PROJECT PORTFOLIO SELECTION IN A COLOMBIAN HOLDING COMPANY

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ABSTRACT

The adequate project selection allows companies to invest resources in specific initiatives that allow them to achieve their strategic objectives and to become more competitive. In contrast, non-adequate projects selection can burden the organizations with large investments that do not impact positively in the organization in general. This paper shows an application of Promethee I method, fifth version, as a multi-criteria method to support the strategic projects selection process, and a sensitivity analysis that were both carried out at the beginning of the planning period in a Colombian holding company. The application of Promethee I in a base scenario, and the development of two alternative scenarios allowed to identify that in the case study's portfolio there are projects with a very high preference, regardless of the criteria weight. Similarly, it allowed to identify the least preferred projects. These results are an important input for projects selection decision-making to be carried out by the holding company board of directors. Moreover, it was identified that the case study's holding company should focus efforts on the relative weights definition and on the measurement scale of each criterion, as this has a significant impact on the results obtained.

INTRODUCTION

Companies grow and expand through strategic projects that add value to their operations (Martins and Kunc, 2015), making projects a meaningful mean to implement the organization's strategy and achieve organizational success (Chih and Zwikael, 2014).

Projects selection is part of important decisions that managers have to make. A wrong decision has negative effects on the organization, such as resource waste in inadequate projects, loss of benefit that could have been obtained by investing in more profitable projects and failure to achieve the strategic objectives, and with this, the strategy is not deployed adequately (Rahmani, Talebpour and Ahmadi, 2012). Consequently, the way in which companies choose their projects may determine their competitive advantage.

The developed case study is about decision making by the Colombian holding company's board of directors, in relation to the definition of the strategic projects to be selected, financed and executed in a specific planning period. Colombian Holding Company selected for this research pertain at the services sector and it comprises more of 8 companies or business units. They operate in several subsectors providing different services, such as financial, insurance, among others.

For the board of directors, it is important that the projects selection process allows a general discussion about each project and its importance in relation to the other possible projects. However, the high number of projects among which they must choose, the diversity of projects' types and the multiple criteria that must be taken into account in the decision-making process, currently generates unstructured discussions and in most occasions lead to a situation where the analysis process is not carried out systematically and in an organized way.

This problem has been reflected in difficulties when executing the selected projects, namely by early closing of projects and not obtaining the expected results, both at project and strategic levels. In view of this situation, the research question is: How can the strategic project selection process of the holding company be carried out in a systematic way, allowing discussion among the decision-makers?

The objective of this work is to propose a method that focus on one of the three aspects that generate difficulties in the projects' selection process of the Colombian holding company case study, specifically on the aspect related to high number of projects to compare at the same time of making debates among the decision makers. Thus, the aspects related to the diversity of types of projects, and to the multiple criteria -for the proposal we work with the criteria that the holding company use currently- are not included in the present proposal and will be subject of future research.

Thus, in this paper we present a proposal that supports the projects selection process in a Colombian holding company, which includes the Promethee I method (fifth version) application and a sensitivity analysis. This proposal allows obtaining a list of preferences among

projects on which the decision-makers can carry out an organized discussion -the preference list is based on the decision criteria define by the holding company- analyzing the preferences among projects delivered by the model, in contrast to having to make the comparison between all the projects of the portfolio, which reduces the dimension of the comparison problem and delivers an ordered list of preferences between projects, allowing a structured analysis.

The remaining paper is organized as follows. Section 2 presents the concepts and definitions on project portfolio management (PPM) and project selection. Section 3 presents the case study background and the methodology followed, namely it describes data collection methods, how data was analyzed, and it shows the Promethee I method application. Section 4 presents the results of the Promethee I method application and Section 5 presents analysis and discussion of the results. Finally, we present conclusions and some highlights for further research.

BACKGROUND

For better understanding the case study problem some concepts and definitions of PPM and project selection are presented.

