ESTABLISHMENT OF PROJECT PORTFOLIO BY USING MULTI-CRITERIA EVALUATION

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Abstract

Both public and private clients whose regular activities require that several investment projects are carried out, need to prioritize the projects to be selected for execution in a rational manner. Establishment of a multi-criteria evaluation model, to be used by the public bodies in the project selection process, is presented in the paper. First, the criteria to be used in the model are identified and justified, and their relative importance is assessed by using the Analytical Hierarchical Process (AHP). Projects that are relevant for the public body under consideration are identified and evaluated by using the Multi-Criteria Assessment Model established in the previous stage. Based on the comprehensive evaluation, the priority list of investment projects under consideration is created.

Key words

construction; multi-criteria assessment model; prioritization; project portfolio

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1 INTRODUCTION

Multi project environment can be often encountered in organisations whose core business is real estate management. The majority of these projects are investment projects that enable the growth of the core business. However, organisations can achieve project success only by doing the right projects, as well as doing projects right [1]. Therefore, the projects need to be assessed from the viewpoint of various criteria in order to identify the »right« projects. In many cases, the major criteria used in the assessment of the individual projects within the portfolio have financial nature, such as expected internal rate of return, or annual income arising from the investment after being put into use.

There are multi-project environments cases, however, where financial indicators are less important due to the specific character of the business carried out by the client organisation. Šetinc et al [2], for example, take into the account economic, social, traffic and political factors. Research presented in [3] deals with highway maintenance, and is founded on the basis of the following criteria: the number of vehicles passing through the selected section; direct and indirect costs of the users; the condition of the overpasses to be repaired, and possibility of joining several refurbishment projects into a group that is repaired at the same time.

Efficient project portfolio management requires, in the first step, that the client identifies all criteria relevant for the business, and uses them in the assessment of various projects being proposed. The resulting utilities are the measure by which the proposed alternatives can be ranked, and, in the next step, selected to be executed. It should be noted that not all criteria selected to be used in this proces are of equal importance to the decisionmaker, therefore the relative importances of the criteria should be determined by using a clearly defined procedure prior to the beginning of the prioritization of the projects.

Criteria that can be used in the assessment of various investment projects rank from project duration, project scope, resources required for the execution, risks associated with the project as a whole, or risks associated with a part of the project, level of importance, to more comprehensive criteria such as strategic value.

Research reported in this paper deals with project portfolio management in the case of governmental body whose core business is not real estate management. However, to be able to carry out their duties, a portfolio of several different facilities that need to be constructed need to be managed. Therefore, the aim of the research presented in this paper is to

a) identify the criteria that are critical for the operation of the client organisation,
b) establish the relative importances of the individual criteria, from the viewpoint of the portfolio owner,
c) assess the projects within the portfolio with respect to the criteria and their relativce importance, i.e. determine their utilities, and
d) rank the projects with respect to the utilities caculated in the previous step.

The group of construction projects that are being evaluated consists of various structures and buildings, and is being used for different purposes. Due to the character of the public body managing this real estate fund, gaining the profit from the investment projects is not the prime objective.

2 LITERATURE REVIEW

Contemporary business environment is increasingly becoming project-oriented. Organisations, business or non-profit oriented, often carry out several projects simultaneously in order to achieve their goals; in other words, they establish a multi project environment [4]. Portfoilo management of these projects is therefore essential for their efficient execution, as well as for achieving the client's goals.

Project portfolio is defined as "a set of large projects that are selected, initiated , coordinated and managed centrally, with the purpose to achieve larger benefits for the organisation"; contrary to the approach where each individual project is dealt with and managed separately [5]. In his work, Garies [6] defines project porfolio as a set of projects that exist in the organisation under consideration in a particular time. Various types of projects, e.g. internal and external; developmental and routine, can be encountered in an organisation. During their execution, even when they are run concordantly with project portfolio analysis, they may be delayed and struggle with resources [7].

In the field of construction, two types of project portfolios can be encountered:

- projects portfolio management carried out in an individual construction contracting company that is executing construction projects [8]; and
- project portfolio management carried by the client who is repetitively initiating construction projects due to their business needs [9, 10].

Research presented in this paper is targeted to the second type of portfolio management.

