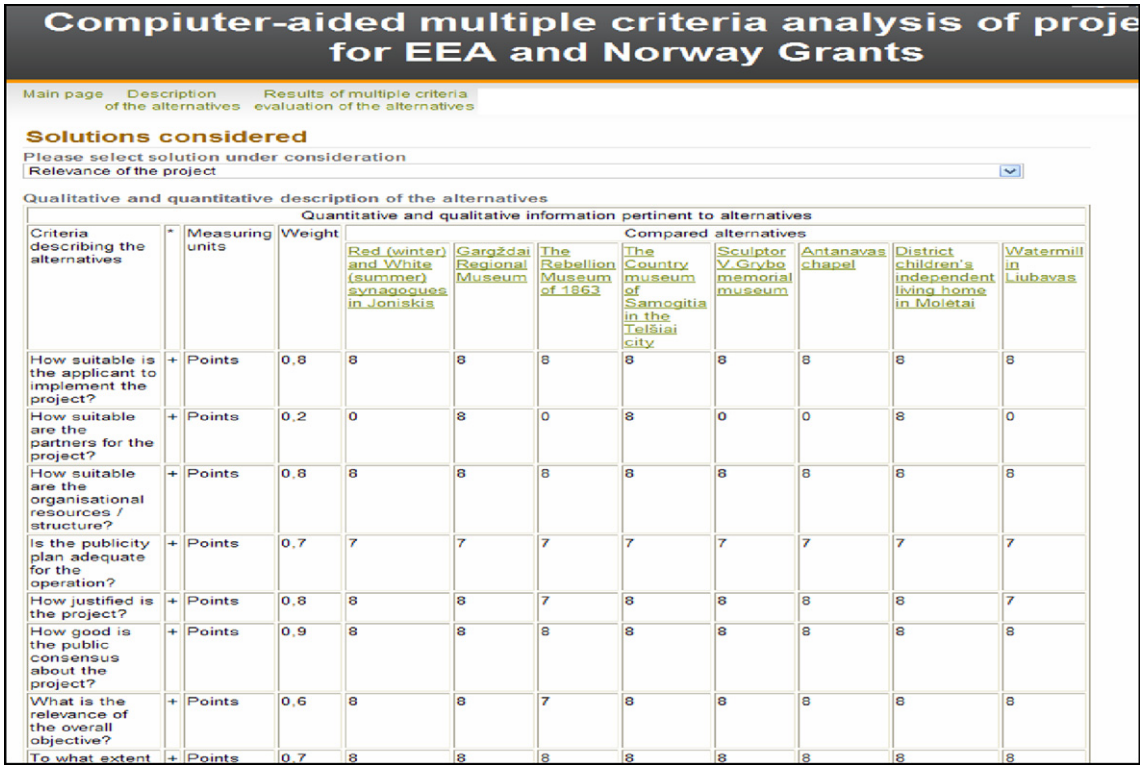
Variant 1. Joniškis Synagogue complex restoration. A unique complex of two synagogues, the only such complex surviving of numerous, two-synagogue complexes from different time periods which had once stood in Lithuania, is in Joniškis Town. Therefore high numbers of local resident communities and tourists visit this site. Over time these synagogues have reached a catastrophic condition. The municipal administration of Joniškis Region has been pursuing means since 1994 to save this synagogue complex and adapt it for societal needs. The Red Synagogue crashed in 2007. Since then the condition of this unique object named in the list of cultural heritage sites under state protection is critical; the building could completely crumble any day. The municipal administration of Joniškis Region lacks funds of its own to handle this situation involving an object that requires considerable financial resources. The synagogue complex is extremely important as one of the most unique sites surviving in the very center of Joniškis Town.

The time of project implementation is 18 months. The project budget is €1.4 million Euros.