Project Portfolio Management

The success of the strategy deployment of an organization is based on the adequate PPM, being the PPM the link between projects and the strategy. For this reason, it is necessary that decision makers always have an organization general vision and the organization goals to deploy PPM (Clegg, Killen, and Biesenthal, 2018).

Therefore, while project management corresponds to operational and tactical processes, PPM is an organizational strategic process, where the prioritization of the project portfolio is one of the main functions in favor to project portfolio alignment with the strategic objectives of the organization (Clegg et al., 2018).

The Markowitz portfolio theory is considered as the origin of portfolio management, which has focus on decision making for capital investment (Hoffman, Spalek and Grela, 2017). Nowadays, a project portfolio is considered as "a collection of single projects and programs that are carried out under a single sponsorship and typically compete for scarce resources. A coordinated project portfolio reflects an organization's investment strategy, adds value beyond the results of an individually managed project, and optimises the available resources" (Hoffman et al., 2017, p. 2).

The traditional approach to project management considers projects as being independent of each other (Laslo, 2010). However, the vast majority of projects take place as one of a group of projects, either a program or a portfolio of projects. Turner (2009) defends that only ten per cent of all projects activity are managed in an isolated way, while the majority of projects are part of a portfolio or program, in which:

- they deliver objectives which attain the full benefit only when several projects have been completed;
- they are dependent on other projects or operations for elements essential to their completion, such as data, new technologies, or raw materials;
- they borrow resources from a central pool and the resources remain within the control of the resource managers; the manager must negotiate release of the resources to the project and may lose them at little or no notice as the organization's overall priorities change.

Portfolio management is the centralized management of one or more portfolios, which includes identifying, prioritizing, authorizing, managing, and controlling projects, programs and other related work, to achieve specific strategic business objectives (PMI, 2017). One important activity of portfolio management is project prioritization, since usually there are more projects available for selection than can be undertaken within the physical and financial constraints of a firm, so choices must be made in making up a suitable project portfolio (Archer & Ghasemzadeh, 1999).

Project Selection

The project selection is an important issue in different organizations, public or private. Some examples of project selections are: new products to launch, investment in infrastructure projects and commitments to policy actions. In this context, the Problem Decision Analysis (PDA) methods have a relevant role as support for decision making processes. In particular, the PDA methods for project portfolio selection capture the properties of the proposal and the preferences of the decision makers (Tervonena, Liesiöb and Saloc, 2017).

Companies must determine their project portfolio composition, as projects usually compete for a limited set of resources. For this, the companies define and use processes and tools that allow to decide which projects to finance, which to discard and which to leave waiting for future available resources (Martins and Kunc, 2015).

In this context, the literature reports numerous PDA methods applications, as well as highlights the practical contributions of its application by allowing multiple attributes to be included in the decision-making process. (Tervonena, Liesiöb and Saloc, 2017). The benefits of studying and working these problems with a multicriteria approach are recognized by different authors, like Kaplan and Ranjithan (2007) and Liesio, Mild and Saloc (2007), among others.

CASE STUDY METHODOLOGY

Case Study Background

The Colombian holding company is focus in services sector. The holding company generates 15.000 jobs, and it is one of the top 20 more important companies in Colombia. Each company must submit annually to the central Project Management Office -PMO- the strategic projects proposed for the next period. The PMO reviews,

categorizes and classifies the projects proposed by the twelve companies. The projects are presented to the holding company board of directors, and the decision of which projects to select is made through the qualitative comparison of the criteria established by the PMO.

Data Collection

The project portfolio case study was retrieved from a set of strategic projects registered in the Project Management Office of a Colombian holding company. The information about the number of projects, type of projects and its attributes, criteria used, as well as the ratings assigned to each project in each criterion was provided by the case study's Project Management Office. The projects correspond to the total number of projects to be analyzed by the holding company board of directors (chief executive, area directors and project office director) in order to define the projects that will be executed in the next strategic period.

