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Decision Support Methodology when Entering New Markets for a Semi-Finished Bronze Products Foundry

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To my Family...

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Resumo

O mundo e sociedade em que vivemos, desenvolve-se cada vez mais a uma velocidade crescente. De forma a que as empresas se mantenham competitivas, estas têm, cada vez mais, de optar por decisões estratégicas de forma a serem bem-sucedidas. Quando o momento de estudar novos mercados e clientes se avizinha, há que avaliar a situação e perceber estrategicamente qual o caminho a seguir. No contexto das fundições de semielaborados de bronze, fábricas que se englobam num ambiente *business-to-business*, é fundamental entender que se atua num mercado competitivo pela tecnologia utilizada, *standards* de qualidade e preços praticados. De forma a fazer frente a empresas rivais que também têm em vista o potencial alargamento de mercado, faz com que cada vez mais empresas apostem em modelos de decisão, para as auxiliar a tomar medidas fundamentadas e estudadas para ter sucesso. Nesta dissertação é sugerido uma metodologia que engloba o cruzamento de várias ferramentas. PESTLE, SWOT e modelos de decisão multicritério cruzam resultados para que possa ser possível apoiar os gestores destas fundições a tomar decisões competitivas. A secção correspondente a modelos de decisão multicritério, foi baseada no *Analytic Network Process.* A dissertação foi desenvolvida dentro de uma fundição de semielaborados de bronze localizada na Alemanha, que tem como ambição explorar os mercados do Brasil, Argentina, Chile e Mexico.

Palavras-Chave: *Business-to-Business*, PESTLE, SWOT, Modelos de Decisão Multicritério, *Analytic Network Process*

Abstract

The world and society that we live in nowadays, develops itself with an astonishing speed. In order for companies to keep themselves competitive, they have, more and more, to choose strategic decisions to be successful. When the moment to study new markets and new clients arrive, it is important to evaluate the situation and understand, in a tactical way, which choice is the best to go. In the context of semi-finished bronze products foundry, factories that are within a business-to-business environment, it is fundamental to understand that they are playing in a very competitive market in terms of technology, quality standards and prices. To deal with competitors that also aim to extend their market, enterprises are betting in decision models to help them to make better decisions and to succeed. In this dissertation, a decision support methodology is suggested that crosses several tools. PESTLE, SWOT and multi-criteria decision-making matchmake results to help decision makers and managers to make competitive decisions. The section that explains the decision-making process was based on the Analytic Network Process. This dissertation was developed within a semi-finished bronze products foundry, located in Germany. This company has the will to expand to Brazil, Argentina, Chile and Mexico.

Keywords: Business-to-Business, PESTLE, SWOT, Multi-Criteria Decision-Making, Analytic Network Process.

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List of Abbreviations

ANP   Analytic Network Process

AHP   Analytic Hierarchy Process

PWCs   Pair-Wise Comparisons

B2B   Business-to-Business

B2C   Business-to-Consumer

CI   Consistency Index

CR   Consistency Ratio

RI   Random Consistency Index

1. Introduction

1.1 Context

Decision making has become one of the most important aspects when significant times arrive. If companies want to become competitive, new approaches must be taken into consideration. Choosing a new market to operate is a strategic choice that businesses deliberate. In order to do that, it is recommended in this thesis to combine strategic analysis tools and decision-making tools to come up with a methodology that helps business managers taking decisions.

One tool that can be used to help taking conclusions is the ANP. This method is a general form of the Analytic Hierarchy Process (AHP) used in multi-criteria decision analysis. The AHP is a method that can be used to measure social and physical domains. In order to feedback networks, it is used the generalization of the AHP model, the ANP. Besides modelling a problem and establishing a hierarchy, it also pairwise comparisons to establish relations within the structure. This way is possible to connect and interact at several levels to reach the best conclusion. (L. Saaty & G. Vargas, 2006). In this dissertation, this network is feed by the results given from the strategic tools PESTLE and SWOT. Like this is possible to evaluate some market variables that are crucial for this study. From the combination of this strategic analysis tools and decision-making tools, results in a methodology that can be used when a business wants to expand to new markets and take an action.

Over time, successful companies had the need to adapt their strategies and decisions according to the economic environment they were in. The ability to decide where to act or predict, even the slightest change in the markets, becomes an advantage towards competitors and a way to avoid future business problems. An overview of the global economy, serve as a guide to initiate the development of the enterprise strategy and in some cases, the modification of the business plan. How are the global markets nowadays? Where should companies invest? In recent years, the global economy is growing. Although forecasts show an economic improvement, some countries such as Canada, Russia or Japan will not feel it as intense as others. In European terms, this area is on the path to recovery. Real income is on the rise, also because the rate of inflation in most countries has recently been negative due to low energy and food prices. The increase in the labour force due to the recent refugee crisis could be an additional help for the annual growths in some countries. Hungary, Austria, Sweden and Germany received more than 1.2 million people in 2015. These are most likely the ones who will receive the largest inflows. (Burnson, 2015)

Acting within this economic environment is the German Company X This thesis it is written within a real project for this enterprise. Having in consideration the market conditions nowadays, the company decided to explore the South America area and explore the possibility to work there with some of their products. Having some corporate decisions to make and questions to answer, this thesis helps to reach a conclusion. Starting with a study of the South America market using strategic tools and showing a well-defined business plan, becomes easier to identify which conditions are present. Afterwards, the Analytic Network Process (ANP) will be applied, which allows selecting the best option after prioritizing all the possibilities.

Company X is a global supplier to the automotive industry that is remarkably well known for the low emissions, reduced fuel consumption, upgraded performance, reliability, quality, and safety when it comes to product engineering and development. This company operates inside the area with products and component segments related with air supply, emission control and pumps. They also develop, manufacture and market supply of pistons, engine blocks, and plain bearings. Since it is an international company, it operates around the globe.

1.2 Objectives

The main objective of this dissertation is to be a strategic model to support semi-finished bronze products foundries making decisions when they want to explore new markets and decide next steps with players from the field. The first approach consists in applying several tools, that allow analysing the different characteristics of the markets. Having in consideration the main tool applied to this methodology, the ANP, it is important to organize all the information, understand the characteristics of the business and discuss the variables, that is going to be used in the decision tool to reach the verdict. Since the topic relates to economic, political, technology applications with benefits, opportunities, costs and risks, and these subjects are dependent on each other, the ANP fits perfectly into this topic. To analyse the different clusters of the decision-making toll, some market research has to be done. It is important to mention, that the markets that are being analysed, are the ones that the businesses want to explore. Political, Economic, Social, Technological, Legal & Environmental analysis (PESTLE) is used to collect and present that relevant data. A complementary tool that is important to use, is the Strengths, Weaknesses, Opportunities and Threats analysis (SWOT). It is possible to compare characteristics from inside the company with the market environment.

Since this type of industries is a Business to Business (B2B) companies, using the connections by phone calls and email with the potential clients, it is possible to combine information to get results.

