COGNITIVE MAPS AND AHP FOR SUPPLIER SELECTION IN A PRIVATE HIGHER EDUCATION INSTITUTION

Ana Lucia Pegetti
University of São Paulo
Department of Naval Architecture and Ocean Engineering
São Paulo, SP, Brazil
E-mail: anapegetti@usp.br

Jesse d´Assunção Rebello de Souza Jr
São Paulo, SP, Brazil
E-mail: jsouza@usp.br

ABSTRACT

Supplier selection is a key decision in the procurement and purchasing processes. Both the choice of criteria and the evaluation of possible alternatives are critical steps in this decision-making process. One of the great challenges of private higher education institutions (PHEI) in Brazil in recent decades has been the attempt to institutionalize administrative practices applied in the business market. The primary goal of this is to optimize their business processes and achieve reduced risks and operational costs, thereby increasing their productivity and the quality of services. These initiatives aim to maintain self-sustaining and competitive institutions in an aggressive market that is constantly expanding. Therefore, a critical and professionalized look at their business processes has been one of the solutions for the PHEI to achieve their organizational goals. In this context, this paper proposes to formalize the decision-making process for the selection of suppliers through their systematization using cognitive maps to structure and identify the criteria that effectively present value during the partner selection of the decision-maker's procurement and purchasing department. The paper also proposes the subsequent prioritization of these criteria for evaluation and selection of potential suppliers by using the AHP multi-criteria method.

Keywords: Supplier selection; cognitive maps; AHP

1. Introduction

In the mid-1970's, with the advent of the economic crisis, competition increased between societies in search of technological innovation and a highly qualified workforce. This workforce was, based on technical and scientific knowledge provided by the universities that have become dupes of an international enforcement of the neoliberal economic model, characterized, among other things, by a considerable diminution in the application of government resources in priority social policies (education, wellness, welfare). This opened the public and private universities to commercial exploitation (Santos, 2011).

It was in the 1990's, with the phenomenon of globalization and attempts to meet the need for more flexible qualifications rather than the rigid trainings offered by the universities, that there was an increase in the creation of non-university training systems that were more compact and focused on specific assignments. Within this backdrop of support for the growing demand for skilled labor from the productive sector, there is the university based on financial results, formed by the expansion of a private network of higher education and university-business partnerships (BERGAMO, 2008).

In Brazil, the attempt to turn teaching into a business sector dates back to the period of the military dictatorship, when the law forbade teaching institutions to profit. This reality was altered with the promulgation of the Constitution of 1988, which explained the possibility of the existence of for-profit schools, which were effectively regulated with the dissemination of guidelines and Bases of 1996.

The consequence of this policy was the cutting of funds sent to public education institutions, reducing the number of places in public universities and increasing vacancies in private institutions. These events have changed the type of relationship between students and educational institutions, demonstrating the customer and service provider relationship where scholarships are replaced by loans. In this scenario, students became customers, universities became a market and education became a service to which anyone can achieve.

Martins (2007) presents a study directed by financial analysts who have compared the current education sector to the health sector in the 1970's. The similarities noted were an unproductive, fragmented, low-level technology with little professional management, and a giant market that creates a large potential for economic exploitation and thus must be handled with a global business vision rather than a traditional institutional vision in order to optimize results.

According to Santos (2011), this system favors private universities since they have greater administrative flexibility and can more easily adapt to market conditions. This causes a gradual power shift at the University from the faculty to administrators trained in carrying out agreements with private agents. This corroborates with the findings of Finger (1997) who says that there have always been conflicts between academics and administrators since they differ in their vision. The latter have a vision aimed at the exercise of procedures often considered secondary or unnecessary by the first, whose focus is directed to the academic services area of teaching, research and extension.

It is in this context of demanding new standards of competitiveness and intense change, that universities are seeking the continuous improvement of their products, services and processes. They seek this improvement through the adoption of administrative practices that aim to improve the implementation of scarce resources (equipment, human and financial) so that they can support appropriate decision-making processes and ensure organizational survival through the adaptation of organizational structure to the reality of uncertainty constants (Kobs, 2011).

Since this change in student - university relationship, which began in the 90s, the Brazilian educational segment has witnessed a significant increase in the number of higher education institutions (mainly private). This has increased competitiveness in the industry and forced these institutions to seek mechanisms to improve their management practices through the implementation of policies to improve processes in order to achieve excellence at all organizational levels.

In the 1990's, because of the stabilization of the economy and the diversification of the productive sector, there was an increase in demand for qualified professionals and training institutions for specialized labor. This was a great milestone in Brazilian higher education because education is regarded as a business. In order to meet this increased demand and due to the expansion of access to higher education promoted by dissemination of the Law 9394/96 – guidelines and Bases for national education, the Brazilian educational sector, especially private higher education (PHE), experienced an accelerated expansion characterized by opening new higher education institutions (HEI).

The demand for higher and graduate level courses has increased which has led to an increase in the number of higher education institutions, the amount of new face-to-face and distance courses, and especially in the number of vacancies. This has led the HEIs to face inevitable competition, due to a glut of vacancies in various courses.

According to data from the Census of higher education, the number of higher education institutions has grown in Brazil by 152% in the period from 1997 to 2006, being 193% the rate of growth of private higher education institutions (Teixeira, 2012).

This competitiveness has forced the HEIs to develop innovative, competitive strategies to attract, win and keep customers to ensure or increase their market share (Lee & Tai, 2008). This competitive environment requires enterprises to look beyond their organizational boundaries in order to optimize their value chain and coordinate their efforts with the others.

In this scenario, looking at the PHEI as a company that has finite resources, it is necessary to invest in the professionalism of its management so that it can apply its resources optimally, in order to achieve a competitive advantage in the market and ensure the full implementation of its productive force. When allocating resources, managers should be aware that any type of resource retrieved from a cost that does not also provide a return, are decapitalizing the company. The main challenge of institutional managers is to maintain the balance between revenue and expenditure, since the educational activity has become a commodity and input costs to maintain productivity are always on the rise.

2. Justification

Due to the increase in the number of PHEIs in the past decades, which has unleashed a great opportunity for undergraduate and graduate studies, the institutions have sought the differentials that are required for their survival through the adoption of administrative professionalized practices.

This study was conducted in a private institution of higher education in order to assist it in improving its decision-making process concerning the selection of suppliers for cleaning and conservation, which today is the largest financial contract of the university.

The vendor selection process is an extremely important activity for most organizations and its realization is one of the first steps towards management of the supply chain. This process is described in the literature as a typical complex problem of decision analysis based on the identification, analysis, assessment and definition of the causal relationships of various quantitative and qualitative criteria raised by specialists. It is characterized as a highly complex issue, especially when it comes to an unstructured problem, where scenarios and decision criteria are not fixed or known a priori, presenting a high risk to the organization.

The Supplier Selection Problem (SSP) can be structured by applying a decision-making method that exists in the literature, in particular, a method that can handle situations where there is a need for comparing multiple criteria and later choose the best alternative which is based on the weighting of criteria selected by the decision maker. These criteria, in turn, can be identified in the existing literature, or be elicited directly from decision-makers through the application of cognitive mapping techniques that take into account the values and subjectivity of a decision-maker in a specific business context.

In this context, the prior application of cognitive maps for the identification of the problem´s criteria, valuation and definition of the causal relationships between these criteria is justified based on several studies that prove the effectiveness of this technique for modeling of complex systems.

After the definition and evaluation of the criteria for decision-making, it is necessary to apply a multi-criteria decision support method that is capable of dealing with the complexity and subjectivity of the proposed system allowing the repeatability of the method. For this purpose, we will use AHP.

3. Objectives

The main purpose of this study is to define a systematic procedure based on the cognitive map's concept and the Analytic Hierarchy Process (AHP) multi-criteria method for decision-making, in order to assist the procurement and asset management departments of a PHEI on SSP. This is due to the lack of studies involving private higher education institutions concerning decision issues triggered by supply selection.

Therefore, Multi-criteria decision-making, using specifically the AHP (Analytic Hierarchy Process) assisted by Cognitive Maps (CM) (both widely used for solving problems that present multiple objectives or multiple criteria), is an ideal alternative when building an analytic structure to systematize the decision process of this kind of problem (supplier selection). This method has been successfully applied in situations like priority definition, cost-benefit analysis, resource allocation, performance measurement,

market research or assessment, requirements determination, strategic decisions, activity planning and sequencing, scenario analysis, negotiation and conflict resolution, decisions and political or social forecasting and analysis of decisions under risk (Shimizu, 2010).

