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Additional Information

USING THE STRATEGIC RELATIVE ALIGNMENT INDEX FOR THE SELECTION OF
PORTFOLIO PROJECTS

APPLICATION TO A PUBLIC VENEZUELAN POWER CORPORATION

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9 **Abstract**

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11 In this paper a new approach that uses the alignment of projects with corporate strategic
12 objectives to prioritize project portfolio in an efficient and reliable way is presented. For this
13 purpose, corporate strategic objectives will be used as prioritization criteria to obtain the
14 Relative Alignment Index (RAI) of each project which indicates how close or far each project is
15 from the strategic objectives of the company. The approach presented uses the Analytic
16 Network Process. This technique allows considering the influences among all the elements
17 within the network, that means, the strategic objectives, and specially the projects within a
18 portfolio. The proposed RAI index helps to select the best strategically aligned projects for the
19 organization. The proposed RAI index and its form of evaluation have not previously been
20 considered in the project portfolio literature until now.
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24 The research methodology for the development of RAI is based on a combination of a synthesis
25 of the literature across the diverse fields of project management, project alignment, multicriteria
26 decision methods and a parallel analysis of an industrial case study. The use of the proposed
27 RAI index is demonstrated using a rigorous methodology with acceptable complexity which
28 seeks to assist managers of the National Electricity Corporation of Venezuela, recently founded
29 and composed by 13 merging old companies, both public and private, in their yearly resources´
30 assignment on their projects portfolio. The aim being to determine a projects ´ranking based on
31 their degree of alignment to corporate strategy and on the judgments of a group of experts, such
32 as the management board. The new corporation assumed the challenge of setting strategic
33 directions (Mission, Vision, Values, Strategic objectives, Plans, Programs, etc.) common to all
34 merging companies. This approach with multi-stakeholders support allows managers to
35 strategically allocate resources to each project in a consensual way.
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39 *Keywords: Strategic Alignment, Project Portfolio; Power Corporation Case Study; Analytic*
40 *Network Project; Multicriteria Decision Analysis.*
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44 **1. Introduction to project prioritization and project alignment.**

45 Organizations using projects as ways to develop corporate strategies believe that the most
46 complex phase of the process is strategy implementation. Cause of this complexity is failing in
47 establishing adequate relationships between business strategy and project portfolio management
48 that is called “strategic alignment”. This issue can be analyzed using the general model
49 proposed by Meskendahl (2010) and can be seen as disconnection between Strategic Orientation
50 and Project Portfolio Structuring. According to Mankins and Steele (2005), this disconnection
51 may cause organizations to barely accomplish a 63% of the total potential value of their
52 strategies or, as suggested by Johnson (2004), only 44% of the corporate strategy is actually
53 implemented. Since these results are evident in the execution phase of a project, organizations
54 have focused on project portfolio management, (defined as the simultaneous management of
55 multiple projects whose characteristics are seen as a single entity) and the direct relationships
56 between the projects of the portfolio and the strategic objectives of the organization (Artto and
57 Dietrich, 2004; Dickinson et al., 2001).
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1 Also, organizations rely on project management offices (PMO) as the units within the business
2 in charge of bridging the gap between strategic planning and portfolio management. PMOs are
3 essential for business success given the complexity involved in managing several projects. The
4 projects are managed in interdisciplinary and variable scenarios and with tight budgets.
5 Therefore, project management has gradually become a highly specialized discipline and
6 specific competencies are required.

7 *Project prioritization* consists on assigning priority or rank order to projects within a portfolio
8 based on a set of priority criteria, whose diversity and classification has been addressed by
9 several authors such as Crawford et al. (2002), Shenhar et al. (2002) and Youker (1999). Other
10 studies have determined the influence of portfolio prioritization as a key factor for business
11 success (Cooper et al., 1999; Elonen and Arto, 2003; Fricke et al., 2000). The aim of portfolio
12 prioritization is to establish an order of importance among the projects in order to determine
13 which projects to implement and which not, such as making decisions on strategic investments
14 in manufacturing technology (Tan et al., 2011).

17 **Project prioritization** is a multidimensional process because it involves a wide range of criteria:
18 technical, economic, social, political and environmental (Meade, 2002; Dey, 2006), and the
19 complex relationships among them so that the process should be repeated regularly, at least
20 once every year (Petit, Y. 2012). It should consider the interdependence of the projects in the
21 portfolio to assess not only the importance of the projects for the achievement of business
22 strategy, but also the influence of certain projects on the other projects of the same portfolio
23 (Patanakul, 2013). Tan et al. (2006) propose managers should use their knowledge and
24 experience of previously delivered projects as an input to the prioritization of future projects.
25 This approach is based on historical cases.

28 *Alignment* is a concept addressed in the literature on project portfolio management
29 (Srivannaboon and Milosevic, 2006) and is defined as the degree to which a project contributes
30 to business strategy (Bergeron et al., 2001). Alignment is realized when all the elements that
31 make up the company (organization, people, processes, projects and technologies) are consistent
32 with the achievement of its objectives. This alignment is the result of proper corporate
33 management. According to Kaplan and Norton (Kaplan and Norton, 1996) alignment can also
34 be defined as the ability of the organization to concentrate all its effort towards achieving
35 objectives expressed in its scorecard: "When everyone understands the long-term goals of the
36 business unit and the action plans to achieve these objectives, all efforts and initiatives of the
37 organization can be aligned with the necessary processes of transformation." The work of
38 Dietrich and Lehtonen (2005) clearly showed that companies that linked the formulation of the
39 project portfolio to strategic planning improved alignment and consequently performance.

42 Efficient corporate management includes, among others, the development of integrated and
43 balanced strategic goals that consider shareholder's financial objectives, but also customer
44 satisfaction, operational and organizational efficiency and quality of life and professional
45 development of workers and society (Kaplan and Norton, 2000). This set of objectives should
46 be the benchmark for all components of the organization, from top management to the units and
47 departments. The breakdown of these objectives into strategic and operational types helps
48 diagnose the organization.

51 Several authors have addressed the issue of alignment of projects with business objectives from
52 the perspective of managerial leadership, change management, project management or a
53 combination of some of these, generating Strategic Alignment Models such as the model of Box
54 and Platts (2005), based on a set of operational management techniques called Business Process
55 Management. Morris and Pinto (2005) also address the alignment of projects to corporate
56 strategy from a business process perspective. Most of the literature on strategic project
57 management emphasizes the importance of aligning projects with corporate strategy as a way to
58 generate value (Bai and Sarkis, 2013). One of the best known models that link a portfolio of
59

1 projects to business strategy is Turner's model (Turner, 1998) in which the business strategy
2 generates a cascading strategy frame for portfolios, processes, plans and projects.

3 In this paper, we propose a way to rank projects of company's portfolio according to their
4 strategic alignment. That means, to measure the estimated contribution of a given project to the
5 achievement of the company's strategy.

6 As far as the authors know, no previous model can be found in the literature which uses the
7 concept of degree of alignment to rank order projects and therefore, for resource allocation.

8 Also, when linking the aspects related to project prioritization: multidimensional nature and
9 influence among projects within a portfolio we notice that the models proposed in the literature
10 for project alignment lack a deeper analysis of this two main issues: (i) the complex
11 relationships among the strategic objectives and (ii) the consideration that the projects within a
12 portfolio may influence each other.

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14 In this paper we want to go one step further and present a model to address these shortcomings
15 based on the following assumptions:

16 a) Project prioritization is a multidimensional process (Meade, 2002).

17 b) Project prioritization should consider the interdependence of the projects in the portfolio to
18 assess not only the importance of the projects for the achievement of business strategy, but also
19 the influence of certain projects on the other projects of the same portfolio (Killen and Kjaer,
20 2012).

21 c) The information required for project prioritization can be qualitative, subjective and
22 probabilistically or lexically uncertain (Ghapanchi et al, 2012); consequently the prioritization
23 process involves making estimates.

24 d) Experience and knowledge of the agents involved in the prioritization process is as important
25 as the methodology itself; therefore a key factor is the right selection of experts.

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28 The challenge addressed in this paper is to propose a methodology for the selection and
29 prioritization of projects that best align to corporate strategy. Project selection and prioritization
30 is based on the estimated contribution of each project to the achievement of the business
31 strategy, the portfolio or the program, depending on the model chosen. This level of alignment
32 (called "Relative Alignment Index") is determined by using the Strategic Objectives of the
33 company as prioritization criteria and the Multi-criterion Decision Making technique (MCDA)
34 called Analytic Network Process (ANP) as the decision tool for project prioritization. The
35 higher the contribution to the achievement of the objectives the better ranked the project will be.

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38 The novelty of the proposed methodology lies in allowing consider (i) the complex relationships
39 among the strategic objectives, (ii) the consideration that the projects within a portfolio may
40 influence each other and (iii) the participation of multiple stakeholders, as the company's board
41 of managers.

42 The rest of the paper is addressed the following way: section 2 presents an overview of the
43 literature on the use of MCDA techniques in project portfolio prioritization; section 3 presents a
44 detailed description of the ANP technique, section 4 presents the proposed methodology,
45 described step by step; section 5 describes the application of the methodology in a case study
46 the National Electricity Corporation of Venezuela; section 6 describes the questionnaire
47 answered by the experts to assess their level of satisfaction with the application of the
48 methodology, and section 7 the conclusions of this study are presented.