This info that is gathered by these connections is the one that is used to feed the strategic and decision-making tools.

The model will be applied to Company X within the South America markets, combining strategic and decision methods. The Company X, located in Germany, belongs to a big German company where the main goal is to explore three different Continuous Cast Metal Alloys Products (Basic Programme, Customized and High Precision) and to analyse if it is worth it to enter the South American Market and if yes, which companies invest time first and how. The interest is around four countries, Brazil, Chile, Argentina and Mexico.

1.3 Research Methodology

This dissertation is essentially motivated by the combination of several scientific papers, books and by the discussion with several professionals of the area. The book Decision Making With The Analytic Network Process written by Thomas L. Saaty and Luis G. Vargas, and two other master thesis from Cabral (2011) and Abreu (2013), where ANP is used in two different ways were essential for the decision marking part. The book gives the theoretical support that is needed and the thesis shows examples of the ANP applied in a real context. For the ANP is fundamental to make pair comparisons, judgements and create criteria. It is an established one network that has several levels of interacting with each other. It is also important to relate that in this method, are the criteria that determine the importance of the alternatives in a network but is also important that the alternatives themselves determine the importance of the criteria in a network. In practice, several conversations with the company experts were held to decide the elements to include on each cluster of the ANP. Then, it was necessary to make questionnaires in order to get the judgments of the Pair-Wise Comparisons. The book Decision Making With The Analytic Network Process written by Thomas L. Saaty and Luis G. Vargas, and two other master thesis from Cabral (2011) and Abreu (2013), where ANP is used in two different ways. were essential for this research. The book gives the theoretical support that is needed, and the thesis shows examples of the ANP applied in a real context. To modelling the ANP network it was used Super Decisions software.

To help to answer the ANP questions, some data regarding the markets that are being studied is essential. To assay which conditions are present, it is possible to use two methods: PESTEL and SWOT Analysis. The strategic marketing tool PESTEL, analyses and monitors the macro-environmental factors. P for political, E for economic, S for social, T for technological, E for environmental and L for legal. SWOT Analysis, an analytical tool used for categorization and identification of internal and external factors, permits the four components to be identified:

strengths, weaknesses opportunities and threats. Like the first step, at this point, it is also important to be informed via journal articles, books and studies. But it is also necessary to get information about the characteristics of the business. Meetings in form of interviews have to be done with experts on the subject.

Since the goal is to explore new markets, having a Macro point if view became very important. Like this, it is possible to see the characteristics in a global way and at the same time revealing marketing activities, processes, institutions and flow of goods and services from a social perspective. Then explore a Micro point of view, where the immediate environment that impacts a business is exposed. Suppliers, customers and stakeholders, including local government agencies or regulatory bodies are analysed. To do that, and to update data, it is necessary to be constantly informed about what is going on. Reading journal articles, books and studies about the markets it shows to be the best way to do it.

Also, to get information about the market conditions and info about the real situation of what was going on in markets that are being studied, it is crucial the communication by phone and phone calls. As said before and, since this business is B2B, it is the relationships with companies in the studied markets that allow getting direct info from the field. Calling and texting with possible clients from the other areas is a crucial source of information.

The research starts with the proposal of realizing the dissertation within the Company X. The German company came up with a problem related to the South America market that needed to be solved. Since the language was a restriction, they were looking for a person that could speak Portuguese or Spanish. After a phone interview and the documents required delivered, the possibility to join the project became settled. The main goal is to answer the question: Is it worth it to act in South America with the German Continuous Cast Product and if yes, where to act? If so, which companies attract and in which way?

With the central tasks defined, the work within the company began. The first visit to all the facilities was provided to better understand how the industries operate. Several questions were made to the experts to figure out if the theoretical background of the dissertation could be implemented into the real problem. It became clear that the primary step is to study the market, identify the important variables of the business and make the final decision on what to do using the ANP method.

As a summary of the research methodology, it is shown in the diagram below, a succinct description of the whole process:

Literature Review on ANP:
- Understand if the tool helps to reach a conclusion based on the info availableland if it adds value to the study

Literature Review on SWOT:
- Understand if the tool helps to organize the internal and external characteristics information of the company and if it adds value to the study

Literature Review on PESTLE:
- Understand if the tool helps to oganize the market information and if it adds value to the study

Journal Articles, Books, Studies:
- Market Characteristics
- Helps to get information

Calls and Emails:
- Helps to get Market Characteristics
- Helps to get information

Figure 1.1 – Research Methodology Diagram

The literature review that follows in Chapter 2, and having in consideration all the methods applied in this thesis, has the main objective to show the importance of these tools combined with each other represent. What is the definition of each method? What is their appliance? What are their individual advantages to using them? And Disadvantages? How can value be created to a business combining strategic and decision tools?

1.4 Research Contribution of this Study

This study attends to help companies that have or are semi-finished bronze foundries within their businesses, in order to support making decisions when they decide to explore new markets. Although the use of the marketing tools, at the first sight, appears to be simple, is the combination of all the tools and especially with the ANP model, that allows creating this methodology. Analysing companies that have a solid business in the area, there is not one of them that doesn't need to continuously grow or to improve their strategy. Nowadays the speed of information and grow is huge and, if the businesses don't keep up, their competition can rise faster and bring serious problems.

Due to that, this Decision Support Methodology When Entering New Markets for a Semi-Finished Bronze Products Foundry brings already a strategy on how to act when the moment to grow arrives. If there is a chance for the company to explore new markets, there is a methodology that can be followed and that is described in this dissertation.

1.5 Dissertation Structure

This dissertation is organized into six chapters. Each one of them has several sub-chapters which describe several important points related to the main one.

- Chapter 1 makes the introduction of all the document. It is where the context, objectives, research methodology and research contribution are described.
- In Chapter 2, literature review on PESTLE, SWOT
- Chapter 3 is where is written the literature review on Models for Decision Making, specifically ANP
- Chapter 4 describes the proposed methodology of this thesis
- Chapter 5 presents the case study. After defining the method theoretically, it is applied to a real case and described in this section.
- Chapter 6 describes the results discussion. Here are presented the results and comments to the methodology applied to Company X.
- Chapter 7 has the conclusions from the proposed methodology and also recommendations to apply to future work.
- Chapter 8 and Chapter 9 have the references used in the literature review and annexes.

2. Strategic Tools

This literature review includes knowledge including substantive findings, as well as theoretical and methodological contributions to the topics related to this thesis. It is a secondary source and does not report new or original experimental work about this methodology. Its main objective is to answer the following questions:

- Which are the tools and models that help to support this methodology?
- How do they differ from each other and what is the most adequate and most up to date tool available?
- How can they contribute to the decision making?
- How should semi-finished products bronze foundry evaluate if it is good to enter in a new market?

This literature review covers the reasons why these tools and models were used instead of others, which is the operational performance that distinguishes them and more importantly, whether these tools and models compete or complement each other.

