

Design of a Multicriteria Model with a Fuzzy Analytical Hierarchy Process - FAHP, For the Selection of Suppliers

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Abstract

The purpose of this article is to socialize ongoing research on appropriate criteria for the selection of suppliers in companies in the telecommunications sector, exposing the design of a multi-criteria model, to obtain a correct and adequate prediction of the best provider depending on the variables and criteria that each company has for the selection. The above is raised, because the selection of suppliers is a problem of multicriteria decision making, because it implies both qualitative and quantitative particularities; suppliers are a very important part of the supply chain of all companies, because they depend on the strengthening of supply management and in turn the selection will depend on criteria beyond the subjective or relationships that are had with the provider

The study proposes a descriptive methodology, with a mixed approach (quantitative and qualitative), which begins with sufficient bibliographic review, through the gathering of information with a technical research instrument (survey) to identify the selection criteria that have the companies in the telecommunications sector and finally designing a proposal for a multi-criteria model based on the application of a combination of the multi-criteria tools Hierarchical Analytical Process (AHP) and Diffuse Hierarchical Analytical Process (FAHP) English), for the selection of telecommunications equipment suppliers, considering defining a group of critical factors to evaluate a possible solution of the best and most appropriate alternative.

The preliminary results and conclusions are based on the contributions that provide an adequate bibliographic review and the validation of the criteria to be surveyed by suitable personnel, concluding with what the research leads, which is a clear sample that the selection of any type of criteria it takes more and more strength to be at the forefront of global technology..

Keywords: Selection of suppliers; multicriteria decision analysis; criterion, alternative; Hierarchical Analytical Process (AHP); Diffuse Hierarchical Analysis Process (FAHP).

1. INTRODUCTION.

In Colombia, the cellular mobile telecommunications business sector is constantly evolving due to the emergence of new technologies and services, variables that, when integrated into the current dynamism of the market and the economy, make it an important sector of information technology. In an increasingly competitive environment, where its consolidation goes hand in hand with business strategies that involve the continuous improvement of its processes; one of these strategies is the strengthening of the different links in the supply chain, which include the proper selection and purchase of mobile telecommunications equipment [1]. This process involves the classification of appropriate suppliers that meet the requirements demanded within the purchase requests, among which is the choice of the best offers based on their price, quality, quantity, delivery dates, payment methods (among other variables), in addition to preventing reprocessing, and breaches. Some companies in the cellular mobile telecommunications sector have flaws in their supplier selection process, which is based on a traditional approach, where their main decision criterion is price, without taking into account the other criteria focused on quality that are fundamental basis for decision making and assertiveness; in order to promote competition, policies are usually established to assign several suppliers of the same product (mobile telecommunications equipment), without ordering the providers according to their real needs, which at the beginning was estimated to give the company more bargaining power and protected it against the uncertainty that represents the dependence of a single supplier (or a few) or the best.

2. BIBLIOGRAPHICAL FUNDAMENTATION.

Several bibliographical sources are taken for research, where the most relevant ones can be highlighted.

The first of them by the authors [2] who in their article expose a wide and varied state of the art in terms of supplier selection, with greater orientation towards quantitative approaches: “The first link and basis of the entire management is the function Provisioning, which until the 1980s, was relegated to the purchase and inventory management operations. However, the

demands of the current competitive environment have led to recognizing its importance in business strategy and it is largely accepted that the good performance of the company depends on the performance of its suppliers”.

Currently, the provisioning is responsible for the supplier-client relationships and guarantees that the necessary equipment and resources are available for the implementation of services, within this the selection of suppliers is immersed as a process that guarantees the company to have good equipment and supplies at the right time and according to the specific needs that are required [3]; In order to make these decisions, two types of criteria must be taken into account: qualitative and quantitative, which cover all the essential aspects to consider when making the decision of who will be the most appropriate and indicated provider as expressed by the authors [4]. The tools used for the selection of suppliers that involve multicriteria decisions are varied, researchers in this field have developed a varied number of case studies applying these methods both for producing companies and for service providers in different economic sectors.