49 50 51 52 **2. MCDA techniques for Project portfolio prioritization**

53 Several authors have highlighted the importance of accurately modeling reality, especially when
54 project prioritization for resource allocation affects business competitiveness (Meade, 2002).
55 MCDA techniques are suitable for solving these problems because they are designed to make
56 decisions based on different perspectives (criteria) that use qualitative or uncertain data.

57
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59 Multicriteria Decision Analysis, MCDA, is generally defined as a decision-aid and a
60 mathematical tool allowing the comparison of different alternatives or scenarios according to

1 many criteria, often conflicting, in order to guide the decision maker towards a judicious choice.
2 MCDA models analyze these different views to identify a set of criteria which are compared
3 and used to assess the alternatives in order to obtain an objective clear judgment. Belton and
4 Stewart (2002) note that subjectivity is inherent in all decision-making, in particular in the
5 choice of criteria on which to base the decision and the relative "weight" given to those criteria.
6 MCDA does not dispel that subjectivity; it simply seeks to make the need for subjective
7 judgments explicit and the process by which they are taken into account transparent, which is of
8 particular importance when multiple stakeholders are involved. Thus, the principal aim of
9 MCDA is "to help decision makers learn about the problem situation, about their own and
10 others' values and judgments, and through organization, synthesis and appropriate presentation
11 of information to guide them in identifying, often through extensive discussion, the preferred
12 course of action".
13

14 Subramanian and Ramanathan (2012) classify project management as one of the most vibrant
15 and dynamic multidisciplinary theme within operations management which involves operations
16 research, decisions sciences, human resource, information technologies, etc. and review AHP
17 applications of project portfolio selection.
18

19 Other authors and researchers have addressed the prioritization of projects in engineering using
20 MCDA techniques. Mavrotas et al. (2006) combined MCDA techniques with Binary
21 Programming for project prioritization under restrictive policies in order to adequately analyze
22 the multifaceted nature of modern businesses in the current complex and changing markets.
23 Nigim et al. (2004) used AHP for prioritization of renewable energy sources as part of a
24 feasibility study in Ontario, Canada.
25

26 Most MCDA techniques assume the criteria have not dependencies between them or no cause-
27 effect relationships exist between the different prioritization criteria. However, in other cases
28 the decision makers and the alternatives -in this case the projects in a portfolio- are strongly
29 related, as suggested by Killen and Kjaer (2012).
30

31 Interdependence and feedback among the elements of a decision problem has been addressed
32 and solved by Saaty using the technique called Analytic Network Process (ANP). A key
33 advantage of ANP is that it does not require a hierarchical structure of criteria and allows more
34 complex relationships between decision levels. ANP is an extension of AHP developed by
35 Saaty to overcome the problem of interdependence and feedback between criteria or alternatives
36 (Saaty, 2001). ANP generalizes the problem modeling process using a network of criteria and
37 alternatives (all called elements), grouped into clusters. All the elements in the network can be
38 related in any possible way. This provides an accurate modeling of complex settings and allows
39 handling the typical case of interdependence among elements in project portfolio prioritization.
40 Summarizing, in contrast to other approaches for project prioritization outlined above:
41

- 42 a) ANP, as any MCDA technique, allows the comparison of multiple perspectives for
43 the identification of priorities.
- 44 b) ANP captures the interdependence among the selection criteria and, in particular,
45 among projects, which is a major constraint in this study, as certain projects affect the
46 execution of others and influence their performance.
- 47 c) The criteria priorities can be determined by experts' judgments based on pair-
48 comparison rates rather than arbitrary scales.
- 49 d) ANP efficiently captures the qualitative judgments used in the decision- making
50 process.
51

52 Some of the recent applications involving ANP in the field of Project Management are found in
53 enterprise information system project portfolio selection (Liang and Li, 2008) (Lee and Kim,
54 2001), resource allocation in transportation (Wey and Wu, 2007); strategic policy planning
55 (Erdogmus et al, 2006); safety manufacturing systems (Silvestri et al. 2012), strategic e-
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business decision analysis (Raisinghani et al., 2007); factors affecting success in enterprises (Karpak and Topku, 2010); determination of the appropriate energy policy (Haktanirlar, 2005).

In order to emphasize the novelty of our approach with respect to the Literature, we have carried out a more specific literature search within the Scopus Database for the last 10 years and found out that:

Under the keywords “AHP” and “Project Portfolio Selection” 10 references appear (Rębiasz et al., 2015; Aragonés-Beltrán et al., 2014; Gomedé and De Barros, 2014; Mihanizadeh et al., 2014; Davoudpour et al., 2012; Fouladgar et al., 2012; Özkir and Demirel, 2012; Godinho et al., 2011; Koppinen and Rosqvist, 2010) This means that AHP can be considered a widely used technique whose goodness in the project portfolio prioritization has been proven.

However, under the keywords “ANP” and “Project Portfolio Selection” only three references appear (Aragonés-Beltrán et al., 2014; Smith-Perera et al., 2010; Tsai et al., 2010) one of which is also from the authors of this paper (Smith-Perera et al., 2010). In this previous study we only prioritized technical improvement action (operative level) of the company and in this new proposal we go one step further and prioritize a portfolio looking for an alignment with the strategic objectives of the company (strategic level).

This means that for the specific field of project prioritization ANP can be considered an innovative technique. The approach presented in this paper tries to go one step further and applies ANP with criteria different from the classical economic or technical ones but with strategic criteria from the company, which allows us to measure the degree of alignment.

3. MCDA technique: Analytic Network Process.

Saaty (2001) proposed two methods for tackling multi-criteria evaluation decision problems: the Analytic Hierarchic Process (AHP) and the Analytic Network Process (ANP). The AHP is a well-known technique that is widely used and conceptually easy to use, but its strict hierarchical structure is inadequate when addressing the complexities of many real-world problems. To resolve this shortcoming, Saaty proposed the ANP model, a generalization of the AHP. The ANP presents decision-making problems as networks of criteria and alternatives (all called elements), grouped into clusters. All the elements in the network can be related in any possible way, such that, for example, a network can incorporate feedback effects and complex inter-relationships within and between clusters. This provides a more suitable model for complex settings. The influence of the elements in the network on other elements in that network is represented by a supermatrix. This new concept consists of a two-dimensional element-by-element matrix which adjusts the relative importance weights in individual pairwise comparison matrices to build a new overall supermatrix with the eigenvectors of the adjusted relative importance weights.

Details on the Analytic Network Process (ANP) can be found in Saaty (2001), however, the main steps are summarized here for completeness:

- (i) Identifying the components and elements of the network and their relationships.
- (ii) Conducting pairwise comparisons on the elements.
- (iii) Placing the resulting relative importance weights (eigenvectors) in pairwise comparison matrices within the matrix (unweighted matrix).
- (iv) Conducting pairwise comparisons on the clusters.
- (v) Weighting the blocks of the unweighted matrix, by the corresponding priorities of the clusters, so that it can be column-stochastic (weighted matrix).
- (vi) Raising the weighted matrix to limiting powers until the weights converge and remain stable (limit matrix).
- (vii) Obtaining the elements prioritizations according to any of the columns of the limit matrix.

(viii) Once the results are obtained, in case some alternatives achieve very similar results, a sensitivity analysis should be carried out in order to demonstrate the robustness of the ranking obtained.

4. Proposed Methodology. Project prioritization using the Relative Alignment Index (RAI).

The methodology presented in this paper uses ANP to obtain a ranking of prioritized projects based on their degree of alignment with corporate strategy. The approach consists of the following steps:

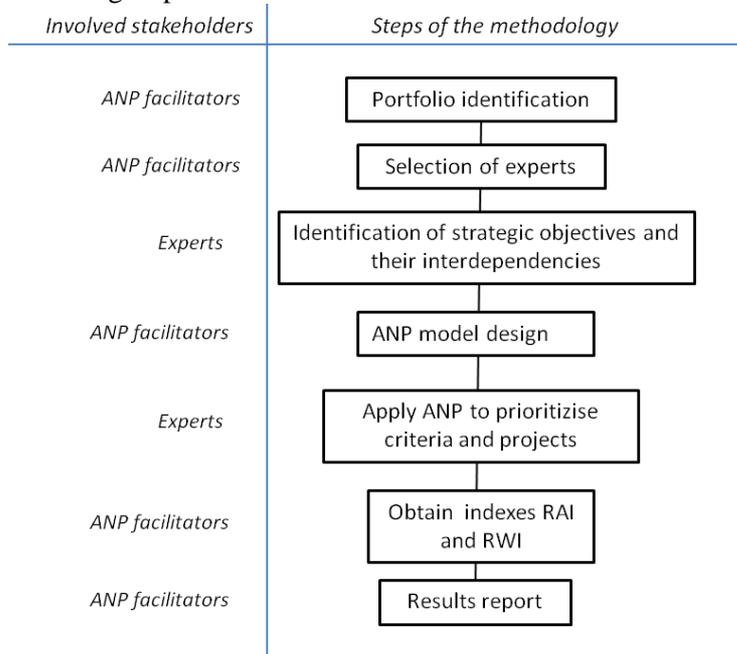


Figure 1. Proposed methodology. Source: designed by authors

The **Relative Alignment Index (RAI)** is defined as the *normalized dimensionless priority value* of each project obtained with ANP using the strategic objectives of the organization as prioritization criteria, and the **Relative Weight Index (RWI)** is defined as the dimensionless priority value of each criterion over the others obtained in ANP-step (v).