In this chapter together with Chapter 3, the relevance and review of each topic are handled separately. The main topics are the following: Brief B2B introduction, PESTLE, SWOT and the main focus of the literature review is related with the decision-making models and why ANP is the best fit for this specific case.

Although there are a lot of strategic tools available to use in methodologies like this one, PESTLE and SWOT analysis showed to be the best fit. For the purpose of this methodology, it is necessary to do study some aspects of the market. These tools allow analyzing the importance and significative aspects that are necessary to feed the ANP network. Also, these tools are commonly used in the academic area and already proved a lot of times their value and quality.

2.1 Business to Business – B2B

Business to Business is when companies focus their on transactions of products produced for consumption by other businesses (industry tools, office provisions and the like) as well as the objects that went into the production process of those other organizations (for example, raw materials like timber or parts, petroleum, other ingredients like bearings, valves, resins and polymers). (Lilien; & Grewal, 2011)

Over the years, the terms have changed. The term 'industrial marketing' has changed to the term 'B2B marketing', and its connotation has grown to follow the activity of constructing mutually

value-generating relationships (including both products and services) between organizations (which include businesses but also government agencies, non-profit organizations and the like) and the many individuals within them. In contrast Business to Consumer (B2C), businesses are mostly focused on the final transaction between the firm and the consumer. (Lilien; & Grewal, 2011)

More and more attention has been given to relationship over the past few decades as buyers and suppliers seek ways to boost profits through sustained relationships (Graça, Barry, & Doney, 2016). In order to meet the requirements of today's market, managers are looking for new sources of value creation as well as opportunities and directions for ensuring continuous improvement of processes carried out in supplier-buyer relationships. One of the most important areas that determine the competitiveness of the supply chain is a reliable supplier base. It can be effectively configured by building partnerships based on trust, risk analysis and wide integration. In the face of a great uncertainty of the business conditions, apart from the prevention against different disturbances, it is essential to effectively respond to the changes occurring in the internal and external environment of the supply chain to minimize their negative impact (Wieteska & Christopher, 2016).

In fact, several studies have emphasised the need to build and sustain relationships not just between suppliers and customers, but spanning the entire network of a business market, which involves a vast number of stakeholders (Cayla, Cova, Management, & Maltese, 2013).

A key difference between companies in the process industries and those in other manufacturing industries is the former's often long, complex and rigid supply/value chains. Moreover, the context for innovation differs radically; in the process industries, development takes place in laboratories and pilot plants rather than in a design office, and the final quality of products is often strongly related to available raw material properties. As a result, there is an intimate relationship between product and process innovation, summarized in the idea that "the process is the product" (Tottie, Lager, & Nordqvist, 2016).

It must be noted that even for collaborative and globalized companies the wilderness of open innovation cannot be entered easily. This especially counts for companies in a B2B environment. The way companies communicate it will depend a lot on the personality and employers. Having a strong bond with all the parts is essential to have success. To keep the relationship going it is necessary to communicate in several ways, face to face or through other means (Katsikis, Lang, & Debreczeny, 2016).

2.2 PESTLE Analysis

There are several definitions for PESTLE analysis. It can be a tool that identifies factors that can affect the organization and it helps to find a way to overcome problems, it can also be seen as a tool to be used to scan the present and the possible external future environment. Having these ideas in mind, it is possible to see PESTLE analysis as a tool that consists with all factors that has in the external organization and it will help the organization to predicts what will happen in the future and then find a way to overcome this factors (Maliki, Ezqhallel, Jahrin, Shairah, & Kamarulzaman, 2012).

Before PESTLE started to be used, it was known as PEST analysis. Then, the legal and environment factor were added in recent times. Since it started to be used for industry analysis, scientific analysis and ethics analysis, it made sense to add those two factors (Kralj, 2009).

PESTLE is a framework that analyses macro-environmental factors. Its letters stand for:

- P – Political Factors, *what are the key Political Factors?* - these cover various forms of political lobbying and government interventions activities in an economy.
- E – Economic Factors, *what are the important Economic Factors?* - these mainly cover the macroeconomic circumstances of the external environment but can also include seasonal/ weather considerations.
- S – Social Factors, *what Cultural Aspects are most important?* - these covers social, people state of mind, demographic and cultural factors of the external environment.
- T – Technological Factors, *what Technological Innovations are likely to occur?* - they include technological changes that affect the external environment, technology-related activities, technology incentives and technological infrastructures.
- L – Legal Factors, *what current and impending Legislation may affect the industry?* - there are certain laws that affect the business environment in a certain country while there are certain policies that companies maintain for themselves.
- E – Environmental Factors, *what are the Environmental considerations?* - These factors include all those that influence or are determined by the surrounding environment. This aspect of the PESTLE is crucial for certain industries particularly for example tourism, farming, agriculture etc.

This kind of tool shows the 'big picture' of the environment facing a company (Ho, 2014). As said before, the constituents of PESTLE can be defined as macro-environmental factors and its practicality lies in the assumption that the success of an organisation or management solution

cannot be understood without having the data relevant to the specific business environment. The term Business environment can be defined as all relevant physical and social factors outside an organization that are considered in the decision-making process. PESTLE analysis assumes that specific indirect and external conditions that describe the business environment, can influence the organisational capacity to produce value. It can also be said that the PESTLE analysis provides a "satellite view" to evaluate the external environment (Chao, Peng, & Nunes, 2007).

PESTLE is used when:

- Working in the strategic team
- Considering new strategies
- Releasing a new product or service
- Entering a new region or country

PESTLE has been traditionally used in several different ways. The two most commons are: first, to examine the situation of a particular organisation or industry sector within a particular business environment; second, to examine the viability of general management solutions in a business environment (Chao et al., 2007). It is also a useful technique to know if you are part of a strategic project team. In all of these instances, there is a need to assess the potential impact of external factors on your organization, from both an operational and a market perspective. It is a company's environmental factors audit to inform strategic decision-making, marketing planning, organizational change, and product development, etc. (Ho, 2014)

However, PESTLE is far from being a precise and clearly circumscribed analysis framework. There is an almost unlimited number of variables that may emerge from each dimension. Therefore, there is the need to prioritise those variables that have the highest impact on the industry, sector, or country being studied.

