MULTI-CRITERIA PROJECT PRIORITIZATION IN A PROFESSIONAL MASTER'S PROGRAM

Emerson Antonio Maccari
Sergio Bomfim Martins
Universidade Nove de Julho UNINOVE, São Paulo, São Paulo, Brasil

Cibele Barsalini Martins
Universidade Federal de Santa Catarina, Santa Catarina, Brasil
_____

ABSTRACT

Results of assessments bring changes to the organizational behavior and management of Higher Learning Institutions (HLI) and may or may not alter their institutional structure. Assessments have enabled HLI to rethink and redesign processes. As a result, institutions are becoming increasingly similar to each other, which is a phenomenon called coercive isomorphism. To propose a distinctive and positive element in the decision-making process, this study examined empirically how the AHP method (*Analytic Hierarchic Process*) can contribute to project prioritization in the Professional Master's Program in Business – Project Management of the University Nove de Julho (UNINOVE). This research was developed based on a case study from a theoretical-conceptual structure. This structure comprised the basis to develop and implement a structured questionnaire to build the multi-criteria hierarchical structure of the AHP method and obtain project prioritization and requirements of the assessment system developed by CAPES - Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, a government agency linked to the Brazilian Ministry of Education in charge of promoting high standards for post-graduate courses in Brazil). The results suggest that this approach can assist the coordinating committee of the Professional Master's Program of UNINOVE to prioritize projects and contribute to its performance improvement in the CAPES assessment system.

Keywords: Portfolio management; CAPES; project selection; analysis of hierarchical process (AHP).

_____

Emerson Antonio Maccari Universidade Nove de Julho UNINOVE, São Paulo, São Paulo, Brasil, E-mail maccari@uninove.br

*Sergio Bomfim Martins, P*rofessor at Master's Professional in Administration - Project Management Universidade Nove de Julho UNINOVE, São Paulo, São Paulo, Brasil E-mail: sergiobomfim@gmail.com

Cibele Barsalini Martins, Universidade Federal de Santa Catarina, Santa Catarina, Brasil E-mail: cibelebm@uol.com.br

1.   INTRODUCTION

The CAPES assessment system has fulfilled its mission of expanding and consolidating graduate studies in Brazil (CAPES, 2013c). According to Maccari (2008), this system can be considered one of the most efficient in the world because it uses quantitative and qualitative indicators that allow assessing program quality and identifying areas that the State wishes to develop.

Studies developed by Maccari, Lima and Riccio (2009) highlighted three points: (1) the assessment system influences program development and is the main strategic program vector; (2) the criteria and assessment items are clear and known by the academic community assessed; and (3) the system demands high quality and productivity and encourages programs to be extended to the society. According to Serafim (2004), the CAPES assessment system also aims to distribute resources from funding agencies through scholarships and loan programs.

However, Maccari, Lima and Riccio (2009) highlighted issues concerning the scarcity of resources. The authors stressed that CAPES has helped programs to allocate resources, both for infrastructure and intellectual production of faculty and students, leading them to better their performance.

Therefore, programs assessed by CAPES need to manage project portfolios to allocate resources to achieve better performance within the development strategy of each program. Kerzner (2004) stated that project portfolio management requires the definition of proper investments in each project of the organization. This approach could contribute to the decision-making process of selected projects using existing portfolio management models (Carvalho &Rabechini Jr., 2011).

This study adopts a comparative approach as it uses the method of Analytic Hierarchic Process (AHP) developed by Thomas Saaty in the 1970s to develop hierarchical structures based on multiple criteria and multiple decision-making processes (Hatcher, 2008).

The AHP could develop in graduate programs a distinctive and positive element in the decision-making process as graduate programs tend to be similar to each other, a phenomenon known as coercive isomorphism (Maccari, Lima *Et Al*., 2009)

When reviewing the structure of CAPES assessment system, we proposed an association between the five criteria in the assessment process and the hierarchical structure according to the AHP method to investigate if the program coordinating committee can use this methodology to provide an effective way to prioritize projects, developed or planned, within a time interval.

Based on this issue, we pose the question: "How can the AHP method contribute to project prioritization in Professional Master's Programs assessed by CAPES?"

This study also aims to identify contributions of the multiple-criteria approach (AHP method) to prioritize projects in graduate programs.

In addition, given the subjectivity in the CAPES assessment (Neves and Costa, 2006), we investigated whether the AHP method helps in the decision-making process and project prioritization in Professional Master's Programs.

The study was structured as follows: literature review about CAPES and project management per portfolio; association between the items of the CAPES assessment

system and hierarchical structure proposed by the AHP method; application of the AHP method in project prioritization in a selected Professional Master's Program; development of the result analysis and the final presentation of the study.

2. THEORETICAL FRAMEWROK

Several researchers have studied the CAPES assessment system (Horta &Moraes, 2005; Maccari, Almeida *et al*., 2009; Maccari, Lima *et al*., 2009; Maccari, Rodrigues, Alessio&Quoniam, 2008; Maccari, Rodrigues, Coimbra&Almeida, 2006; Maccari, 2008; Martins, Maccari, Storopoli, Almeida&Riccio, 2012; MELLO *et al*., 2010; Mello &Crubellate, 2008; Pereira, 2005; Viana *et al*., 2008). Many researchers have investigated portfolio management using the AHP method (Archer & Ghasemzadeh, 1999; Begičević, Divjak & Hunjak, 2010; Carvalho & Pessôa, 2012; Cooper, Edgett&Kleinschmidt, 1999, 2000; Costa, 2011; Ensslin, ANDREIS, Medaglia, De Carli & Ensslin, 2012; Forman & Gass, 2001; Forsberg, Mooz & Cotterman, 2005; Ghasemzadeh & Archer, 2000; Modica *et al*., 2010; Padovani, Carvalho & Muscat, 2010; Padovani *et al*., 2008; Saaty, 1999; Wallenius *et al*., 2008). However, the relation between these two themes is scarce.

2.1. CAPES and its assessment system

Assessment as a means of control is a static and closed question recurrently associated with punishment and it is used to discipline and punish (Foucault, 1987). To be effective, assessment needs to be transformed into a process based on data collection, selection and processing, evolving into interpretation and converted into knowledge to be disseminated, contributing to a dynamic, open and constructive way for decision making (UNESCO, 1998).

Schwartzman (1990) and Durham (1992) emphasize the dynamism of assessment processes and highlight that they can help address two questions. The first question regards the role of the State in allocating resources and managing the pressure from the society to expand access to quality education. The second question regards universities in their objective to avoid a double danger: failure to respond to social pressures and become obsolete institutions and dealing with immediate pressures, detrimental to the ability to develop basic scientific research.

In this sense, CAPES, a foundation of the Ministry of Education (MEC) plays a key role in the expansion and consolidation of *strict sensu* postgraduate courses (Master's and Ph.D. Programs) in Brazil (CAPES, 2013c).

Among the activities performed by CAPES are: assessment of *strict sensu* graduate studies, access and dissemination of scientific production, investments in training of high-level human resources in the country and abroad, promoting international scientific cooperation, induction and promotion of initial and continuous professor training for basic in-person and distance education (CAPES, 2013c).

