# EVALUATION OF THE COMPLEXITY OF RESEARCH PROJECTS BY MULTI-CRITERAL DECISION METHODOLOGIES

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The complexity of the projects is in constant ascent thus be understood, analyzed and measured as well using modern project management. The major objective of this article is to define a measure of the complexity of the projects in order to be used in decision-making, especially when looking at a portfolio with several projects, or when studying different parts of a project. The purpose of this paper is to identify the relative factors relative to the four sizes, which are representative of the construction of the complexity framework of a project, and to identify the multiple criteria in the multi-criterion decision-making methodology for assessing the complexity of the project. These tools will allow for a relative measure of the complexity of the project, which may be part of the decision-making process.

Keywords: decision-making methodology, evaluation, research project

## INTRODUCTION

A project represents a unique but temporary effort to achieve technical, scientific results. These results can be reflected in changing the partner or coordinating organization in projects in: processes, performance, products and services. In this sense, human resources, time and financial resources are allocated to generate the results, which can be produced, and / or improved and / or improved, or new skills and new knowledge in the field of project management. Every project is unique because it always represents one of the following parameters that changes: objectives, resources and the environment.

Consequently, project management was created as a structured and formal methodology. The complexity of the project is reflected in the failures and mistakes of a project management. In other words, the growing complexity of the project is a source of continuous growth in the risks of its implementation. Identifying sources of complexity and complexity levels of the project has become a crucial issue in order to practice a modern project management.

The complexity of the project in terms of the system complexity of the project and not the algorithmic complexity in solving project management problems as well as problem programming was discussed in the research by Edmonds (1999), Latva Koivisto (2001) and Nassar and Hegab (2006), researches that were crucial sources in generating this list of 40 measurable indicators of the complexity of a project.

A project can undoubtedly be considered a system. A project exists in a specific environment that aims to achieve context-specific objectives (the teleological aspect). A project must carry out a set of activities using methods and methodologies (the functional aspect). A project has an internal structure composed of human resources, materials, suppliers, tasks, IT systems, etc. (ontological aspect). Finally, a project develops over time by consuming resources, delivering the product, changing members and gaining experience without losing its own identity (genetic aspect). In the view of thinking systems, the evolution of the project system is considered to be a presumption

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of the future underlying perpetuation (Prigogine, 1996), which excludes the use of analytical tools.

The complexity of the project is the property of a project that makes it difficult to understand, predict and control its overall behavior even when there is reasonable overall information about the project system. The determining factors are the ones that define the size of the project, its variety, the interdependence of the project and the context of the project. In other words, the complexity of the project is the property that makes it difficult to understand, to anticipate and to keep under control each of these aspects.

There are two main scientific approaches to complexity (Schlindwein and Ison, 2005):

- The first approach, often known as the descriptive domain of complexity, considers complexity as an intrinsic property of the system, a vision that has induced researchers to try to quantify or measure it.
- A second approach is the perception of complexity, which presents subjectively complexity, because the complexity of a system is improperly understood in the perception of an observer.

Both approaches can be applied to the complexity of the project and the complexity of project management.

Thus, corroborating the information from the literature, we can identify a large number of important factors of the complexity of the project using an approach based on the four main aspects of the thinking systems (Vidal and Marle, 2008).

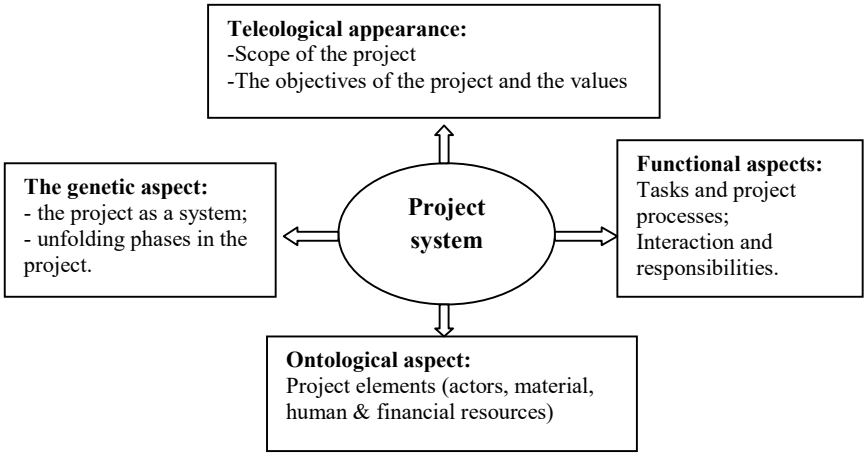


Figure 1. An approach based on systems thinking to describe projects. Source: Vidal, L.A. and Marle, F. (2008), Understanding project complexity: Implications on project management, *Kybernetes*, 37(8), 1094-1110