The steps of the proposed methodology are summarized in the following:

4.1 Project identification

Identify projects portfolio that possibly contribute to business strategy. This Identification should be carried out each time the strategic planning of the company is scheduled.

4.2. Selection of experts

The experience and knowledge of the experts involved in the process of project prioritization is as important as the methodology itself. Therefore it is essential to find the right experts. They should have a holistic view of the company. They should have enough expertise to understand the problem on stake and know the company from different perspectives (Garcia-Melón et al, 2012). This selection must be done carefully.

4.3. Identification of strategic objectives and their relationships

Strategic planning is based on the technique known as Balanced Scorecard (BSC) (Kaplan and Norton, 1996). BSC indicators are obtained from a strategic management technique consisting of the following questions:

1. How are shareholders / stakeholders served?

This is known as "financial outlook" and consists of defining goals aimed at generating financial value in the company. It is usually measured by financial indicators such as Cash Flow, Return on Investment, Rates of Return, Net Present Value among others.

2. How do customers / users see us?

The "user / community perspective" includes objectives that are associated with the company's relationship with its customers, such as product quality, delivery times, customer satisfaction or loyalty.

3. How well do we perform?

This approach, known as "internal processes" is a way of achieving goals that promote increased productivity, efficiency, effectiveness, i.e. objectives that tend to improve processes.

4. Can we continue to improve?

This approach, known as the "innovation and learning," includes objectives related to technology leadership and knowledge management.

These four BSC perspectives are used in this methodology to systematically formulate a set of strategies and strategic objectives that help the company to achieve its general goals. The relationships among the strategic objectives are obtained with the help of the experts. In case the company did not have stated strategic objectives, the objectives chosen have to be agreed by all the experts in this step of the methodology in a consensus group process.

4.4 ANP model design and application

Corporate strategic objectives will be used as prioritization criteria for the ANP model. The Balanced Scorecard management system will be used to cluster these criteria, e.g. each BSC perspective will include several of the strategic objectives. No matter how many strategic objectives have been obtained, they all have to be clustered in the four BSC perspectives.

Judgments of the experts will be elicited by means of individual questionnaires and processed in order to obtain results. Each expert has to respond all the questions of the model. This is the reason why they should have a holistic view of the company. For the global judgment, the geometric mean of the individual judgments will be applied, following Saaty's recommendation (Saaty, 2001)

4.5. Obtaining RAI and RWI

The required calculations of the ANP model will be carried out. For that, the facilitators introduce all the individual judgments in the Superdecisions software. The Relative Alignment Index (RAI) for each project (ANP index for the alternatives) and the Relative Weight Index (RWI) for each strategic objective (ANP index for the criteria) will be obtained.

5. Case study in the electrical sector of Venezuela

With the entry into force of the Decree N° 5,330 of the Organic Law for the Reorganization of the Electric Sector in Venezuela, the company Corporación Eléctrica Nacional S.A. (Corpoelec) was created as an state-owned operating company in charge of carrying out the activities of generation, transmission, distribution and commercialization of power and electric energy, managing the 14 existing operating companies, some of which were private, such as Electricidad de Caracas, ENELVEN, Seneca, etc. and others were state-owned (e.g. CADAPE, EDELCA, etc.). By the end of 2011 there was a single centralized electrical corporation with the functions of coordination, planning, operation and maintenance based on a common corporate strategy. However, this transformation also began an arduous journey towards the consolidation of what had been a diversity of views, values, objectives and strategies. The new corporation assumed the challenge of setting strategic direction (Mission, Vision, Values, Strategic objectives, Plans, Programs, etc.) common to all merging companies.

However, beyond the legal constitution of the corporation, its implementation involved the application of strategic actions aimed at consolidating the merger of companies in the activities of generation, transmission, distribution and commercialization of power as well as in support

processes (human resources, finance, procurement, technology, etc.).

The Office of Technology and Information Systems was the national body in charge of coordinating the process of technology integration in areas such as Automation, Information Technology and Telecommunications. The Office elaborated an operational management system and presented the Corporation's Managing Board a portfolio of projects aiming at:

- a) Ensuring short-, medium- and long-term technology support for the successful integration of systems and platforms.
- b) Improving the economic performance of the commercial offices through better connectivity and automation.
- c) Ensuring continuity of technology systems and services that support operation and management.

This portfolio of technology projects, called "Technology Master Plan 2010-2015", consists of ten national strategic projects in the areas of Automation, Technology and Telecommunications (AT&T).

As usual in the management of this kind of portfolios, the Office of Technology and Information Systems had to establish an order of priorities for efficient allocation of available resources based on their alignment to the company's strategy.

The following paragraphs describe the application of the methodology proposed in Section 4 to the case study.

5.1 Project Identification and Prioritization.

Projects included in the Technology Master Plan portfolio are shown in Table 1. For this particular case study the timeframe of the project portfolio selection is five years.

Code	Project	Description
PT001	Corpoelec Unique Business Management System	Implementation of a unique business management system (ERP) administered by ATIT Corpoelec, that consolidates the administrative support functions of the old operators.
PT002	Adaptation of the system that supports the commercial management of Corpoelec	Adequacy of infrastructures and computer systems of the commercial offices with the highest sales revenues and correction of 9 faults identified in OPEN system (SGC, Adececa, etc)
PT003	Corpoelec Data Network Integration system	Updating and integration of the different data networks of the old electrical operators into one national network run by ATIT Corpoelec
PT004	Integration of Corpoelec Telephone Systems	Updating and integration of the telephone systems of the old electrical operators in a single national telephone system administered by ATIT Corpoelec
PT005	Integration of Corpoelec Radio Communication Systems	Updating and integration of the radio systems of the old electrical operators in a single national radio communication network administered by ATIT Corpoelec
PT006	Services Management Systems	Implementation of a single Services Management system (incident management, requirements management, monitoring, help desk, etc...) for all systems and services of ATIT Corpoelec
PT007	Global Data Center	Adaptation of a Global Data Center and Design, procurement, construction and implementation of a Support Data Center for the support of all systems and services of ATIT Corpoelec
PT008	Integration of Corpoelec Data Transport Systems	Updating and integration of the data transport systems of the old electrical operators in a single data transport network administered by ATIT Corpoelec
PT009	Knowledge Management System	Implementation of a document and knowledge management system for Corpoelec
PT010	Operations Management System	Implementation of an operations management system for the management Generation Plants, National Office, Regional Offices and Distribution Offices nationwide
PT015	Corpoelec Unique email System	Implementation of a unique email system (@corpoelec.gob.ve) that replaces of email systems of the old operators

Table 1. Technology Master Plan Portfolio. Source: compiled by authors.

5.2 Selection of Experts.

Four experts from the Corporation were selected to implement the methodology. One of them was a General Manager and related to the strategic objectives of the Corporation, two of them were coordinators of departments and with experience in tactical objectives and the fourth one was a operations’ coordinator with experience in operational objectives. See more details in table 2.

Experts were interviewed and they were informed on the ANP methodology and on the characteristics of the problem to solve and were asked to participate in the whole procedure.

Expert	Objectives	Position
1	Strategic	General manager of the Office of Technology and Information Systems of MPPEE
2	Tactical	Corporate Coordinator of Automation, Technology and Telecommunications
3	Tactical	Leader of AT&T Projects
4	Operational	Leader of the Operations Unit

Table 2. Selected experts. Source: compiled by authors

5.3 Identification of strategic objectives and interdependencies.

In this case study, the strategic objectives were part of the general corporate strategy of Corpoelec. These objectives are:

BSC Perspectives				
	Financial	Users and stakeholders	Internal processes	Learning and innovation
strategic objectives	1. Consolidate Corpoelec as an efficient public service company	3. Commitment with environment protection, safety and labour conditions	5. Guarantee the electric energy supply	7. Technical and human development of employees
	2. Leverage new social, financial and environmental value	4. Social commitment and company-community realations improvement	6. Efficient use of energy maximization	8. Promotion of the use of green energy sources
				9. Promotion of the R&D management

Table 3. Corpoelec Strategic Objectives grouped by BSC perspective. Source: compiled by authors

For simplicity we have shortened the names of the strategic objectives as follows:

1. Consolidation
2. Leverage
3. Commitment
4. Improvement
5. Guarantee
6. Maximization
7. Development
8. Promotion

9. Research

Since the objectives were obtained from the strategic goals of the company the experts were devoted to determine how this objectives should enter the ANP model. ANP is a network model in which the relations among the different models should be established beforehand.

5.4 ANP model design

The ANP model used in the case study is shown in Figure 2.

The main step in this methodology is the determination of the influence of some elements over others, because these influences will determine the number and characteristics of the pairwise comparisons used in the next step of the process.

To achieve that a face-to-face meeting with the four experts was hold to determine the relationships between objectives. The results were obtained by consensus among experts.

Table 4 shows the relationships among the strategic objectives of the company.

Objective	Related with the objective
1	2, 5, 6, 7, 8, 9
2	1, 3, 4, 5, 6, 7, 8
3	2, 5, 6, 7, 8
4	2, 4, 7, 8
5	1, 2, 6, 7, 8, 9
6	1, 2, 7, 8, 9
7	1, 2, 3, 4, 5, 6, 8, 9
8	1, 2, 4, 6, 9
9	1, 2, 3, 4, 6

Table 4. Relationships among objectives. Source: compiled by authors.