The project portfolio is composed by 20 projects, where it is necessary that each project would have impact in at least 2 of the 12 companies that belong to the holding company. The criteria that are currently evaluated for each project are: strategic alignment, participation, efficiency, complexity, service, culture and people, risk and result. The first six criteria are assessed qualitatively by the Project Management Office based on the information provided by the company that proposes the project. For this, a Likert scale with 1 as a minimum value and 5 as a maximum value is used. Result criterion, is measured by the company that proposes the project, is equivalent to Net Present Value -NPV- (COP\$, Colombian Peso); risk criterion is measured as the NPV standard deviation.

Table 1 shows an example of the assessment of three projects that belong to the portfolio. Due to a confidential agreement with the holding company, risk and result values that are presented are a linear transformation of the original values for these criteria.

Table 1: Example of assessment for three projects

N.	Criteria	A	B	C
C1	Strategic alignment	2.00	2.00	2.00
C2	Participation	1.00	1.00	1.00
C3	Efficiency	4.00	4.00	3.00
C4	Complexity	1.00	1.00	1.00
C5	Service	1.00	3.00	2.00
C6	Culture & People	3.00	4.00	4.00
C7	Risk	0.78	0.17	0.22
C8	Result	0.34	0.52	0.37

Promethee I Method Application

For the comparison of the projects, the multicriteria method Promethee I (fifth version) was used. Promethee is part of the methods that allow us to approach the problem of decision analysis -PDA- from a multicriteria approach, and it is relatively easy to understand for the decision makers (Vinodh and Girubha, 2012).

Promethee I method results in the partial ranking, and define a preferences flow between alternatives, building a preferences positive flow and a preferences negative flow. One alternative is better than another when it is better for both positive and negative preference, and because of this procedure some alternatives could not be compared (Vinodh and Girubha, 2012).

This method was used because it delivers information about the preference between projects according with qualifications that each project obtained in each criterion. With this information the decision-makers can carry out an analysis around the preferences between projects and, based on this, the holding company directors can make the decision of which projects to execute in the next strategic period.

For the Promethee I method application, the eight criteria scales were normalized and converted into a numerical scale between 0 and 1. In all cases, values of 1 or close to 1 are the best possible score; values of 0 or close to 0 are the worst possible score. Thus, a project with a value of 1 in risk criterion represents the lowest level of risk (best possible score in the scale), while a project with a value of 0 in the risk criterion represents the highest level of risk in the entire portfolio (worst possible score in the scale).

As the initial scale of the criteria strategic alignment, participation, efficiency, culture and people, complexity and service, are assessed in a Likert scale between 1 and 5, the resulting standardized values vary by 0.2 units homogeneously, generating 5 values for each criterion. For this reason, it was decided not to apply values associated with limits of preference [q] and indifference [p] for those criteria. Appendix 1 shows the standardized data (scale 0-1) for attributes of each project.

Equation 1 shows the expression to calculate the dominance between each pair of projects (defined as *a* and *b*) $[C_i(a,b)]$ for each criterion "i" equivalent to strategic alignment, participation, efficiency, culture and people, complexity and service.

$$C_i(a,b) = \begin{cases} 1, if: a_i \geq b_i \\ 0, if: a_i < b_i \end{cases} \quad (1)$$

Where a_i is the value of attribute "i" for the project a, and b_i is the value of the same attribute for the project b. Equation 2, 3 and 4 show the expression to calculate the dominance between each pair of projects for risk and result criteria.

$$C_i(a,b) = 1, if: a_i + q_i \geq b_i \quad (2)$$

$$C_i(a,b) = 0, if: a_i + p_i \leq b_i \quad (3)$$

If equation (1) or (2) is not satisfied, expression for dominance is:

$$C_i(a,b) = \frac{a_i - b_i + p_i}{p_i - q_i} \quad (4)$$

Where 'q$_i$' and 'p$_i$' represent, for Promethee I (fifth version), preference and indifference limits respectively.

