

Challenges of MCA in Public Investment Projects

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Abstract. Paper investigates peculiarities of management of public investment projects subject to State Investment Program (SIP) in Lithuania. Using comparative analysis for compatibility of European Structural and Investment Funds (ESIF) and SIP management systems as well as utilizing multi criteria analysis (MCA) techniques with attention to the Euclidean distance author reveals challenges of rationality of evaluating, selecting and implementing public investment projects according to the requirements of inclusive growth applicable to the country under ESIF management system. In this regard, there is as well noticed that current regulations for public investments under SIP in the country inevitably requires significant improvement in order to ensure the rational use of the state budget funds and comply with the requirements for inclusive growth as set under ESIF management system. Subsequently possible solutions proposed focusing on improving specific tasks of the management process of evaluating, selecting, implementing public investment projects.

Keywords: public investments, project, multiple criteria, analysis, management, evaluation, Euclidean distance.

JEL Classification: D22, D23, D81, D92, L14, L24.

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Introduction

With the Europe 2020 strategy (EC 2010), smart, sustainable and inclusive growth got a more prominent place as it became its main pillars. Its objectives are developing an economy based on knowledge and innovation, promoting a more resource efficient, climate friendly and competitive as well as a high-employment economy delivering social and territorial cohesion. Actions under these priorities aim at modernizing and strengthening society and business with focus on creativity and effectiveness for “greener”, knowledge and innovations based economy. The latter also encompass solutions for employment, education, social protection systems incl. labor participation and reducing structural unemployment, as well as increasing social responsibility among the market participants including public governance organizations.

In order to contribute to the EU strategy on smart, sustainable and inclusive growth the European Structural and Investment Funds (ESIF) focus on the promotion of sustainable and quality economic development with effective employment, labor mobility, health and social security (and inclusion). Consequently, every EU member implements Operational Programs which are specifying concrete areas, measures indicators for the results to be achieved and measured accordingly to the requirements of the Europe 2020 strategy targets. Beside ESIF there is as well the State Investment Program (SIP) in Lithuania aimed to support in principle the same goals (LR 1999; SPM 2002). Consequently, scientific researches on state investment programs alike are not sufficient and fragmentary. There has been no research made in order to form the basis for preparation and effective implementation of economically proven SIP program in concert with ESIF management made until now in Lithuania. In this respect the paper synthesizes a vast spectrum of literature and empirical data in an attempt to systematically approach this issue with specific focus on rationalization of evaluation process of the SIP using multi criteria analysis (MCA) tools. Accordingly, the terms of ESIF measures set for ensuring rational management of related investment processes and the use of funds (in compliance the Europe 2020 strategy goals) will be considered.

Theoretical background and literature review

Traditionally the project is understood as a measure for seeking an advancement (as quantitative as qualitative) when transforming available inputs into particular outcomes. The alternative approach is that the project is seen as a temporary formal (or even informal) structure where a group of individuals temporarily enacts a common cause (Packendorff 1995; Jugdev *et al.* 2001; Packendorff, Lindgren 2014). There is proposed as well another approach (“approach” is understood by the author as certain perception of a reality) on investment project management, suggesting that project work needs to take into account a complexity of actions, social processes also value creation. There is important to understand as well that the project as an open system is interacting with its business environment and respectively stimulate the development of any form of organization acting as a project owner or (and) maker (Winter *et al.* 2006a, 2006b; Winter, Szczepanek 2008, 2009). As a part of this approach, four different perspectives on business projects were considered:

- projects as value creation,
- organizational change,
- intervention,
- service delivery.

In addition, Winter and Szczepanek propose seven pragmatic images for making sense of the complex realities of investments, namely as following: social, political, intervention driven, value creation, development focused, temporary activity, and change driven.

Furthermore, recently another, rather complementary approach on project management could be found (Svejvig, Andersen 2015) with following factors proposed for consideration: the project concept encompassing environment and organizational strategy, social and political aspects, alternative management methods, complexity and uncertainty, rationality of implementations.

Positions given above have one criteria in common – the purpose of the project. In this respect two project management perspectives can be seen:

- the task-oriented (the project is aimed at making a unique product with main focus on compliance with delivery, a budget and requested quality requirements), or
- the organization-oriented (the project is rather a temporary project entity of particular legal form acting in close interaction with a permanent (mother) organization (a founder of a project organization) with main focus on creating value to the mother organization (Andersen 2014, 2016).

As to conventional wisdom a project is regarded as a non-repetitive task (PMI 2014), a temporary activity undertaken to create unique goods, services as well as combination of both. It is a traditionally used a task-oriented approach. In this regard, specifying task-oriented project management approach the objectives of the project are to be set at the beginning of the project, respecting the following three key attributes, namely: the completion date, the budget of the project, the quality specifics of project deliverables.

