

MULTI-CRITERIA COMPLEX FOR PROFITABILITY ANALYSIS OF CONSTRUCTION PROJECTS

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Abstract

In the last decades significant changes in technology, economy, society and politics have seriously modified the environment in which construction enterprises operate. Market globalisation and deregulation encourage appearing of new players. International construction projects do not necessarily bring high profit, as opposed to what is generally expected of high-risk international attempts. Construction projects become complicated and fragmented due to the fact the contractors of different specialisations are involved. Construction enterprises and objects are complex systems, emerging in many forms in different application domains, and consist of many facets where the proper understanding requires the contribution from multiple disciplines. As in any other scientific discipline or engineering branch, construction organisations require the development of models, not only as a help to better understand the area, but also as the basis for the development of methods and tools for better decision-making. In fact proper decision-making in all phases of the construction enterprises life cycle needs to be based on well argued and verified models and methodologies. Modelling has nowadays become very important for any construction organisation that strives to achieve a differentiated competitive advantage, especially if the company is small or medium sized.

The article offers a methodology for profitability analysis of construction projects. For this purpose was used the modelling, cost estimates, cost benefit analysis. Du Point pyramid was used for the profitability assessment of the construction project. Du Point pyramid analysis was applied in various sectors of economy such as: finance, the country's gross domestic product (GDP) for the detection and etc. Du Point pyramid analysis was not applied in construction. In this paper Du Point pyramid analysis and game theory rule was used for the profitability assessment of the construction project. Finally, the projects under consideration are ranked according to the performance ratio. Practical example shows that purposed model can be applied in the praxis.

Keywords: Construction, profitability, MCDM, complex analysis, enterprise, rank.

JEL Classification: M11, O22, O43, P34, P42.

Introduction

In the last decades significant changes in technology, economy, society and politics have seriously modified the environment in which construction enterprises operate. Market globalisation and deregulation encourage new players to appear. International construction projects do not necessarily bring high profit, as opposed to what is generally expected of high-risk international attempts. Construction projects become complicated and fragmented due to the fact the contractors of different specialisations are involved. Construction enterprises and objects are complex systems, emerging in many forms in different application domains, and consist of many facets where the proper understanding requires the contribution from multiple disciplines. The article offers a methodology for profitability analysis of construction projects. The aim of this research is to establishment the profitability ratio taking in to account of risk level. Success of a project depends on a different criteria set. Investigation of construction process at the planning and designing stage prevents failures. The most profitable project is selected on the basis of the Multi-Criteria Decision Making (MCDM) methods. A project is described by a set of profitability criteria: effectiveness of construction activities, investment evaluation, financial accounting and evaluation of enterprises management, etc. Du Point pyramid analysis was applied in various sectors of economy such as: finance, the country's gross domestic product (GDP) for the detection and etc. Du Point pyramid analysis was not applied in construction. In this paper Du Point pyramid analysis and game theory rule was used for the profitability assessment of the construction project.

Profitability analysis of construction projects

Many researchers investigated the problem of success and the importance of rational decision-making in changing and risky environment (Zavadskas *et al.*, 2008; Zavadskas *et al.*, 2010). The mean of security of

insurance companies' financial soundness and stability - a solvency margin, determining not only the lower default risk of the insurance company, but at the same time the additional costs of insurance business (Jurkonyte & Girdzijauskas 2010). Literature and practice provide several frameworks in the context of business performance measurement. Some are offering pre-defined sets of performance indicators, others provide just concepts, and moreover, there are some holistic methodologies which integrate a concept with concrete performance criteria. The performance measurement concept may include a process model, rules to execute the measurement or guidelines to identify relevant business challenges. Globalized competition and customer needs forced construction companies to measure their performance beyond the financial measures such as profitability, turnover, etc. As qualitative determinants were added to measurement systems, their investigation and evaluation became a major area of research. The impact of “resources and capabilities,” “strategic decisions,” “project management competencies” and “strength of relationships with other parties” on “company performance” was investigated. A framework has been proposed to consider the contribution of decision making and dynamic planning in the profitability of a project under uncertainty. Some of the strategies can be, for instance, expanding, contracting, switching, abandoning, waiting, and transferring. (Garcia-Fernandez & Garijo 2010). Small or medium size enterprise (SME) is one of the most important economic growth factors having the basic impact on the general development of the country's economy and social stability, creation of new work places, therefore its development is one of the most important country's economic political trends (Tamosiunas & Lukosius 2009). Utility is a wide term complicate to define. The performance is practically impossible to define without perception of concepts. It is impossible not only in terms of building construction, but in all real cases the significance must be carried out in order to derive the maximum benefit. The market itself determines the kind and quantity of goods to be produced. Naturally it creates the need for a useful resource. Operational performance must be controlled to gain the highest profit. Utility should be used to determine the criteria that are calculated from the business income, balance sheet, and cash flow statements. In particular, it is important to determine whether the company is financially able to continue their activities. Informed about potential disruptions firm operating losses and their causes: the use of outdated technology, the short-term funding from the (current) funding sources, late payments and so on. There is a number of criteria characterising the performance: profitability, profitability, liquidity and solvency according to the study and the object chosen. Usefulness (profitability, cost and rates) is determined by the construction companies and facility level, the choice of the objectives, type, production, investment appraisal, financial accounting and management scope, as well as coverage of the indicators (Figure 1).