Variant 2. Agluonėnai ethnographic farmstead restoration and adaption for societal needs. This project aims to restore the Agluonėnai ethnographic farmstead and preserve it to serve public needs for cultural, educational and social activities. The farmstead consists of four buildings which are entered in the Register of Cultural Properties of the Republic of Lithuania: a dwelling-house, barn, livestock shed and cellar. The project aims to preserve the unique, wooden architectural site in the Klaipėda Region, that is, the Agluonėnai ethnographic farmstead, and to adapt it for public needs relevant to cultural, educational and social activities.

The time of project implementation is 18 months. The project budget is €3.7 million Euros.

Variant 3. Museum of the 1863 Revolt in Paberžė reconstruction. Implementation of the initiated project is planned for Paberžė Village in the Kėdainiai Region, which has numerous meaningful and valuable cultural and historical sites that attract tourists from everywhere in Lithuania and from abroad. The aim is to preserve historical and cultural sites. A landscape-historical reserve has been established in Paberžė. The Museum of the 1863 Revolt – a



Compiuter-aided multiple criteria analysis of proje for EEA and Norway Grants

Main page | Description of the alternatives | Results of multiple criteria evaluation of the alternatives

Solutions considered

Please select solution under consideration

Relevance of the project

Qualitative and quantitative description of the alternatives

Quantitative and qualitative information pertinent to alternatives

Criteria describing the alternatives	*	Measuring units	Weight	Compared alternatives							
				Red (winter) and White (summer) synagogues in Joniskis	Gargždai Regional Museum	The Rebellion Museum of 1863	The Country museum of Samogitia in the Telšiai city	Sculptor V.Grybo memorial museum	Antanavas chapel	District children's independent living home in Molėtai	Watermill in Liubavas
How suitable is the applicant to implement the project?	+	Points	0,8	8	8	8	8	8	8	8	8
How suitable are the partners for the project?	+	Points	0,2	0	8	0	8	0	0	8	0
How suitable are the organisational resources / structure?	+	Points	0,8	8	8	8	8	8	8	8	8
Is the publicity plan adequate for the operation?	+	Points	0,7	7	7	7	7	7	7	7	7
How justified is the project?	+	Points	0,8	8	8	7	8	8	8	8	7
How good is the public consensus about the project?	+	Points	0,9	8	8	8	8	8	8	8	8
What is the relevance of the overall objective?	+	Points	0,6	8	8	7	8	8	8	8	8
To what extent	+	Points	0,7	8	8	8	8	8	8	8	8

Fig. 2. Some of the initial data for multi-attribute analysis.

cultural heritage object – was established in 1993 in a wooden manor built in Paberžė 215 years ago, in 1793. It was partially restored 18 years ago, in 1990; however, it was reconstructed in the standard manner with no consideration of the authentic data about the manor building. The 2006 evaluation of the museum building's condition shows that it's in a poor state, which does not satisfy the needs of museum visitors and employees. The established problems with the museum building are the poor condition of its structure, the worn and unauthentic roof, rotted building windows and doors, worn building foundations and others.

The time of project implementation is 15 months. The project budget is €890,000 Euros.

Variant 4. Restoration of the Ethnographic Museum of Žemaitija (Samogitia) lands established under an open sky on the southwestern shore of Mastis Lake in Telšiai. This museum is on authentic, end-19th to start-20th century territory covering 7.5 ha. It exhibits numerous items used for daily life, farm implements and furniture of those times. However, the constructions have become worn over several decades due to atmospheric and environmental impacts. Therefore they need to be preserved and restored as quickly as possible.

The main aim of this project is to preserve the exhibitions, valuable examples of wooden architecture, of the Žemaitija lands museum. The project aims to restore the major museum building-exhibitions for properly serving the museum visitors.

The time of project implementation is 19 months. The project budget is €280,000 Euros.