Consequently, detailed planning is needed at the start of the project. The task is split into subtasks and put together into a concrete action plan. Experts of different categories can be contracted, and the project entity is formed. Responsibilities for the subtasks are assigned among the members of the project entity. Leadership is often dynamic with the mix of liberal, democratic and autocratic reflecting respectively the compliance of the progress with the action plan. The project manager oversees the tasks stimulating the performance by rewards and punishments accordingly.

The project manager will follow up as well with the project risk analysis to reveal potential threats to project success. On the basis of the analysis, the latter decides on mitigation action to secure the project against the risks. Respectively, stakeholder analysis is to be done as to understand which stakeholders represent threats to the project and who will contribute to execution of the project.

The task-oriented approach shows that the task of the project is in focus. The task is defined at the beginning of the project. The project manager with experts team are expected to focus on execution of the task taking care of any challenges faced. The comprehensive plan is prepared and all project team members act according to the plan. Reporting is continuous and in case of any deviations of estimations of deadline, budget and quality of results the corrective measures are applied. Targeted control will secure that objectives are reached as planned. The unique result is achieved at the end of the project implying the end of the project.

In comparison to the context above the organizational perspective is the alternative to task-oriented project management approach. Under this approach project is seen as a temporary organization (respective form of legal entity), established by its mother organization to carry out an assignment on its behalf (Andersen 2014, 2016; Kenis *et al.* 2009).

Considering an organization-oriented, project management focus on the relationship between the permanent and temporary organization. The temporary organization execute an assignment received from the mother organization. Under the organization-oriented approach the project’s goal is to add value to the mother organization having consequently all the project stakeholders working together. This is the prerequisite for progress. Whereas the project should contribute as demanded by the mother organization there have to be established rationally functioning ecosystem with all relevant attributes (resources, processes, outputs). The latter is a living organism thus lifetime of project entity can be adjusted (extended or shortened) according to the specifics of the needs of the mother organization.

Creating value to the mother organization may require significant changes to the latter and thus stipulate a complex of deliveries over the project life time which can be changing according to the mother organization development needs. In this respect, it can be complicated for the project team to make a complete plan at the beginning of the project, however the importance of planning function should not be overlooked. Therefore, the project may have a generalized plan during the start-up with relevant detailed plans developed during implementation process. A project entity has to consist of the team with the knowledge as of the project objectives as of the needs of mother organization and of specifics of its business model. Attention is paid to the trade off of the possible changes in strategy, tactics and operations of the mother organization in terms of arising opportunities and challenges. Hence, in contrast to the task-oriented approach the organization-oriented perspective defines the project as an open (temporary) organization dynamically interacting with the mother organization, its business environment.

While having the second perspective rather justified in comparison to the task-oriented one, the synergy driven combination of both could be considered as even more perspective especially with regard to the Europe 2020 strategy objectives. Whereas such junction has greater potential for effectiveness in terms of strategic, tactical and operations management levels as at project as at organization levels relevant challenges and possible solutions for public investments subject to SIP shall be discussed in following chapters.

Methodology and key findings

The study made is rather qualitative and interpretative and builds on investigation of legislation sources of ESIF (EC 2010) and SIP management system (LR 1999; SPM 2002) with particular focus on regulatory measures subject to investment planning, evaluation, selection and implementation incl. monitoring and control functions. According to the investigation made it can be seen that the transformational change resulting of implementation of the Europe 2020 strategy will need more focus, clear goals and transparent benchmarks for assessing progress. This will require a rational management framework providing relevant instruments (and (or) revealing possibilities how to find and use particular solutions (Kunz *et al.* 2016)) as to business as to public governance to ensure timely and effective implementation. It has to be explained for the purpose of this paper that the term effectiveness concerns whether the objectives formulated (it applies to every party context) are being achieved – what are the actual results? What have been the successes and difficulties, and how appropriate have the solutions chosen been and what is the influence of external factors (Haque 2016). Reasonably, on the other hand, the term efficiency is about comparing the actual outputs and the inputs. In this respect cost minimization is subject to efficiency (and not to the effectiveness if objectives were not achieved).