According to the experts, the objective 1 "Corpoelec Consolidation as an efficient public company" depends on "The creation of economic, social and environmental values" (Objective 2), "guarantee the electric energy supply" (Objective 5), "Efficient use of energy maximization"(Objective 6), "Human and technical development of its employees" (Objective 7), "To promote the use of alternative and renewable energy" (Objective 8) and "Good management of Research, Development and Innovation".

The model also includes the dependencies among the projects of the Master Plan portfolio, in which some projects are important for the execution of others and influence their performance, contributing to their RAI.

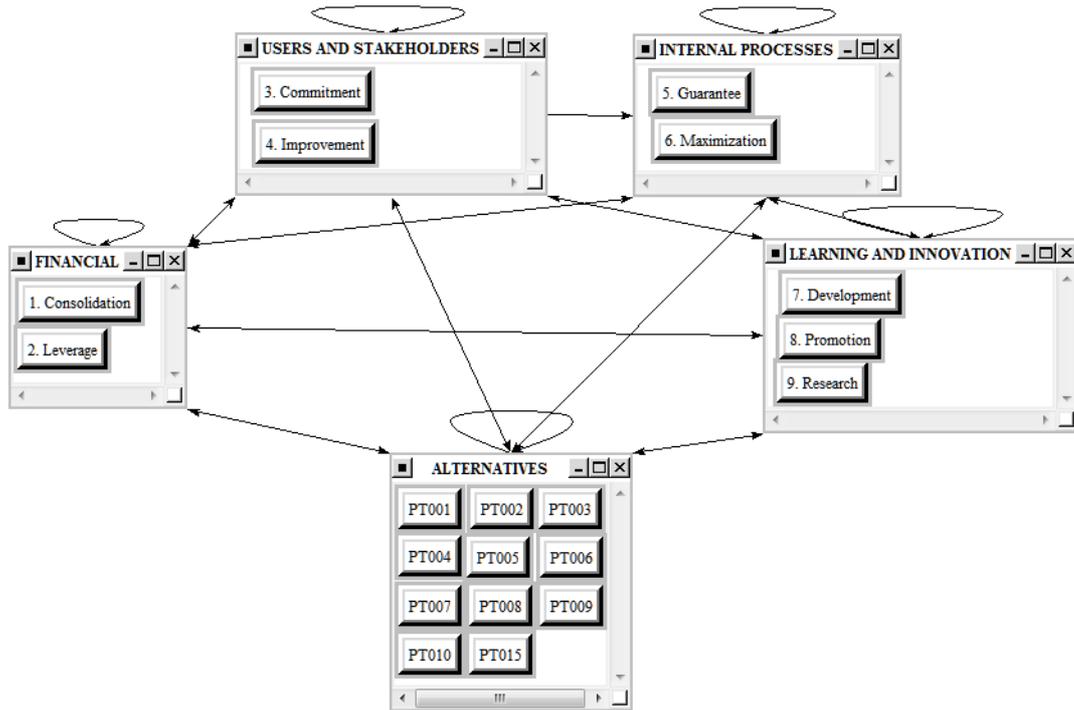


Figure 2. ANP network for the case study. Source: compiled by the authors with Superdecisions ©

Following that, a second session took place in order to determine the weights both of the strategic objectives and the different projects. These weights were obtained by addressing individual questionnaires to the four experts with all the required ANP-based pairwise comparisons questions of the consensus model. This session was individual since the experts expressed a preference to answer the questionnaires individually and without time pressure. The individual results were averaged by the geometric mean according to (Saaty, 2001).

Figure 3 shows an example of the questionnaire that was handed to the experts.

In your opinion, what will influence more in the Consolidation of Corpoelec as an efficient public company (Obj 1) to promote the human and technical development of its employees (Obj.7) or to promote the use of alternative and renewable energy (Obj.8)? By how much?

Promote human and technical development of its employees
Promote the use of alternative and renewable energy

Which is more influential?	<input checked="" type="checkbox"/> Development	<input type="checkbox"/> Promotion.			
To what extent?	<input type="checkbox"/> Equal	<input checked="" type="checkbox"/> Moderate	<input type="checkbox"/> Strong	<input type="checkbox"/> Very strong	<input type="checkbox"/> Extreme

Figure 3. Example of questionnaire

The response shown in this example means the responder believes that in order to consolidate Corpoelec as an efficient public company it is moderately more important to promote the human and technical development of its employees than to promote the use of alternative and renewable energy.

As seen in the example for each stake comparison the experts should indicate what criterion is most important and to what extent, using Saaty's scale (Saaty, 1980) explained in Part (ii) Section 3

of this paper. The experts recorded their responses on a form to eliminate transcription errors.

All this data were computed with software Superdecisions© which allowed us to obtain the individual results as well as the inconsistency index of each expert (always under 10%). As said before and according to Saaty, these individual results were aggregated by means of the geometric mean to obtain the group results.

5.5 Analysis of Results.

The results are shown below.

a) Unweighted Supermatrix

The resulting relative importance weights (eigenvectors) obtained through pairwise comparison matrices of the judgements issued by the experts are placed in columns within a supermatrix.

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Unweighted Supermatrix																							
	PT001	PT002	PT003	PT004	PT005	PT006	PT007	PT008	PT009	PT010	PT015	Consolidation	Leverage	Commitment	Improvement	Guarantee	Maximization	Development	Promotion	Research			
PT001	0	0,10714	0,03068	0,03626	0,0688	0,17906	0,04808	0,15336	0,0972	0,03359	0,44457	0,35459	0,1033	0,07211	0,08742	0,03002	0,07961	0,10646	0,08775	0,02892			
PT002	0,06718	0	0,03066	0,05128	0,06256	0,11502	0,05891	0,05658	0,07168	0,02793	0,02831	0,02079	0,39983	0,06152	0,32356	0,03304	0,07173	0,05861	0,07792	0,0446			
PT003	0,10093	0,16427	0	0,3218	0,1195	0,12036	0,30884	0,36989	0,15077	0,24396	0,22145	0,16839	0,2051	0,12815	0,0602	0,05907	0,13581	0,10478	0,07792	0,22282			
PT004	0,02333	0,0887	0,08357	0	0,08536	0,13677	0,06014	0,13502	0,06786	0,17232	0,03063	0,03601	0,0979	0,06717	0,06385	0,10515	0,08313	0,02093	0,08205	0,1696			
PT005	0,02228	0,03365	0,03546	0,03771	0	0,023	0,03465	0,03055	0,07663	0,1589	0,03032	0,05467	0,032	0,11796	0,0602	0,20421	0,11255	0,02313	0,17198	0,10868			
PT006	0,05614	0,06192	0,06156	0,05832	0,12281	0	0,05402	0,04121	0,12878	0,06057	0,03754	0,02129	0,01939	0,07211	0,05926	0,03166	0,07204	0,05152	0,08205	0,03149			
PT007	0,20031	0,11526	0,33039	0,06192	0,08014	0,08256	0	0,10268	0,09019	0,0517	0,06156	0,05501	0,03528	0,12519	0,05926	0,04437	0,12655	0,03157	0,09211	0,05659			
PT008	0,13817	0,18277	0,315	0,31371	0,14888	0,23602	0,30177	0	0,09019	0,12058	0,08847	0,08658	0,05162	0,11521	0,06479	0,0756	0,11955	0,04418	0,08205	0,11205			
PT009	0,02277	0,03301	0,03557	0,03261	0,06767	0,02234	0,03355	0,03918	0	0,04668	0,02958	0,01732	0,01811	0,06152	0,10508	0,03112	0,06645	0,31882	0,08205	0,16576			
PT010	0,02061	0,02346	0,03391	0,0378	0,07407	0,02029	0,0364	0,02643	0,08289	0	0,02757	0,02046	0,01557	0,11752	0,05772	0,35487	0,06981	0,11415	0,08205	0,02987			
PT015	0,34829	0,18982	0,0432	0,04858	0,17022	0,06459	0,06364	0,0451	0,14381	0,08378	0	0,1649	0,02188	0,06152	0,05867	0,03091	0,06278	0,12584	0,08205	0,02964			
Consolidation	0,85712	0,33333	0,16667	0,8	0,75002	0,66667	0,125	0,75002	0,33333	0,85712	0,87497	0	100.000	0	0	0,25	0,5	0,8	0,75002	0,75002			
Leverage	0,14288	0,66667	0,83333	0,2	0,24998	0,33333	0,875	0,24998	0,66667	0,14288	0,12503	1	0	1	1	0,75	0,5	0,2	0,24998	0,24998			
Commitment	0,16667	0,14288	0,2	0,2	0,2	0,16667	0,24998	0,16667	0,12503	0,14288	0,2	0	0,11111	0	0	0	0	0,2	0	0,12503			
Improvement	0,83333	0,85712	0,8	0,8	0,8	0,83333	0,75002	0,83333	0,87497	0,85712	0,8	0	0,88889	0	1	0	0	0,8	1	0,87497			
Guarantee	0,8	0,85714	0,5	0,83333	0,75	0,8	0,5	0,8	0,24998	0,9	0,5	0,8	0,2	0,09999	0	0	0	0,85714	0	0			
Maximization	0,2	0,14286	0,5	0,16667	0,25	0,2	0,5	0,2	0,75002	0,1	0,5	0,2	0,8	0,90001	0	1	0	0,14286	1	1			
Development	0,64833	0,54693	0,45995	0,71723	0,68698	0,6301	0,63699	0,72184	0,77202	0,7903	0,74184	0,73064	0,8	0,83333	0,85714	0,7153	0,44444	0	0	0			
Promotion	0,12202	0,34454	0,22113	0,08808	0,18648	0,15146	0,10473	0,08376	0,05455	0,07199	0,0752	0,08096	0,2	0,16667	0,14286	0,09774	0,11111	0,14286	0	0			
Research	0,22965	0,10852	0,31892	0,19469	0,12654	0,21844	0,25828	0,1944	0,17344	0,13771	0,18296	0,18839	0	0	0	0,18696	0,44444	0,85714	100.000	0			

Table 5. Unweighted Supermatrix.

b) Weighted Supermatrix

The following step consists of the weighting of the blocks in the unweighted supermatrix, by the corresponding priorities of the clusters, so that it can be column stochastic.