In a summary, to maximize the benefit of the PESTLE Analysis it should be used on a regular basis within an organization to enable the identification of any trends. The impact of a certain external factor may have more severe consequences for a particular division or department and the PESTLE technique can help clarify why change is needed and identify potential options. As with all techniques, there are advantages and disadvantages to using it to help organizational strategy:

Advantages:

- Delivers a simple and easy-to-use framework for your analysis
- Involves cross-functional skills and know-how

- Helps to decrease the impact and effects of potential threats to the organisation
- Aids and encourages the growth of strategic thinking within your organisation
- Provides a mechanism that allows the organisation to recognise and exploit new opportunities
- Enables the manager to assess implications of entering new markets both nationally and globally. (Kotler & Keller, 2012)

Disadvantages:

- Managers can oversimplify the information that is used for making decisions
- The process has to be led regularly to be effective and often organizations do not make this investment
- Managers must not succumb to "paralysis by analysis" where they gather too much information and forget that the objective of this tool is the identifications of issues so that action can be taken
- Organizations frequently restrict who is involved due to time and cost considerations. This limits the technique's efficiency as a key perspective may be missing from the discussions
- Manager's access to quality information is often restricted because of the cost and time needed to collate it.
- Assumptions often form the basis for most of the data used, making any decision made based on such data subjective. (Kotler & Keller, 2012)

2.3 SWOT Analysis

SWOT analysis has its origins in the 1960s. It is based on the view of the internal resources, capabilities and core competencies of the organization, and advocates building strategies on these foundations to assure the competitiveness of the organization and the attractiveness in the area to further develop the resource-based view arguing that a resource was strategic if it satisfied the criteria for being effective and efficient. (Dyson, 2004)

Using SWOT analysis continues to enrich the academic literature. Research supports SWOT analysis as a tool for planning purposes. Over the past years, SWOT research has focused on analyzing companies for suggested strategic actions. As a procedure for strategic positioning, SWOT analysis has been extended beyond companies to countries and industries and is used in almost every published business case. Additionally, the usage of SWOT is also an education tool for consultants, trainers and educators. (Helms & Nixon, 2010)

Throughout strategy definition, the outcomes of the external and internal environmental analyses are summarised and combined to examine the situation facing the organisation and identify choices. When defining the business strategy, the aspects outside the management's control are examined within the context of the organisation and its resources. One of the techniques that may be used to define organisational strategy is SWOT analysis. (Kotler & Keller, 2012)

The SWOT analysis is one of the oldest and best-known organizing frameworks in management. This business analysis method allows organisations to analyse their performance for each of its products, services, and markets when deciding on the best way to achieve future development. The procedure includes identifying the strengths and weaknesses of the organization, and opportunities and threats present in the market that it operates in. The first letter of each of these four aspects creates the acronym SWOT. (Cadle, Paul, & Turner, 2010)
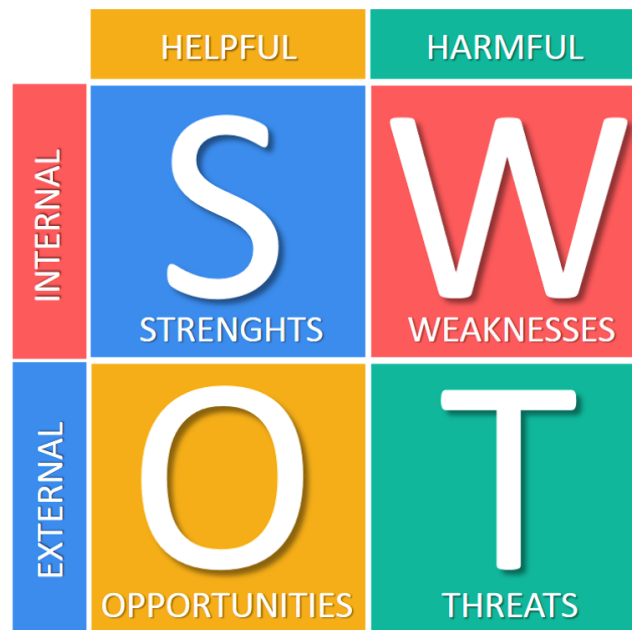
Figure 2.1 - SWOT Diagram

- S – Strengths, *what do we do well? What resources do we have at our disposal?* - Strengths deliver an area to list everything done right either individually or as an organization. This section contains both strengths within the organization and external strengths, such as client relationships.
- W – Weaknesses, *what can we improved or altered? What do we do badly?* - Weaknesses are facets of the business that diminish from the value the company offers or place the company at a competitive disadvantage. Organisations need to enhance these areas to compete with the best competitors.

- O – Opportunities, *Is this market situation a breakthrough?* - Opportunities are factors that represent reasons for the business that are likely to prosper. Such as being able to expand a franchise into a new city, while some others may appear with pure luck, such as another country opening up its market to foreign business.

- T – Threats, *Is this new customer behaviour normal?* - Threats include external aspects beyond companies' control that could place the strategy, or the business itself, at risk. There is no control over these, but sometimes organisations may benefit by having contingency plans to address them if they should occur.

The completion of a SWOT analysis should help organisations decide which market segments offer the best opportunities for success and profitable growth over the cycle of the product or service. It helps to identify the companies' position towards its competitors, identify best future opportunities and highlight current and future threats. (Cadle et al., 2010)

These definitions are exposed to interpretation and a weakness of the SWOT technique is that it can be highly subjective. Some features will always be easy to classify, and the point is that the strength of this method, comes from the fact that it can be applied to many different organizational situations, must be done with clear thinking and good judgment to obtain any real value from using it. The procedures of clearly identifying the business objective and categorizing the SWOT factors are equally important because they are interdependent. (Valentin, 2013)

This interdependence means that the SWOT analysis is frequently an iterative process in which the findings cause the objective to be reset and another analysis made. The output of any analysis is not necessarily definitive. (Chang & Huang, 2006)

Advantages:

- Helps to better understand the business
- Shapes organization's strengths
- Develops business goals and strategies to achieve them
- Identifies the core competencies of the firm
- Maximize its response to opportunities
- Reverse its weaknesses
- Overcome organization's threats
- Assists in clarify objectives for strategic planning
- Source of data for strategic planning (Bell & Rochford, 2016)

Disadvantages:

- Can produce a lot of information, but not all of it is useful.
- Doesn't deliver solutions or offer alternative decisions
- Doesn't prioritise issues
- Can create too many ideas but not help to choose which one is best
- It can be subjective (Bell & Rochford, 2016)

3. Decision Making Tool

Analysis to break down a problem into its essential components to study their behaviour has been the main tool of scientific review to test hypotheses and solve problems. It has confirmed to be tremendously effective in dealing with the world of matter and energy. It has allowed a man to harness the energy of the atom, to land on the moon, to invent the computer, to master global communication, and to produce tens of thousands of useful and not so useful things.

People that work within science whose theories are based on the use of Cartesian axes and on scales of measurement believe that there is only one way to measure things. In their way of thinking, it is needed a physical measurement scale with a zero and a unit to apply to objects. If we based our understanding and judgements, that are the most fundamental determinants of why we want to measure something, we can also derive accurate and reliable relative scales that do not have a zero or a unit.

When someone has the role as a decision maker, generally it assumes that logical thinking is the best and only way to make good decisions. By doing that, it is neglected the observation of our mind in both rational and emotional. The emotional side of each person, is often related to feelings and hunches, while the rational side is related to logical and structured reasoning.