The values of the preference [q] and indifference [p] limits were defined by the Project Management Office director, being q = 0.05 and p = 0.10. The overall dominance level of a project "a" over a project "b", that is the input for dominance matrix, is shown in equation 5, where W_i is the weight of criterion "i".

$$C(a,b) = \sum_i W_i * C_i(a,b) \qquad (5)$$

Relative weights of each criterion correspond to the weights currently used by the holding company's Project Management Office, since, as mentioned above, the focus of the case study is not the definition of the criteria and their weights. Table 2 shows the weights of each criterion.

Table 2: Decision criteria weights

Strategic alignment (C1)	20%
Participation (C2)	10%
Efficiency (C3)	10%
Complexity (C4)	10%
Service (C5)	15%
Culture & People (C6)	10%
Risk (C7)	10%
Result (C8)	15%

Decision Process – Sensitivity Analysis

As an important input for the decision process, a sensitivity analysis was carried out. The scenarios focused on the variation of the weights of the criteria to identify possible alterations in project preferences order. The following scenarios were developed:

- *Scenario 1: In this scenario the criteria strategic alignment, service and result, accounting for 50% of the overall weight, have twice their initial weight; the other criteria have no weight in the decision.*
- *Scenario 2: All criteria have the same weight (12.5%).*

RESULTS

The sum of the scores of the rows of the matrix "C(a,b)" allows to establish the degree at which each project is better than the others, i.e. one project is better than another if the sum of the values of the rows is greater than the same sum for another project. On the other hand, the sum of the columns of the matrix "C(a,b)" allows to establish the degree to which other projects are better than the project to which the row corresponds (higher values indicate that other projects are better).

Figure 1.a orders the projects from highest to lowest according to the value obtained from the sum of the rows of the matrix C (a, b), and figure 1.b orders the projects from lowest to highest according to the sum of the columns of the matrix C (a, b).
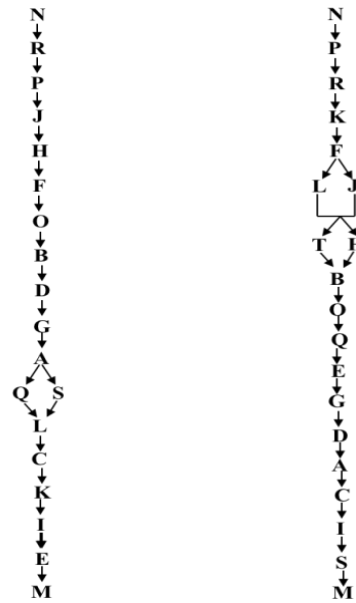

Figure 1: Hierarchy of C(a,b)
a. Sum of rows C(a,b)   b. Sum of columns C(a,b)

The Promethee I method applied to the project portfolio selected, through the combination of the hierarchies presented in Figure 1.a and 1.b, allowed establishing the order of preference among projects, as shown in Figure 2. It can be seen that project "N" has the highest preference in the portfolio, followed by the projects "P" and "R". Projects "I", "E" and "T" are shown as very low preference projects, these being preferred only over project "M", which is the least preferred project of the portfolio.
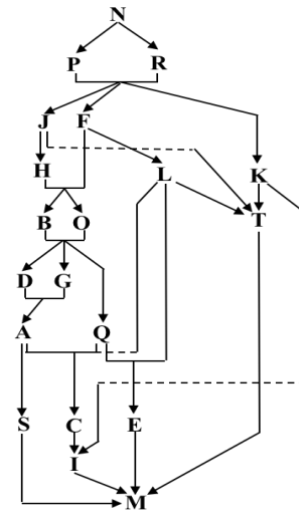