The CAPES assessment system has been used since 1976 and features the following objectives: a) establish and identify the quality standard required of Master's and Ph.D. courses; b) substantiate the opinions of the National Council of Education on authorization, recognition and renewal of Master's and Ph.D. courses in Brazil; c) boost

the development of the entire National System of Postgraduate Education (SNPG) through goals and challenges that express the advances of modern science and technology and the increase of the national competence in this field; d) contribute to the improvement of each graduate program through discerning expert opinions and a reference about the current stage of development of the program; e) contribute to the increased effectiveness of programs in meeting the needs for high-level training of national and regional human resources; f) provide the country with an efficient database on the situation and development of graduate students; g) offer the basis for the definition of the development policy for graduate studies and for the justification of decisions about actions of governmental funding agencies on research and graduate studies (CAPES, 2013a).

Academic representatives and consultants carry out assessments and their system encompasses two processes: assessment of graduate programs and proposals for new courses. The former comprises the completion of annual monitoring and triennial assessment of the performance of all programs and courses that are part of the National System of Post-graduate Course (SNPG). The results of this process, expressed by a 1-7score, underpin the CNE/MEC decision about what courses will attain the recognition renewal to take effect in the subsequent three years (Viana, Mantovani, & Vieira, 2008). The latter comprises the implementation of new programs and courses to SNPG, assessments and proposals, and submission of results of this process to support program recognition (CAPES, 2013a). Accreditation of Master's and Ph.D. courses at CAPES isrequired by the Brazilian legislation. To be recognized and recommended by CAPES, a course needs to obtain a score equal to or greater than 3 in the assessment (Maccari, 2008).

According to Pereira (2005), the CAPES assessment process shows a complex system of judgments about several factors regarding graduate courses. Essentially, it includes factors related to research and teaching. The final concept of a program comes from the assessment by a committee representing each area of knowledge. The assessment is carried out based on information submitted by graduate programs in special forms as well as visits to institutions. The information presented can be divided into qualitative and quantitative data.

In all, CAPES assessment system comprises five questions: (1) program proposal; (2) faculty; (3) student body; (4) intellectual production and (5) social inclusion (Maccari, Almeida, *et al*., 2009; Martins *et al*., 2012). For Maccari, Lima *et al*. (2009), the program proposal is qualitative in nature and has no weight. It is interpreted as adequate or inadequate. In this question, we also observe coherence, consistency and comprehensiveness of the curricular structure as well as the infrastructure for education, research, extension courses, innovative and different activities for the academic degree of faculty members.

The question about faculty members accounts for 20% of the total weight in the score and seems to be the most influential on the remaining questions (Maccari, Lima *et al*., 2009). The second question regards the academic degree of faculty members as well as adequacy, composition, dedication, profile in relation to the program proposal, performance in undergraduate education and participation in research and project developments.

The third question regards the student body, theses and dissertations and accounts for 35% of the total weight in the CAPES score. This question comprises the percentage of Master's and Ph.D. thesis defenses in relation to permanent faculty,

adequacy and compatibility of the relationship advisor/advisee, participation of graduate and undergraduate students in publications, dissertations and theses related to publications, quality of theses and dissertations and average time of course completion of Master's and Ph.D. programs (Maccari, Lima *et al*., 2009). Although this item is significant in the score composition, researchers highlight the inexistence of indicators that take into account perspectives of the student body about their satisfaction and quality of education (Moreira, Hortale & Hartz, 2004).

Intellectual production also accounts for 35% of the assessment weight. It comprises qualified publications of the program by permanent faculty, distribution of qualified publications in relation to permanent faculty, technical or technological production, production of high impact as well as assessment of quality and quantity of publications of faculty by establishing rules for minimum production for each program level (Maccari, Lima *et al*., 2009). For Horta and Moraes (2005), bibliographic production is a discriminating question that through the quality of the media. Co-authoring cooperation in intellectual production can promote the acquiescence of the programs in relation to CAPES requirements (Mello & Crubellate, 2008).

Finally, social integration accounts for 10% of the total weight of the assessment, highlighting its qualitative nature. Social integration comprises insertion and regional impact (and, or national), integration and cooperation with other programs as well as visibility and transparency. The CAPES assessment system induces programs to extend social inclusion and this item is evidenced to programs with scores 6 and 7 (Maccari, Lima *et al*., 2009).

In this sense, requirements imposed by CAPES have forced HLI and their graduate programs to plan and manage their programs more effectively (Maccari *et al*., 2006). In addition, studies show that the conscious and planned use of the CAPES assessment system allows meeting the demands of the society regarding the   academic degree of highly qualified human resources and knowledge production in the field of business management in Brazil (Maccari *et al*., 2008; Martins, 2013)

2.2.   Portfolio management

A project portfolio is a group of projects that run under the management of a particular organization (Archer & Ghasemzadeh, 1999). According to these authors, projects compete for scarce resources (people, finances, time, etc.) as resources are not enough to accomplish each proposed project. Besides, some projects do not meet the minimum requirements of the organization regarding certain criteria, such as profitability potential, etc.

Cooper *et al*. (1999, p. 335) have raised questions regarding the process dynamics for concepts of portfolio management – "a dynamic process where projects are constantly altered and revised". According to these authors, three main objectives comprise portfolio management: a) maximum value; b) balancing, and c) strategic alignment.

Cooper *et al*. (1999) state that portfolio management is related to the effectiveness of an enterprise regarding three aspects of business management: 1) strategy: alignment of projects to corporate goals, 2): resource allocation of investments in various projects considering the financial and human resources, and 3) prioritization of projects to ensure strategy and achievement of business goals.

The selection of a project portfolio is an important decision in many organizations where proper allocation of investments is complex due to different risk levels, resource requirements and interaction among proposed projects (Ghasemzadeh &Archer, 2000).

According to Kent (2002), portfolio management is a management process guided by five steps: a) project identification; b) alignment of strategies and opportunities with the organization; c) assessment of investments and resources; d) portfolio development; and e) portfolio management.

Thus, the process of project portfolio management involves different stages of decision making to select and prioritize projects that add value to organizations (Padovani *et al.*, 2010).

Duarte (2007) highlights the need to establish a distinction between project selection and portfolio selection. The author explains that project selection refers to the choice of a subset of project proposals available, considering particular features and restrictions on projects. Portfolio selection aims to compose a portfolio to choose a set of projects taking into account not only particular features and restrictions on projects, but also the relationship between them.

For Costa (2011), this statement is based on the conceptual origin of the word portfolio coined by Harry Markowitz who created the Modern Theory of Portfolio that aimed at combining assets (stock market) in the best possible way. Thus, Markowitz (1952) pointed out that the definition of a portfolio is associated with the best combination of assets and not only with its selection.

According to Archer and Ghasemzadeh (1999), project selection involves various and simultaneous comparisons within the dimensions of peculiarities to reach a harmonized classification. From this classification, projects are selected for the portfolio and subject to availability of resources. Five types of techniques comprise portfolio selection: (1) ad hoc approaches, (2) comparative approach, (3) scoring models, (4) portfolio matrices and (5) optimization models.

2.3. AHP method

This study aimed to deepen the comparative approach by using a portfolio classification model called Analytic Hierarchic Process (AHP method) developed by Thomas Saaty in the 1970s. This model allowed the development of hierarchical structures from multiple criteria and multiple decision-making processes (Hatcher, 2008; T. Saaty, 1999).

For Forsberg *et al.* (2005), the AHP is a decision-making process based on the comparison of pairs of criteria followed by the use of a process to calculate the relative importance of each criterion. The alternatives are scores using the comparison of pairs against the criteria to determine the best candidate.