The first group brings together the factors that are relative to the size of the project system, the second group brings together those relative factors to the variety of the project system. These two first groups correspond globally to the ontological aspect of the project system. The third gathers those that are relative through interdependencies and intercorelations within the project system, which corresponds to some extensions of

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the functional aspects of the project system. Finally, the fourth one functions in a contextual dependence of the complexity of the project, which corresponds mainly to the teleological and genetic aspects of the project system.

The contextual dependence of the complexity of the project was also emphasized by Koivu, Nummelin, Tukiainen, Tainio and Atkin (2004), who insisted on the fact that "the practice and the context applied to a project are not directly transferable to other projects with other institutional and cultural configurations must be taken into account in the project management and leadership processes."

## RESEARCH METHODOLOGY

To draw up a set of relative factors, we aim to follow this methodology:

• Identifying the relative factors relative to the 4 sizes that are representative of the construction of the complexity framework of a project

• Identifying the criteria in the multi-criterion decision methodology for assessing the complexity of the project

### Conceptual Presentation of the Relative Factors in Constructing the Working Framework of the Project Complexity

This concept requires that any project manager identify and characterize a descriptive vision of complexity for all practical purposes. Moreover, it should be remembered that this framework of work is a consensual form of project complexity and that this complexity can not be essentially driven by a generic consensus. This framework should be considered as a starting point for better understanding of complex projects and for identifying the main sources of complexity within a project. To build a framework for the complexity of a project by identifying a set of relative factors means to "stream" the conversion of a flow of processes from a project consisting of activities, information transfer, know-how, material and cost flows, programming limited resources in the project, etc. Nassar and Hegab (2006) defined a measure for the activities covered by the project plans. This measure of complexity is presented with the formula below for an activity in the project network:

$$C_n=100 * (\text{Log}(a/(n-1))/\text{Log}[(n^2-1)/4(n-1)])\% \textit{ if } n \textit{ is unknown}$$
$$C_n=100 * (\text{Log}(a/(n-1))/\text{Log}[n^2/4(n-1)])\% \quad (1)$$

But this formula also has a number of disadvantages due to certain reasons. First of all, some limits have highlighted the safety of these measures is that these measures mainly refer to one complex aspect of the project, notable in terms of interdependence. These mathematical formulas can not refer to factors of the complexity of the project in reality: the identification of sources of complexity of the project and the possible actions for control / reduction of complexity are not facilitated. Moreover, such measures are difficult to calculate for unknown users, which further complicates their implementation and analysis.

A project can be designed, modeled using different WBS (Work Breakdown Structure) maps, PERT networks or GANT graphics, depending on the level of detail, the wishes of the project manager, etc. Consequently, to prevent the disadvantages of these measures, this article aims to establish a framework of project complexity able to point sources of complexity of the project when building measure, so that the user can

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analyze more accurately the complexity of the project and they make decisions with a vision good on the problem.

**Identifying Multiple Criteria in the Multi-Criteria Decision Methodology for Assessing the Complexity of the Project**

Decision-making, even within project management, is the study of identifying and choosing alternatives based on the values and preferences of the decision-maker. Adopting a decision implies that more alternatives have to be considered and only one will best fit the goals, goals, wishes and values of the problem. Gerhson (1981), Deason (1984) and Tecle (1988) show that the problem of selecting the most appropriate method seems to be a multi-criterion itself: in the case of evaluating the complexity of the project, these multiple criteria are proposed in Table 1.

The multi-criteria methods identified are elementary methods, multi-criteria optimization methods, classification methods, or simple methods of approaching the synthesis criterion. They have been checked by corroborating the information in the literature on the identified requirements. The first criteria are evaluated on the Boolean scale, which makes it possible to assert that these criteria are respected by the method or not. Consequently, when a method is tested with 0 for one of these criteria, the next evaluation of the method is no longer executed, and the method is eliminated. Then the set of the last criteria is evaluated on the fifth level of the Likert scale. The assessment of the criteria (adapted to the environment of the project) is based considerably on the information and scientific surveys to test the use of these methods in the project management literature. A difference is found as a comparison in absolute values with the ideal method that would be marked with the 5th mark on each criterion in this set.