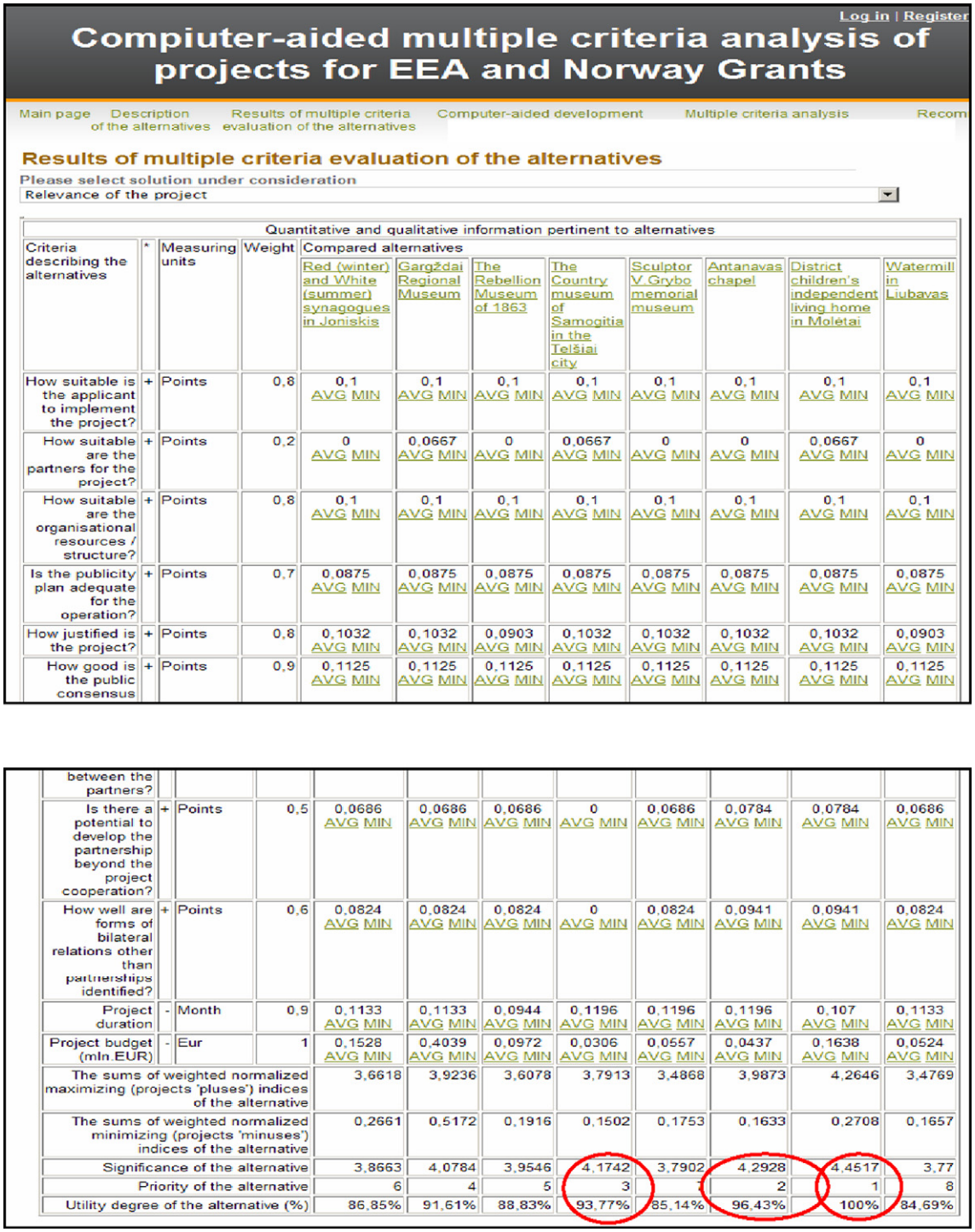
Variant 5. Sculptor V. Grybas Memorial Museum reconstruction and adaptation for cultural and public needs. This project would contribute to the creation of new cultural tourism products and an informal area of public education and, in the meantime, assure proper usage of this cultural heritage object. It would also encourage cultural growth in the Jurbarkas Region, thereby increasing its appeal for tourism, generating conditions to develop tourism services and contributing to the economic growth of the region.

This project aims to adapt the Jurbarkas Manor Estate buildings, where the V. Grybas Memorial Museum is installed, for cultural and public needs, thereby contributing to the social and economic growth of the Jurbarkas Region.