In relation to the above, [5] they conclude in the study that they carried out that of 78 articles published between 2000 and 2008, the own approaches are more used than the integrated approaches, being the Data Envelopment Analysis (DEA) the most used, followed by mathematical programming and the AHP model. The AHP model is the hierarchical analysis process for the most widely used multi-criteria decision making as indicated in its article [6]. It is in this way that it is possible to appreciate that the AHP process is a useful, practical and systematic method for the selection of suppliers [7]. However, in practice, clear data is sometimes inadequate to design a real-life situation [8], since human judgments are vague and cannot be represented with exact numbers [9]; which is why the AHP methodology with fuzzy triangular numbers is used to represent the comparison of judgments in decision making as expressed by the authors focused on a washing machine company [10]. The theory of fuzzy sets is similar to human reasoning in the use of approximate information and in the uncertainty generated by decisions and offers the advantage of representing mathematically such uncertainty and vagueness, providing formalized tools to deal with the intrinsic imprecision of many problems [11].

According to the authors [12], where they expose us that “the axes of the investigation are related to the application of the AHP and FAHP theory, which are widely applied for the selection of the best alternative of the existing ones, depending on the selection of multiple criteria, for which linguistic labels are used, which allow ambiguities to be avoided in the experts’ responses. The proposed model will serve as support in decision making when selecting methodologies.” It is a clear sign that the selection of any type of criterion is increasingly taking force to be at the forefront of global technology.

In general, these academic works show a current trend towards the consolidation of supplier management processes, it should be noted that for cellular mobile telecommunications companies, what was found evidencing the relevance of this research was void. Being these, the findings closest to the need for this research in companies in the telecommunications

sector, those multicriteria tools that have been studied for the selection of high impact projects and those that seek to find the utility of multicriteria decision methods (such as AHP) in an environment of increasing competitiveness in companies related to Information Technology and communication (TIC).

2.1 Characterization of the decision process and selection tools.

2.1.1 The decision process.

To start, it is essential to identify what is understood by decision, and then describe the main components that are directly related as a decision problem. Decision: It is a deliberate and thoughtful process that leads to the selection of a certain course of action (alternative) within a set of possible actions. According to [13] the decision process necessarily implies that there is a comparison between the possible alternatives of decision-making selection: in the first instance, it is necessary to separate the problem from the elements that compose it in the decision-making process, in order to make a comparison among them, said comparison is made by providing measures to the criteria to establish preferences between one element and another, that is, a hierarchy.

The decision problem scheme (see Fig. 1) consists of three main parts:

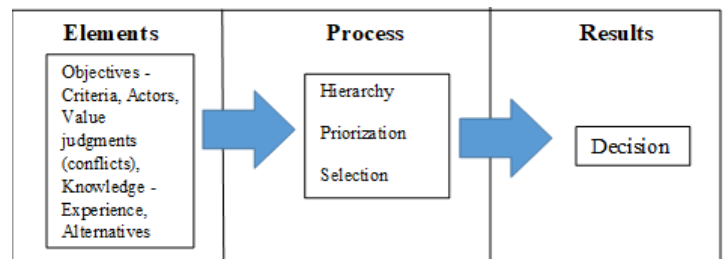


Figure 1. Multicriteria Evaluation [13].

Figure 1 shows how a decision problem is constituted and how fundamental it can be to have an adequate process for the use of the elements, because if you want to have an effective and efficient tool that supports decisions, it is vital It is important to have the greatest amount of analysis elements and use the most appropriate process for this. In it you can see both the elements, the process and the results (decision), the system indicates some inputs (elements) and some outputs of the process (decision) these three components have the following description:

- Elements:

The elements that participate in a decision process are usually measured on different scales (weight, distance or time, for example), so it is necessary to transform these units into an abstract unit that is valid for all scales.