Working in several (often interrelated) programs (as, e. g., ESIF, SIP) of different size, duration, budget and complexity, and sharing in principle the same resources (as systemic as individual, business or public based), results in the challenges of balancing multiple and heterogeneous demands, rapid adjustments to changing prerequisites and prioritizing ability whereas an organization (whether private or public) as well as an economy (its part, or sector, or its other attribute) is constantly changing. Previous research (Blomquist *et al.* 2010; Zika-Viktorsson *et al.* 2006) on management of various spectrum of investments has shown how fragmentation, disruption and inefficiency caused by switching between commitments to parallel and sometimes conflicting programs, projects may result in a waste of tangible (incl. public funds) and intangible resources. Consequently, investments in question must be considered in the context of complexity of the environment (internal and external) in which they are executed and treated as respective socio-economic accomplishments per particular Europe 2020 strategy objectives. Therefore, for his purpose, it could be reasonable to consider, for example, the respective ESIF strategic management framework (Fig. 1) already transformed into specific prerequisite objectives, measures and actions for all EU members.

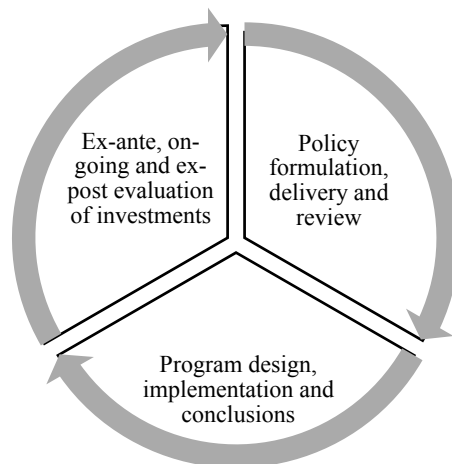


Fig. 1. ESIF strategic management framework (Source: author)

While, having in the mind the context author considers, as the outcome of the research made, ESIF management system as satisfactorily rational (although that can be argued as well as if changing the context of the subject) in terms of its regulatory scope and scale, the SIP management system (LR 1999; SPM 2002), in comparison to ESIF, is subject to severe critics per as strategic, tactical and operational contexts, e.g. as following:

- there are no any criteria, no any lists of result indicators to be used as for evaluation, selection of the projects to be financed via SIP as for the implementation progress control neither for monitoring sustainability of the utility of investment results;
- investment planning and reporting system is not specific if considering role in the SIP management of particular sector ministry;
- networking system among ministries for sector interrelated investments is not determined as well;
- there no any standardized, neither otherwise explicitly made instructions for project makers (as well for sector ministries in charge of SIP) therefore there is no clearly defined prerequisites for the use of cost-benefit analysis and (or) cost effectiveness (neither other more complex multi-criteria analysis methods) for any of interested parties;
- there are no explicit instructions for SIP investments compliance with Europe 2020 strategy which is, as to the comparison, is fundamental for ESIF utilization.

Findings of the investigation let to notice a few regularities on management of public investment projects, namely as following:

- the complexed projects have significantly greater risk exposure as well are more intensively consuming resources in comparison to the average levels of similar (in terms of inputs and deliverables) projects as to acknowledged business practices,
- the complexed projects are significantly more risk exposed to missing deadlines, budget limits and quality requirements for the project results;
- the complexed projects require well-functioning management systems,
- non-effective (as to the findings provided above) supervision of public investments may be even stipulating ineffective use of public funds (Villena, Reus 2016) at least due to a lack or improper application of the risk mitigation measures.
- non-effective supervision of public investment does negatively affect the implementation of well-prepared investment projects.

In order to improve regulatory system as well as contribute to the better project management as of project making or project results consuming party as of any other stakeholder possibilities of application of MCA measures will be considered in the following chapter.

Opportunities for MCA in managing public investments

The crucial function of the MCA measures to be used for is to cope with the difficulties that decision makers have been in most cases experiencing when dealing large amounts of complex and dynamic data (Burdett, Kozan 2016; Renzi, Leali 2016). Following the progress on ESIF projects as well as SIP investments and their management challenges and regularities described in the previous chapter would confirm the latter statement.

Probably all the decisions rely on some weighting systems (Podinovski 2016; Sini *et al.* 2016), though perhaps implicit, and not necessarily consistent (Youcheng, Shouyang 2016; Wu *et al.* 2016). In this regard MCA techniques can be used for identification of a most preferred solution, for ranking the options (Ben-Zvi *et al.* 2016), as well as prioritizing a limited number of alternative for subsequent detailed appraisal, or just in order to distinguish the eligible from not qualified alternatives.