Table 1. Identify multiple criteria in multi-criteria decision making methodology for project complexity assessment

| Criteria | Description of requirements |
|---|---|
| Multi-criteria | The method should be able to compare alternatives on multiple criteria of natural differences. |
| Identification of qualitative criteria | The method should also be able to handle the qualitative criteria, in addition to the quantitative ones. |
| Criteria prioritization | The method should be able to determine the user to prioritize the criteria, because they may have different influences. |
| The evaluation of a set of discrete alternatives | The method should be able to look for the best alternative in a discrete alternative sett known initially. |
| Classification of alternatives | The method should not only provide the most complex project in the portfolio but also prioritize the functions of the projects according to their level of complexity. |
| Classification of alternatives according to the cardinal scale | The method should classify alternatives according to the cardinal scale. This scale is used after building a cardinal relative complexity measures we have proposed it. |
| Safety | The method should provide a safe result for being eligible in decision-making support. |
| Registration | The method should be recorded to make rapid calculations on computers |
| Easy interface | The method should have an easy interface; this includes two aspects, namely not requiring special skills to run the processes and |

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| Criteria | Description of requirements |
|---|---|
| | the results to be easy to understand and manage. |
| Autonomy | Users (mainly project managers) should be autonomous and should be able to make changes. |
| Evolution | Changes need to be easy to implement |
| Adaptation to the project environment | The method should be adapted to decision-making processes in the project environment and take into account project characteristics (limitations, abilities, information systems, need for networking, etc.) |

Regarding the problem of evaluating the complexity of the project, it is preferable to use the analytical method (AHP), due to the numerous applications within the context of the project management. According to Al-Harbi, 2001 "AHP has a flexible and repetitive assessment procedure that can be easily understood by which decision-maker in selecting the right software tool for project management." This analytical method is also used for analyzing and evaluating project risks, assuming the project's risks are more important. AHP allows integration of both qualitative and quantitative aspects of decision making, making it more effective and efficient in more complex contexts.

If we consider alternatives: projects, or possible future projects compared to the initial ones, the stages of a given project or possible future project scenarios in a mono-project environment, and to be the score of the priority $A_i$ alternatives obtained due to calculations of the AHP analytical method ($0 \leq S_i \leq 1$), we propose that the relative complexity of the $A_i$ alternatives, given the specific context of the set of alternatives, can be expressed under the following ratio:

$$CI_i = \frac{S(i)}{\max(S(i))} \rightarrow 0 \leqslant CI_i \leqslant 1 \quad (2)$$

A relative scale of the complexity of the project between 0 and 1 can thus be built due to this method. This index allows the classification of projects / scenarios of projects / phases of a project according to the main sources of complexity of the project. This scale allows us to provide a relatively complex indicator of the project, because it is closely related to the initial set of alternatives. But this indicator does not depend on the project models, but only on the evaluation of the expert in projects related to the evaluation criteria. The sub-scales can be defined in the same way to focus on the specific aspects of project complexity and to highlight how a project is complex in terms of interdependence or scientific or technical context.

## CONCLUSIONS

This paper elaborates a methodology based on an analytical hierarchical process and the measure of evaluating the relative complexity of a project. Of the project models that are used for project management (WBS, PERT networks, Gantt diagrams, risk lists, etc.), none of these models are needed as a reference to evaluate the complexity of the project. The ability to highlight the sources of complexity of the project when building scale and complexity subscales, these scales allow the user to address more issues in terms of decision-making and project complexity.

In project management, in addition to its performance, out-of-the-out terms, intermediate results, a correct assessment of project complexity - is one of the criteria to

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be considered before deciding on project management. Some aspects of the complexity of the project are very present or specific to any area of project activity.

Another conclusion is that it is important to prioritize projects within a project portfolio in order to focus on the most complex projects (those where more than complex management methods and tools are needed). Project managers should pay special attention to the complexity of the project to get the best relative score. On the contrary, some aspects of the complexity of the project (low scores) can potentially be neglected at first glance. This set of information allows managers to focus more effectively on the main complexity factors of the project according to the project environment. Future research will explore the possibility of extending this conceptual model to assess the complexity of a project through an ANA (Process Analytic Network) model. Building an NAP network structure to assess the complexity of the project may be interesting because it includes interdependence and feedback.

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