Vincke (1992) states that the study field of Multi-Criteria Decision Support features two lines of thought: the French school (MCDA-Multiple Criteria Decision - Aid) represented by the methods ELECTRE (Elimination et Choix Traduisant la Realité) proposed by Bernard Roy (1968) whose principles are flexible and accept that alternatives are not comparable with each other. Besides, it does not use the axiom of transitivity and PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations) that was proposed by Jean-Pierre Brans (1984) and is used for

an infinite number of alternatives. Another school is the American School (MCDM - Multiple Criteria Decision Making) represented by the AHP method and proposed by professor Thomas L. Saaty in the 1970s. MCDM uses binary assessments between intangible (qualitative) and tangible (quantified) criteria.

According to Forman and Gass (2001), the AHP is a model for structuring, measuring and synthesizing and has been applied in a wide range of issues including selection between competing alternatives in an environment with multi-objectives, allocation of scarce resources and resource forecasts. For these authors, the main use of the AHP method is to address issues concerning choices in a multi-criteria environment. Therefore, the model includes comparisons of objectives and alternatives in pairs and in a natural way. The method converts individual preferences within a range of weight ratios that are combined into linear additive weights for the associated alternatives. These resulting weights are used to rank alternatives and help the decision-maker to make a choice or predict a result.

Goodwin and Wright (2005) summed up the use of the AHP method in five steps:

a) Organization of decision hierarchy: the highest level is represented by the general proposal. Then the attributes (criteria) related to the problem to be decided. These attributes can be divided into a lower level (sub-criteria). The last level is represented by alternatives;

b) Paired comparison of criteria and alternatives: used to determine the relative importance of attributes as well as compare the importance of all the attributes with each other, belonging to the same level in the hierarchical structure. The paired comparison has three criteria, "A", "B" and "C". It carries the comparison between "A and "B", "A" and "C" and "B" and "C", not requiring the comparison of "B" with "A", for example, because the methodology uses reciprocating trials;

c) Allocating weight to comparisons besides validating the consistency rate of comparisons of the decision maker;

d) Use of received weights from the comparisons to obtain grades for different opinions and then taking the interim decision;

e) Completion of the sensitivity analysis.

Figure 1 shows the results of a survey conducted by Wallenius *et al*. (2008) who reported on the amount of research conducted per methodological area. The increase of publications related to the AHP method is high as well as the recent increase of publications in EMO (Evolutionary Multicriterion Optimization). On the other hand, programming by objectives (Goal Programming) and by mathematics (Mathematical Programming) have shown a stable increase pattern. The authors identified difficulties in finding research based on methods of the French School.
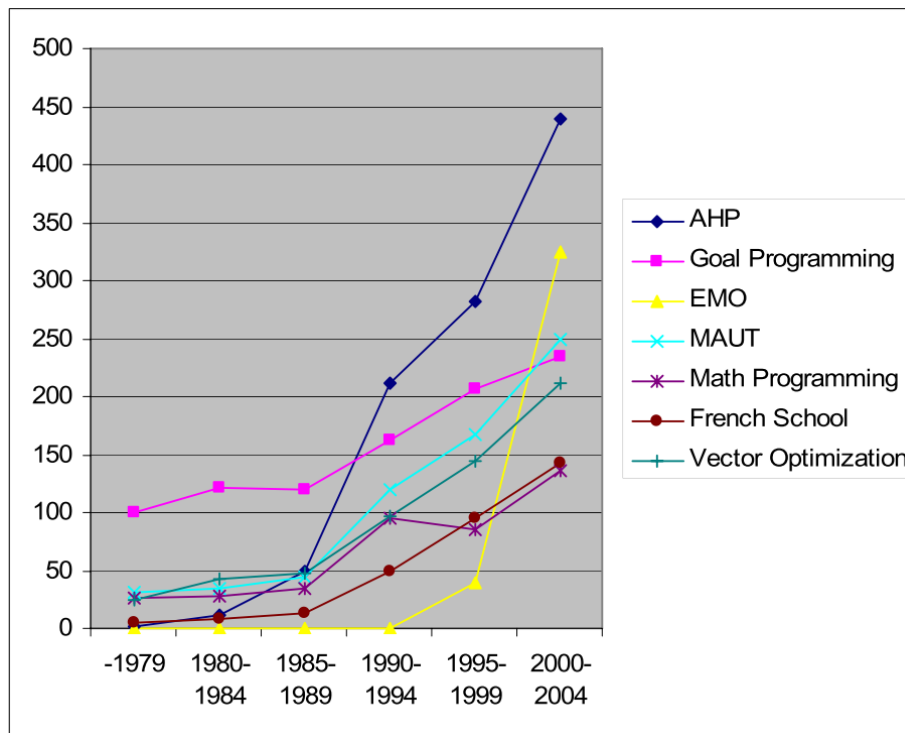
Figure1–Publications per field of research

Source: Wallenius *et al*. (2008, p. 8).

Forman and Gass (2001) state that the very essence of the AHP is not generally understood. The AHP is more than just a methodology for situations of choice. It is not just a tool of analysis. The best way to explain the AHP is to describe its three basic functions: (1) the hierarchical structuring of complexity: a means found by Saaty to deal with complexity in homogeneous groups of factors; (2) measurement on a relationship scale: Saaty uses paired comparisons of hierarchical factors to derive (rather than assign) scale relationship of measures what can be interpreted as final sorting priorities (weights); and (3): synthesis: concerning combination of the parts in a whole, the capacity of the AHP method to measure and synthesize the multiplicity of factors in hierarchy.

Thus, any situation that requires measurement, structuring and, or synthesis is a good candidate for the application of the AHP method (Forman & Gass, 2001). According to these authors, when we use a hierarchical structure to analyze alternatives of choice, the AHP provides probabilities for the choice of hierarchical structure as well as priorities for the alternatives in such a structure.

The AHP method has been used in new areas, such as data envelopment analysis, science of negotiation, electronic commerce, spatial modeling, and engineering, more broadly (Wallenius *et al*., 2008). From 1970 until the end of June 2007, roughly 7,000 studies worldwide were published involving topics related to this approach. These authors believe that this type of method is likely to be used even more.

Similar studies conducted by Padovani *et al*. (2008) highlighted important sectors in Brazil that have adopted the AHP method, namely the aeronautical industry, banks, business information technology, construction, Defense Department of the State, the energy sector, governments, chemical, pharmaceutical and oil industries, among others. In Brazil, Modica *et al*. (2010) studied the use of the AHP method in the oil

sector while Ensslin *et al*. (2012) evaluated the use of the method in a power distribution company.

In the European educational sector, Begičević *et al*. (2010) showed the use of the AHP method in HLI to address problems of project selection of projects. In Brazil, Carvalho and Pessôa (2012) investigated the use of the AHP method in the innovation department of a public HLI.

This study proposed the use of the AHP method as a tool to support coordinators of Professional Master's Programs to prioritize projects. We used the criteria in the CAPES assessment system to make an association between the questions and the hierarchical structure proposed by the AHP method. The objective was to investigate if this methodology could be used by program coordinators to provide an effective way to prioritize projects developed or forecast within a time interval of three years maintaining equivalence with the periodicity of the CAPES assessment. Next, we present the methods and survey techniques used to answer the research question: "How can the use of the AHP method contribute to project prioritization in Professional Master's Programs assessed by CAPES?"

3. RESEARCH METHOD

The objectives of this study were verified through a single case study, exploratory in nature, besides the use of a bibliographic research strategy using as evidence the development of a structured interview (Martins & Theóphilo, 2009; Yin, 2010).