3 METHODOLOGY

The selected methodology consists of two elements. First, the criteria relevant for the evaluation of the portfolio under consideration are identified and justified. Then, their relative importance is determined by using Analytical Hierarchical Process [11]. This procedure ensures that the opinions and views of the decisiomakers are appropriately accounted for within the model. Utility of each individual project, U_i, is determined as the weighted sum of the partial utilities assigned to the project. The following expressions are valid when utility of project i, U_i, is calculated:

$$U_i = \Sigma\,(U_{ij}\, w_j)\ ;\ i=1, \ldots n\ ;\ j=1, \ldots .m \tag{1}$$

$$\Sigma\,(w_j) = 1\ ;\ j=1, \ldots m \tag{2}$$

m is the number of criteria introduced to the decision model, and *n* is the number of projects being evaluated. U_{ij} is the partial utility associated with criterion j, received when project i is selected to be executed.

The projects comprising the portfolio are then ranked with respect to the calculated total utility of the projects, U_i. On this basis, the projects with highest total utility scores can be selected to be executed, provided that there are more potential projects than available resources. The procedure ensures that the client receives the outcome of the project with the highest benefit when finished.

The following 4 criteria were identifed as relevant and as such, selected to be used in the evaluation of the potential projects:

1. project cost,
2. discounted net income of the project and
3. other benefits and
4. project duration. (m=4)

Increasing project cost and project duration results in lower partial utility, U_{ij} , assigned to the project i from the viewpoint of these two criteria:

$$U_{ij} = 1 - u_{ij} / u_{ij\,max} \; ; \; \text{when } j=\{1; 4\}; \; j=1, ..n \; ; \tag{3}$$

while larger discounted net income and other benefits result in higher partial utilities:

$$U_{ij} = u_{ij} / u_{ij\,max} \; ; \text{ when } j=\{2; 3\}; \; j=i, ..n \; ; \tag{4}$$

$u_{ij\,max}$ is the largest partial utilitiy gained in the group of projects under consideration.

4 DESCRIPTION OF THE PROJECT PORTFOLIO

The case analysed in this paper deals with a group of structures and buildings procured, managed and maintained by one of the Ministries. The building stock under consideration is diverse and consists of 7 facilities (n=7), as presented in Table 1. The facilities need to be either constructed or refurbished.

Tab. 1: Costs and benefits of projects within the project portfolio

Project No.	**Criteria**			
	Project cost (EUR)	**Discounted net income (EUR)**	**Other benefits**	**Project duration (months)**
	1	**2**	3	4
1	1,130,000	5,392,196	Reliable availability of the capacities, increased storage safety, decreased risk of data storage	4
2	410,000	822,894	No other benefits	3
3	2,350,000	3,148,172	Improved data, introduction of new technology	16
4	405,000	1,063,460	Reliability of signal, larger area covered by the signal	5
5	2,520,000	1,749,075	Improvement of structure and operation of key infrastructure	7
6	660,000	0	Improvement of national defence system structure and operation, increase national safety	6
7	1,550,000	2,187,091	Compliance to contemporary standards, efficiency of the organisation, development of the organisation, credibility of the country	8

Project 1 deals with upgrading the existing archive facility. The facility is planned to host the archive required for permanent archiving the documentation. The building is in relatively poor

shape and needs appropriate drainage for rainwater, repair of the facade and roof. The documentation being stored requires temperature range 13 to 18 C and relative humidity 55% to 65%, therefore it needs comprehensive refurbishment. Renovation of a group of 77 appartments is foreseen within Project 2. They are located in various locations and mostly in poor condition. The main benefits gained by executing this project are increased possibility to rent them, and decreased maintenance and operation costs.

Optical network construction (required for efficient operation of the Client) is planned in Project 3. Financial benefit gained by the project is estimated (based on the investment estimate of 2,350,000 EUR) to be 19,304 EUR per month. Within Project 4, antenna tower, substituting the existing (obsolete) tower is planned. The works planned in tis project include demolition of the existing tower, construction of new access roads, and installation of the fence. The project estimate is 405,000 EUR. It can be assumed that the refurbishment does not affect maintenance costs. The income (rent for the land) is estimated to be 5,125 EUR per month. Net income calculation for the investment assumes 30 years of operation.

The motivation for the initiation of the project 5 (shooting range) is the need for modernisation of the organisation as a whole; as the current equipment enables only basic training of the personnel. Due to central location, savings can be expected in the field of transportation costs of the personnel. The new facility has the potential to be used by other users as well. The expected service life of the new technology is 20 years. Discounted net income the therefore estimated to be 1,749,075 EUR (taking into the account 4 % of discount rate). Project 6 deals with construction of training facility, required to maintain the combat competencies of the personnel. The estimated investment is 660,000 EUR (VAT excluded). There is no income associated with this project, but there are several other significant benefits; such as, as already mentioned, improved combat competences of the personnel.