In order to achieve the proposed objective, A case study on the Procurement and Asset Management departments of an educational institution was performed following these stages:

- Utilization of a constructivist approach to identify and structure a decision problem using cognitive maps to build a dresser cognitive map in order to identify all the criteria that are subjectively important in the supplier selection process
- Comparison of the criteria raised in the research with the criteria currently used by the dresser, with the objective being to choose which selection criteria are important to effectively structure the supplier selection decision process
- Identification of strategic suppliers whose performance will be assessed according to identified criteria
- Prioritization of the identified suppliers (alternatives) using the AHP (Analytic Hierarchy Process) method
- Overview and analysis of results

This study can be classified as applied research, since a practical application of the data obtained in the literature will be performed, and targeted at the resolution of the specific problem. As for the approach, the work done classifies as qualitative, since it does not require the application of statistical methods and techniques (Silva & Menezes, 2005). As for its objectives, this is an exploratory research, and its technical procedures are based on bibliographical research and case study, with the purpose to better comprehend the presented problem.

4. Literature Review

After the identification of the study problem, the needs faced by HEIs to improve their administrative processes and survive market demands and the initiatives implemented in order to achieve this goal were found in the study of Bergamo (2008). The next step consisted in evaluating which existing approaches for solving supplier selection problems are available and these were mainly found in the work of Wu and Barnes (2012).

The next step was to seek specific publications on approaches for structuring decision problems and, in the work of Eden (2004) and Costa (1992) cognitive maps appeared as a method for working on complex problems. Using interviews and cognitive mapping to capture individual views of an issue, maps were constructed through the aggregation of individual cognitive maps which were used to facilitate negotiation about value/goal systems, key strategic issues, and option portfolios. This identified the necessary criteria for decision-making and increased knowledge in the system (process) modeling. Cognitive maps are largely used as a support tool for structuring application problems, starting from an analysis of cause and effect between the listed criteria and elucidating the relationship between their variables.

In the final stage of supplier selection we chose to use the AHP method once the method of structuring was defined and the content published on the work of Saaty and Vargas (2001) was researched along with several other papers published in ISAHP. We chose this method because it has been successfully employed in decision-making that involve prioritization, costs and benefits evaluation, resource allocation and strategic decisions, among others.

5. Relevance of work

Nowadays, there are few studies in the field of higher education institutions that discuss decision problems relating to the selection of suppliers. This is due to the fact that only in recent years have the PHEIs come to adopt successful consolidated administrative tools in order to improve their processes and achieve excellence in their services. In addition, the modeling of the decision-making problems of the nature referred to does not follow a specific theoretical framework.

Furtado (2005) has conducted an exploratory study in order to determine the degree to which companies conduct formal processes for selecting suppliers. The author figured out, depending on the level of replies received in the survey, that only 15% of companies had formal processes for the structuring of the vendor selection problem, which means that there´s a *lack of formalization* (structure) of the selection process of suppliers.

In the scientific field, the present proposal can reveal more areas of application of Cognitive Maps associated with AHP in decision-making processes related to vendor selection to compose the supply chain of an institution of higher education. No studies using the two approaches (cognitive map and AHP) for the solution of the vendor selection problem in HIEs, specifically have been found.

6. Theoretical Reference

6.1 Supplier selection problem (SSP)

Due to strong competitive pressure, companies have been forced to improve their strategies if they want to overtake their competitors. In light of that, managers have realized the importance of having commercial network suppliers that fulfill their business needs and that are aligned with their market strategy, adequately meeting their demands and sharing ideas, expectations and concerns.

Christopher (2007) comments that the supply chain is the "organization network involved, through links northbound and southbound, on the different processes and activities that produce value manifested as products and services targeted to the end consumer". He also noted that its management has proven to be a powerful tool when it comes to obtaining competitive advantage, since it sets out to meet the interests of the company's productive chain. The adequate management of the network allows optimized production, decrease in costs and ability to meet the expected quality standards. The

purchasing department is responsible for price negotiation with suppliers, which will determine, in a way, the company's competitiveness.

Therefore, given the importance of decisions related to the supplier selection problem, organizations have been rethinking their business processes, making this topic a highlight in literature about the acquisition of products and services. A common finding in these studies is that supplier selection is a complex problem, which includes several trade-offs between the criteria involved in decision-making. It qualifies as a typical case of multi-objectives and multi-criteria (qualitative and quantitative), with several possible alternatives. Clemen and Reilly (2001) state that, "The essential problem of decision-making with multiple objectives is to decide how to balance the biggest value of an objective with the smallest value of another one."

According to Furtado (2005), the main characteristic found in this process is the presence of criteria that aim to identify aspects that help create a vendor profile, and then move forward to the decision of the supply source. The criteria can be quantitative (such as price, productive capacity) which can be easily assessed in order to compare alternatives, or qualitative (such as trust, administrative compatibility) which carry a large subjective factor in the assessment and strongly rely on the personal judgment of the responsible for the process.

Several studies have been dedicated to the analysis of methods for supplier selection. Wu and Barnes (2011) perform a systematic review of 140 international articles from 2001 to 2011, classifying them per the criteria and selection approaches used in accordance with a framework based on the work of De Boer et al. (2001) and Luo et al. (2009), which serves as a reference when defining the stages of supplier selection. The authors define four stages of supplier selection: *criteria formulation, qualification, final selection and feedback application*.

De Boer et al. (2001) states that the usage of a reference model for supplier selection increases the effectiveness of the process, since it helps the buyer:

- On the resolution of the right problem;
- To identify and take into consideration most relevant criteria for the decision-making;
- To model more precisely the decision problem, considering tangible and intangible factors.

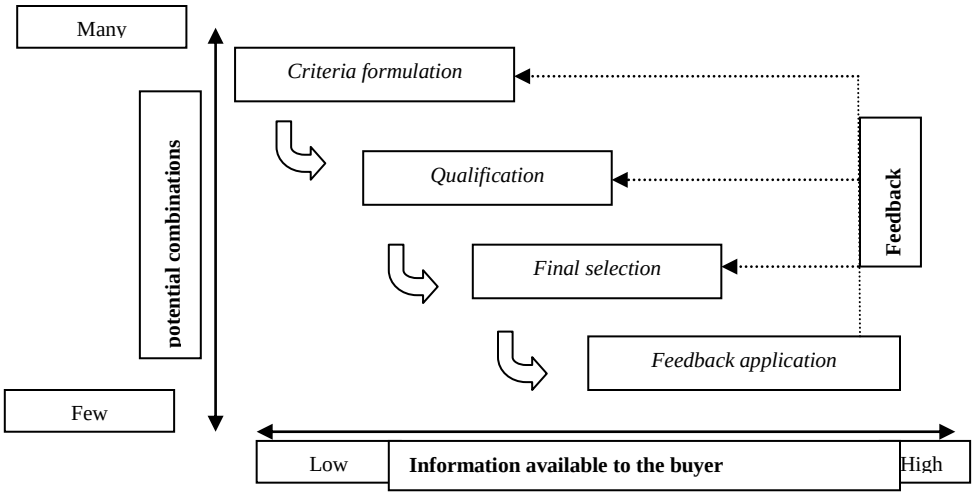

Figure 1. Adapted from Wu e Barnes (2011)

In the first phase of the framework, *criteria formulation*, the criteria that will be used in the decision making process are determined. According to Wu and Barnes (2012), the *price* criterion is still the most widely used, especially in an era of globalized competition. In the authoress's point of view, to consider only the *price* criterion is a tactical approach and not a strategic one. This occurs because decision-makers make better decisions based on other important *quantitative* and *qualitative* criteria, making the selection of suppliers a complex decision-making process.

In the second phase, *Qualification*, a pre-selection is carried out in order to reduce a set of potential suppliers to a smaller set of acceptable suppliers. This phase is seen as a process of pre-selection or classification rather than a prioritization process itself.

In the third stage, *Final selection*, we found most of the models developed for the selection of suppliers. In this phase, after the qualification of suppliers, according to some basic criteria, selected companies are contracted to establish partnership with the contractor.

The main objective of the fourth phase, *Application Feedback*, according to Wu and Barnes (2011), is providing a mechanism that allows decision makers to evaluate the performance of existing suppliers, in order to continuously improve the selection process ensuring that the best suppliers will always be hired.