According to Yin (2010), three conditions determine the choice for research strategy: the type of research question to be answered, the control level the investigator has about events that will be researched and the level of focus on the contemporary phenomenon as opposed to the historical phenomenon. Thus, research questions like "how" or "why", the little control that the researcher has about the events to be investigated and when the focus is on a contemporary phenomenon inserted in real life are assisted by the strategy of the case study (Yin, 2010).

The emphasis on reality observation based on a logical expression of scientific discourse indicates that the positivism would be the appropriate methodological approach to be used in this context (Martins & Theóphilo, 2009). In addition, the need to understand complex social phenomena makes the case study strategy suitable for an investigation that preserves the holistic and meaningful features of real life events (YIN, 2010). For this reason, the case study was chosen as an empirical observation.

According to Yin (2010), the use of a single case study is also justified when it represents the critical case in a test of a well-designed theory. Therefore, the study may confirm, challenge or expand the theory and can be used to determine if the same propositions are correct or if any alternative set of explanations may be more relevant. Another justification cited by Yin (2010) for this type of study is when the single case is representative or typical to capture circumstances and conditions of a daily situation or commonplace.

To understand the phenomenon of project prioritization in a Professional Master's Program, this case study established a series of methodological procedures

divided into four phases: exploratory), b) single case study, c) in-depth research and d) assessment.

In the first phase, basic issues were identified from a literature review of CAPES focused on its assessment system and project portfolio management with emphasis on the AHP method, which served as support for developing the questionnaire.

The second phase comprised the single case study and the choice of analysis unit using Geo Capes tool (CAPES, 2013b), the CAPES database, which consists of reference information according to the geographical location of the unit. We selected all Professional Master's Program in 2011in the municipality of São Paulo. In all, there were seven programs and in this study, we decided to place emphasis on the Professional Master's Program in Project Management from the University Nove de Julho (UNINOVE) that has the score 4 in the CAPES assessment system (CAPES, 2013b). The questionnaire developed during the exploratory phase was applied to the program coordinator with more than 10 years of experience in questions related to the CAPES assessment system having served as an ad hoc consultant of this assessment system. The coordinators of the other programs were newly sworn in and had no equivalent experience to the guest coordinator in this research, thus, we opted to include only one respondent.

Overall, we carried out two interviews with the same coordinator focusing on the approach of Saaty (2008; 1999) and Padovani (2007). We used the paired analysis of criteria and alternatives in the Saaty scale (1-9) (Chart 1).

Chart 1 –Saaty scale

Importance intensity	Definition	Explanation
1	Equal importance	Both attributes contribute equally to the objective.
2	Weak or slight importance	Experience in judging favors slightly one attribute over another.
3	Moderate importance	
4	Slightly strong importance	Experience in judging favors significantly one attribute over another.
5	Strong importance	
6	Stronger importance	One attribute is significantly influenced over another; its dominance is demonstrated in practice.
7	Stronger or demonstrated importance	
8	Very strong importance	Evidence favors one attribute over another with a high degree of certainty.
9	Extreme importance	

Source: Saaty (2008).

Chart 1 shows the fundamental scale of Saaty where the numbers represent the degree of intensity of a given attribute in comparison to another and a verbal scale is associated with each number to facilitate the understanding during the assignment of weights (SAATY, 2008). Next, we create a matrix in which the numbers in the table represent the degree of importance of an attribute in the row against another attribute in the column.

In the third phase, we decided to consolidate the information obtained from the program coordinator, collected by questionnaires, in a multi-criterion hierarchical structure formed based on the application of the AHP method supported by a spreadsheet.

We have validated the paired comparisons with the Consistency Index (CI) to check for any inconsistency in the trials conducted. This index was the result of maximum eigenvector Λ_{max} by the number of elements considered in the matrix (n) and

divided by the subtraction of "n – 1"(SAATY, 2005, p. 28) represented by the formula:

$$\mu = \frac{\lambda_{max} - n}{n-1}.$$

For Saaty, the ideal consistency in the AHP method is up to 10%, that is, the result the ratio between the CI and the Random Index (RI) must be <= 0.1 in the formula: $CR = \frac{CI}{CR}$ where CR = Consistency Ratio. According to Saaty (1987), the RI derived from an experiment with a sample of 500 elements of a reciprocal matrix randomly generated using the scale 1/9, 1/8, 1/7 ... 1, 7, 8, 9 to ensure if the calculated consistency is about 0.10 or less. Thus, the RI value used to find the CR corresponds to the matrix order of the problem (Table 1):

Matrix Order	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Table 1 – Random Index
Source: Saaty (1987).

However, minimizing inconsistency is not main purpose of the analysis. We aimed at a better understanding of the problem since a set of random trials can lead to a perfect consistency, but not necessarily lead to the best decision (GOODWIN & WRIGHT, 2005). For Bozóki and Rapcsák (2007), paired comparison matrices are rarely consistent in decision-making processes in real life.

To use the AHP method in this study, we adopted the hierarchical structure in Figure 2:
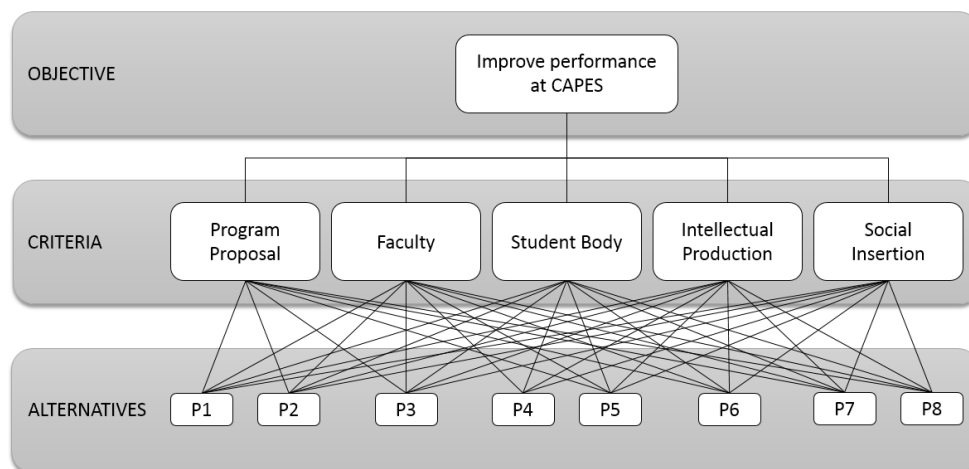
Figure 2 – Multi-criterion hierarchical structure

Source: Developed by the authors

Figure 2 shows the hierarchical structure components of the AHP method used in this work. The main objective is at the top of the hierarchical structure, which is performance improvement in the CAPES assessment in this study. The criteria represented by the five criteria of the CAPES assessment are presented in the medium part. In the lower part, we show the alternatives that were represented by projects considered more adherent to achieve the objective (paired comparisons between criteria and purpose and between alternatives and criteria were asked to coordinator of the Master's Program).

This information was used to develop the fourth and last phase of the research that comprised the analysis of the results that were part of a final report with the conclusions as well as its recommendations.

4. ANALYSES OF THE RESULTS

Respecting the program mission and providing bases for the decision-making process to ultimately improve performance in the CAPES assessment system, we considered the five questions of these assessment system criteria. From this understanding, the program coordinator listed eight major projects that would generate results within the next three years (Table 3), which composed the alternatives of multi-criterion hierarchical structure, keeping the temporal equivalence between the CAPES assessment issues and related projects.

Chart 2–Project list

Projects	Description
P1	International Symposium on Project Management – SINGEP
P2	Bentley UniversityInternational Module
P3	Technological/Technical Production Protocol
P4	Resident
P5	Academic Studies Plan – Electronic PEA
P6	Control/Tracking of Graduates
P7	Management Platform for Post-Graduate Courses
P8	Science of School

Source: Developed by the authors.