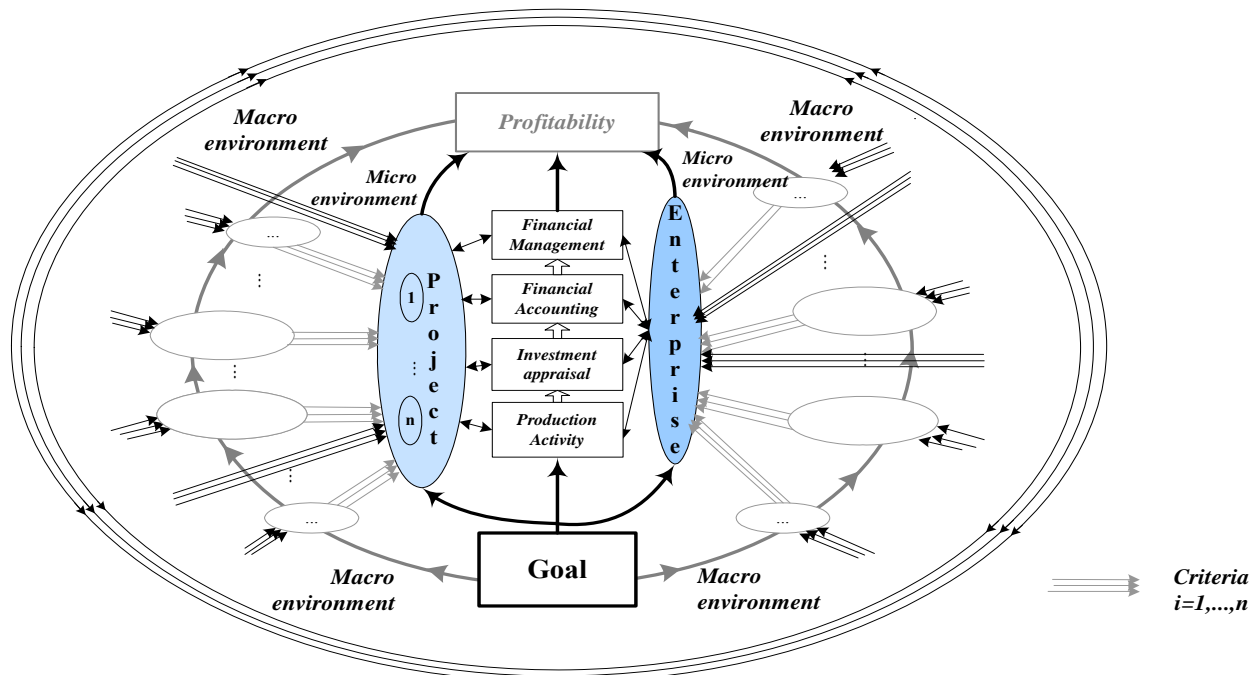


Figure 1. Construction performance assessment model
Methodology

Availability of wide range of MCDM problem solution techniques. Each method has its own strengths, weaknesses and possibilities to be applied. It causes phenomena known as the inconsistent ranking problem

that can be caused by different MCDM method. A major criticism of MCDM methods is that due to the differences among different techniques, different results are obtained when applied to the same problem. The differences of algorithms are the following:

- Using weights differently;
- Selection of the best solutions;
- Attempt to scale the objectives;
- Introducing additional parameters that affect solution.