Weighted Supermatrix																				
	PT001	PT002	PT003	PT004	PT005	PT006	PT007	PT008	PT009	PT010	PT015	Consolidation	Leverage	Commitment	Improvement	Guarantee	Maximization	Development	Promotion	Research
PT001	0	0,01048	0,003	0,00355	0,00673	0,01751	0,0047	0,015	0,00951	0,00329	0,04348	0,07653	0,0101	0,01556	0,00991	0,00529	0,02107	0,01041	0,00858	0,00298
PT002	0,00657	0	0,003	0,00502	0,00612	0,01125	0,00576	0,00553	0,00701	0,00273	0,00277	0,00449	0,0391	0,01328	0,03667	0,00583	0,01899	0,00573	0,00762	0,00459
PT003	0,00987	0,01606	0	0,03147	0,01169	0,01177	0,0302	0,03618	0,01475	0,02386	0,02166	0,03634	0,02006	0,02766	0,00682	0,01042	0,03595	0,01025	0,00762	0,02295
PT004	0,00228	0,00868	0,00817	0	0,00835	0,01338	0,00588	0,0132	0,00664	0,01685	0,003	0,00777	0,00958	0,0145	0,00724	0,01854	0,022	0,00205	0,00802	0,01747
PT005	0,00218	0,00329	0,00347	0,00369	0	0,00225	0,00339	0,00299	0,00749	0,01554	0,00297	0,0118	0,00313	0,02546	0,00682	0,03601	0,02979	0,00226	0,01682	0,01119
PT006	0,00549	0,00606	0,00602	0,0057	0,01201	0	0,00528	0,00403	0,0126	0,00592	0,00367	0,0046	0,0019	0,01556	0,00671	0,00558	0,01907	0,00504	0,00802	0,00324
PT007	0,01959	0,01127	0,03231	0,00606	0,00784	0,00807	0	0,01004	0,00882	0,00506	0,00602	0,01187	0,00345	0,02702	0,00671	0,00782	0,0335	0,00309	0,00901	0,00583
PT008	0,01351	0,01787	0,03081	0,03068	0,01456	0,02308	0,02951	0	0,00882	0,01179	0,00865	0,01869	0,00505	0,02486	0,00734	0,01333	0,03164	0,00432	0,00802	0,01154
PT009	0,00223	0,00323	0,00348	0,00319	0,00662	0,00218	0,00328	0,00383	0	0,00456	0,00289	0,00374	0,00177	0,01328	0,01191	0,00549	0,01759	0,03118	0,00802	0,01707
PT010	0,00202	0,0023	0,00332	0,0037	0,00724	0,00198	0,00356	0,00259	0,00811	0	0,0027	0,00441	0,00152	0,02536	0,00654	0,06257	0,01848	0,01116	0,00802	0,00308
PT015	0,03406	0,01856	0,00422	0,00475	0,01665	0,00632	0,00622	0,00441	0,01406	0,00819	0	0,03559	0,00214	0,01328	0,00665	0,00545	0,01662	0,01231	0,00802	0,00305
Consolidation	0,144	0,056	0,028	0,13441	0,12601	0,11201	0,021	0,12601	0,056	0,144	0,147	0	0,16801	0	0	0,09898	0,29718	0,13441	0,12601	0,13269
Leverage	0,024	0,11201	0,14001	0,0336	0,042	0,056	0,14701	0,042	0,11201	0,024	0,02101	0,37075	0	0,37075	0,19468	0,29694	0,29718	0,0336	0,042	0,04423
Commitment	0,09114	0,07813	0,10937	0,10937	0,10937	0,09114	0,1367	0,09114	0,06837	0,07813	0,10937	0	0,06076	0	0	0	0	0,10937	0	0,072
Improvement	0,4557	0,46871	0,43747	0,43747	0,43747	0,4557	0,41014	0,4557	0,47847	0,46871	0,43747	0	0,48608	0	0,63367	0	0	0,43747	0,54684	0,50383
Guarantee	0,10962	0,11744	0,06851	0,11418	0,10276	0,10962	0,06851	0,10962	0,03425	0,12332	0,06851	0,24189	0,0274	0,03023	0	0	0	0,11744	0	0
Maximization	0,0274	0,01957	0,06851	0,02284	0,03426	0,0274	0,06851	0,0274	0,10277	0,0137	0,06851	0,06047	0,10962	0,27213	0	0,33389	0	0,01957	0,13702	0,14428
Development	0,03263	0,02753	0,02315	0,0361	0,03458	0,03171	0,03206	0,03633	0,03886	0,03978	0,03734	0,08115	0,04027	0,09256	0,04999	0,06715	0,06263	0	0	0
Promotion	0,00614	0,01734	0,01113	0,00443	0,00938	0,00762	0,00527	0,00422	0,00275	0,00362	0,00379	0,00899	0,01007	0,01851	0,00833	0,00918	0,01566	0,00719	0	0
Research	0,01156	0,00546	0,01605	0,0098	0,00637	0,01099	0,013	0,00978	0,00873	0,00693	0,00921	0,02092	0	0	0	0,01755	0,06263	0,04314	0,05033	0

Table 6. Weighted Supermatrix

c) Limit Supermatrix

Raising the weighted supermatrix to limiting powers until the weights converge and remain stable the limit supermatrix will be obtained. In this matrix, the elements of each column represent the final weights of the different elements considered.

For all the elements within the matrix a dimensionless value between 0 and 1 is obtained. For alternatives this value (once normalized) means their priority. For criteria, this value (once normalized) means their weight.

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	Limit Supermatrix																				
	PT001	PT002	PT003	PT004	PT005	PT006	PT007	PT008	PT009	PT010	PT015	Consolidation	Leverage	Commitment	Improvement	Guarantee	Maximization	Development	Promotion	Research	
PT001	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149
PT002	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260	0,0260
PT003	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149	0,0149
PT004	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090
PT005	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090
PT006	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065	0,0065
PT007	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090	0,0090
PT008	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109	0,0109
PT009	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096	0,0096
PT010	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087	0,0087
PT015	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095	0,0095
Consolidation	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672	0,0672
Leverage	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633	0,1633
Commitment	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279	0,0279
Improvement	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572	0,4572
Guarantee	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394	0,0394
Maximization	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515	0,0515
Development	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475	0,0475
Promotion	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092	0,0092
Research	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091	0,0091

Table 7. Limit Supermatrix

5.5.1. Results on the projects portfolio and the Relative Alignment Index (RAI)

The ranking of the projects is obtained from the overall priority value of the alternatives in the Limit Supermatrix. This dimensionless value, once normalized per unit, is called Relative Alignment Index (RAI), where the higher the RAI value is the better the alignment of the project with the strategic objectives of the corporation.

Project	Normalized RAI
PT002	0.203
PT001	0.11661
PT003	0.1164
PT008	0.08513
PT009	0.07504
PT015	0.07432
PT007	0.07069
PT004	0.07014
PT005	0.07011
PT010	0.06808
PT006	0.05047

Table 8. Ranking of projects according to their RAI

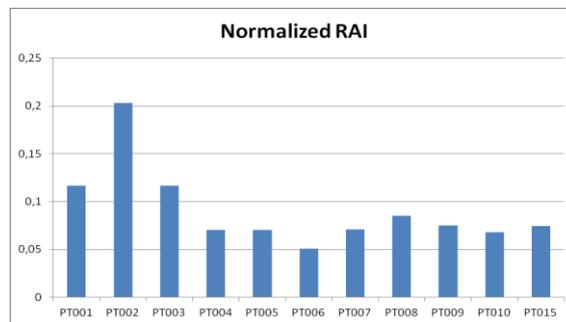


Figure 4. Ranking of projects according to their RAI

The three projects with the highest alignment score with the corporate strategy and therefore of highest priority are:

- PT002 OPEN SGC: Adaptation of the system that supports the commercial management of Corpoelec.
- PT001 SEUC: Corpoelec Unique Business System.
- PT003: Corpoelec Data Network Integration system.

Whereas the three projects with the poorest alignment and therefore of lowest priority are:

- PT005: Integration of Corpoelec Radio Communication Systems.
- PT010: Operations Management System.
- PT006: Services Management system.