The paradigm of measurement has numerous practical implications. It makes it possible for us to deal with intangible factors together with tangibles used in science and mathematics in a realistic and justifiable way.

Decision makers were always worried, for a long time, with the evaluation of physical and psychological actions. By physical, means what is known as tangibles in so far as they constitute some kind of reality external to the individual conducting the evaluation. In the opposite side, the psychological conclusions used in decision making belong to the subjective ideas, feelings, and beliefs of an individual, of a group working together, and more generally, of society. The question is: Is there an articulate theory that involves both these realities without compromising either? (L. Saaty & G. Vargas, 2006)

The multi-criteria decision-making (MCDM) method, becomes the task of decision-making easier. By organizing all the hunches, perceptions, memories and judgments into an outline that shows the features that impact a decision. It has been proven by experts, that multi criteria logic gives different and better answers than commonplace logic and does it in a competent way. (Mourão de Melo e Abreu, 2013)

In fact, there were no operative ways to combine rationality and hunches in a structured and mathematical way. The introduction of the MCDM with two of its theories, the Analytic Hierarchy Process (AHP) and its generalization to dependence and feedback the Analytic Network Process (ANP), came to revolutionize the topic. The AHP/ANP is fundamentally a way to measure crucial aspects by using pairwise comparisons with verdicts that represent the dominance of one element over another, with respect to a characteristic that they share. It is a development of laying out a structure of all the critical characteristics that influence the conclusion of a decision. (Whitaker, 2007)

The MCDM has demonstrated to have a lot of benefits when compared to other methods, such as they:

- Simplifies the evaluation of alternative scenarios, by backing up what if and sensitivity analysis.
- It shows the relative importance of the factors
- Supports group decision-making
- Allows to focus on each detailed part of the problem
- Structures the decision-making process
- Includes both quantitative and qualitative factors
- Delivers a truthful portrayal of the problem

Decision making has several tools that can be used in order to reach a conclusion. In this dissertation. the ANP is chosen as the main tool since it is identified a need of having feedback networks. It is necessary to establish a hierarchy and pairwise comparisons to establish relations within the structure. This way is possible to connect and interact at several levels to reach the best conclusion.

3.1.1 Analytic Hierarchy Process

In decision-making, the idea of priority is of paramount importance and how priorities are resulting can decide to result in positive or negative. They must be unique and not with several options, they must also salient the order expressed in the decisions of the pairwise comparison matrix.

The fact that the AHP permits inconsistency since in making decisions people are naturally erratic and ordinally intransitive. For several motives, this is a positive thing, otherwise, people would be robots incapable to change their minds with new signs and unable to look within for judgments which characterise their thoughts and feelings. The Analytic Hierarchy Process (AHP) is a method

that can be used to create measures in both the physical and social domains. It is a method to derive ratio scales from paired comparisons. (Saaty, 2001)

Introduced by Saaty in 1977 as an aid to help solve amorphous problems in economics, social, and management sciences, the AHP is a decision-making theory that has helped our understanding and approach to decision-making. The AHP turns a complicated problem into a simple hierarchy, where many quantitative and qualitative aspects are evaluated in a logical way under multiple criteria. In other words, AHP deals with MCDM difficulties that consider the distribution of goals amongst the elements that are being compared and, judges the elements that have a bigger influence on the goal (Mourão de Melo e Abreu, 2013).

The AHP is a flexible multi criterion decision making method that can be used to successfully characterise the judgments given by a team of experts to make good decisions in a complex atmosphere, where both tangible and intangible criteria must be considered. The application of the AHP to the complex problem usually involves four major steps:

1   Outline the problem and discover the kind of knowledge required.

2   Build a hierarchy, from the top with the goal of the decision, then the objectives, after the intermediate levels (criteria that the following elements depend) to the lowest level (which usually is a set of the alternatives).

3   Make a set of pairwise comparison matrices. The upper-level elements are used to compare the elements in the level immediately below with respect to it.

4   In order to weigh the priorities in the level immediately below, use the priorities obtained from the comparisons. Do this for every element. The process continues, then for each element in the level below add its weighed values and obtain its overall or global priority. This steps of weighing and adding are done until the final priorities of the alternatives at the bottom-most levels are obtained. (Saaty, 2008)
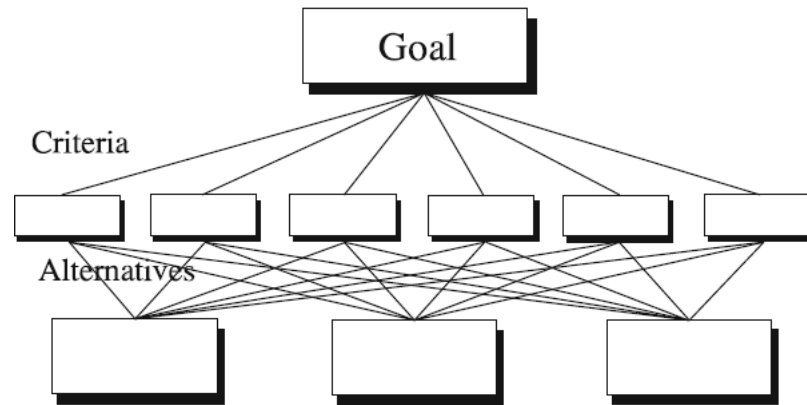
Figure 3.1 – Example of a 3 level Hierarchy

3.1.2 The Fundamental Scale

To make comparisons, we need a scale of numbers that indicates how many times more important or dominant one element is over another element with respect to the criterion or property with respect to which they are compared.

The fundamental scale of values to represent the intensities of judgments is shown in Table 2.1. This scale has been derived through stimulus-response theory and validated for effectiveness, not only in many applications by many people but also through the theoretical justification of what scale one must use in the comparison of homogeneous elements.

When estimating domination while comparing, specially, when the segmentation of the comparisons is impalpable, instead of using two numbers X_i and X_j from a scale (having in mind that their ratio is X_i / X_j) we assign a number from 1-9 as shown in the fundamental scale of absolute numbers, to represent the ratio (X_i / X_j). The scale will help to reveal what the X_i and X_j are. This is the reason that we apply this kind of approach and the need for a fundamental scale. This scale is derived from basic principles involving the generalization of comparisons to the continuous case, obtaining a functional equation as a necessary condition and then solving that equation in the real and complex domains. (Saaty, Thomas L; Vargas, 2006)

Table 3.1 The Fundamental Scale

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
1.1 – 1.9	When activities are very close a decimal is added to 1 to show their difference as appropriate	A better alternative way to assigning the small decimals is to compare two close activities with other widely contrasting ones, favouring the larger one a little over the smaller one when using the 1 – 9 values
Reciprocal of above	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	A logical assumption
Measurements from ratio scales		When it is desired to use such numbers in physical applications. Alternatively, often one estimates the ratios of such magnitudes by using judgment