There are many MCA techniques (eg.: MACBETH, SMART, PROMETHEE, REMBRANT, ELECTRE, AHP, COPRAS, TOPSIS, VIKOR (Macharis *et al.* 2004; Behzadian *et al.* 2010; Brito *et al.* 2010; Corrente *et al.* 2014; Yang *et al.* 2016; Masri, Houda 2016; Norese 2016; Omar, Fayek 2016; Scholten *et al.* 2015; Zolfani *et al.* 2014) and their number seem to be growing. The reasons for that could be as following:

- level of analyzability of the objective (in terms of needed input, their transformation and expected output);
- level of variability of the objective;
- level of complexity of the objective;
- timing of analysis needed for the decision making;
- skills needed for the decision making;
- management specifics and requirements.

With respect to these reasons listed above when selecting MCA techniques, the following criteria have to be considered:

- consistency and reasonability;
- transparency;

- simplicity of use in terms of time and other resources;
- data requirements not inconsistent with the importance of the issue being considered;
- ability to provide an audit trail, and software availability, where needed.

Even choosing MCA technique can be an exercise of decision making requiring MCA as well. For example, there are a number of criteria, the performance of each technique could be prepared and scored against each criterion with the criteria weighted in order to build up an overall order of preferences of MCA techniques and decided on the most suited one (Hurson, Siskos 2014; Wei, Zeshui 2016).

A minimum requirement for any multi-criteria analysis, considering the specifics of any MCA technique, is building a performance matrix, where every row describes an option and every column represents the performance of the options against each criterion. The individual performance assessments are often numerical, but may also be expressed in various qualitative terms as well as using mix of them (where due to the compatibility challenges various normalization methods have to be used). Nevertheless, as to the simplest example of MCA, the performance matrix may be the final product of the analysis. For example, there is a performance matrix, consisting of some number of data (which could be as the quantitative as qualitative or mixed and hardly compatible (Fayek, Omar 2016; e.g., a lot of crisp and (or) fuzzy information; Table 1).

Table 1. Performance matrix (Source: author)

	C_1	C_2	...	C_n
A_1	\tilde{n}_{11}	\tilde{n}_{12}	...	\tilde{n}_{1n}
A_2	\tilde{n}_{21}	\tilde{n}_{22}	...	\tilde{n}_{2n}
...
A_m	\tilde{n}_{m1}	\tilde{n}_{m2}	...	\tilde{n}_{mn}

As per performance matrix of the Table 1 (where $A = \{A_1, A_2, \dots, A_m\}$ is, for instance, a set of m investment alternatives, $C = \{C_1, C_2, \dots, C_m\}$ is a set of n criteria, whose weights satisfying $w_j \in [0,1], \sum_{j=1}^n w_j = 1$), the decision makers are then left with the task of assessing the extent to which their objectives are met by the entries in the matrix. Such intuitive processing of the data can be quick and effective, but it may also lead to the use of unjustified assumptions, causing incorrect ranking of options. Hence even relying on cognitive heuristics (this seems to be the case for current SIP management system as per expressed critiques in the previous chapter) may require considering a risk mitigation measures for possible miss-ranking and related consequences.

Perhaps most relatively simplest (as in comparison to those listed above MCA techniques) and reasonably efficient MCA exercise for evaluating and ranking alternatives could be based on Euclidean distance. For instance, if any investment alternatives A, B, C, D and E were characterized by two criteria x and y and ranked according to the Euclidean distance $d = [(x^{max} - x)^2 + (y^{max} - y)^2]^{1/2}$ from the ideal choice $I = (x^{max}, y^{max}) = (11, 12)$ as shown in the Table 2 the following order of preferences is build up: $A > B > D > C$ with A as most preferred. Let us assume that alternative D (1, 12) under first case has been reasonably corrected by the relevant sector ministry in charge of particular SIP objectives to (1, 8) as per second case (Table 2).

Table 2. Changing order of preferences (Source: author)

Investment alternatives	First case			Second case			Third case				
	Criteria		Euclidean distance	Investment alternatives	Criteria		Euclidean distance	Investment alternatives	Criteria		Euclidean distance
	x	y			x	y			x	y	
A	5	7	7,81	A	5	7	6,08	A	5	7	7,21
B	9	4	8,25	B	9	4	4,47	B	9	4	7,28
C	11	0	12,00	C	11	0	8,00	C	11	0	11,00
D	1	12	10,00	D (corrected)	1	8	10,00	D (corrected)	1	8	10,44
E	0	0	0,00	E	0	0	0,00	E (added)	1	11	10,00
Ideal (I)	11	12	0	Ideal (I)	11	8	0	Ideal (I)	11	11	0
Order of preferences:	$A > B > D > C$			$B > A > C > D$; if D corrected			$A > B > E > D > C$; if E added				

Due to the remarks of the ministry the ideal choice is changing as well to $I = (x^{max}, y^{max}) = (11, 8)$ meaning that order of preferences changes into $B > A > C > D$. Since typically (or at least in the number of the calls of ESIF as well as cases of SIP) application process is continuous and (or) repetitive due to annual budgeting for SIP and financing arrangements for ESIF currently up to 2020, the list of investment alternatives can be extended. Respectively let us add as per third case (Table 2) the alternative E (1, 11). Such development, even if E is not the best choice, changes further the order of preferences to $A > B > E > D > C$.