These results are consistent with the activities of the corporation, proving that the methodology adequately reflects the actual implementation of the corporate strategy and the importance given by the management of the corporation to project alignment. The projects prioritized in the top of the table are those that lead to the effective merger of the companies, increase revenue and support the continuity of the corporation. Project PT001 is considered the cornerstone of the corporation's management system as it involves the consolidation of the payroll system of former electrical operators, the integration of management systems and even warehouses. Project PT002 aims to upgrade technology services in the sales offices, which represent 47% of the revenue of the corporation. And finally, Project PT003 involves integrating the data networks of the old electrical operators, aiming at the creation of a single network, as well as strengthening its current technology services.

On the other hand, the projects at the bottom of the ranking involve operationally stable and functionally updated services, and consequently are considered medium- and long-term priority projects.

These results may be used for different purposes, such as the allocation of human and financial resources, management of the corporate's communications plan, etc.

5.5.2. Results on the importance of the strategic objectives

The limit supermatrix also provides an indication of the importance that the experts give to the different strategic objectives of the corporation, conditioning the priority of each project. The Relative Weight Index (RWI) is shown in Table 7.

Level	Strategic objectives		RWI (%)
Financial	O1	Consolidation	7,705
	O2	Leverage	18,724
Users and stakeholders	O3	Commitment	3,202
	O4	Improvement	52,417
Internal processes	O5	Guarantee	4,514
	O6	Maximization	5,905
Learning and innovation	O7	Development	5,444
	O8	Promotion	1,049
	O9	Research	1,039

Table 9. Ranking of Objectives according to RWI

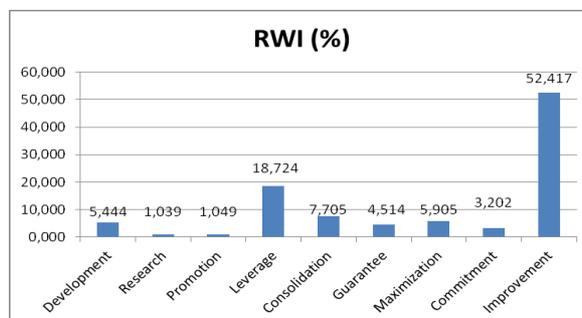


Figure 5. Graphical analysis of results by Objectives. Source: compiled by authors

In the opinion of the experts, the two most important strategic objectives for the Corporation are:

- The improvement of social management and company/community relationship
- Economic, Social and Environmental Leverage.

The distribution of the prioritization weights for these two objectives is consistent with the national policies issued by the national executive, which tend to favor the efforts aimed at the integration of state-owned companies with the local communities and the creation of value, i.e. increased revenues, reduced costs and efficient use of available resources.

In the opinion of the experts the three least important strategic objectives are:

- Commitment to environmental protection and occupational health and safety.
- Promoting the use of alternative and renewable sources of energy.
- Management of Research, Development and Innovation.

Under the current circumstances the group of experts considered that the strategies related to promoting the use of alternative energies, research, development and innovation, and environmental issues are under control and thus are not of highest priority.

These results may be used to:

- a) Determine the degree of alignment of the Master Plan projects with the corporate's strategy, according to the panel of experts.
- b) Analyze and interpret corporate strategy and its implementation across the portfolio of projects.
- c) The relative importance given by the experts to the strategic objectives of the corporation, which is of great importance to properly interpret the results.

5.5.3. Particular results on each individual project

The influential relationships between the projects and objectives can also be seen in the unweighted supermatrix (Table 5). In other words, it is the alignment index of each project considering one particular objective without considering the dependencies among objectives. This is the way some other MCDA techniques such as the weighted sum or the AHP proceed.

These results can be analyzed in two different ways (i) finding out how important is each objective for one particular project or (ii) finding out the prioritization of the projects portfolio according to only one specific objective.

For example, if we want to analyze what is the importance of the different objectives for the two best ranked projects, results show:

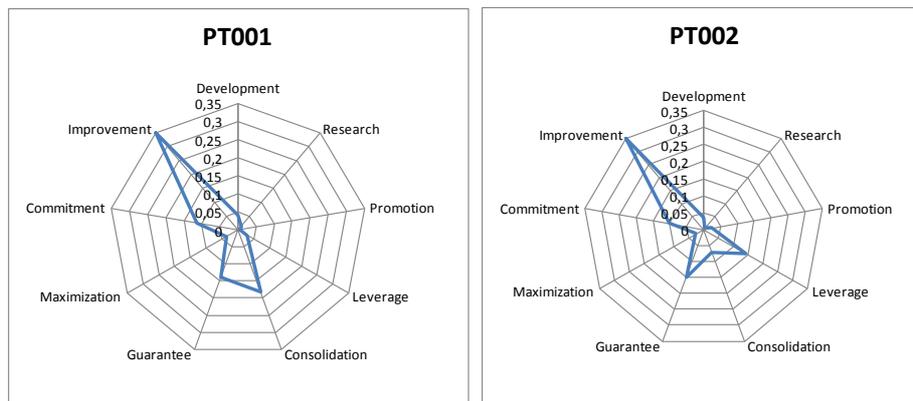


Figure 6. Individual results for each project

In this figure we can observe that both projects, PT001 and PT002 show a similar profile. For both of them the most important criterion is *Improvement* followed by *Consolidation* for PT001 or by *Leverage* and *Guarantee* for PT002. These results are very consistent with the global results.

On the other hand, if we want to analyze the ranking of the projects for one particular objective, in this case *Improvement* and *Leverage* because they are the most important strategic objectives, the results show:

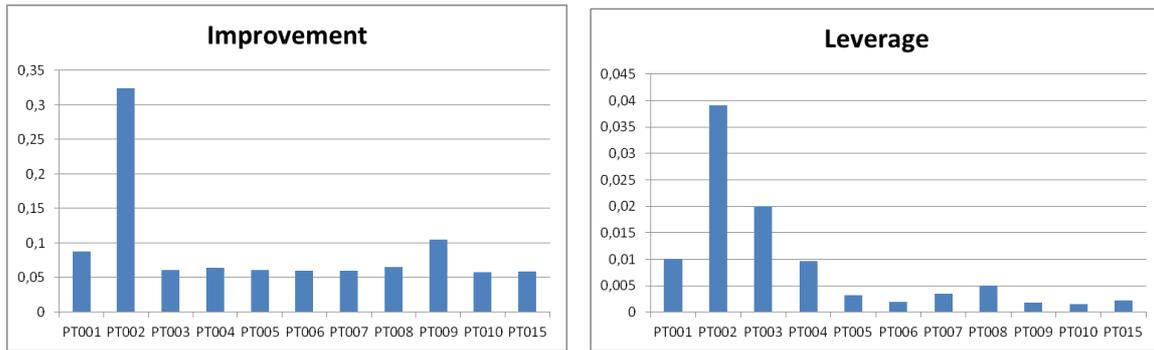


Figure 7. Ranking of the projects according to the two main criteria

In these figures we see two very different profiles. If we only considered the objective Improvement, the most important project would be PT002, same results as for the global, followed by PT009. However, if we only considered the strategic objective Leverage, the most important project would be PT002 by far, followed by PT003 and PT001. It is interesting to stand out that for this last prioritization Project PT009 would be relegated to the tenth position. The managers of the company, once the results of the ANP are computed, could do as many individual analyses as they wanted.

5.5.4. Sensitivity analysis

In order to analyze the robustness of the results obtained by the different projects (alternatives) a sensitivity analysis has been carried out by the facilitators. We have performed an analysis based on the weights of the clusters. Since the most important cluster is “Users and Stakeholders” (55% of the importance with respect to the alternatives) we have focused on it. Two sensitivity steps have been calculated, (1) reducing the weight until 50% and (2) reducing the weight until 40%:

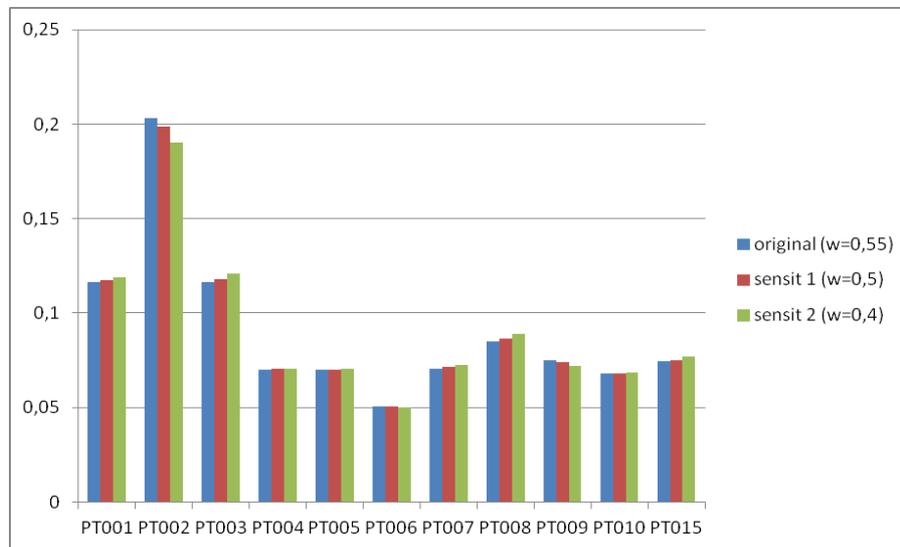


Figure 8. Sensitivity analysis for the projects' prioritization

According to these results we can conclude that the prioritization obtained for the projects is robust. The three projects with the highest alignment score with the corporate strategy remain the same.