Figure 2: Preferences among projects

The results of scenario 1 and scenario 2 are shown in Figures 3.a and 3.b respectively.
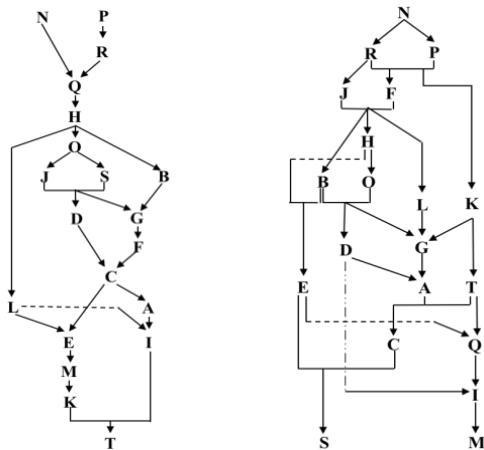
Figure 3: Sensitivity analysis - scenarios 1 and 2 results
a. Scenario 1   b. Scenario 2

DISCUSSION

Case study results allow to identify the hierarchy of dominance among the projects of the portfolio. This allows the decision-makers, in this case, the directors of the holding company, not to carry out the analysis of portfolio project by project but in terms of dominance hierarchy. Thus, for the example presented, the decision makers should understand that based on the qualifications assigned to each criterion, project "N" is the project that dominates the other 19 projects.

In this sense, the decision-making process related to which projects to select can be done by selecting the project with the highest preference (Figure 1) and continue the selection going down along the hierarchy of preferences, i.e, the process starts at the highest level and follow through with next below level; whenever necessary making the analysis among the projects for which a relationship of dominance could not be established. Focusing on the analysis between projects that do not show dominance among them, reduces the difficulty of the decision-making process, on one hand by decreasing the number of comparisons to be made, and on the other hand, by delivering a systemic structure to help on deciding which projects to select, going from having to make 190 comparisons -review each pair of projects- to make only 37 comparisons.

Additionally, the sensitivity analysis shows that for the strategic projects portfolio of the holding company case study, "N", "P" and "R" projects are always the three projects that are most preferred, which suggests that those are the projects that should be selected, given the superior results expected from them compared to the other projects in the portfolio.

For the based scenario and the two sensitivity scenarios studied, it was found that project "M" is always among the three least preferred projects of the portfolio, being the least preferred project of portfolio in two of three scenarios. This suggests that this project could be eliminated from the analysis that should be carried out by the holding company executives to decide which projects

will be selected. In this same sense, projects "I", "E", "A" and "C", in all scenarios, are among the 45% of lower preference projects, which suggests that they are unattractive projects for the organization, regardless of the importance weight that decision-makers assign to decision criteria.

Although sensitivity scenario 2 shows some variations in preference hierarchy of the projects compared to the baseline scenario, these variations are not highly significant, maintaining the hierarchy of preferences between both scenarios. This is due to the fact that in the baseline scenario all the criteria have a weight that corresponds to 10% or 15%, with exception of strategic alignment criterion that weighs 20%, being the difference of weights non-significant compared to scenario 2 that proposed having all the criteria with the same weight (12.5 %).

A different situation occurs in sensitivity scenario 1, which shows some important preference variations. An example is the preference of project "Q", which in baseline scenario and scenario 2 is part of the 8 projects of least preferred, while in scenario 1 it is part of the 4 projects of most preferred. A similar situation also occurs with the project "S". This shows that the holding company decision makers must work in order to define weights of criteria in a structured way, which will allow them to guarantee that the importance of each criterion reflects correctly their preferences; otherwise, project selection processes could lead to wrong decisions.

In the results presented, from the qualitative point of view of the authors of this paper, some of the projects presented numerical values of global preference with insignificant differences. This raises the need to go deeper in identifying which numerical differences in the values of global preference between projects could be considered significant in practice, identifying for example, reference values for preference and indifference limits in final results among projects. This could give greater robustness to the results obtained.