- Process:

Hierarchy: Corresponds to the order relationship between the alternatives, for which a decision model is required.

Prioritization: It consists in determining a proportionality reason, defined in terms of the importance of an alternative with respect to another; this requires an evaluation process [14].

- Result:

It includes the decision to select an alternative, hierarchy or prioritization of projects based on process and procedure improvements.

It is in this way, as in the analysis of a problem we can incorporate different dimensions (criteria), this is a way of bringing the model closer to reality. However, the difficulty of considering more than one dimension is that questions such as; what is now the most appropriate provider? How do you determine the importance of these factors, and then synthesize all this information to make the best decision? This implies, first, to recognize the complexity of the decision-making process, whether individual or group. In addition to recognizing, that many intangible variables are impossible to quantify in traditional measures, political, social and environmental aspects, for example, that must be represented by a common scale. And that these variables are difficult to measure in economic terms, which limits the use of traditional supplier evaluation methods, as the authors comment [13].

2.1.2 Multicriteria process.

Multicriteria analysis is a method that facilitates and guides decision making based on multiple criteria. It is mainly used to solve decision problems through judgments that arise after making comparisons between several alternatives, so it can also be used as an evaluation method [3].

This method implies that there is participation by different stakeholders or interested groups such as: decision makers, technicians, experts, beneficiaries, among others and intends to integrate their diverse opinions regarding the possible alternatives to choose in order to make the best decision. Its objective is then to reach a solution by simplifying the problem taking into account, at all times, the preferences of those involved [15]. Currently, this method is mainly used to provide tools that facilitate the decision-making process framed in problem solving.

2.1.3 Decision-making process tools.

At present, there are methods that are mainly used to provide tools that facilitate the decision-making process framed in problem solving.

2.1.4 Hierarchical Analysis Process (AHP).

The AHP was developed by Saaty in the 70's allowing modeling a complex system of multiple criteria through a hierarchical structure [16]. As mentioned in this document, it is a methodology to structure, evaluate and simplify. The AHP is a mathematical model that involves all aspects of the decision-making process: it works under a hierarchical structure, it is based on a priority scale considering preferences of one

element over another, it manages several alternatives, makes binary comparisons between the elements, synthesizes the judgments issued and delivers the alternatives in the form of a ranking or arrangement according to the weights obtained (priorities) [17].

The AHP is composed of three fundamental stages:

- Analysis of a hierarchy where the main elements involved in the problem are taken into account. The highest level of hierarchy is the objective pursued, the following or intermediate levels are composed of the criteria and sub-criteria that will help to achieve the objective and finally at the lowest level are the alternatives considered. (See Figure 2).
- Issuance of judgments through paired comparisons. The judgments are collected in pairs of comparison matrices, in order to obtain the priorities of each element of the hierarchy.
- Prioritization and synthesis. In this stage the calculation of local priorities is carried out, from which the global ones are generated, which, when synthesized, gives the total priorities of the alternatives.

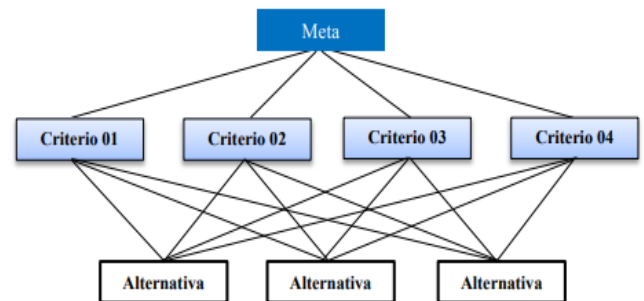


Figure 2. Hierarchical Analytical Process [16]

According to the authors [18] two of the great advantages that this process presents over other multicriteria decision methods are:

- Lets you break down a problem into parts.
- It allows to measure qualitative and quantitative criteria through a common scale.