Furtado (2005) states that there are two perspectives to the selection process of suppliers: select new suppliers for the product or service in question, or work with a vendor that already provides service. Since the current Supplier has recurring problems related to the misconduct of its employees, this work considers the first perspective of selecting new suppliers for the service in question.

In this study, the current provider of the cleaning service was excluded from the process because the goal was to rescind the current contract based on recurring problems related to theft of belongings of employees, property damage and improper conduct of employees of the service provider that have been reported and filmed by the institution. Thus, the fourth step was not performed as the existing supplier was not being considered.

6.2 Supplier selection criteria

The hiring company is responsible for defining the attributes or criteria that will be used in the process of supplier selection, notwithstanding the tools that are going to be used to do so. According to Furtado (2005), this definition is performed according to an existing derisory context.

There are few examples of methods which assist in the identification of the best criteria for supplier selection in the literature (Wu and Barnes, 2011), but the main criteria among the several existing academic publications are still *quality*, *delivery*, *price* and *service*. The conclusion of several studies indicates that, even belief that it is important to use multiple criteria in vendor assessment, in reality, the supplier selection which presents the lowest *cost* is prioritized.

Which criteria to use and which method can be used to compare suppliers are the two most important questions of an SSP problem. There are several studies that present literature reviews on criteria and methods applied to SSP, but in one of the first articles published on the theme, Dickson (1966) identified twenty-three criteria qualitatively classified and sorted by importance as shown in Table 1.

Table 1
Criteria for selecting providers

Classification	***Criteria***	***Evaluation***
1	Quality	Most importance
2	Delivery	Considerable importance
3	Historical performance	
4	Collateral policies	
5	Productive capacity	
6	Price	
7	Technical competence	
8	Financial position	
9	Compliance with procedures	Media importance
10	Communication systems	
11	Reputation in the industry	
12	Desire in business	
13	Management and organization	
14	Operational Controls	
15	Repair Services	
16	Attitude	
17	Feeling	
18	Skill in packs	
19	Labor relations	
20	Geographic Location	
21	Number of trades	
22	Support for training	
23	Reciprocity in the provision	Minor importance

6.3 Structuring decisory problems

For several authors, structuring the problem is the most important as well as the most difficult stage of the entire decisory process. Einstein stated "the formulation of a problem is more important than its solution, since the solution requires mathematical or empiric skills". Yu et. al. (2011) argues that the definition of a problem (framing) is subjective, since each individual defines a problem, according to past experiences, knowledge and preferences, which makes the structuring process subjective. The author also states that, "when a problem is inadequately defined, all the effort of its solution can be wasted". In light of that, other authors, like Montibeller (1996), agree on the importance of building a structure which allows the criteria and factors considered important during the decision making process to be represented in an organized manner. This emphasizes the importance of structuring a decisory problem so that the correct

problem is solved, through the correct identification of the objectives, exploration of alternatives and better understanding of the situation.

The decisory processes are basically divided into two stages: firstly, the structuring of the problem and then, the assessment of potential actions. During the structuring stage, a model is created that schematically represents the decisor's problem. This is a fundamentally important stage which precedes the decision-making. The Problem Structuring Methods (PSMs) are approaches that are not based on quantitative methods and cannot be mathematically represented, and their creators are rooted in the traditions of Operational Research, or PO Hard (Rosenhead & Mingers, 2001).

In this study, cognitive maps for structuring the proposed problem will be applied, through building the criteria that must be used by the decisions, and afterwards, the AHP will be used to assess the alternatives, in light of the identified criteria. The adopted approach is constructivist, since it allows the modelling of the decision problem, absorbing in a participative way values and interests of the people involved in the process.

6.4 Cognitive maps

According to Eden (2004), cognitive mapping is a task performed in order to describe someone's thoughts in regards to a specific problem. The graphical representation of these thoughts is presented via a cognitive map. It is grounded on Kelly's Personal Construct Theory (1955), which has three main presuppositional statements (Eden, 1988):

- Man is constantly trying to explain his world.
- Man establishes the sense in his world through relativism.
- Man organizes his system of ideas when organizing his world.

This last presupposition states that someone's ideas are organized and interconnected in a hierarchy which is created according to the experience and understanding of each person, forming a private system of constructs. Colin Eden's cognitive mapping can be seen as an attempt to isolate and represent someone's constructs, laying them out in a hierarchical manner.

The maps are a network of knots and arrows as links where the arrow direction represents a perceived causality, originated from interviews with the purpose to represent the interviewee's subjectivity. It is considered a formal modelling technique, with specific rules which makes it recommended for structuring decisory problems. It can be defined as a quadruple cognitive representation, lagged in time (Ensslin et al., 2001), according to Figure 2.

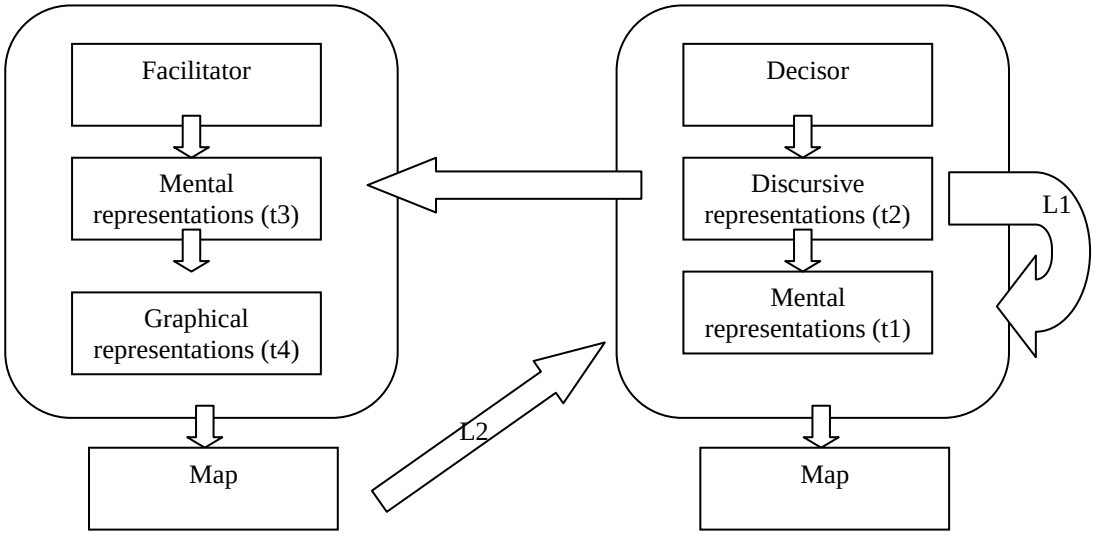

Figure 2. Model construction of cognitive map

Ensslin et al. (2001) explains that the representation is quadruple and lagged in time because in t1 there are mental representations of the decisor projected on the t2 instant, in discursive representations (oral or written) transferred to the facilitator through discourse. The facilitator interprets this discourse in t3, generating their mental representations, so that in t4 they transform them into graphical representations through the cognitive map.

This process is re-triggered by arrow L2, reducing the distance between the mental representation of the decisor and the construction of the cognitive map. On arrows L1 and L2, the constructivism paradigm and the problem comprehensively through building the cognitive map and the problem description by the decisor through discourse are present. Therefore, the actor builds mental representations according to the problem in question. By way of these representations, the decisor develops discursive representations which are transmitted to the facilitator through a discourse from which mental representations are made, and then transformed into graphical representations, i.e., the cognitive map.

Generally, the cognitive map is built based on interviews made by facilitators and decisions. Building a cognitive map depends on the approach by the facilitator, as well as establishing a negotiation process. The facilitator should have a neutral stand, without expressing preferences or judgments, leaving the interviewer comfortable when they present any kind of hesitation or doubt. Because this is a process that demands a lot of mental effort and it can become unproductive due to tiredness, each interview should last from 60 to 90 minutes, and should be held either in the interviewee's environment or in a neutral location.

The interviewee should, as often as possible, position themselves to the left of the facilitator (when right-handed). This way, the interviewee feels engaged in building the map and the facilitator will have them as allies in the process.

In order to build a cognitive map, one goes through the following stages, according to Ensslin and Montibeller (1998):

- Define a label with the problem: in this stage, the name of the problem to be solved is defined with the decisor;
- Define the primary assessment elements (PAEs): these represent the objectives, values, targets regarding the problem, according to the decisions view;
- Build the concepts (CM), based on PAEs: the primary element of assessment is action-oriented, supplying the first pole to the concept. The sense of the concept is partially based on the action it suggests. Such dynamism can be obtained by putting the verb before the concept (for instance, "to ensure", "to supply", "to increment", etc.) (Ackermann, Eden and Cropper, 1992). Therefore, the map must have an action-oriented perspective;
- Build the concept hierarchy (definition of end connections, means connections and influence connections). The map structure is formed by means and ends concepts, tied by influential connections;
- Generate the cognitive map: oin this stage, the map is validated with each decisor.