CONCLUSIONS AND FURTHER RESEARCH

Promethee I method, fifth version, made possible to reduce the difficulty of the decision-making process for projects selection of project portfolio studied. This was achieved through the reduction of the number of elements to be compared, by going from comparing project versus project to analyzing preferences between projects, and only doing so in cases where the result did not show preference.

The difficulty reduction is also due to the order of preferences between projects that result from Promethee I method application. The result gives a systematic path to be followed by decision-makers (holding company management) in its analysis and comparison process and in the definition of which projects should be selected. This is because the preference between projects itself, provides a sequence of comparisons to be analyzed.

In business contexts, as the case study demonstrated, sensitivity analysis is a technique that provides valuable information to decision makers. The identification of

changes in preferences between projects when the weights of some criteria are modified, allows the decision-maker to better understand the composition of the portfolio and the dimension of its benefits and impacts in the final decision.

The subjective assessment of 6 of the 8 criteria makes the current process influenceable through the information provided by those that propose a project. Therefore, we must work on the definition of linguistic scales and standardized tables of qualitative qualification that allow us to reduce the bias and the interpretation of the qualification given the same criterion for different projects.

Evaluation functions that incorporate the preference of the decision-makers could be added, and it can give greater strength to the projects comparison, thus, the holding company's decision-makers value function could be represented according to subjective rating of each criterion. In order to do this, it is necessary to study in detail the decision-making process carried out by the board of directors of the holding group in order to represent the rating of each criterion according to the preferences of the decision-makers.

Due to the case study scope delimitations, aspects related to the criteria to be used, the criteria weights and the effects of projects typology were not analyzed. These aspects present an opportunity for future research and thus improve the decision-making process of the company.

Specifically, the criteria definition and the criteria weights assignment must be reviewed in the project portfolio, because the analysis of the results showed that this aspect has influence on the preference relationships that are delivered as an input to the decision-making process.

Moreover, the integration on the processes associated with risk measurement for each of the established criteria is also an opportunity for future work, since in the present case study only the risk associated with the result criterion was analyzed.

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Appendix 1: Standardized data (scale 0-1) for attributes of each project

	Criteria							
	C1	C2	C3	C4	**C5**	**C6**	**C7**	**C8**
A	0.50	0.00	1.00	0.00	0.00	0.50	0.73	0.36
B	0.50	0.00	1.00	0.00	0.50	0.75	0.00	0.48
C	0.50	0.00	0.67	0.00	0.25	0.75	0.07	0.32
D	0.50	0.00	1.00	0.00	0.00	0.50	0.50	0.76
E	0.00	0.00	1.00	0.00	0.25	0.75	0.33	0.63
F	0.50	0.50	0.67	0.00	0.75	0.75	0.87	0.13
G	0.50	0.50	0.67	0.00	1.00	0.50	0.50	0.00
H	0.50	0.00	1.00	0.00	0.50	0.50	0.50	0.70
I	0.50	0.00	0.00	0.50	0.00	0.50	0.97	0.04
J	0.50	0.75	0.67	0.00	1.00	0.75	0.57	0.09
K	0.00	0.00	0.67	1.00	0.00	1.00	1.00	0.47
L	0.00	1.00	0.67	0.00	0.75	0.50	0.53	0.85
M	0.00	0.00	0.00	0.00	0.00	0.75	0.83	0.51
N	1.00	0.50	1.00	0.50	1.00	0.75	0.60	0.58
O	0.50	0.00	0.00	0.00	0.00	0.75	0.83	0.92
P	0.50	1.00	0.33	0.50	1.00	0.50	0.43	1.00
Q	0.50	0.50	0.00	0.00	0.25	0.50	0.03	0.93
R	0.50	1.00	0.67	0.00	1.00	0.75	0.47	0.71
S	0.50	0.00	0.67	0.00	1.00	0.50	0.03	0.08
T	0.00	0.75	0.67	0.75	0.00	0.50	1.00	0.38