As recommended by Forsberg *et al*. (2005) and designed by Saaty (1999), the decision making process through AHP was based on comparison between pairs of criteria, followed by the use of a process to calculate the relative importance of each criterion. Next, the alternatives were graded after comparison with the criteria to determine the benefit of each alternative to achieve the objective proposed.

After creating the multi-criterion hierarchical structure (Chart 2) and collecting the questionnaire with weight attributions to each criterion, according to the program coordinator's opinion, we obtained prioritization of alternatives through six steps: 1) development of comparison; 2) preparation of standard matrix; 3) calculation of weight percentage of criteria/alternatives; 4) validation of weight consistency; 5) analysis of comparisons with weights obtained; 6) obtaining the prioritization.

In Step 1, we structured the comparison matrix for the criteria according to the intensity degree of importance among peers, from the coordinator's perspective, using 1-9 scale for comparisons between the sets of criteria (T. Saaty, 1999) (Table 2):

Table 2–Criteria comparison matrix of coordinator

Criteria	Program Proposal	Faculty	Student Body	Intellectual Production	Social Insertion
Program Proposal	1	1/9	1/7	1/8	1/6
Faculty	9	1	9	9	9
Student Body	7	1/9	1	1/8	8
Intellectual Production	8	1/9	8	1	8
Social Insertion	6	1/9	1/8	1/8	1
Sum	31.000	1.444	18.268	10.375	26.167

Source: Developed by the authors.

Table 2 shows the answers obtained through the questionnaire. The reading occurs by comparing criterion in the row with criterion in the column. Number 1 represented the intersection between equal criteria (same importance). The assessment between intersections row x column, where criterion in the row was considered more important than criterion in the column, was represented by an integer and its value indicated the intensity of this importance according to the coordinator's responses. Consequently, the opposite comparison between the criteria was represented by the fraction.

In Step 2, we found the weight percentage of the values obtained in Step 1 (Table 3):

Table 3–Normalized matrix for criterion comparison of the coordinator

Criteria	Program Proposal	Faculty	Student Body	Intellectual Production	Social Insertion
Program Proposal	0.032	0.077	0.008	0.012	0.006
Faculty	0.290	0.692	0.493	0.867	0.344
Student Body	0.226	0.077	0.055	0.012	0.306
Intellectual Production	0.258	0.077	0.438	0.096	0.306
Social Insertion	0.194	0.077	0.007	0.012	0.038
Sum	1.000	1.000	1.000	1.000	1.000

Source: Developed by the authors.

Table 3 shows the standardization results of Table 1 through the division of each weight for the total sum of their respective column (T. SAATY, 1999). We highlight the importance of the criterion "Faculty" in relation to the others.

In Step 3, we calculated the weight percentage of the criteria (T. SAATY, 1999) (Table 4):

Table 4 – Criteria weight – coordinator's perspective

Criteria	Criteria Sum	Average	Weight %
Program Proposal	0.135	0.027	2.70%
Faculty	2.687	0.537	53.70%
Student Body	0.675	0.135	13.50%
Intellectual Production	1.175	0.235	23.50%
Social Insertion	0.328	0.066	6.60%
Sum	5.000	1.000	100%

Source: Developed by the authors.

In Table 4, we added the weights obtained in the columns of Step 2 (column "criteria sum"). Next, we carried out the normalization of each criterion (average) and

for the best visualizations, the values obtained were displayed in percentage (%). For Padovani (2007), this step is important for the application of this method as it allows the analysis of quantitative dimensional elements along with the subjective opinions of the evaluator. A comparative analysis with the weights of CAPES showed that the coordinator's response points to "Faculty" as the most important criterion, followed by "Intellectual Production" and the "Student Body". For CAPES, these criteria presented percentage weights of 20%, 35% and 35%, respectively. In other words, this high importance degree for "Faculty" compared with others was already investigated by Maccari, Lima *et al.* (2009). The authors highlight that it is explained by the power of influence that this criterion has over the others.

In Step 4, we carried out the validation of weight consistency (T. SAATY, 1999) by calculating the average of the product by weight percentage (Table 5):

Table 5 − Average calculation of the product by weight percentage

Criteria	Weight %	Product	Product / Weight	Average (Product / Weight)
Program Proposal	2.70%	0.146	5.405	7.040
Faculty	53.70%	4.701	8.749	
Student Body	13.50%	0.938	6.944	
Intellectual Production	23.50%	2.116	9.004	
Social Insertion	6.60%	0.334	5.098	

Source: Developed by the authors.

Table 5 shows the value of weight percentage obtained in Table 3. We calculated the column "Product" by multiplying the Comparison Matrix Criteria of the Coordinator (Table 1) by the column "Weight%".We divided the value obtained in the column "Product" by "Weight%" and in the last column, we calculated the sum average of the column result "Product /Weight" obtaining the eigen value of the matrix comparison criteria, in this case 7.040. From this result, we found the consistency of coordinator's judgments (Table 6):

Table 6 − Validation of consistency of coordinator's weight

Criteria	Average (Product / Weight)	Number of Criteria	CI	SI	CI / SI
CAPES weight (coordinator)	7.040	5	0.510	1.120	45.50%

Legend: CI (Consistency Index), SI (Saaty Index).

Source: Developed by the authors.

In Table 6, we showed the calculations for the Consistency Index (CI) of the comparison matrix for five criteria (T. SAATY, 1999), where CI = (average value of Product by Weight Percentage − number of criteria)/(number of criteria − 1); SI (Saaty Index) was the value of the Saaty table for random indexes (T. SAATY, 1999)obtained in Matrix with $a_{ii}=1$; $a_{ij} = 1/a_{ji}$, which corresponded to the index for five elements; and to test the consistency of weights, we divided the value obtained in CI by SI, resulting in the percentage of 45.5%. For Saaty (1999), the comparison is consistent when result of CI/SI does not exceed 10%. In this case, the result of the criteria comparison matrix

of the coordinator showed inconsistency and we needed to review the weights reported by the Coordinator.

We conducted another interview with the coordinator to revalidate the informed criteria (Table 7):

Table 7- Criteria comparison matrix of the coordinator-revalidation

Criteria	Program Proposal	Faculty	Student Body	Intellectual Production	Social Insertion
Program Proposal	1	1/9	1/9	1/8	1/6
Faculty	9	1	7	7	9
Student Body	9	1/7	1	6	9
Intellectual Production	8	1/7	1/6	1	8
Social Insertion	6	1/9	1/9	1/8	1
Sum	33.000	1.508	8.389	14.250	27.167

Source: Developed by the authors.

In Table 7, in comparison with the first interview, the coordinator promoted five changes in rating: a) increased the degree of importance of the criterion "Student Body" compared with the criterion "Program Proposal, Social integration and Intellectual Production"; and b) decreased the degree of importance of the criterion "Faculty" in relation to criteria "Student Body" and "Intellectual Production".

Following the same logic of the calculations presented in the Steps 2-4 above, we obtained the new percentage of judgment consistency of the coordinator (Table 8):

Table 8 – Validation of consistency of the coordinator's weights

Criteria	Average (Product / Weight)	Number of Criteria	CI	SI	CI / SI
CAPES weight (coordinator)	6.619	5	0.405	1.120	36.10%

Source: Developed by the authors.