The main project operations are the renovation of the museum buildings and their adaption for cultural tourism and informal educational activities (preparation of a technical project, renovation of the building facilities, repair of the administration building foundations, construction of the roof for the administration building and workshops (art laboratories) and replacement of the cover and installation of a heating system); acquisition of equipment for operating cultural tourism and informal educational activities and acquisition of computers, furniture, exhibition furnishings, ceramics and glass firing furnaces, ventilation systems and such).

The time of project implementation is 19 months. The project budget is €510,000 Euros.

Variant 6. Reconstruction of the wooden Antanavas Chapel – a unique object of cultural heritage reflecting sacral, folk construction in Lithuania. The Cultural Heritage Department of the Ministry of Culture and the Kazlų Rūda Municipality initiated the preservation and restoration works. Antanavas Chapel is one of three such objects still surviving in Lithuania. This large hexagonal chapel was built of wood at the end of the 18th century on the territory of the Antanavas Manor Estate as a manor chapel and family burial grounds. The Antanavas Chapel has never been reconstructed from the time it was built except for interior rearrangements in the mid-19th century. Surviving iconographic material provides an opportunity to reconstruct this unique object of cultural heritage. The project aims to reconstruct the chapel and adapt it for public needs.



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Compiuter-aided multiple criteria analysis of projects for EEA and Norway Grants

Main page | Description of the alternatives | Results of multiple criteria evaluation of the alternatives | Computer-aided development | Multiple criteria analysis | Recom

Results of multiple criteria evaluation of the alternatives

Please select solution under consideration

Relevance of the project

Quantitative and qualitative information pertinent to alternatives											
Criteria describing the alternatives	*	Measuring units	Weight	Compared alternatives							
				Red (winter) and White (summer) synagogues in Joniskis	Gargždai Regional Museum	The Rebellion Museum of 1863	The Country museum of Samogitia in the Telšiai city	Sculptor V.Grybo memorial museum	Antanavas chapel	District children's independent living home in Molėtai	Watermill in Liubavas
How suitable is the applicant to implement the project?	+	Points	0,8	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN
How suitable are the partners for the project?	+	Points	0,2	0 AVG MIN	0,0667 AVG MIN	0 AVG MIN	0,0667 AVG MIN	0 AVG MIN	0 AVG MIN	0,0667 AVG MIN	0 AVG MIN
How suitable are the organisational resources / structure?	+	Points	0,8	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN	0,1 AVG MIN
Is the publicity plan adequate for the operation?	+	Points	0,7	0,0875 AVG MIN	0,0875 AVG MIN	0,0875 AVG MIN	0,0875 AVG MIN	0,0875 AVG MIN	0,0875 AVG MIN	0,0875 AVG MIN	0,0875 AVG MIN
How justified is the project?	+	Points	0,8	0,1032 AVG MIN	0,1032 AVG MIN	0,0903 AVG MIN	0,1032 AVG MIN	0,1032 AVG MIN	0,1032 AVG MIN	0,1032 AVG MIN	0,0903 AVG MIN
How good is the public consensus	+	Points	0,9	0,1125 AVG MIN	0,1125 AVG MIN	0,1125 AVG MIN	0,1125 AVG MIN	0,1125 AVG MIN	0,1125 AVG MIN	0,1125 AVG MIN	0,1125 AVG MIN
between the partners?											
Is there a potential to develop the partnership beyond the project cooperation?	+	Points	0,5	0,0686 AVG MIN	0,0686 AVG MIN	0,0686 AVG MIN	0 AVG MIN	0,0686 AVG MIN	0,0784 AVG MIN	0,0784 AVG MIN	0,0686 AVG MIN
How well are forms of bilateral relations other than partnerships identified?	+	Points	0,6	0,0824 AVG MIN	0,0824 AVG MIN	0,0824 AVG MIN	0 AVG MIN	0,0824 AVG MIN	0,0941 AVG MIN	0,0941 AVG MIN	0,0824 AVG MIN
Project duration	-	Month	0,9	0,1133 AVG MIN	0,1133 AVG MIN	0,0944 AVG MIN	0,1196 AVG MIN	0,1196 AVG MIN	0,1196 AVG MIN	0,107 AVG MIN	0,1133 AVG MIN
Project budget (mln.EUR)	-	Eur	1	0,1528 AVG MIN	0,4039 AVG MIN	0,0972 AVG MIN	0,0306 AVG MIN	0,0557 AVG MIN	0,0437 AVG MIN	0,1638 AVG MIN	0,0524 AVG MIN
The sums of weighted normalized maximizing (projects 'pluses') indices of the alternative				3,6618	3,9236	3,6078	3,7913	3,4868	3,9873	4,2646	3,4769
The sums of weighted normalized minimizing (projects 'minuses') indices of the alternative				0,2661	0,5172	0,1916	0,1502	0,1753	0,1633	0,2708	0,1657
Significance of the alternative				3,8663	4,0784	3,9546	4,1742	3,7902	4,2928	4,4517	3,77
Priority of the alternative				6	4	5	3	7	2	1	8
Utility degree of the alternative (%)				86,85%	91,61%	88,83%	93,77%	85,14%	96,43%	100%	84,69%