In many cases there are elements that are equal or almost equal in measurement and the comparison must be made, not to know how many times one is larger than the other, but what fraction it is larger than the other. There are comparisons to be made between 1 and 2, and what we want is to guess verbally the values such as 1.1, 1.2, ... There is no problem in making the judgements by directly estimating the numbers, indeed Saaty and Vargas proposal is to continue the verbal scale to make these distinctions. Like this, 1.3 indicates moderately more, 1.5 strongly more, 1.7 very strongly more and 1.9 extremely more. This type of classification can be used in any of the intervals from 1 to 9 and for further refinements if one needs them, for example, between 1.1 and 1.2 and so on. It is important to mention that the aspect of paired comparisons is the reciprocal property. When one element is classified to be x times more important than another with respect to a given property, the lesser one is used as the unit and the larger is estimated to be some multiple of that unit. (Saaty, 2008)

Evaluating one practical example of the outcome of decisions using the fundamental scale, it helps to understand the concept. The topic is the consumption of drinks in the United States by answering the questions: Which drink on the left (e.g., coffee) is consumed more in the US over the drink on the top (e.g., wine) and how much more than another drink? Table 2.2 shows the answers of an audience of about 30 people and how they used consensus to combine each group judgment instead of the mathematically proven geometric mean. (Saaty, 2008)

Table 3.2 – Consumption of Drinks in the USA

Drink Consumption in the US	Coffee	Wine	Tea	Beer	Sodas	Milk	Water
Coffee	1	9	5	2	1	1	1/2
Wine	1/9	1	1/3	1/9	1/9	1/9	1/9
Tea	1/5	2	1	1/3	1/4	1/3	1/9
Beer	1/2	9	3	1	1/2	1	1/3
Sodas	1	9	4	2	1	2	1/2
Milk	1	9	3	1	1/2	1	1/3
Water	2	9	9	3	2	3	1

Table 3.3 – Derived Scale

The derived scale based on the judgements in the matrix is:						
Coffee	Wine	Tea	Beer	Sodas	Milk	Water
0.177	0.019	0.042	0.116	0.190	0.129	0.327
With a consistency ratio of 0.022. The actual consumption is:						
0.180	0.010	0.040	0.120	0.180	0.140	0.330

When we have numerous criteria to prioritize and obtain synthesis, we need to also associate the relevance of the criteria with respect to higher level criteria or with respect to a goal to determine their priorities, and as above, derive priorities for the alternatives with respect to each criterion.

To obtain a general ranking of the options, it is necessary to multiply the regularized priorities of the alternatives by the corresponding normalized priorities of the criteria and add. The same procedure is done for the criteria by using the priorities of higher level criteria. This is called the distributive method of the AHP. It is assumed, as often happens in practice that an alternative depends on the number and quality of other alternatives with which it is compared. It is also used when the criteria also depend on the alternatives as in the ANP. This method will be explained further. The ideal mode of the AHP is to require for convenience in practice that the priorities of the alternatives should not be influenced by the number or quality of other alternatives, or if the criteria are not attributes directly related to the alternative. In each criteria, it is divided the priorities of the alternatives by the largest value among them and then multiplied by the corresponding normalized priority of that criterion and add over the criteria. The same thinking is used in the ANP for each control criterion because, the control criteria are needed to make paired comparisons and are not attributes of the alternatives whose priorities depend on the alternatives directly as in the ANP or indirectly (by comparing them with respect to a higher criterion or goal influenced by any existing or ideal alternative) as in the AHP. (Saaty, Thomas L; Vargas, 2006)

3.1.3 Analytical Network Process

The ANP is a general theory of comparative measurement used to originate composite priority ratio scales, from individual ratio scales, that mean comparative measurements of the influence of elements that interact with respect to control criteria. Through its super matrix whose elements are themselves matrices of column priorities, the ANP shows the consequence of dependence and response within and between clusters of elements. The AHP with its dependence assumptions on clusters and elements is a special case of the ANP. The ANP provides an overall framework to deal with choices and decisions, without having prospects about the individuality of higher level elements, from lower level elements and, about the independence of the elements within a level. In fact, the ANP uses a network without the need to specify levels as in a hierarchy. Influence is a central concept in the ANP. The ANP is a useful tool for forecast and for representing a diversity of competitors with their guessed interactions and their relative strengths to influence in making a decision (Zammori, 2010).

The Analytic Network Process (ANP) is a multi-criteria approach introduced by Thomas L. Saaty. We use the ANP when we have complex connections and indirect relationships existing between the elements of our problem. According to Thomas L. Saaty, the ANP is our rational way to deal with dependence. To him, a hierarchy is a special case of a network with networks going only in one direction. (Zammori, 2010)

A network has clusters of elements. These elements in one cluster are connected to elements in another cluster (outer dependence) or the same cluster (inner dependence) (Saaty, Thomas L; Vargas, 2006). The difference between a hierarchy and a network is illustrated in Fig. 3.2:
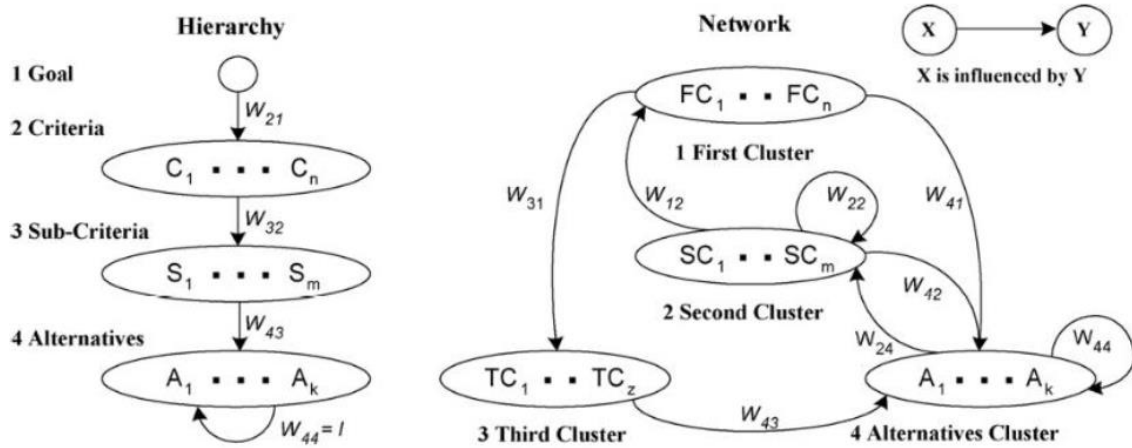

Figure 3.2 – Hierarchy bs Network

People who labour in decision making, use typically very simple hierarchic structures consisting of a goal, criteria, and alternatives. Not only are decisions gotten from a simple hierarchy of three or four levels, different from those obtained from a multilevel hierarchy. Choices obtained from a network can be expressively different from those added from a more multifaceted hierarchy. We can't think that only a structure of two levels, criteria and alternatives, and expectation to capture the consequence of connections in the form of highly summarised decisions that properly reproduce all that goes on in the world. We must learn to crumble these judgments through more sumptuous structures and organize our intellectual and calculations in cultured but simple ways to serve our thoughtful of the complexity around us. Knowledge indicates that it is not hard to do this though it takes more time and effort. We must use feedback networks to reach the kind of decisions needed to handle the future (Saaty & Hall, 1999).