After its creation, the cognitive map is analyzed in order to identify the essential aspects to the decisor in the selection process, transitioning to the multi-criteria model. In order to perform a cognitive map analysis, one should (Ensslin et al., 2001):

- Identify the heady concepts (the ones which do not send arrows, meaning the desired objectives) and tail concepts (the ones which send arrows, meaning the number of prepared alternatives in order to achieve the objective of the problem).
- Identify clusters (which are common concepts that establish a representative connection, separating common concepts and allowing a macro view of the relationships between the branches in a global map).
- Identify re-triggering knots (which act like vicious cycles).
- Identify argumentation lines and branches (which consist of the path used by the connected concepts to reach the goal).
- Identify the descriptors that represent the possible states of the potential actions.

According to Ensslin et. al (2001), after identifying the branches of a cognitive map, one can migrate to the multi-criteria model. This is because the assessment axes are established over the branches expressing the relevant aspects to the decisor in regards to the analysis of their problem. Branch identification allows the facilitator to identify an upcoming stage, the decisor's Fundamental Points of View (FPsV). Costa (1992) defines FPsV as the values that help a decisor reach their goals, which reflect their fundamental values. These fundamental objectives limit the choice of existing alternatives in a

decisory context. This definition is quite similar to the concepts about cognitive maps proposed by Eden (2004).

However, before stating that something is a FPV, the information (concept) must fulfill the axioms proposed by Costa (1992):

- Isolable: the FPV should be independent from the impact aspects when it comes to the other FPsV of the model;
- Essential: this value should be considered fundamental. It cannot be a means to achieve a value considered fundamental.
- Controllable: taking into consideration only those consequences that are influenced exclusively by the set of alternatives.

The concepts validated in this stage of the cognitive map analysis are seen as the criteria and sub-criteria in the supplier selection process, and serve as a base to the hierarchical structure of the model. The definition of FPV candidates, according to Ensslin et al (2001), is done through the cognitive map analysis, observing the concepts that are neither overly ends (since they would be strategic objectives) nor means (since they would constitute potential actions). Following the ends → means direction of a branch, the facilitator initially identifies the first concept that exists between the decisor's strategic objectives and the potential actions. Then, they validate the concept using Costa's axiom, and if it does present these properties the concept becomes an FPV candidate. If it does not present such properties, the concept is rejected and the facilitator moves forward with the branch analysis.

It is important to note that, although grouped in clusters or branches, the FPsV are not subordinated amongst themselves, since the tests performed on the path ends (means have the purpose to identify fundamental and independent aspects (Lima, 2008). Subordination is due to a need to decompose an FPV in order to make it operational. To address the characteristics of potential actions more effectively, decomposing an FPV is often necessary. This decomposition increases the understanding of the performance of the FPV potential actions.

By nature, EPVs are subordinated to the FPsV, and their identification happens in a similar way to that of the FPsV: the facilitator, through the analysis of the cognitive map on the path ends (means, instead of validating with the decisor the concepts in light of the axioms defined by Costa (1992), observe if there are declared means with the purpose to reach the concepts validated as FPsV. Keeney (1992) notes the detail that an FPV will only be decomposed if there are, at least, two EPVs to the validated FPV. After identifying the FPsV and their possible decomposition into EPsV, it is possible to build a point of view hierarchical tree.

6.5 AHP

The AHP method was developed in the 1970s by Thomas L. Saaty, and has been used in complex decisory processes across several knowledge areas including health, business, government, industry, etc. It is a simple and clear method that is easy to explain to

decisors and allows an interaction between analyst and decisor. Its application depends on a hierarchical structure of the problem that demonstrates the relationship between the problem objective, assessment areas, criteria, sub-criteria and alternatives. Therefore, a complex problem can be divided into smaller problems on different levels and uncertainties and other influencing factors can be included in the assessment.

The fundamental elements of the AHP method are as follows:

- Attributes and Properties: a set of finite alternatives is compared according to a finite set of criteria.
- Binary Correlation: when comparing two elements in light of a criterion, an element can be preferable or indifferent in regards to another one.
- Fundamental Scale: a priority value is given to each element, based on a numerical scale from 1 to 9.
- Hierarchy: set of elements sorted by preference and homogeneous in their respective hierarchical levels.

The method is grounded in psychological and mathematical principles that are based on the capacity of the human mind to perform comparisons of elements in pairs and matrices. When facing a comparison problem among several elements of a set, the human mind creates a hierarchical process on which the AHP is based. The main objective of the study rests at the highest level, then on the following levels rest the criteria (properties through which the alternatives will be assessed) and on the lowest level rest the alternatives to be selected.

In order to apply the AHP, the following stages must be performed:

- Definition of the decisory problem
- Decomposition of the decisory problem into a hierarchy of easily understandable problems
- Identification of meaningful criteria
- Identification of meaningful alternatives
- Designation of the relative significance of the attributes by the decisor, through passing parity judgments to assess both the importance of each criterion and the performance of each alternative in light of those criteria
- Designation of their preference in regards to each attribute and pair of alternatives
- Registration of the comparisons between attributes and alternatives on matrices of 1/9 and 9 fractions, where each matrix is assessed by its eigenvalue to check the coherence of the judgments, generating a "coherence ratio", which will be equal to 1 if all judgments were coherent amongst themselves
- Calculation of the global preference values to each alternative
- Alternative selection
- Sensitivity analysis

7. Case study

With the goal of continually improving their processes to meet the needs triggered by the changes in the organizational context and translating strategic objectives into measurable targets, PHEIs have been adopting modern administrative practices and tools to reduce operational costs, to elevate productivity and increase agility and efficiency, given the dynamic and complex nature of the market.

This case study was done in a renowned private higher education institution (PHEI), located in the Southeast Region of Brazil, specifically in the city of Santos, on the southern coast of the state of Sao Paulo. This organization has as one of their institutional policies the pursuit of better business processes as an important ally for cost reduction and focus on activities that effectively add value to the business and to the client.

The business process chosen for this study is part of a macro process related to the acquisition of products and services for the University, a responsibility currently shared by two departments: PSD and AMD. The research problem of this study will be solved following these stages:

- Structuring the problem using cognitive maps to build the criteria which are to be used by the decisors. The adopted approach is constructivist, since it allows for modelling of the decision problem and incorporates values and interests of the people involved in the process.
- Development of the decisor's cognitive maps to structure the decisory Supplier Selection problem according to the construction methodology described by Ensslin and Montibeller (1998). The goal is to contextualize the Institution process within the framework proposed by Wu and Barnes (2011) with the series of criteria discussed on section 6.2 Supplier Selection Criteria as a foundation;
- Analysis of cognitive maps to identify and validate the fundamental points of view (FPsV) obtained on each decisor's cognitive map, according to Costa's axioms (1992);
- The hierarchical structure based on the listed FPsV and EPsV (criteria and sub-criteria);
- The passing of peer-to-peer judgments using the AHP method, along with the decisors;
- Sensitivity analysis on the weight of the listed criteria to assess the impacts associated with the value alterations of the decisor's judgments (entry variables) on the exit variables (alternatives, i.e., priority of the selected Suppliers).

7.1 AMD –Asset Management Department

AMD is a sector associated with the Administrative Pro-Vice-Chancellor, whose mission is to manage an infrastructure of over nine hundred thousand square feet; as well as services and assets intended to support the end activity of the University by transforming them into a differentiated value perceived by the client. It is composed of thirty-eight employees who perform various functions, including the AMD Manager, who will be referenced as the Decisor of the conducted case study. The activities performed by this sector include maintenance, a variety of services, infrastructure and asset.

Nowadays, AMD is responsible for 77% of institutional costs related to the acquisition of products and services, and *Electric Power, Cleaning and Conservation, Computer Maintenance, Repairs and Maintenance* and *Security* services are the most expensive to the Institution. At the University, the Cleaning and Conservation services are currently the biggest consumers of financial resources, representing approximately 3.1% of the total expenses paid by the Institution. Therefore, it is a service of great importance and visibility to the organization.