Fig. 3. Part of the conducted multi-attribute analysis.

The time of project implementation is 19 months. The project budget is €400,000 Euros.

Variant 7. Children's Home for Independent Living in Molėtai construction. This Home was built in 1962 and, since that time, it has practically not been renovated except for changing the windows and reconstructing the heating system. All the other similar institutions in the district have been renovated except for the Molėtai Children's Home. The greatest numbers of children under care reside in this home, and the condition of its building is in the poorest condition. Since renovation is no longer expedient, the decision was made to build a new Children's Home for Independent Living in Molėtai. A newly established home for independent living would assure implementation of the general goals of child care: conditions would be instilled for a comfortable, home-like environment suitable for training social skills and independence alike and for providing social services.

The time of project implementation is 17 months. The project budget is €1.5 million Euros.

Variant 8. Liubavas Manor Estate Watermill restoration and adaptation for cultural and public needs. VĮ Europos Parkas, a

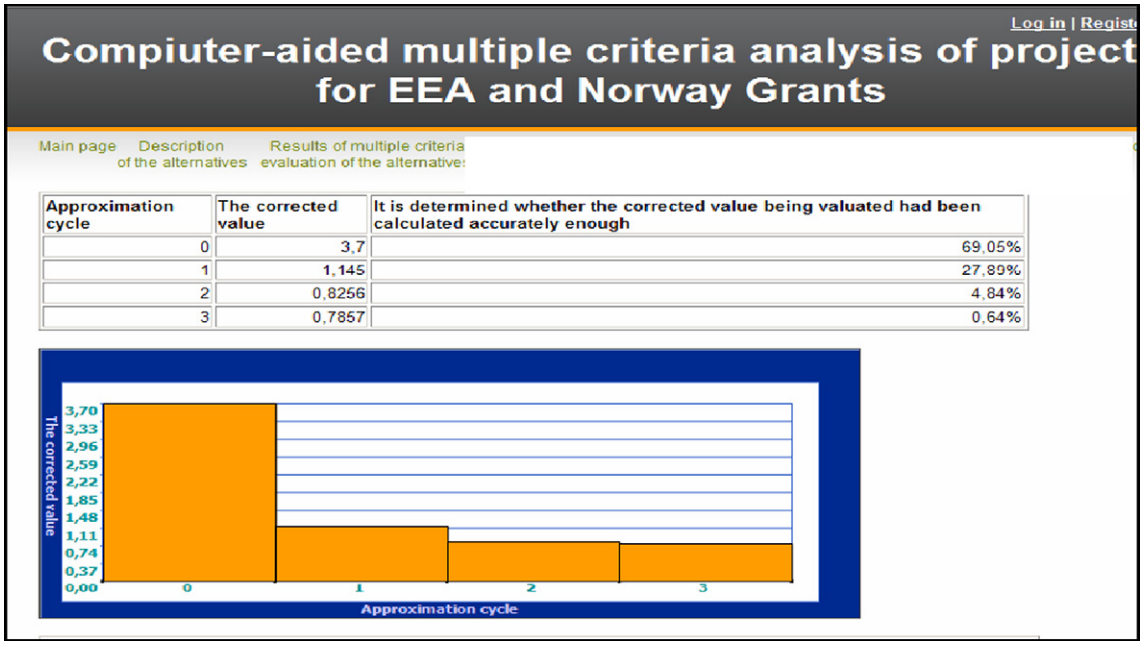

Fig. 4. Part of the market value analysis of project alternatives.

non-profit organization, seeks to restore and revitalize the former Liubavas Manor Watermill. Europos Parkas approached the EEA and Norwegian Financial Mechanism for funding and prepared investment and technical projects. The project concept is to restore the Liubavas Watermill and install a museum in it. Since the Liubavas Watermill is a source of local history and culture, has retained its authentic mechanisms and is located near Europos Park at the geographical center of Europe, it has resources that need exploiting to provide the public with an opportunity to visit, to encourage social and economic development in the area and to promote responsible use of natural and cultural resources. The project aims to restore the former Liubavas Manor Estate Watermill and adapt it for cultural and public needs.

The time of project implementation is 18 months. The project budget is €480,000 Euros.

A system of qualitative and quantitative criteria was employed to select the project for the financing allocation. A 48-criteria system was developed for this purpose (see Table 6).

Next the initial decision-making matrix for the multi-attribute analysis of alternatives is developed (see Fig. 2).

Following this, the system performs the second stage of calculations, i.e., the models performing multi-attribute analysis and prioritization and determining project utility degree perform the multi-attribute analysis on the basis of the initial data on the variants in the database (see Fig. 3).