The calculations followed the same logic to create Table 6 and in this case, the new value of the weight consistency reduced by 36.1%. Although considered of low precision according to Saaty (1999), there was a refinement in comparison with the first assessment (9.4% improvement). According to Saaty (1999), thin inconsistency in the trial would be allowed because the result of the CI calculation can direct the decision maker to improve the trial and better understand the problem.

For the analysis of criteria comparisons with the weights obtained, we performed paired comparisons of alternatives for each criterion using questions that addressed the degree and intensity of importance between the alternatives (PADOVANI, 2007; T. SAATY, 1999) comparing them with the CAPES criteria (Table 9):

Table 9 – Matrix of paired comparison of alternatives in relation to the CAPES criteria

Program Proposal	P1	P2	P3	P4	P5	P6	P7	P8
P1	1	1/6	6	6	6	1/9	7	6
P2	6	1	1	7	8	1/9	7	8
P3	1/6	1	1	8	6	1/8	7	8
P4	1/6	1/7	1/8	1	5	1/9	7	8
P5	1/6	1/8	1/6	1/5	1	1/8	5	5
P6	9	9	8	9	8	1	8	9
P7	1/7	1/7	1/7	1/7	1/5	1/8	1	5
P8	1/6	1/8	1/8	1/8	1/5	1/9	1/5	1

Faculty	P1	P2	P3	P4	P5	P6	P7	P8
P1	1	1/6	1	5	3	1/8	5	4
P2	6	1	1/7	5	1/5	1/7	1/5	1/4
P3	1	7	1	7	7	5	6	5
P4	1/5	1/5	1/7	1	1/6	1/7	1/6	1/4
P5	1/3	5	1/7	6	1	5	6	4
P6	8	7	1/5	7	1/5	1	1/4	5
P7	1/5	5	1/6	6	1/6	4	1	6
P8	1/4	4	1/5	4	1/4	1/5	1/6	1

Student Body	P1	P2	P3	P4	P5	P6	P7	P8
P1	1	1/7	1	1	1	1/9	5	5
P2	7	1	7	8	5	1/8	6	8
P3	1	1/7	1	6	4	1/8	7	8
P4	1	1/8	1/6	1	5	1/8	5	6
P5	1	1/5	1/4	1/5	1	1/8	5	5
P6	9	8	8	8	8	1	8	9
P7	1/5	1/6	1/7	1/5	1/5	1/8	1	3
P8	1/5	1/8	1/8	1/6	1/5	1/9	1/3	1

Intellectual Production	P1	P2	P3	P4	P5	P6	P7	P8
P1	1	8	1/8	6	1/6	1/8	5	6
P2	1/8	1	1/8	7	1/6	1/8	6	6
P3	8	8	1	8	8	8	9	9
P4	1/6	1/7	1/8	1	1/7	1/7	4	5
P5	6	6	1/8	7	1	7	7	8
P6	8	8	1/8	7	1/7	1	5	7
P7	1/5	1/6	1/9	1/4	1/7	1/5	1	6
P8	1/6	1/6	1/9	1/5	1/8	1/7	1/6	1

Social Insertion	P1	P2	P3	P4	P5	P6	P7	P8
P1	1	1/7	1/8	1/5	6	1/9	5	5
P2	7	1	5	1/6	5	1/8	6	6
P3	8	1/5	1	1	6	1/8	7	8
P4	5	6	1	1	6	1/8	7	6
P5	1/6	1/5	1/6	1/6	1	1/8	6	7
P6	9	8	8	8	8	1	9	9
P7	1/5	1/6	1/7	1/7	1/6	1/9	1	5
P8	1/5	1/6	1/8	1/6	1/7	1/9	1/5	1

Source: Developed by the authors.

Table 9 shows the responses obtained from the questionnaire concerning the coordinator's assessment in the paired comparison of alternatives (projects) for each of criterion (requirements). The reading follows the same logic presented in the construction of Table 2 using cross-comparison between the alternatives (row x column) in which the coordinator assessed the most important alternative and its intensity in relation to the criterion under examination. The structured analysis of this assessment weighted by the relative weights of each alternative showed to the coordinator a broad vision of the importance of projects considering the criteria allowing project prioritization, as shown in the next step.

Following the same logic of calculations in Steps 2-4, we verified the new values of judgment consistency of the coordinator (Table 10).

Table 10 – Validation of the weight consistency of the coordinator

		Average (Product / Weight)	CI	SI	CI / SI
Criteria	Program Proposal	11.350	0.480	1.410	33.90%
	Faculty	13.640	0.810	1.410	57.10%
	Student Body	10.110	0.300	1.410	21.40%
	Intellectual Production	11.730	0.530	1.410	37.70%
	Social Insertion	11.220	0.460	1.410	32.60%

Source: Developed by the authors.

The calculations followed the same logic to create Table 6. The results showed that the criterion "Student Body" showed lower inconsistency in the judgments (21.4%). On the other hand, "Faculty" had a greater inconsistency degree (57.1%). These results were important to assist the decision maker in improving the judgment and better understanding of the issue (T. SAATY, 1999).

In Step 5, we presented the results for weight percentages obtained from paired comparisons between alternatives and criteria (Table 11).

Table 11– Results of judgments according to weights of the coordinator

Criteria		Program Proposal	Faculty	Student Body	Intellectual Production	Social Insertion
Coordinator Weights		2.60%	51.90%	24.80%	14.40%	6.30%
Projects	P1	0.140	0.150	0.060	0.100	0.070
	P2	0.170	0.080	0.220	0.080	0.140
	P3	0.120	0.280	0.120	0.380	0.130
	P4	0.070	0.020	0.080	0.040	0.160
	P5	0.040	0.160	0.060	0.200	0.050
	P6	0.400	0.150	0.410	0.150	0.410
	P7	0.030	0.120	0.030	0.030	0.030
	P8	0.020	0.050	0.020	0.020	0.020

Source: Developed by the authors.

Table 11 shows the responses obtained through the questionnaire regarding the coordinator's assessment in the paired comparison between alternatives and criteria. Reading followed the same logic already presented in Table 3. The structured analysis of this evaluation weighted by the relative weights of each criterion provided the coordinator a broad vision of project importance in terms of criteria allowing project prioritization, as shown in the next step.

In Step 6, we calculated the contribution percentage of each project to performance improvement in the CAPES assessment (Table 12).

Table 12 – Hierarchy of alternatives – coordinator's weights

		Contribution %	Prioritization
Projects	P1	11.63%	5°.
	P2	11.84%	4°.
	P3	24.05%	2°.
	P4	4.67%	7°.
	P5	12.88%	3°.
	P6	24.07%	1°.
	P7	7.50%	6°.
	P8	3.36%	8°.

Source: Developed by the authors.

In Table 12, we presented the results for project prioritization based on coordinator's assessment. The results were obtained by the sum of the multiplication of each alternative by weight percentage of the criterion (Table 11) (Camanho, 2012; T. Saaty, 1999).

This analysis highlighted the presence of three groups of projects. The first represented by P6 and P3 projects (Tracking Graduates and Technical/Technological Production Protocol). Both with 24% of contribution attain improved performance in the CAPES assessment. A second group of projects (from 3rd to 5th) with an average contribution of 12% (PEA electronic, International Module Bentley and SINGEP) and the last three positions for P7, P4 and P8 projects (Management Platform for Post-graduate Course, Resident and School of science, respectively) showed reduced influence to achieve the objective (improve performance in the CAPES assessment).