The main purpose of the Cleaning and Conservation services hired by the University and made possible by their suppliers is to prepare the environment and keep the order. They are to allow for greater safety and a better performance of the actions that need to be implemented by the Institution, therefore improving the client's perception regarding the quality of the services provided.

The main objectives of the Cleaning and Conservation services are:

- To keep the environment clean and pleasant for clients and employees;
- To conserve equipment and installations;
- To prevent accidents in general;
- To preserve the image of the Institution;
- To ensure safety and confidentiality.

For these reasons, the cleaning as well as the asset conservation services are very important to all organizations since, if not performed or if performed without meeting minimal quality standards, they can directly and negatively affect their users, something that can damage the image of the service provider, in this case the Institution, in the eyes of the customers.

7.2 Supplier selection process in the PHEI

The supplier selection process for the Cleaning and Conservation services currently performed by the PHEI is based on the AMD Manager's knowledge and experience, consisting of an empirical process, one that is not structured or adapted to the Institution.

The AMD Manager has autonomy to make decisions concerning the processes under his scope, which include Cleaning and Conservation. He must however provide a justification to the Administrative Pro-Vice-Chancellor (to which he is a subordinate) about the problems with the current supplier because it is the most expensive service to the PHEI, having a dedicated ledger account. Once the need of a change in suppliers is identified, the same supplier will not take part in the selection process due to its troubled history.

After the endorsement is received, the Manager, supported by their team, performs a benchmarking with local companies with similar qualifications in order to identify possible supplier candidates. This helps reduce the list of alternative from the beginning. During this stage, the two criteria used in the pre-selection of possible candidates are:

references obtained on the contracts and experience with support for other same-size companies. These two criteria are, in fact, pre-requirements for the company in order to be added to the list of alternatives for upcoming suppliers. From this stage, an initial list with the names of companies that provide services is generated, and a proposal request with a statement of work and a few pre-established rules is prepared. This request is then submitted to all these companies and a deadline of thirty days is designated for them to present their proposals.

After these proposals are received, the companies are assessed in accordance with the following criteria: service price, number of labor claims, financial capacity, conformity with the category employees' convention, and number of workers available to provide the service, contract permanence time, references obtained during the benchmarking, Area Manager's empathy and service plan.

For this last criterion, the Manager schedules a meeting with the pre-selected companies and asks for the detailed work plan, based on the specific needs established by the PHEI. Once the plan is received, the companies are also assessed according to administrative organization criteria, technical support capacity and the quality of the materials, described in the work proposal. As soon as this assessment is completed, the supplier is hired.

In this particular study, after the completion of the pre-selection stage (based on an initial list of eliminatory pre-requisites), only two of the seven companies contacted were approved to participate in the final selection stage: *CM and InService*.

7.3 Case study development

This case study was initiated after the definition of the finalists (two final alternatives, *C.M. and InService*) which were going to be assessed with AHP.

The first step was to hold meetings with the decisor in order to build the cognitive map, applying the stages described on Section 6.4 Cognitive Maps. The creation of the decisor's cognitive map was initiated with the definition of a label to the problem, in order to represent the main objective, still observing the organizational purposes regarding resource optimization. Therefore, the label "Cleaning services supplier selection" was chosen and validated with the decisor.

Next, we proceeded to build the primary assessment elements. In order to do that, the we asked the decisor to present which aspects they considered important when it comes to selecting a cleaning services supplier. A list with the main PAEs can be found below:

Table 2
Primary assessment elements of the AMD manager

Label: Selection of Cleaning Service supplier	
1. History of labor processes 2. Officials replacement 3. References benchmarking 4. Residence time in contracts 5. Qualified Supervisor 6. Best Value Service 7. Supplier with financial capacity 8. Compliance with the collective bargaining agreement 9. Work plan	AMD Manager

After obtaining the PAEs stated by the decisor, the next stage consisted of transforming these PAEs into concepts. The goal is to build the concept hierarchy. For each listed concept, through questions like "why is this concept important?" (heading towards the end concepts that are located at the top of the hierarchy), and "what are the means to achieve this concept?" (heading towards the means concepts), new concepts which assisted with the comprehension of the aspects stated by the decisor were generated. From this dynamic, after a few iterations and refinements, we managed to finalize the decisor's cognitive map.

After the creation of the decisor's cognitive map, the next step was to analyze the cognitive map, starting by the cluster identification. For the AMD Manager, these clusters were identified: Cluster I – Resources Optimization, Cluster II – Service Quality, Cluster III – Administrative Structure and Cluster IV – Credibility, presented in Table 3:

Table 3
Clusters of cognitive map of the AMD manager

Cluster I - Resource Optimization	***C7, C8, C9, C16, C31, C32, C33, C34***
Cluster II - Quality of service	C3, C6, CC19, C20, C21, C28, C29, C30, C35
Cluster III - Administrative Structure	C10, C12, C13, C36, C39, C41, C42, C43
Cluster IV - Credibility	C4, C5, C25, C26, C27

With the clusters identified in Figure 3, the next stage of the methodology consisted in identifying the branches on the maps. This stage is important because clusters are very generic and they make it hard to establish the FPsV, which are the aspects that the decisors wish to measure when choosing a supplier.

Regarding the map of each decisor, the facilitator of the process (this study's author) identified the branches which are candidates to FPsV. Eight branches were identified to the AMD Manager: Branch 1 – Service Value, Branch 2 – Risk Reduction, Branch 3 – Service Continuity, Branch 4 – Team Qualification, Branch 5 – Internal Organization, Branch 6 – Operational Capacity, Branch 7 – Quality of the Materials and Branch 8 – References.

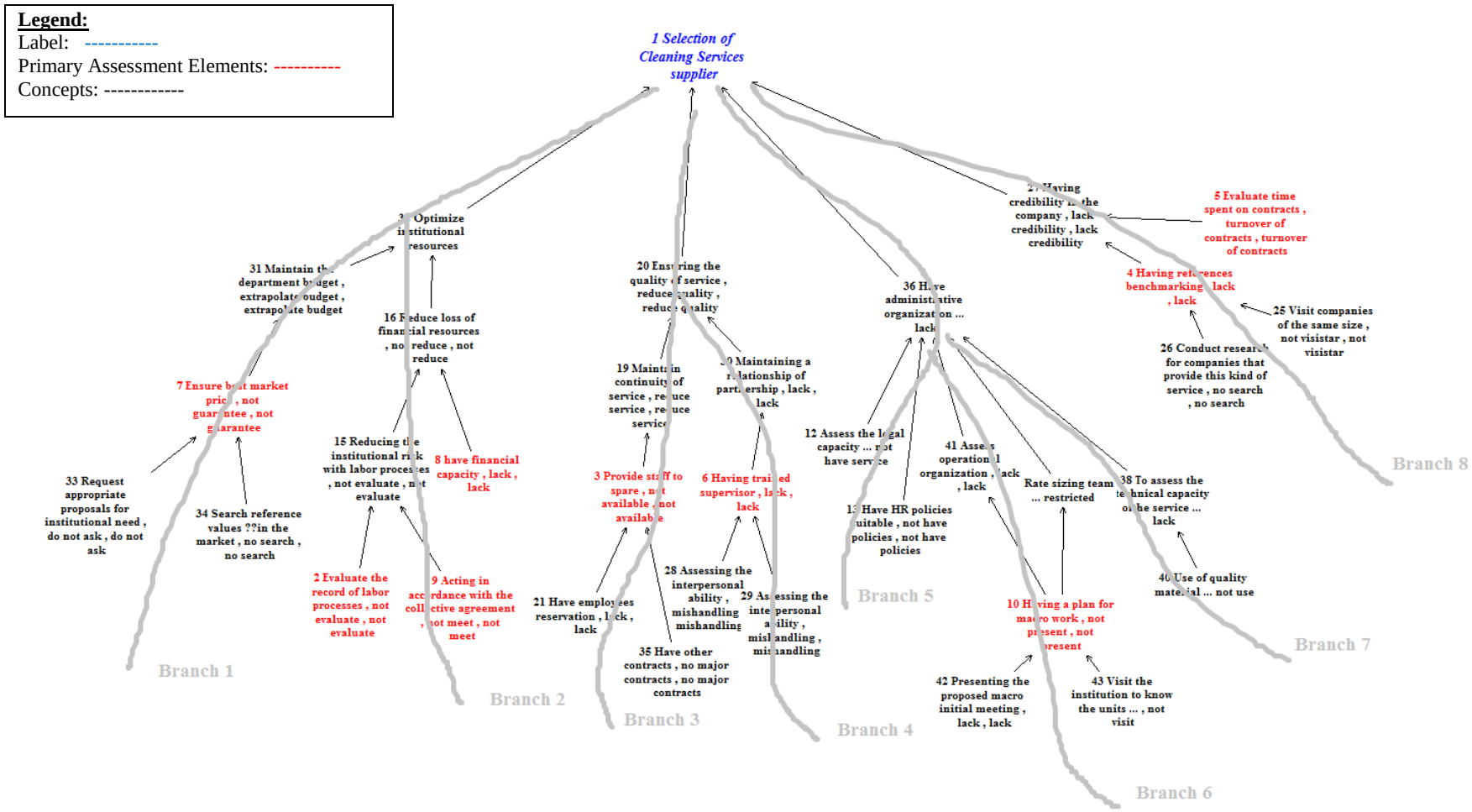

Figure 3. Cognitive map with identified branches

The branches identified on the map of the AMD Manager are presented on Figure 3. Table 4 below shows the branches grouped by cluster:

Table 4
Branches on the cognitive map of the AMD Manager

Clusters	***Branches***	***Name***	***Concepts***
Cluster I - Resource Optimization	**Branch 1**	Value of the service	C32, C31, C7, C33, C34
	Branch 2	Risk reduction	C32, C16, C15, C8, C2, C9
	Branch 3	Continuity of service	C20, C19, C3, C21, C35
Cluster II - Quality of service	**Branch 4**	Training of Staff	C20, C30, C6, C28, C29
	Branch 5	Internal organization	C36, C12, C41, C13
Cluster III - Administrative Structure	**Branch 6**	Operating capacity	C36, C39, C10, C42, C43
	Branch 7	Quality of material	C36, C38, C40
Cluster IV - Credibility	**Branch 8**	Credibility	C27, C4, C5, C25, C26,

On the facilitator's analysis, the identified branches represent the following decisor's concerns:

- Branch 1: Does the supplier have a service value compatible with the market and with the budget of the department, in a way of optimizing the institutional resources?
- Branch 2: Does the supplier comply with the labor laws, so that it minimizes risks of institutional losses due to labor claims?
- Branch 3: Does the supplier have a contingent in order to replace service providers in the event of absences, so that the continuity of the services is maintained?
- Branch 4: Does the supplier have a trained team and a skilled supervisor in order to develop a relationship based on partnership, rather than merely the provision of services?
- Branch 5: Does the supplier have an internal organization in order to deal effectively with HR, law-related and operational issues?
- Branch 6: Does the supplier have a technical team able to produce an adequate work plan to the institution?
- Branch 7: Does the supplier use high-quality materials when performing its operational activities?
- Branch 8: Does the supplier have good references from the market in which it operates?

Having identified the branches, the next stage of the method is the identification of the FPsV through validating the concepts contained on the map, according to Bana and Costa's axioms (1992). Regarding each of the branches on the decisor's map, the facilitator started the process of identifying FVP candidates, analyzing and later checking

with the decisor elements which qualify as being isolable, controllable and essential to the decisor's judgement.

The FVP candidates presented by the AMD decisor:

- FPV1: Support Capacity, with origins on R3.
- FPV2: Administrative Organization, with origins on R5.
- FPV3: Institutional Risk, with origins on R2.
- FPV4: Price, with origins on R1.
- FPV5: Credibility, with origins on R8.
- FPV6: Quality of the Materials, with origins on R7.

After decomposing the FPsV into EPsV, the next step was building the points of view hierarchical tree from the decisor's perspective, which finalized the structuring of the multi-criteria model. The family tree of PVs that was built, presented in Figure 4, qualifies the structuring of the decisor's multi-criteria model, in which the criteria are represented by FPsV and the sub-criteria, by EPsV.

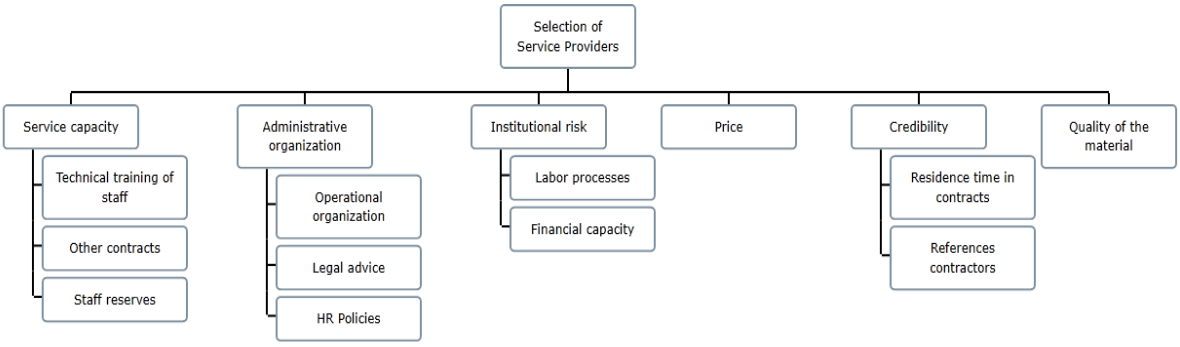

Figure 4. Multicriteria model based on the cognitive map of the decisor

Having built the multi-criteria model with the usage of the cognitive map of the AMD decisor, the next step was to create a hierarchical model on the software tool, establishing the hierarchical relationship between the elements. The hierarchy displayed in the figure represents a situation in which the decisor wishes to select a new supplier for the Cleaning Services.

The criteria that have an impact on the general objective, displayed on the second level of hierarchy, are: Support Capacity, Administrative Organization, Institutional Risk, Price, Credibility and Quality of the Materials. The criteria Support Capacity, Administrative Organization, Institutional Risk and Credibility are subdivided into third level sub-criteria: Teams Technical Qualification, Other Contracts, Backup Employees, Operational Organization, Legal Advice, HR Policies, Labor Claims, Financial Capacity, Contract Permanence Time and References from Hiring Companies. On the last level, the alternatives are: Company C.M. and Company InService.

After creating the hierarchical model, it was necessary to fulfill the dominant matrices, where the alternatives in relation to each criterion and the criteria of a specific level in relation to the criterion on the immediately superior level were compared. Saaty's Fundamental Scale was used, establishing the preference of the decisor. In this manner, the verbal judgments were transformed into a numerical scale. The decisor's judgments are presented in Table 5:

Table 5
Comparison matrix of the criteria of the problem of Supplier Selection

	Service Capacity	***Administrative Organization***	***Institutional risk***	***Price***	***Credibility***	***Material Quality***	***Relative priority***
Service Capacity	**1**	1/4	1/4	1/2	1/2	1/3	***0,06***
Administrative Organization	4	**1**	1/4	1/3	1/2	1/3	***0,09***
Institutional risk	4	4	**1**	3	3	1/2	***0,27***
Price	2	3	1/3	**1**	1/2	1/3	***0,12***
Credibility	2	2	1/3	2	**1**	1/3	***0,13***
Material Quality	3	3	2	3	3	**1**	***0,32***

Therefore, the criteria prioritization order is: Quality of the Materials, Institutional Risk, Credibility, Price, Administrative Organization and Support Capacity. The same calculations for sub criteria Support Capacity, Administrative Organization, Institutional Risk and Credibility were performed, which resulted on the following sub criteria prioritization order.

Afterwards, the RC of the decisor's judgments was calculated. Using the equation $Aw = \lambda max\ w$ in order to obtain the eigenvector, we have:

$$\begin{bmatrix} 1 & 1/4 & 1/4 & 1/2 & 1/2 & 1/3 \\ 4 & 1 & 1/4 & 1/3 & 1/2 & 1/3 \\ 4 & 4 & 1 & 3 & 3 & 1/2 \\ 2 & 3 & 1/3 & 1 & 1/2 & 1/3 \\ 2 & 2 & 1/3 & 2 & 1 & 1/3 \\ 3 & 3 & 2 & 3 & 3 & 1 \end{bmatrix} \times \begin{bmatrix} 0{,}061 \\ 0{,}099 \\ 0{,}271 \\ 0{,}118 \\ 0{,}132 \\ 0{,}317 \end{bmatrix} = \begin{bmatrix} 0{,}38 \\ 0{,}62 \\ 1{,}82 \\ 0{,}80 \\ 0{,}88 \\ 2{,}09 \end{bmatrix}$$

Figure 5. Matrix multiplication by its normalized value

Applying formula λmax = average of vector Aw / w, we obtain the eigenvector:

$$\lambda_{max} = \frac{1}{6}\left(\frac{0{,}38}{0{,}061} + \frac{0{,}62}{0{,}099} + \frac{1{,}82}{0{,}271} + \frac{0{,}80}{0{,}118} + \frac{0{,}88}{0{,}132} + \frac{2{,}09}{0{,}317}\right) = 6{,}54$$

And applying equation (λmax – n)/ (n-1), the IC will be IC = (6,54 – 6) /(6-1) = 0,108.