The AHP hierarchical analytical process is not only used for supplier selection, this methodology can be implemented in several fields by applying a number of several according to each need and each object to be evaluated, as well as starting from this scoop they have a variety of research that seeks applicability within different fields or concepts to use, in this sense we find that the authors [19] seek to select forest management methods under the AHP methodology (Hierarchical Analytical Process), conclude within the investigation that the application of the methodology AHP helps to consider all possible criteria for making better decisions at all levels: technical, environmental, social and economic. It allows to take into account tangible and intangible

criteria, which is of utmost importance in the field of forest management, because many of them are difficult to quantify.

2.1.5 Process of Fuzzy Hierarchical Analysis Process (FAHP).

In the AHP the judgments that are issued are based on a discrete scale known as the Saaty scale, which works from the concept of traditional logic and uses numbers from one to nine to represent linguistic judgments, according to the author [20]; but everyday life and human thought do not work that way, so that problem solving can be closer to reality, it is necessary to consider the uncertainty and inaccuracy of human thought. The diffuse hierarchical analytical process results from a combination between fuzzy logic and the AHP as an alternative solution to this problem, since it allows decision makers to express their opinions and preferences in a more subjective and not so precise way.

For [21] the application of this methodology considers the following three stages:

- Construction of the hierarchical structure for the problem to be solved.
- Obtaining the fuzzy matrix of comparisons.
- Perform a ranking of the alternatives and select the most appropriate.

When expressed, the process of diffuse hierarchical analysis (FAHP) is the combination of fuzzy logic and the process of hierarchical analysis (AHP), several investigations arise that support this expression, used in various disciplines, providing with this combination a variety of alternatives that reflect a complexity that within this methodology can be obtained solution. In this context there are investigations that identify the above, this is how the authors [22] carry out a case study in Colombia to design a diffuse multicriteria decision model for the selection of contractors in infrastructure projects, with the study demonstrating that Multicriteria decision methods are increasingly useful for solving problems in the selection of construction and infrastructure contractors due to an increased understanding of their usefulness, this is achieved by testing the fuzzy logic that converges with the decision model.

Under this perspective and understanding the diffuse multicriteria process are utilities that were not intended to be found in the past centuries, it is currently known that this methodology has helped identify relevant variables to achieve alternatives in the selection that is required. In this sense, the research carried out by [23] is located, where they incorporate different ecological, social, economic, infrastructure and institutional variables, in order to build a diffuse hierarchical analytical process in the selection and evaluation of resilience in affected areas Due to disasters, taking into account the multidimensions that make up resilience, this research aims to select variables related to resilience in areas affected by natural disasters, considering the limitation in terms of quantity and quality of information in existing countries developmental. In the research, the authors comment that “The 103 variables identified through the scientific literature and the experience of 26 experts are subjected to a selection methodology based on

the Diffuse Hierarchical Analytical Process. The criteria used by five experts in statistics, economics, sociology and management to determine the weighted selection structure are: relevance, functionality, availability, reliability and usefulness. Each variable is qualified, obtaining as a result 56 indicators that adapt to the environment of uncertainty of information, which characterizes the territories that can potentially be affected by a phenomenon of natural origin”.

With the literary review it is verified that from an environmental point of view the concept of diffuse hierarchical analytical process is highly used, but there is a deficit when it comes to speaking and focusing on the selection of telecommunications equipment providers, the different industries have found A real utility to facilitate management processes within companies, from an academic point of view, research takes great meaning and value in identifying its viability.

3. METHODOLOGY

For [24], “mixed methods represent a set of systematic, empirical and critical research processes and involve the collection and analysis of quantitative and qualitative data, as well as their integration and joint discussion, to make inferences resulting from all information collected (metainferences) and gain a better understanding of the phenomenon under study”

The research is within the qualitative and quantitative approach [25]. It is not intended as a single exercise in satisfying the question; within the research, but the possibility of generating changes and transformations in the industrial sector of companies related to cellular mobile telecommunications, hence it is introduced in the research based on design or modeling.