Looking in detail in Fig. 2.5, a hierarchy (on the left) is a linear top-down structure with no feedback from the bottom to top levels. Hierarchy is characterized by clusters with a goal at the top and with the alternatives clusters in the end. There is a loop at the bottom level of the hierarchy to show that each element of that level depends only on itself and that is the reason why nodes are independent. A network (on the right) does not need a severe hierarchy organization for its clusters and can feast in any way. Like this, influencers and inner dependencies can be communicated from a cluster to another either directly or through one of the paths of the network. (Cabral, 2011)

The components of the two systems are characterised as nodes, and two nodes are linked by an arrow if there is communication between them. The alignment of an arrow displays the direction of the influences between nodes. As shown in the figure, X to Y means that the elements of component X depend on component Y. Loops signify inner dependencies among nodes of the same cluster.

The strength of the dependencies is given by W_{ij}. It is a matrix covering numerical entries of the priorities of the strengths of influences of the *ith* cluster nodes on the elements of the *jth* cluster. The structure of a network it is determined by its clusters, its nodes or elements, and the connections between them. Clusters contain elements that segment common attributes and can be measured to be similar in some regard. (Saaty, 2008)

Connections represent the interdependency of two nodes and the arrow direction demonstrates in which directions the influences flow. Therefore, in an ANP network, two clusters are connected by an arrow when at least one element in the first cluster is connected to one or more elements in the second cluster (Zammori, 2010)
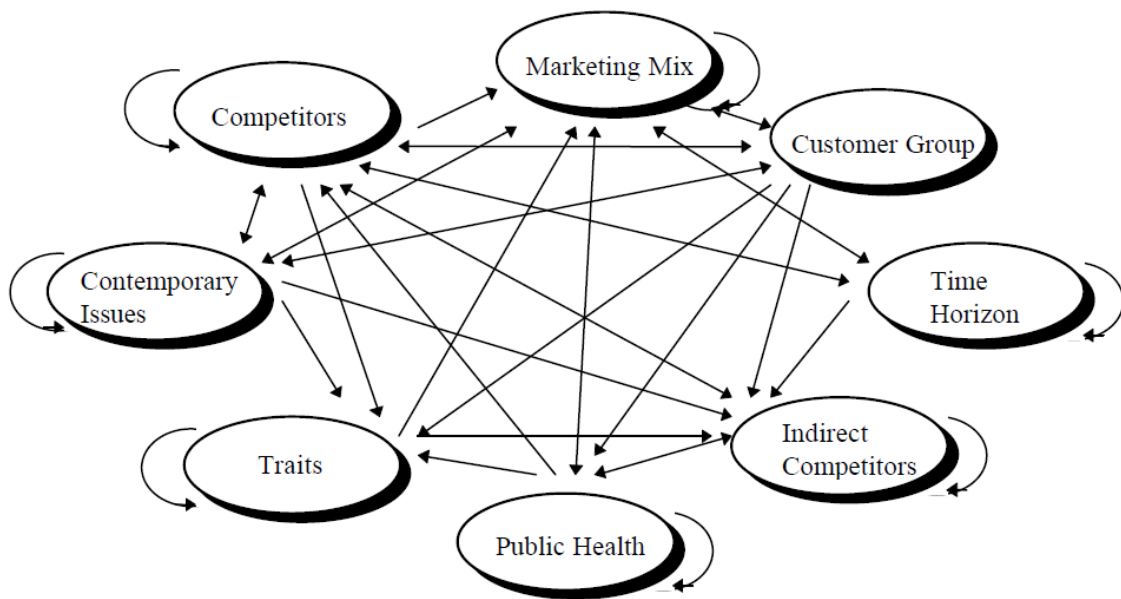
Figure 3.3 - Overall Goal: Market Share of Competitor Group

For example, if we talk about promotion, is nutrition important than packaging, and if so, by how much. In another way, given a limited budget, the company must prioritize spending on promoting one message over others. The importance of this comparison is the basis for connecting the Marketing Mix cluster to elements in the Contemporary Issues cluster (packaging, nutrition, waste disposal and recycling). The reverse connection is also important because management is aware

of the themes in the Contemporary cluster influence elements in the Marketing Mix differently. For example, using more costly materials that can be recycled, may raise prices more than the promotion of this fact to the public may bring in new business. Through this process of analysing dependencies, the prevailing understanding of the marketplace is mapped out in the ANP model of Fig. 3.3. (Saaty & Hall, 1999)

3.1.3.1 ANP Steps

According to T. L. Saaty, to mature an ANP model, we can track a set of steps. These stages may not be always followed meticulously, each decision makers can adapt to his problem. Here is the list of those steps:

1. Define the decision problem in detail counting its objectives, criteria and sub-criteria, performers and their objectives and the possible consequences of that decision. Bounce details of effects that determine how that decision may come out.

2. Define the control criteria and sub-criteria in the hierarchies according to benefits, opportunities, costs and risks of that decision and obtain their priorities from paired comparisons matrices.

3. If a control criterion or sub-criterion has a global priority of 3% or less, you may consider eliminating it from further consideration. When using a software, automatically it deals only with the criteria or sub-criteria that have subnets under them. For benefits and opportunities, it must be taken into consideration what gives the most benefits or presents the greatest opportunity to fulfil the control criterion. For costs and risks, evaluate what incurs the most cost or faces the greatest risk. Rarely the comparisons are made simply in terms of benefits, opportunities, costs, and risks in the aggregate without using control criteria and sub-criteria.

4. Draw the general network of clusters and their elements that apply to all the control criteria. In order to organize in a better way the development of the model, number and arrange the clusters and their elements in a suitable way. Use the identical label to characterise the same cluster and the same elements for all the control criteria.

5. When looking to control criterion or sub-criterion, define the clusters of the general feedback system with their elements. Attribute them according to their outer and inner dependence influences.

6. An arrow shows the influence. It is drawn from a cluster to any cluster whose elements influence it.

7. Define the method you want to follow in the analysis of each cluster or element, inducing other clusters and elements with respect to a criterion, or being predisposed by other

clusters and elements. The sense of being influenced or influencing, necessarily apply to all the criteria for the four control hierarchies for the entire decision.

8. In each control criterion, construct the super-matrix. Lay out the clusters by numerical numbers and all the elements in each cluster, both vertically on the left, and horizontally at the top.

9. Insert the appropriate position of the priorities that came from the paired comparisons as sub-columns of the corresponding column of the super-matrix.