Given that n = 6 and the random index (IR) associated with the dominant matrix is 1,24, we calculate RC = IC/IR = 0,108 / 1,24 = 0,0873 < 0,10. In this manner, the inconsistency emitted by the decisor towards the criteria is acceptable. Performing the same calculations on sub criteria of criteria Support Capacity, Administrative Organization, Institutional Risk and Credibility, we achieved, respectively, the following values: RC: 0,0512 < 0,10, RC: 0,0512 < 0,10, RC: 0,0 < 0,10 e RC: 0,0 < 0,10. Therefore, the inconsistency emitted by the decisor towards the sub criteria was also acceptable.

Next, the alternative priority vectors were calculated, according to each criterion, by way of normalization and the priority vector calculation, which resulted on the values shown in Table 6.

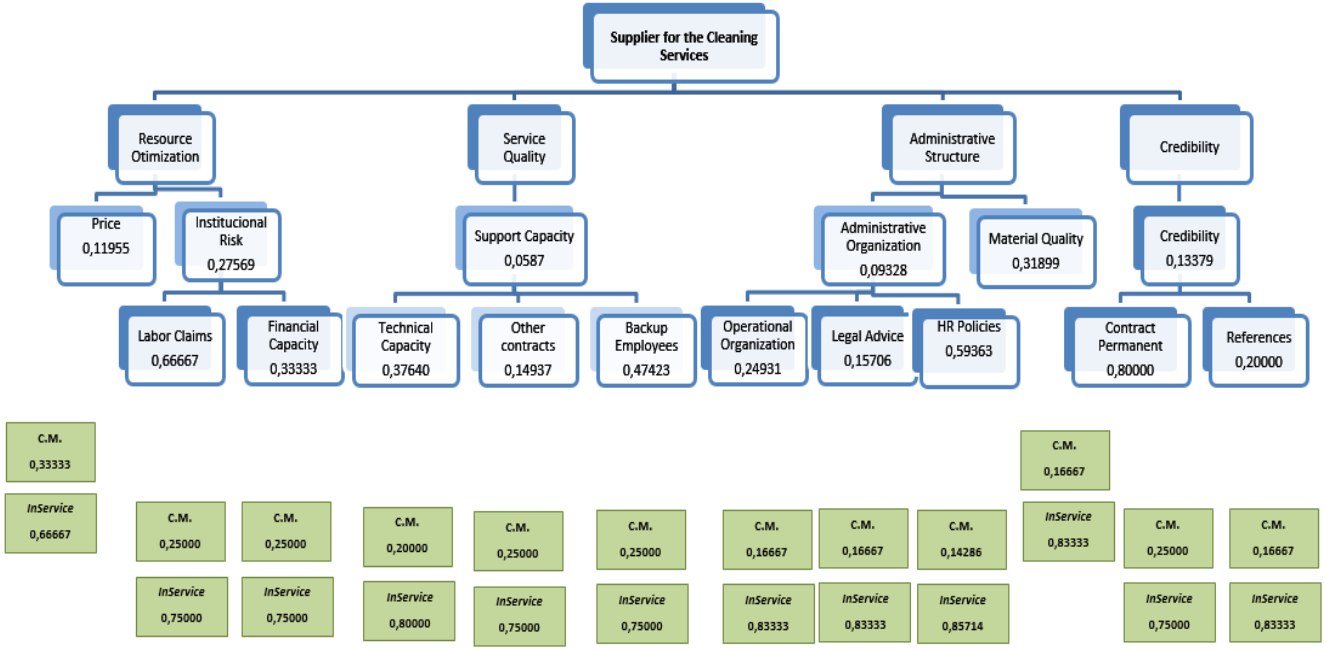

Figure 6. Family tree of the fundamental point of view of the AMD Manager

	Criteria	Price	Institucional Risk		Support Capacity			Administrative Organization			Quality of the material	Credibility		Rankimg
		0,11955	0,27569		0,05870			0,09328			0,31899	0,13379		
	Subcriteria		Labor Claims	Financial Capacity	Technical capacity	Other contracts	Backup Employees	Operacional Organization	Legal Advice	HR Policies		Contract Permanent Time	References	
			0,66667	0,33333	0,37640	0,14937	0,47423	0,24931	0,15706	0,59363		0,80000	0,20000	
Alternatives	C.M.	0,33330	0,25000	0,25000	0,20000	0,25000	0,25000	0,16667	0,16667	0,14286	0,16667	0,25000	0,16667	0,22095
	InService	0,66667	0,75000	0,75000	0,80000	0,75000	0,75000	0,83000	0,83000	0,85714	0,83333	0,75000	0,83000	0,77883

Figure 7. Weights obtained for the Supplier Selection Problem

Table 6
Final calculation

Alternative	Calculation	Final ranking
C.M.	(0,11955*0,33330)+(0,27569*0,66667*0,25)+(0,27569*0,33333*0,25)+(0,0587*0,3764*0,2)+(0,0587*0,14937*0,25)+(0,0587*0,47423*0,25)+(0,09328*0,24931*0,16667)+(0,09328*0,15706*0,166667)+(0,09328*0,59363*0,14286)+(0,31899*0,16667)+(0,13379*0,8*0,25)+(0,13379*0,2*0,16667)	0,22095
InService	(0,11955*0,66667)+(0,27569*0,33333*0,75)+(0,27569*0,33333*0,75)+(0,0587*0,3764*0,8)+(0,0587*0,14937*0,75)+(0,0587*0,47423*0,75)+(0,09328*0,24931*0,83)+(0,09328*0,15706*0,83)+(0,09328*0,59363*0,85714)+(0,31899*0,83333)+(0,13379*0,8*0,75)+(0,13379*0,2*0,83)	**0,77883**

With the purpose of demonstrating the robustness of the method, we moved forward to the sensitivity analysis of the model generated for each criterion judged by the decisor. The assessment process on the Price criterion was initiated, with a variation of 10% (for more and for less) on the criterion weight value, without having any alteration in the order of the alternatives.

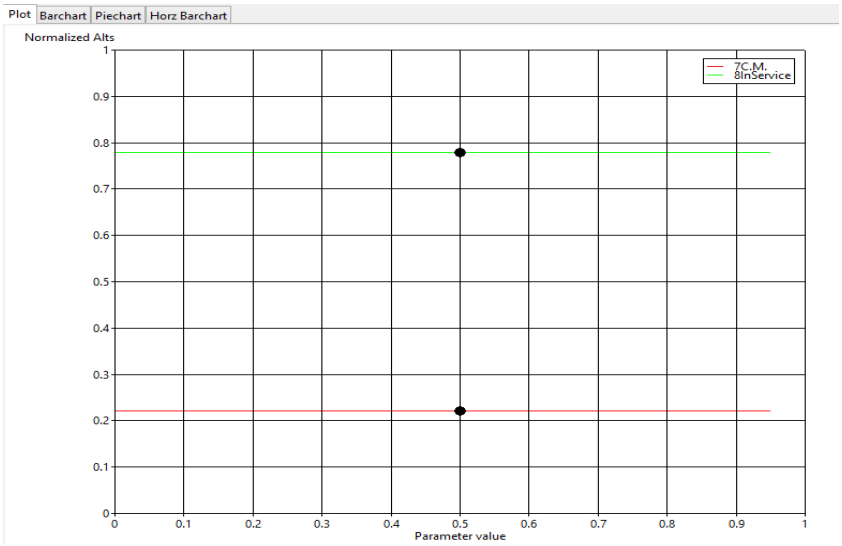

Figure 8. Sensitivity Analysis of the model

This procedure was repeated on each model criterion and no alteration was identified, which demonstrates that the proposed method satisfactorily fulfilled the criteria modelling objective, and that company InService fulfilled in a satisfactorily superior way the criterion designated by the decisor.

Therefore, with the conclusion of the sensitivity analysis, the case study according to the objective defined for this paper was concluded.