With respect to the type of study, the research is based on the documentary review, which consists of the analysis of information on a certain subject, with the purpose of establishing relationships, differences, stages, postures or current state of knowledge regarding the subject object of study [26].

According to the above, the research is Theoretical-Practical and documentary, having as a general method: the deductive method and as specific methodologies; case study, documentary analysis and modeling [26].

The research is carried out in two stages, the first one is qualitative, because it investigates and collects information within companies, to review in the management departments how the processes for decision making are structured and developed in terms of the selection of suppliers. The second stage is a quantitative approach since it covers the development, application, and simulation of the behavior of the multicriteria model, in cellular mobile telecommunications companies.

4. PRELIMINARY RESULT

The main objective of the research seeks to propose a multicriteria model design with a Diffuse Hierarchical Analysis Process - FAHP for the selection of the best provider of telecommunications equipment, based on the application of the most important variables, variables that depend on companies and your usual way of selecting suppliers.

Those objectives that will allow to reach that main objective are founded as specific objectives and are formed in the phases of the development of the investigation, it begins with the collection of information of the main methodologies, for the appropriate selection of the best provider of cellular mobile telecommunications equipment. Next, the criteria to be followed to build the multi-criteria model for the classification of telecommunications equipment suppliers that best fit the needs of the company are defined. Then, the main criteria that involve the selection of company suppliers in the cellular mobile telecommunications sector must be analyzed. To conclude with the development of a classification model based on the use of the multi-criteria FAHP technique, for the selection of the provider that best suits the needs of the company in the cellular mobile telecommunications sector.

Within the investigation we are located in the first two phases (See table 1):

Table 1. Phases of the investigation

Phase	Activity
Phase 1 Data Basis	Collect information on the main methodologies, for the appropriate selection of the best provider of cellular mobile telecommunications equipment.
Phase 2 Information gathering and data analysis	Perform an analysis of data or variables involved in decision making that facilitates the selection of suppliers. The analysis will simplify and improve the work of the next block responsible for forecasting or designing the model.

This indicates that the investigation is ongoing, in the phases of data foundation and information gathering, for which it was carried out in phase 1, the analysis of the information found, where it was possible to identify and conclude that there is no evidence within from the literature of models that use the diffuse hierarchical analytical process for the telecommunications sector in terms of the providers of cellular mobile telecommunications equipment, which shows that there is a knowledge gap in this regard and that it is relevant to develop the research.

In phase 2, a technical instrument of information gathering (Survey) was validated by experts in the field to evaluate these criteria and necessary variables when selecting a supplier within a company. This phase is still ongoing, to complete its development effectively, giving application to the instruments with companies in the telecommunications sector. Some criteria taken into account within the instrument are based primarily on the analysis of categories, such as: Criteria for

quality, criteria for price, criteria for compliance, criteria for post-sale service. This will allow, to analyze the information collected with the instrument, and it became necessary to categorize the research variables, to unify the description criteria “Each category of elements or dimensions of the investigated variables are called categories and which will serve to classify or group according to them the various units” [27].

5. CONCLUSIONS

For ongoing research and the phases developed, it can be concluded that there is no multicriteria model supported by the diffuse hierarchical analytical process, so it can be evidenced in the literature that, although there are models that use this process in some sectors of industry, this has not been worked from the point of view of the telecommunications sector in terms of the suppliers of cellular mobile telecommunications equipment.

In the partial application of the technical research instrument (survey) to mobile cellular telecommunications companies, a lack of knowledge was observed for this type of tools, and the selection of the provider is carried out in a subjective way, or in many others it was evidenced that they perform it. by tender, where it has three competent suppliers and which only one will meet all the requirements to win and be the selected supplier, usually by an appropriate person, who in turn acts as judge for the selection, indicating this situation that the model that is planned to propose in the final phase of the investigation, is the most timely solution for the adequate and correct selection of the providers of the cellular mobile telecommunications companies.

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