A simulation by Zanakis *et al.* (1998) evaluated eight MCDM methods: SAW - *Simple Additive Weighting* (MacCrimon 1968), TOPSIS - *Technique for Order Preference by Similarity to Ideal Solution* (Hwang & Yoon 1981), COPRAS - *Complex Proportional ASsessment* (Zavadskas *et al.* 2009a), ARAS - *Additive Ratio ASsessment* (Zavadskas & Turskis 2010, Zavadskas *et al.* 2010b), game theory (Kaplinski & Tamosaitiene 2010). MCDM methods modification: COPRAS-G (*Complex Proportional ASsessment method with Grey interval numbers*) (Zavadskas *et al.* 2008b, 2009b) ARAS-G (Turskis & Zavadskas 2010a), ARAS-F (Turskis & Zavadskas 2010b) and SAW-G (Zavadskas *et al.* 2010c).

The Du Pont analysis is the method for assessing a company's return on. The Du Pont analysis was pioneered in large part by the Du Pont Corporation of America, which was founded in the 1920s as the Pyramid of Ratios, named the Du Pont pyramid. The Du Pont analysis breaks down a company's Return on Equity by analysing asset efficiency or turnover ratio, operating efficiency and financial leverage. This approach measures the company's gross book value (also known as the Du Pont identity, Du Pont equation, Du Pont Model or the Du Pont method)- an expression which breaks Return on Equity into three segments:

- Financial Leverage (calculated using an equity multiplier)
- Asset use efficiency (calculated using asset turnover)
- Operating efficiency (calculated using the profit margin)

Ultimately, Du Pont analysis and outcome presentations created through their manipulation may affect the nature and quality of the planning process and decisions.

A set of multiple criteria to determine the usefulness of digital information processing and logical methods of analysis are used in the system. It is important to know the essence of research methods and their applicability, to be able to choose them on the basis of research challenges and existing background information. The logical way of econometric techniques, heuristic (psychological), graphics, and specific ways the group (Table 1). for the following investigation of a system are applied for determining profitability of a construction project. Analysis profitability of construction project by using Du Pont pyramid is presented in Figure 2.

The most profitable project is selecting are of Multi-Criteria Decision Making (MCDM) methodology.

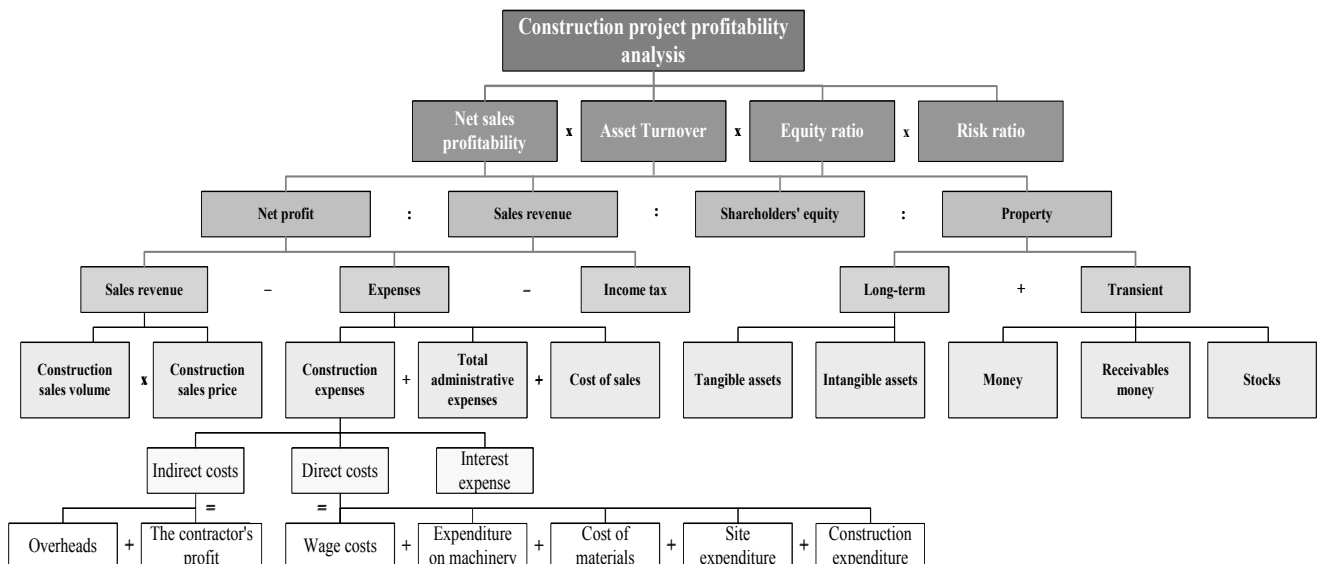


Figure 2. Du Pont pyramid profitability analysis of construction projects

Case study: complex multi-criteria profitability analysis of construction projects