Given that the second interview applied aimed at a refining the judgments conducted before, we observed a strong influence on projects prioritized in the 1st and 2nd places to achieve the objective proposed by the method, because they are in this position in both questionnaires, that is, P6 projects (Graduates Control) and P3 (Technical/Technological Production Protocol), respectively.

Project P6 reinforces previous discussions about the importance of monitoring graduate students of professional Master's program. These discussions are also

available in documents on the CAPES website by the Assessment Committee in the Field of Management, Accounting and Tourism (CAPES, 2011, 2012a, 2012b). In short, programs need to carry out surveys to track graduates for at least three years after they received their academic degree (CAPES, 2011). In addition, the Institution needs to define the importance of applicants' profile, regarded as a central aspect in the criterion "Program Proposal" (CAPES, 2012a). The program needs to mention issues related to multidisciplinary and interdisciplinary in the field of study, emphasizing the impact that graduates bring to the society and alignment of proposed study projects with graduates' profile (CAPES, 2012b).

Therefore, the crosschecking of all judgments allows the decision maker to assess priority of each item and project toward to program objective. The methodology presented in this study can be replicated in other programs under the regulation of the CAPES assessment system.

This work aims to contribute to the improvement of management practices of graduate programs, presenting a methodology to use a recognized tool in the academic field, that is, the AHP method. The discussion about the use of this method, along with the understanding of the CAPES assessment, assists program coordination to optimize the use of existing resources in projects for improving the program performance at CAPES. The main contribution of the AHP method refers to project prioritization in Professional Master's Programs. Studies of Goodwin and Wright (2005) corroborated these findings. The authors stated that the objective of any decision support is to provide insights and understanding rather than prescribe a "correct" solution.

Next, we present final remarks, study limitations and proposals for new studies.

5. FINAL REMARKS

The use of the AHP method allowed answering the question: "How can the AHP method contribute to project prioritization in Professional Master's Programs assessed by CAPES?" The method contributed to the analysis and prioritization of a project portfolio using simultaneous comparisons in particular dimensions to achieve a harmonized classification (Archer and Ghasemzadeh, 1999).

Another contribution of the AHP method observed in this research was the facility to structure the decision-making process through the use of a process to calculate the relative importance of each criterion and alternative to determine the best candidate, also noted by Forsberg *et al*. (2005).

The main use of the AHP method refers to addressing problems of choice in a multi-criteria environment(Forman and Gass, 2001). As presented in this study, CAPES requirements were used as the basis for rating programs subject CAPES assessments. In this sense, prioritizing projects that ensure better performance within the CAPES assessment system is fundamental for the program to meet the quality requirements of the assessment system, providing recognition to the Master's Program or reinforcement of its recognition (CAPES, 2013a).

A study limitation was to consider only the main requirements of CAPES, not its sub-items. A broader approach of questions using the AHP method is the proposal for further studies. Another limitation was the use of the questionnaire to only one

coordinator. However, this feature was present in the study analysis, besides the coordinator's experience and knowledge of CAPES assessment criteria and projects made the research relevant.

Thus, in further studies, the analysis should be extended to the entire organization, including all existing Programs to allow a comparative assessment between the weights assigned by coordinators in relation to CAPES requirements. The use of a methodology to assist in defining the most important criteria is suggested to prioritize projects. The Delphi method could help in this regard to calibrate the AHP method through weight validation of the importance of criteria for panelists.

REFERENCES

Archer, N. P., & Ghasemzadeh, F. (1999). An integrated framework for project portfolio selection. *International Journal of Project Management*, *17*(4), 207–216.

Begičević, N., Divjak, B., & Hunjak, T. (2010). Decision-making on prioritization of projects in higher education institutions using the analytic network process approach. *Central European Journal of Operations Research*, *18*(3), 341–364.

Bozóki, S., & Rapcsák, T. (2007). On Saaty's and Koczkodaj's inconsistencies of pairwise comparison matrices. *Journal of Global Optimization*, *42*(2), 157–175. doi:10.1007/s10898-007-9236-z

Camanho, R. (2012). *A Abordagem Múltiplos Critérios (AHP). Apresentação de Técnicas e Ferramentas para Avaliação com Multicritérios Processo Decisório – Capacitação na Metodologia AHP*. São Paulo.

CAPES. (2011). Relatório da Reunião de Acompanhamento dos Programas da Área de Administração, Ciências Contábeis e Turismo. Retrieved December 12, 2013, from http://www.capes.gov.br/images/stories/download/avaliacao/Relatorio_Reuniao_Coorde nadores_Adm.pdf

CAPES. (2012a). Comunicado no. 003/2012 - Área de Administração, Ciências Contábeis e Turismo - Orientações para novos APCNS. Retrieved December 12, 2013, from http://www.capes.gov.br/images/stories/download/avaliacao/Criterios_APCNs_Adminis tracao.pdf

CAPES. (2012b). Comunicado no. 004/2012 - Área de Administração, Ciências Contábeis e Turismo - Considerações sobre Multidisciplinaridade e Interdisciplinaridade na Área. Retrieved December 12, 2013, from http://www.capes.gov.br/images/stories/download/avaliacao/Interdisciplinaridade_admi nistracao.pdf

CAPES. (2013a). Avaliação da pós-graduação. Retrieved May 22, 2013, from http://capes.gov.br/avaliacao/avaliacao-da-pos-graduacao

CAPES. (2013b). GeoCapes. Retrieved May 22, 2013, from http://geocapes.capes.gov.br/geocapesds/

CAPES. (2013c). História e missão. Retrieved May 22, 2013, from http://www.capes.gov.br/sobre-a-capes/historia-e-missao

Carvalho, K. E. M., & Pessôa, L. C. (2012). Classificação de projetos: um estudo da

aplicação do método AHP. *Revista de Gestão E Projetos*, *3*(1), 280–298.

Carvalho, M. M., & Rabechini Jr., R. (2011). *Fundamentos em gestão de projetos: construindo competências para gerenciar projetos*. Atlas.

Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (1999). New product portfolio management: practices and performance. *Journal of Product Innovation Management*, *16*(4), 333–351.

Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (2000). Portfolio management: fundamental to new product success. *The PDMA Toolbook for New Product Development*, 331–364.

Costa, H. R. (2011). *Apoio à seleção de portfólio de projetos de software baseado na moderna teorio do portfólio* (Tese de Doutorado). Universidade Federal do Rio de Janeiro, Rio de Janeiro.

Duarte, M. D. O. (2007). *Modelo Multicritério para Seleção de Portfólio Considerando a Sinergia* (Dissertação de Mestrado). Universidade Federal de Pernambuco, Recife.

Durham, E. R. (1992). A institucionalização da avaliação. In E. R. Durham & S. Schwartzman (Eds.), *Avaliação do ensino superior*. São Paulo: EdUSP.

Ensslin, L., Andreis, M., Medaglia, T. A., De Carli, H., & Ensslin, S. R. (2012). Modelo multicritério para avaliação e seleção de projetos de pesquisa e desenvolvimento em uma empresa distribuidora de energia. *Revista Gestão Industrial*, *8*(1), 164–198.

Forman, E. H., & Gass, S. I. (2001). The analytic hierarchy process—an exposition. *Operations Research*, *49*(4), 469–486.

Forsberg, K., Mooz, H., & Cotterman, H. (2005). *Visualizing Project Management: Models and Frameworks for Mastering Complex Systems*. John Wiley & Sons.

Foucault, M. (1987). *Vigiar e punir: nascimento da prisão*. Petrópolis: Vozes.

Ghasemzadeh, F., & Archer, N. P. (2000). Project portfolio selection through decision support. *Decision Support Systems*, *29*(1), 73–88.