For example, the utility degree and priority of the submitted projects were determined over the course of the calculations. Of the obtained results, it can be seen that the best variant of the projects under consideration is the seventh in the table. Its utility degree is N7 = 100%. The sixth project variant in the table is second in terms of utility degree (N6 = 96.43%). The fourth project variant in the table is the third (N4 = 93.77%) and so forth.

On the basis of the MAMVA Method, the system's multiple criteria model determining the utility degree and market value establishes the price at which an alternative under assessment would be equally competitive in the market by comprehensively assessing all the positive and negative attributes of the alternatives under consideration.

The specified values of the projects under analysis are automatically submitted in the multiple criteria analysis of projects under consideration window (see Fig. 4).

The user of the system can click on any of the names of variants under consideration in this window and receive detailed information on the analysis for determining the market value of the variant of interest.

The establishment of the market values of the project variants can serve as an example for discussion. The system's model for determining the multi-attribute utility degree and value establishes the price at which an alternative under assessment would be equally competitive in the market by comprehensively assessing all the positive and negative attributes of the alternatives under consideration. For example, if the budget of Variant 2 (Agluonėnai ethnographic farmstead) were reduced from €3.7 million Euros to €780,000 Euros, its chance of receiving financing would be greater as compared with the most attractive project variant, which is in first place. Meanwhile the utility degree would increase from 91.61% to 94.81%. Furthermore this alternative would rise from fourth to third place in the priority row (see Fig. 4).

5. Conclusions

The developed Multi-Attribute Market Value Assessment (MAMVA) Method permits establishing the market values of projects under analysis comprehensively by considering the entire life cycle of a project including all interested groups and assessing all the positive and negative attributes of the alternatives under consideration.

A multi-attribute decision-making system has been developed and a complex database of construction and retrofit projects formed. Based on this database, the system generates conditions to comprehensively analyze the submitted construction and retrofit projects in quantitative and conceptual forms.

The rational amounts of funding support and the market values of construction and retrofit projects financed by the EEA and Norway Financial Mechanism Grants can be established with the help of the developed method and multi-attribute decision-making system.

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