Complex methods: Du Point and game theory for the problem solution was applied for the profitability analysis of construction projects. Effectiveness of construction activities, investment evaluation and financial accounting were analysed. Construction profitability analysis was calculated by applying Du Point and game theory. Hodges & Lehmann (1952) rule was used for the assessment of the risk level. The subject of investigation is nine- floor administration and business complex building in Vilnius city. Each contractor is described by eight attributes. The construction project is of 36 month duration and the total value of the project is above 5 mln. €. Attributes and their weights were determined on the basis of the questionnaires.

The attributes of risk evaluation are as follows: x_1 - bid estimates [million €], x_2 - construction duration [months], x_3 - guarantee period for screen works [year], x_4 - guarantee period for finishing works [year], x_5 - experience of firm in construction [year], x_6 - total amount of works performed by contractor [rate], x_7 - level of communication with stakeholders [point], x_8 - quality of performed projects [point]. Calculation results are presented in the tables 1, 2 and 3.

Table 1. Initial decision-making matrix with values

Alternative	Attributes							
	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
	min	min	max	max	max	max	max	max
Attribute weight – q_j	0.18	0.14	0.12	0.09	0.14	0.09	0.10	0.14
A ₁	5.00	26	10	5	13	0.74	8.00	9.01
A ₂	5.54	23	10	10	13	0.61	7.21	9.24
A ₃	4.63	30	10	2	13	0.55	8.51	8.38
A ₄	5.56	22	15	10	18	0.71	9.22	8.15
A ₅	5.14	24	15	2	57	0.77	7.32	8.08
A ₆	4.99	28	10	5	48	0.79	8.48	7.51
A ₇	4.57	29	10	2	15	0.65	7.21	7.84
A ₈	5.15	27	15	5	13	0.72	7.72	7.35
A ₉	5.25	19	10	5	50	0.85	8.50	8.61
A ₁₀	5.31	25	10	10	56	0.72	7.36	8.45

Table 2. Optima attribute values of optimum criterion K_i at a different risk level

Alternative	λ						
	0.000	0.167	0.333	0.500	0.667	0.833	1.000
A ₁	5.753	4.913	4.087	3.239	2.400	4.913	5.753
A ₂	6.045	5.161	4.257	3.397	2.513	5.161	6.045
A ₃	5.192	4.438	3.737	2.933	2.178	4.438	5.192
A ₄	6.719	5.734	4.758	3.770	2.785	5.734	6.719
A ₅	6.455	5.516	4.569	3.644	2.705	5.516	6.455
A ₆	6.265	5.351	4.403	3.529	2.615	5.351	6.265
A ₇	5.180	4.427	3.697	2.926	2.173	4.427	5.180
A ₈	5.799	4.952	4.153	3.263	2.416	4.952	5.799
A ₉	6.768	5.781	4.798	3.813	2.825	5.781	6.768
A ₁₀	6.830	5.831	4.555	3.841	2.843	5.831	6.830

Table 3. Calculation results of construction project profitability analysis

Alternative	A ₁	A ₂	A ₃	A ₄	A ₅	A ₆	A ₇	A ₈	A ₉	A ₁₀
Construction project profitability ratio	0.59	1.07	1.55	1.28	1.85	1.49	2.04	2.42	1.63	2.75

The 10th alternative has been selected the best one according to the calculated optimum criterion values at different risk levels and profitability of construction project.

Conclusion

Profitability of construction project is carried out on a basis of the multi-criteria set to describe current state and the feasible future of projects. The projects under consideration are ranked according to multiple criteria analysis. Practical example shows that the expedient model would be applied in practice. The result of practical example demonstrates that this model successfully would be applied for the solution of practical problem in construction. There is created newly developed model for multi-criteria complex for profitability analysis of construction projects. The determined criteria set, determined weights of each criterion, presented practical example, which was implemented in practice. The proposed model and calculation results show that the proposed model could be successfully applied for practical problem's solution.

On the basis of the solution results the 10th alternative was selected the best according to the profitability of construction project and risk level. Overall, the 10th alternative has been selected the best one according to the calculated optimum criterion values at different risk levels and profitability of construction project.

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