Goodwin, P., & Wright, G. (2005). *Decision analysis for management judgment* (3rd ed.). New York: John Wiley & Sons.

Hatcher, M. (2008). Asset Evaluation and Selecton Using the Analytic Herarchy Process. *International Journal of Business Research*, *8*(3), 118–125.

Horta, J. S. B., & Moraes, M. C. M. (2005). O sistema CAPES de avaliação da pós-graduação: da área de educação à grande área de ciências humanas. *RevistaBrasileira de Educação*, *30*, 95–116.

Kent, C. J. (2002). *The Strategic Project Office, A Guide to Improving Organizational Performance*. New York: Marcel Dekkler.

Kerzner, H. (2004). *Gestão de Projetos - As melhores práticas*. Bookman.

Maccari, E. A. (2008). *Contribuições à gestão dos programas de pós-graduação stricto sensu em administração no Brasil com base nos sistemas de avaliação norte americano e brasileiro* (Tese de Doutorado). Universidade de São Paulo, São Paulo.

Maccari, E. A., Almeida, M. I. R., Nishimura, A. T., & Rodrigues, L. C. (2009). A gestão dos programas de pós-graduação em administração com base no sistema de avaliação da Capes. *REGE Revista de Gestão*, *16*(4), 1–16.

Maccari, E. A., Lima, M. C., & Riccio, E. L. (2009a). Uso do sistema de avaliação da CAPES por programas de pós-graduação em administração no Brasil. *Revista de Ciências da Administração*, *11*(25), 68–82. doi:10.5007/2175-8077.2009v11n25p68

Maccari, E. A., Lima, M. C., & Riccio, E. L. (2009). Uso do sistema de avaliação da CAPES por programas de pós-graduação em administração no Brasil. *Revista de Ciências da Administração*, *11*(25), 68–96.

Maccari, E. A., Rodrigues, L. C., Alessio, E. M., & Quoniam, L. M. (2008). Sistema de avaliação da pós-graduação da Capes: pesquisa-ação em um programa de pós-graduação em Administração. *Revista Brasileira de Pós-Graduação*, *5*(9), 171–205.

Maccari, E. A., Rodrigues, L. C., Coimbra, F. C., & Almeida, M. I. R. (2006). Uso do Planejamento Estratégico por um Programa de Pós-Graduação com base no Sistema de Avaliação da CAPES. In *VI Colóquio Internacional sobre Gestão Universitária na América do Sul*. Blumenau.

Markowitz, H. (1952). Portfolio selection. *The Journal of Finance*, *7*(1), 77–91.

Martins, C. B. (2013). *Desempenho dos programas de pós-graduação stricto sensu em Administração, Ciências Contábeis e Turismo no Brasil: Um estudo dos programas no período de 2001 a 2009* (Tese de Doutorado). Universidade Nove de Julho, São Paulo.

Martins, C. B., Maccari, E. A., Storopoli, J. E., Almeida, M. I. R., & Riccio, E. L. (2012). A influência do sistema de avaliação nos programas de pós-graduação stricto sensu brasileiro. *Revista Gestão Universitária Na América Latina-GUAL*, *5*(3), 155–178.

Martins, G. A., & Theóphilo, C. R. (2009). *Metodologia da investigação científica para ciências sociais aplicadas* (2a. ed.). São Paulo: Atlas.

Mello, C. M., Crubellate, J. M., & Rossoni, L. (2010). Dinâmica de relacionamento e prováveis respostas estratégicas de programas brasileiros de pós-graduação em administração à avaliação da Capes: proposições institucionais a partir da análise de redes de coautorias. *Revista de Administração Contemporânea*, *14*(3), 434–457.

Mello, C. M. de, & Crubellate, J. M. (2008). Respostas Estratégicas de Programas Brasileiros de Pós-Graduação em Administração à Avaliação da CAPES: Proposições Institucionais a Partir da Análise de Redes de Co-Autorias. In *XXXII EnANPAD* (pp. 1–16). Rio de Janeiro.

Modica, J. E., Rabechini Jr., R., & Braun, E. M. (2010). Prioritization of a Portfolio of Projects. In *8th International Pipeline Conference* (pp. 41–48). Calgary.

Moreira, C. O. F., Hortale, V. A., & Hartz, Z. de A. (2004). Avaliação da pós-graduação: buscando consenso. *Revista Brasileira de Pós-Graduação*, *1*(1), 26–40.

Neves, R. B., & Costa, H. G. (2006). Avaliação de programas de pós-graduação: proposta baseada na integração ELECTRE TRI, SWOT e sistema CAPES. *Revista Eletrônica Sistemas & Gestão*, *1*(3), 276–298.

Padovani, M. (2007). *Apoio à decisão na seleção do portfólio de projetos: uma abordagem híbrida usando os métodos AHP e programação inteira* (Dissertação de Mestrado). Universidade de São Paulo, São Paulo.

Padovani, M., Carvalho, M. M., & Muscat, A. R. N. (2010). Seleção e alocação de recursos em portfólio de projetos: estudo de caso no setor químico. *Gestão & Produção*, *17*(1), 157–180.

Padovani, M., Muscat, A. R. N., Camanho, R., & Carvalho, M. M. (2008). Looking for the right criteria to define projects portfolio: multiple case study analysis. *Product: Management & Development*, *6*(2), 127–134.

Pereira, G. G. (2005). *Avaliação da CAPES: abordagem quantitativa multivariada dos programas de administração* (Dissertação de Mestrado). Universidade de São Paulo, São Paulo.

Saaty, R. W. (1987). The analytic hierarchy process—what it is and how it is used. *Mathematical Modelling*, *9*(3–5), 161–176. doi:10.1016/0270-0255(87)90473-8

Saaty, T. (1999). The seven pillars of the Analytic Hierarchy Process. In *5th International Simposium on the Analytic Hierarchy Process* (pp. 1–15). Kobe.

Saaty, T. L. (2005). *Theory and applications of the analytic network process: decision making with benefits, opportunities, costs, and risks*. RWS publications.

Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International Journal of Services Sciences*, *1*(1), 83–98.

Schwartzman, S. (1990). *O contexto institucional e político da avaliação de ensino superior*. São Paulo: Núcleo de Pesquisas sobre Ensino Superior Universidade de São Paulo.

Serafim, A. B. (2004). A pós-graduação no Brasil - políticas de desenvolvimento. In *Colóquio Internacional sobre gestão universitária na América do Sul*. Florianópolis.

UNESCO. (1998). La Educación Superior em El Siglo XXI. Visión y acción. Presented at the Conferencia Mundial sobre La Educación Superior, Paris.

Viana, A. B. N., Mantovani, D. M. N., & Vieira, A. R. (2008). Análise dos programas de pós-graduação avaliados pela CAPES: relação entre conceitos dos programas e índice de publicação. In *XXXII EnANPAD* (Vol. 32). Rio de Janeiro.

Vincke, P. (1992). *Multicriteria decision-aid*. New York: John Wiley & Sons.

Wallenius, J., Dyer, J. S., Fishburn, P. C., Steuer, R. E., Zionts, S., & Deb, K. (2008). Multiple criteria decision making, multiattribute utility theory: Recent accomplishments and what lies ahead. *Management Science*, *54*(7), 1336–1349.

Yin, R. K. (2010a). *Estudo de caso: planejamento e métodos* (4a. ed.). Porto Alegre: Bookman.

Yin, R. K. (2010). *Estudo de caso: planejamento e métodos* (4a. ed). Porto Alegre: Bookman.