Consequently, taking into account Euclidean distance, the L_p – metric (see Eq. (1)) as an aggregating function have been proposed by Zeleny (2010, 2011):

$$L_{pi} = \left\{ \sum_{j=1}^n [(f_j^* - f_{ij}) / (f_j^* - f_j^-)]^p \right\}^{1/p} \quad 1 \leq p \leq \infty; i = 1, 2, 3, \dots, m. \quad (1)$$

The latter became perhaps one of keystones for such well known multi criteria decision making methods like VIKOR, TOPSIS (Opricovic, Tzeng 2004, 2007).

For example, in the VIKOR method $L_{1,i}$ (as S_i) and $L_{\infty,i}$ (as R_i) are used to formulate order of preferences. The solution obtained by $\min S_i$ is with a maximum group utility (“majority” rule), and the solution obtained by $\min R_i$ is with a minimum individual regret of the “opponent”. Assuming that each alternative is evaluated by each criterion function, the compromise ranking could be performed by comparing the measure of closeness to the ideal alternative. The various m alternatives are denoted as $A_1, A_2, A_3, \dots, A_m$. For alternative A_i , the rating of the j th aspect is denoted by f_{ij} , i.e. f_{ij} is the value of j th criterion function for the alternative A_i ; n is the number of criteria.

Nevertheless, having in the mind the context of those challenges of the SIP management as stated in the previous chapter, the application of MCA techniques seems to be an ambitious endeavor for the SIP projects pipeline. Firstly, SIP management system has to be improved accordingly. Consequently, it has to be ensuring that the following steps of multicriteria decision analysis are respected for all the interested parties directly and indirectly involved:

- setting up evaluation criteria;
- generating alternatives;
- evaluating possible alternative solutions in terms of criteria;
- applying a normative multicriteria analysis method;
- accepting “the best” alternative as an “optimal” (preferred);
- if the final solution is not accepted, decision makers may need to update the data and iterate all the steps from very beginning.

As the result, MCA may provide a framework in which all the interested parties can take part in decision-making. Therefore, MCA may in a quantitative way allow the individual opinions of various counterparties to be taken into consideration, as well as the processing of interactions within complex networks especially when dealing with vast spectrum of heterogeneous investments. Furthermore, the MCA techniques may be helpful in reaching a compromise (as to VIKOR, TOPSIS, for instance) or defining a coalition of views. Despite these factors, due to scoring and weighting challenges as well as fuzziness (Fayek, Omar 2016; Gupta, Mohanty 2016) of the criteria a rationality of multicriteria analysis could be limited to the ex ante evaluation tasks of public investments. The latter as well can be useful for formulation of policies, their programs. Hence, respectively basing upon MCA findings, one may argue that improving SIP can be less rational exercise than just extending the application of ESIF strategic management framework over the SIP projects pipeline. If that were the case, inevitably, measures of restructuring the SIP management system affecting all the authorities in charge would have to be considered.

Conclusions

Findings of the empirical study let to determine a number of systemic weaknesses in the management system of State Investment Program (SIP) in comparison to the European Structural Investment Funds (ESIF) strategic management framework. Under critical approach, the latter could develop even further into severe outcomes in terms of wasted budget funds as well as human and other resources while questionably contributing to the implementation of Europe 2020 strategy objectives. There has to be noticed as well that an organization-oriented project management perspective is the one which is more justified due to its scope especially in the context of Europe 2020 strategy, and the latter is used for ESIF management to reasonable extend. However, this is not the case when analyzing SIP projects pipeline – the use of organization-oriented project management perspective is rather fragmented in most of cases. Furthermore, the study shows that even if there is a variety of MCA techniques (with some limitations of application), it is even more challenging to use them due to the systemic weaknesses determined of SIP management. Nevertheless, the revealed simplicity of application of Euclidean distance in MCA process can be an attempt to influence the insight how planning, formulation, evaluation tasks of project management cycle could be improved. Respectively the results

of the research presented in the paper can be useful for further studies on improving management of investments subject to public interest with pivotal focus on utilization of MCA measures. Due to their variety, the latter potential (and weaknesses) may need more comprehensive analysis especially investigating possibilities of application of specific MCA technique under the particular investment project circumstances and its coherence with relevant country development policies.

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