6. Level of satisfaction with the results.

To determine whether the results obtained in this study are consistent with the experts' expectations and to what extent they found the methodology easy to use, a short questionnaire was developed with five closed questions (Figure 9).

In your opinion, the results obtained with the methodology in relation to your expectations are:				
1. Very Little in accordance	2. Little in accordance	3. Somehow in accordance	4. In accordance	5. Much in accordance
In your opinion, the process of application of the methodology was:				
1. Very long	2. Long	3. Normal	4. Short	5. Very short
In your opinion, the application of the methodology was:				
1. Very difficult	2. Difficult	3. Normal	4. Easy	5. Very easy
In your opinion, would you use again this for the prioritization of a Project portfolio?				
1. No	2. Maybe	3. Possibly	4. Very probably	5. Definitely

Figure 9. Questionnaire of Satisfaction. Source: compiled by authors

Item	Expert 1	Expert 2	Expert 3	Expert 4
In your opinion, the results obtained with the methodology in relation to your expectations are:	5	4	4	5
In your opinion, the process of application of the methodology was:	3	2	2	3
In your opinion, the application of the methodology was:	5	5	5	5
In your opinion, would you use again this for the prioritization of a Project portfolio?	4	5	5	5

Figure 10. Individual results of the Questionnaire of Satisfaction. Source: compiled by authors

The scale used was 1 (lowest) to 5 (highest). The results of the survey indicate that the experts are satisfied with the results, giving an average score of 4.5 in *level of satisfaction*. Regarding its level of ease it was given an average score of 5. Finally, the probability that they will use this method in the future was given an average score of 4.75. However, the process of application of the methodology was considered quite long with a score of 2.5.

We can conclude that the experts found the results obtained coherent. All the experts considered that it was very easy to implement the methodology and they agree or strongly agree that the results are consistent with their expectations. Although the process was perceived as long, they would use it in future project prioritization processes.

7. Conclusions and Recommendations.

This paper proposes a new methodology for the prioritization of a projects portfolio for an alignment with the strategic objectives of the company. The model provides a ranking of projects ordered by their degree of contribution to the achievement of strategic objectives according to the opinion of a group of experts, which is one of the main functions of Project Offices.

This methodology uses ANP as a tool that allows to capture the influences among criteria and among projects to calculate their weights and priorities. These relationships form a complex network of influences whose analysis with other multicriteria techniques might be incomplete or

inefficient since they are not able to consider these influences.

We want to stand out that the model can be useful both as a descriptive and a prescriptive model. Used descriptively the model can help structure the degree of contribution each project has to the achievement of strategic objectives and it could be useful as a research instrument. Academics can use the model to analyze other portfolios and structure their findings in a way that allows ready cross-case comparisons. They can also use other multicriteria methods, such as AHP, to compare the results when considering influences among projects and when considering that the projects are completely independent and the resource allocation might be done independently.

When using the model in a prescriptive way it can guide project managers in creating and maintaining project alignment to corporate objectives, and let them strategically allocate resources to each project. By doing so the chance of success in implementing the projects may increase.

Concerning the use of ANP as a tool for project prioritization, experts stated that the first meeting for defining and agreeing the criteria was fruitful because it allowed them to think about what they were really expecting from the projects on stake. Despite the extension of the questionnaire (more than 100 questions requiring more than two hours to be answered), participants considered that it was neither difficult nor tedious to be filled in. On the contrary, once the logic of the questioning was grasped through the first group of questions, they were able to proceed straightforwardly. By doing that, they reflected on their preferences and were able to think deeply about the projects and the strategic objectives of the company and their real implications. Experts concluded that the procedure allowed them to deal with prioritization in an organized and systematic way and that this way of proceeding enhances participation and transparency and it is a necessary source of information and support for their decisions.

The methodology has been used to analyze the projects portfolio of the Venezuelan corporation Corporación Eléctrica Nacional S.A., particularly to prioritize the Technology Master Plan projects. The strategic objectives are prioritized in order of importance depending on the current situation and the short, medium and long term prospects of the corporation and the need to solve certain management aspects. The obtained RAI values help to assist managers to allocate yearly resources' assignment on their projects portfolio of the National Electricity Corporation of Venezuela, recently founded.

Regarding the prioritization of strategic objectives it can be concluded that the corporation promotes the improvement of social management and company/community relations and the creation of economic, social and environmental values.

Regarding the portfolio prioritization the most important projects for the corporation are those that aim to improve commercial management, i.e. the projects that directly generate business value (PT002 OPEN SGC: Adaptation of the system that supports the commercial management of Corpoelec), integration of the company unifying its administrative and management systems (PT001 SEUC: Corpoelec Unique business management system) and the promotion of an updated technological infrastructure for the development of its functions (PT003 Integration of Corpoelec data network system). Therefore it is recommended to dedicate human and material resources to carry out these three projects first.

The group of experts who participated in the case study found the technique easy to apply and the results reliable and although they considered the process to be long (due to the number of comparisons because of the high number of projects), definitely they would use it again.

Some further suggestions for the project managers are:

a) The prioritization methodology by RAI and RWI should be repeated at least once a year, as the priorities ordered by RWI may vary depending on the social, technical, political and

economic environment.

b) The application of the questionnaires must include the project leaders as experts to capture the RWI from the perspective of each project.

Finally, we want to highlight the fact that as important as the correct application of the methodology is the in-depth knowledge of the environment in which the projects will be developed.

The application of the methodology in the case study has been useful for the new corporation to achieve the challenge of setting strategic directions (Mission, Vision, Values, Strategic objectives, Plans, Programs, etc.) common to all merging companies.

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Figure 1

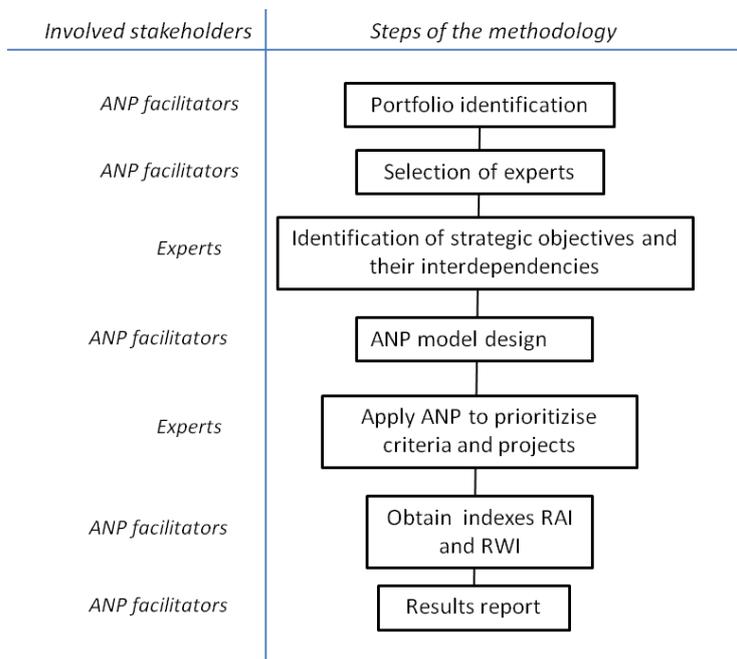


Figure 1. Proposed methodology. Source: designed by authors

Figure 2

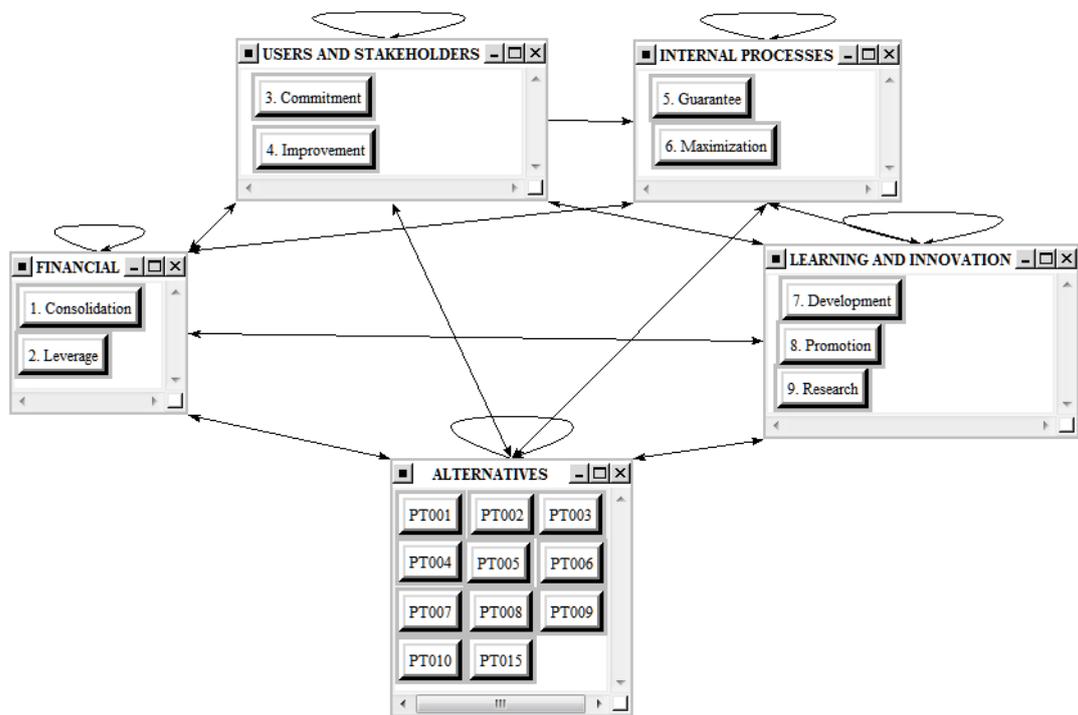


Figure 2. ANP network for the case study. Source: compiled by the authors with Superdecisions©