8. Limitations of the model

The major limitation of this study is that it is a case study within the education industry; therefore, the results may not be applied to the supplier selection process in other industries. Another limitation was the sample size of suppliers: though the project has successfully implemented the AHP approach in the supplier selection process and proposed the final best choice, there still might be better choices outside the candidate pool.

Due to the institutional need to immediately hire another company to replace the current provider, only two companies were able to present their proposals. This case study does not have the objective to determine a method for selecting suppliers, nor does it intend to define the criteria which should be considered in problems of supplier prioritization. It limits itself to presenting a systematic procedure that allows structuring the decision criteria in a recursive and replicable way.

Through the analysis of the proposals and without applying the model, we noted a dominance of one company over the other. One of the characteristics of the created model is that it does not consider evaluating the current vendor, therefore excluding them from the supplier selection process. The exclusion of the current vendor from this selection process was intentional.

9. Conclusions

After the decisor's assessment, results were transferred to the SuperDecisions tool, with the purpose of performing and displaying the calculations regarding the method. The identified criteria were prioritized according to the following importance order, defined by the decisor: *Quality of the Materials, Institutional Risk, Credibility, Price, Administrative Organization and Support Capacity*.

Table 7
Weights obtained for the Supplier Selection problem

Total	Quality of the material	Institucional Risk	Credibility	Price	Administrative Organization	Support Capacity
100%	**31,9¨%**	27,6%	13,4%	12%	9,3%	**5,9%**

The fact that the *Quality of the Materials* criterion came on top of the list of relevant criteria was a revelation to the AMD Manager, since, to him, the most relevant criterion were *Organization and Support Capacity*, which ended up at the bottom of the list.

The evaluation of alternatives by the AHP method was performed twice by the decision maker, and in these assessments the criterion *Quality of Materials* had a small advantage over *Institutional Risk*.

From a business point of view, the *Quality of Materials* criteria is more important than the *Institutional Risk* criteria since the latter is a condition for the pre-selection of suppliers. Before the final selection by the AHP method, an initial list of potential suppliers was generated and prior research on the financial situation and ongoing lawsuits for each participating supplier of the process was carried out. Those who had many judicial events or low financial performance were excluded from the final list, so the *Institutional Risk* was reduced from the beginning of the process.

Although in most of the supplier selection problems the price criterion is a key point for the decisor´s final decision, for PHEI it was not because bid prices submitted by companies were very similar. The true differentiation was determined by the quality of the material used.

This criterion strongly impacts the perceived final value of the service by PHEI´s Manager. It´s important to review *Table 2 – Criteria for Selecting Providers* which refers to a study by Dickson (1966) who has identified twenty-three criteria qualitatively classified and sorted by importance, and according to the table, the *quality criterion* is considered the most relevant in the SSP. Therefore, the AHP method applied on this model validated itself and confirmed the robustness of the multi-criteria model that was built, since after performing the sensitivity analysis to assess the coherence of the decisor's judgement, the order of the alternatives was unchanged. This qualifies the selected alternative as an absolute dominant.

Regarding the selected alternative, the decisor, before structuring the problem and considering the criteria, had already manifested their preference for the *InService* company based on the proposals presented by the two companies.

After the completion of this case study, the analyzed PHEI showed interest in applying the method on more strategic business decisions, i.e., to develop other models for the most important and complex decisions. The decision-maker that took part on this study also showed interest in reviewing the model considering the stage of evaluation of the service providers.

Regarding the scientific field, the importance of this work is revealing yet another area for application of the cognitive maps associated with the multi-criteria decision-aiding approach (AHP). This can be applied specifically to decision-making processes linked to supplier selection, with the goal of creating the supply chain for a higher education institution, since few studies of this nature have been found, none that use the aforementioned approaches (cognitive maps and AHP) to problem-solving supplier selection on HEIs, specifically. In short, the AHP method offered an effective and efficient way to select suppliers, incorporating a consistence check to reduce human discrepancy, providing a method that combined objective factors and subjective expert judgments and taking into account both qualitative and qualitative information.

In the future, the problem of selecting suppliers covering all stages of selection described in the Wu and Barnes (2011) framework, mainly to phase 4 – *Feedback Application*, for the monitoring of suppliers selected, which relates to the ongoing assessment of the suppliers selected by means of a performance analysis could be developed. This step is important and has been raised by the decision maker of this work since, in many cases, one can use the performance evaluation of a service provider to determine whether or not to include it in a new supplier selection process. In this context, there is a dependency between the possible criteria used for decision-making which restricts the use of AHP method, this being one of its limitations as it has the premise of independence among the criteria. In this case, the ANP method is indicated which is a generalization of the AHP, and considers the decision problem as dependent on a network of criteria.

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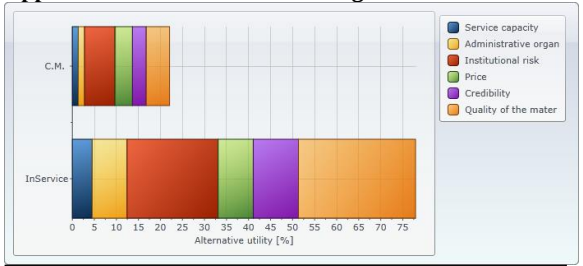
APPENDICES

Appendix A – Alternatives ranking



Alternatives Ranking

Chart data

Alternative	Total	Service capa	Administrativ	Institutional	Price	Credibility	Quality of the
InService	77.90	4.51	7.91	20.68	7.97	10.26	26.58

Appendix B – Criteria weights

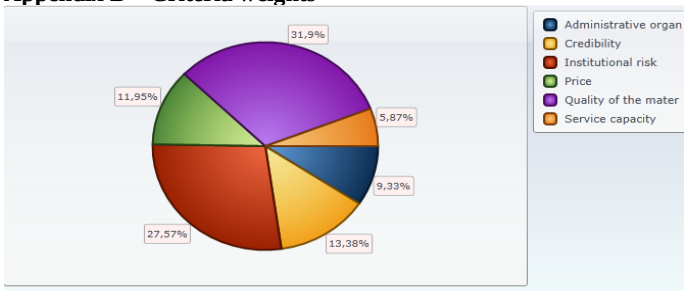


Chart data

Criterion	Weight
Administrative organ	9.33
Credibility	13.38
Institutional risk	27.57
Price	11.95
Quality of the mater	31.90
Service capacity	5.87

Appendix C – Alternative comparison

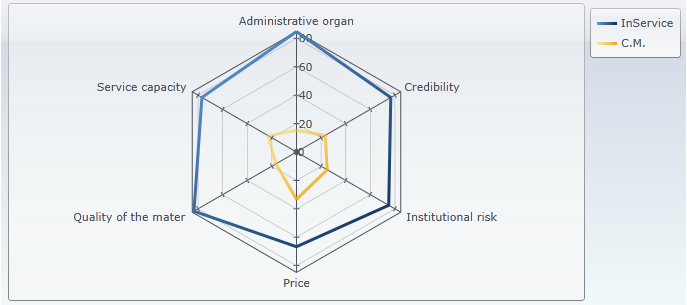


Chart data

Criterion	InService	C.M.
Administrative organ	84.75	15.25
Credibility	76.67	23.33
Institutional risk	75.00	25.00
Price	66.67	33.33
Quality of the mater	83.33	16.67
Service capacity	76.88	23.12

Appendix D – Criteria and sub criteria weights

- **Selection of Service Providers** [L=100,0%][G=100,0%]
  - **Administrative organization** [L=9,3%][G=9,3%]
    - **HR Policies** [L=59,4%][G=5,5%]
    - **Legal advice** [L=15,7%][G=1,5%]
    - **Operational organization** [L=24,9%][G=2,3%]
  - **Credibility** [L=13,4%][G=13,4%]
    - **References contractors** [L=20,0%][G=2,7%]
    - **Residence time in contracts** [L=80,0%][G=10,7%]
  - **Institutional risk** [L=27,6%][G=27,6%]
    - **Financial capacity** [L=33,3%][G=9,2%]
    - **Labor processes** [L=66,7%][G=18,4%]
  - **Price** [L=12,0%][G=12,0%]
  - **Quality of the material** [L=31,9%][G=31,9%]
  - **Service capacity** [L=5,9%][G=5,9%]
    - **Other contracts** [L=14,9%][G=0,9%]
    - **Staff reserves** [L=47,4%][G=2,8%]
    - **Technical training of staff** [L=37,6%][G=2,2%]