The goal of Project 7 is a contemporary structure that will improve exchange of experience within international cooperation. The estimated cost of the project is 1,550,000 EUR. Several offices will be able to relocate to this building, resulting in 140,000 EUR of benefits annually. The discounted net income over the expected service life (25 years) is 2,187,091 EUR. Several intangible benefits, such as compliance to relevant international standards, ensuring the development of the public body under consideration, and appropriate ICT network can be identified as well.

5 FORMULATION OF THE MULTI-CRITERIA MODEL EMPLOYED

The criteria defined in the previous sections (project cost, discounted net income, other benefits and project duration) are not equally important for the decision maker. Relative importance of individual criteria needs to be therefore determined. Analytical Hierarchical Process (AHP) [11] was selected for this purpose. This method includes and measures tangible and intangible, quantitatively measurable and qualitative criteria; and enables determination of the relative importance of the criteria by asking the respondents to evaluate the relationship between each pair of criteria. The respondents taking part in this process should represent the decision-makers and other relevant stakeholders, depending on the decision problem under consideration. When the process of pair-wise comparison of the criteria is finished, relative importance for all criteria within the same level of the decision tree is obtained. Further explanation can be found in [8].

For the purpose of the case study under consideration, a small group of competent professionals was interviewed in order to determine the relationships among individual criteria employed in the study. The values for relative importance of the criteria were obtained by using the procedure proposed by Saaty [11]; they are presented in Tab. 2. It can be seen that the criterion "Other benefits" was perceived as extremely important (i.e. its relative importance, w_j, is the largest), as it predominantly accounts for strategic value of the project, while other criteria are judged to be significantly less important.

Tab. 2: Relative importance for the individual criteria considered in the study

Rel.importance of the criterion (w_j)	**CRITERION** *(j)*			
	Proj.cost (1)	Disc.net income (2)	Other benefits (3)	Project duration (4)
	0,101	*0,208*	*0,643*	*0,048*

Partial and total utilities calculated for the individual projects with respect to the criteria being employed are determined by using the Eqs. (1 - 4), and their values are presented in Table 3. Partial utility of project i with respect to criterion j, u_{ij}, is determined by using linear interpolation. It can be seen that project no. 6 (training facility) is extremely important for the client due to its large strategic value; that leads to its highest utility. The same can be stated for Project No.5 (shooting range), while the calculated total utilities of other projects are much lower.

Tab. 3: Determination of total utility for considered projects

w_j	**CRITERION** *(j)*					
	(1)	*(2)*	*(3)*	*(4)*		
	0,101	*0,208*	*0,643*	*0,048*		
PROJECT NO. *(i)*	u_{ij}				**U_i**	**Ranking**
1	0,552	1,000	0,421	0,750	**0,570**	**5**
2	0,837	0,153	0,000	0,813	**0,155**	**7**
3	0,067	0,584	0,789	0,000	**0,636**	**4**
4	0,839	0,197	0,632	0,688	**0,565**	**6**
5	0,000	0,324	1,000	0,563	**0,737**	**2**
6	0,738	0,000	1,000	0,625	**0,748**	**1**
7	0,385	0,406	0,789	0,500	**0,655**	**3**

6 CONCLUSIONS

Public clients need to establish rational procedures when investment projects are being selected. Their execution is associated with high costs, therefore rational and efficient spending of public funds is a must. In the majority of cases, the available budget is limited, and not all projects being identified as necessary can be financed. The legislature (Public Procurement Law) requires that the process of selection is transparent and defined in advance.

As a consequence, the client stands in front of a demanding task when projects that will have priority have to be identified.

The proposed procedure enables the client to set his priorities (by defining the criteria) and to identify the projects that are the most important from his viewpoint. However, it should be emphasized that one should place special attention to the identification of the criteria, and estimate their (relative) importance.

When the financial estimates are known as well, the client has the possibility to proceed with projects that have the highest priority (ranking), as long as the financial constraint is not exceeded. However, it is possible that the available budget is not sufficiently high to enable financing of all projects envisioned. In such cases, other techniques and models should be used in order to identify an efficient solution.

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