*In your opinion, what will influence more in the **Consolidation of Corpoelec as an efficient public company (Obj 1) to promote the human and technical development of its employees (Obj.7) or to promote the use of alternative and renewable energy (Obj.8)? By how much?***

Promote human and technical development of its employees
Promote the use of alternative and renewable energy

Which is more influential?	<input checked="" type="checkbox"/> Development	<input type="checkbox"/> Promotion.			
To what extent?	<input type="checkbox"/> Equal	<input checked="" type="checkbox"/> Moderate	<input type="checkbox"/> Strong	<input type="checkbox"/> Very strong	<input type="checkbox"/> Extreme

Figure 3. Example of questionnaire

Figure 4

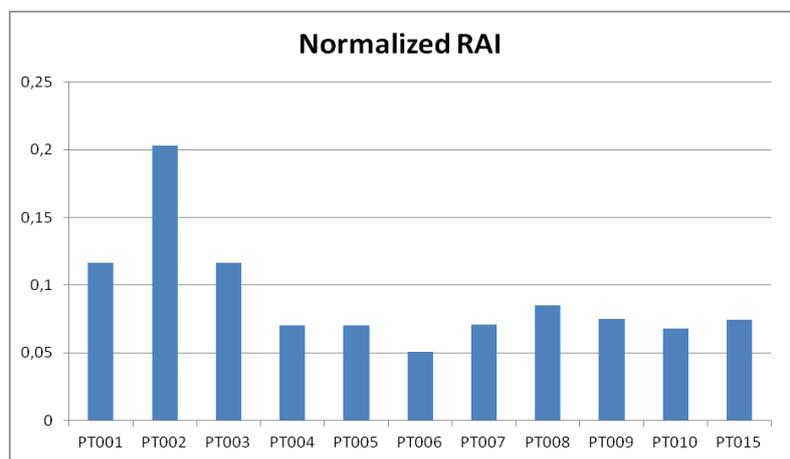


Figure 4. Ranking of projects according to their RAI

Figure 5

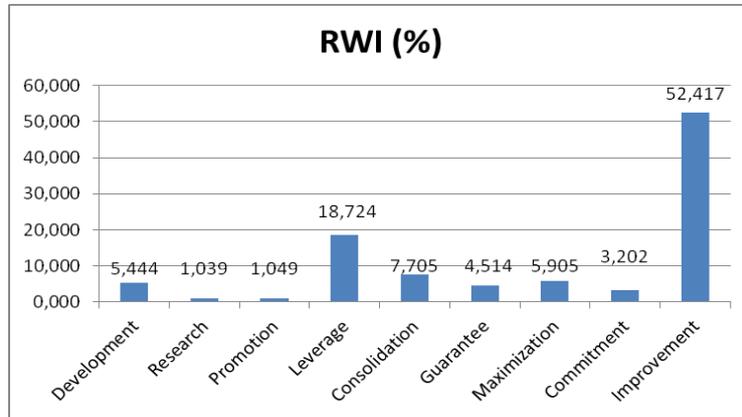


Figure 5. Graphical analysis of results by Objectives. Source: compiled by authors

Figure 6

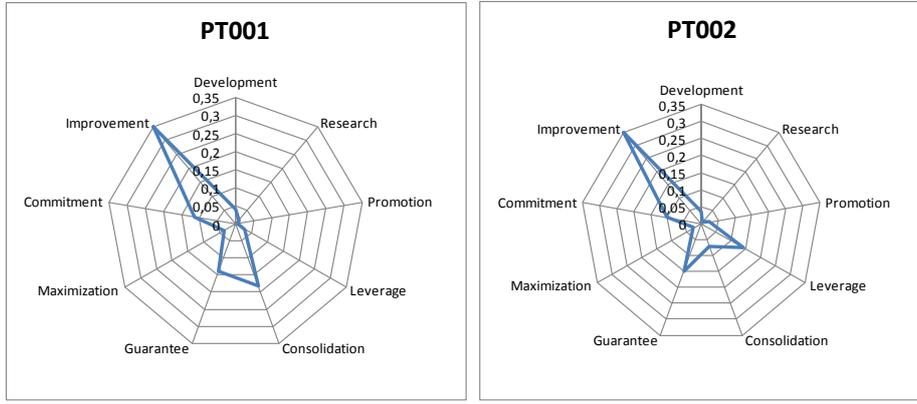


Figure 6. Individual results for each project

Figure 7

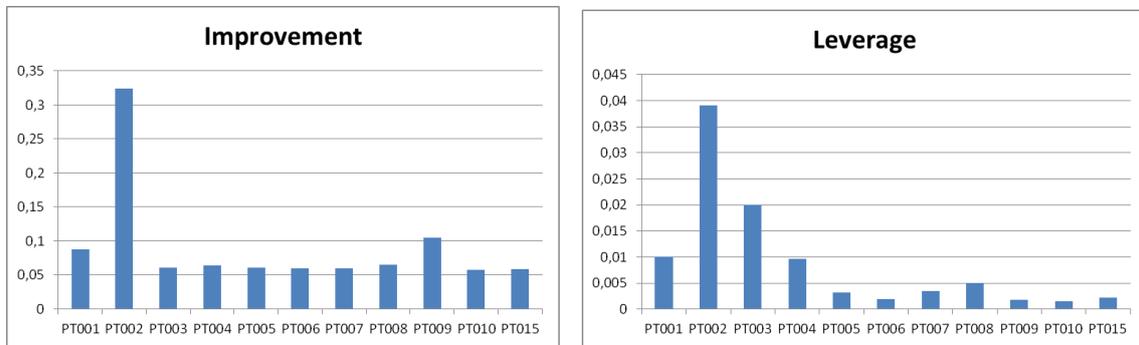


Figure 7. Ranking of the projects according to the two main criteria

Figure 8

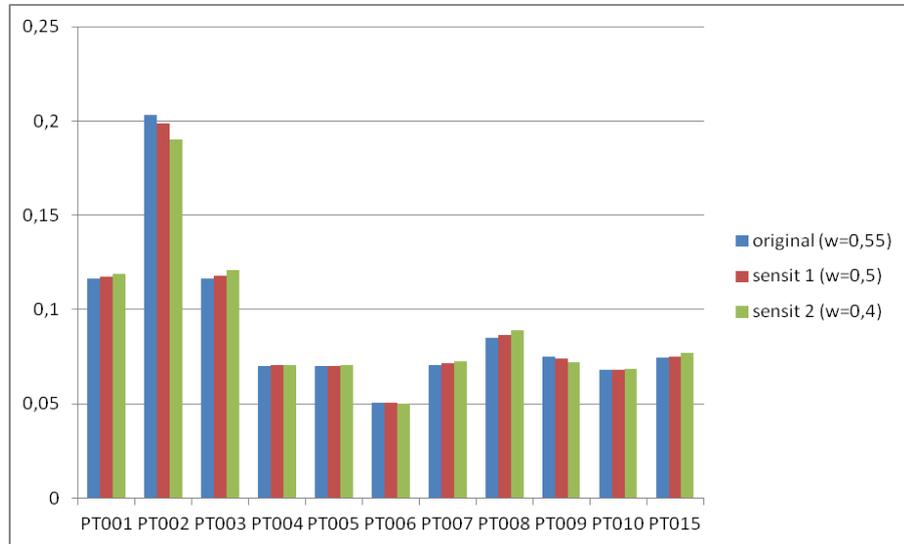


Figure 8. Sensitivity analysis for the projects' prioritization

Figure 9

In your opinion, the results obtained with the methodology in relation to your expectations are:				
1. Very Little in accordance	2. Little in accordance	3. Somehow in accordance	4. In accordance	5. Much in accordance
In your opinion, the process of application of the methodology was:				
1. Very long	2. Long	3. Normal	4. Short	5. Very short
In your opinion, the application of the methodology was:				
1. Very difficult	2. Difficult	3. Normal	4. Easy	5. Very easy
In your opinion, would you use again this for the prioritization of a Project portfolio?				
1. No	2. Maybe	3. Possibly	4. Very probably	5. Definitely

Figure 9. Questionnaire of Satisfaction. Source: compiled by authors

Figure 10

<i>Item</i>	<i>Expert 1</i>	<i>Expert 2</i>	<i>Expert 3</i>	<i>Expert 4</i>
In your opinion, the results obtained with the methodology in relation to your expectations are:	5	4	4	5
In your opinion, the process of application of the methodology was:	3	2	2	3
In your opinion, the application of the methodology was:	5	5	5	5
In your opinion, would you use again this for the prioritization of a Project portfolio?	4	5	5	5

Figure 10. Individual results of the Questionnaire of Satisfaction. Source: compiled by authors