10. Make paired comparisons on the elements within the clusters, according to their influence on each element in another cluster they are connected to (outer dependence), or on elements in their own cluster (inner dependence). When making comparisons, you must always have a criterion in mind. Comparisons of elements according to which element influences a given element more and how strongly more than another element it is compared with are made with a control criterion or sub-criterion of the control hierarchy in mind.

11. Perform paired comparisons on the clusters as they influence each cluster to which they are connected with respect to the given control criterion. The derived weights are used to weight the elements of the corresponding column blocks of the super-matrix. Assign a zero when there is no influence. Thus, obtain the weighted column stochastic super-matrix.

12. Compute the limit priorities of the stochastic super-matrix according to whether it is irreducible (primitive or primitive [cyclic]) or it is reducible with one being a simple or a multiple roots and whether the system is cyclic or not. Two kinds of outcomes are possible. In the first all the columns of the matrix are identical and each gives the relative priorities of the elements from which the priorities of the elements in each cluster are normalized to one. In the second the limit cycles in blocks and the different limits are summed and averaged and again normalized to one for each cluster. Although the priority vectors are entered in the super-matrix in normalized form, the limit priorities are put in idealized form because the control criteria do not depend on the alternatives. (Saaty & Hall, 1999)

3.1.3.2 Supermatrix

Having in consideration that we have N components and that the elements of each component have interaction or influence in other elements of other component governing the interactions of the system, such as political influence or capital. See the figure below:
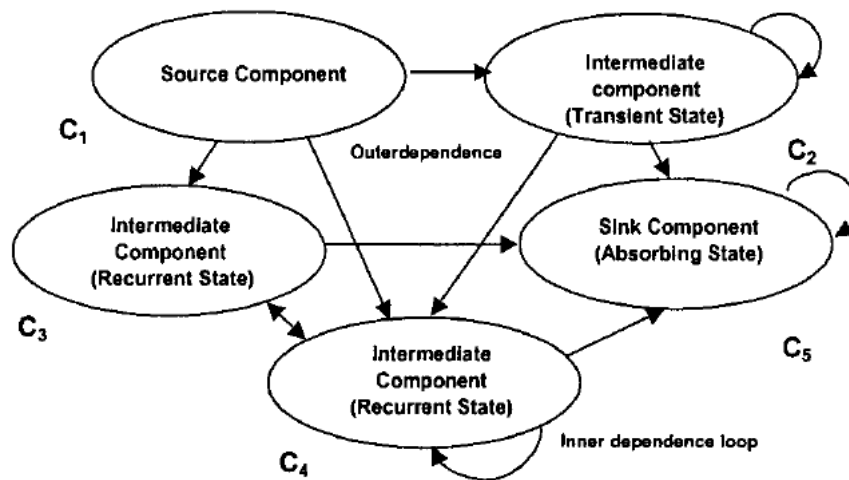
Figure 3.4 Types of Components in a Network

Generally, a network has several components and elements in these components. Indeed, creating structures to represent problems, it may be larger parts to consider that component. About the size, there is a system that is made up of a subsystem, which each subsystem made up components and each component made up of elements. It has to be considered that the whole need not be equal to the sum of its parts but may be bigger or smaller in the sense of contributing to a goal. The context would make this clear (L. Saaty & G. Vargas, 2006).

The components are shown in Figure 3.4 which no arrow enters are source components such as C_1 and C_2. The ones which no arrow leaves, are known as sink components such as C_5 and last, the ones that arrows both enter and exit are known as transient components like C_3 and C_4. Also, C_3 and C_4 form a cycle of two components since they feed back and forth into each other. C_2 and C_4 have loops that connect to themselves, which makes them inner dependents. All the other connections represent dependence between components that are thus known to be outer dependent.

Aa component of a decision network is represented by C_h, h = 1, ... m, and assume that it has n_h elements, which we denote by e_{h1}, e_{h2},.., e_{hmh}. The influences of a given set of elements in a component on any element in the system are represented by a priority vector derived from paired comparisons. It is these derived vectors, how they are grouped and arranged, and then how to use the resulting structure which turns out to be a matrix, that interests us here. This matrix is thus used to represent the flow of influence from a component of elements to itself as in the loop that flows back to C_4 above, or from a component from which an arrow is directed out to another component. Sometimes, as with hierarchies, one is concerned with the influence of the component

at the end of an arrow on the component from which the arrow begins; one must decide on one or the other. The influence of elements in the network on other elements in that network can be represented in the following supermatrix:

$$
W =
\begin{array}{c}
 \\
\end{array}
\begin{bmatrix}
W_{11} & W_{12} & \cdots & W_{1N} \\
W_{21} & W_{22} & \cdots & W_{2N} \\
\vdots & \vdots & \cdots & \vdots \\
W_{N1} & W_{N2} & \cdots & W_{NN}
\end{bmatrix}
$$

Figure 3.5 Supermatrix of a Network

A typical entry W_y in the supermatrix is called a block of the supermatrix. It is a matrix of the form:

$$
W_{ij} =
\begin{bmatrix}
W_{i1}^{(j_1)} & W_{i1}^{(j_2)} & \cdots & W_{i1}^{(jn_j)} \\
W_{i2}^{(j_1)} & W_{i2}^{(j_2)} & \cdots & W_{i2}^{(jn_j)} \\
\vdots & \vdots & \cdots & \vdots \\
W_{in_i}^{(j_1)} & W_{in_i}^{(j_2)} & \cdots & W_{in_i}^{(jn_j)}
\end{bmatrix}
$$

Figure 3.6 Block of the Supermatrix

Each column of W_{ij} is a principal eigenvector of the influence (importance) of the elements in the *ith* component of the network on an element in the *jth* component. Some of its entries may be zero corresponding to those elements that have no influence. Thus, we do not need to use all the elements in a component when we make the paired comparisons to derive the eigenvector, but only those that have a non-zero influence. Figures 3.5 and 3.6 and their super matrices represent a hierarchy and a holarchy of m levels. As with any super matrix, an entry in each of the foregoing two super matrices is a block W_{ij} positioned where the *ith* component or level is connected to and influences the *jth* level immediately above. The entry in the last row and column of the super matrix of a hierarchy is the identity matrix *I*. It corresponds to a loop at the bottom level, used to

show that each element depends only on itself. It is a necessary aspect of a hierarchy (or any sink) when viewed within the context of the supermatrix. The entry in the first row and last column of a holarchy is nonzero because the top level depends on the bottom level.
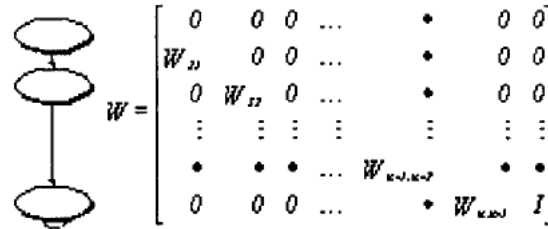
Figure 3.7 Structure and Supermatrix of a Hierarchy
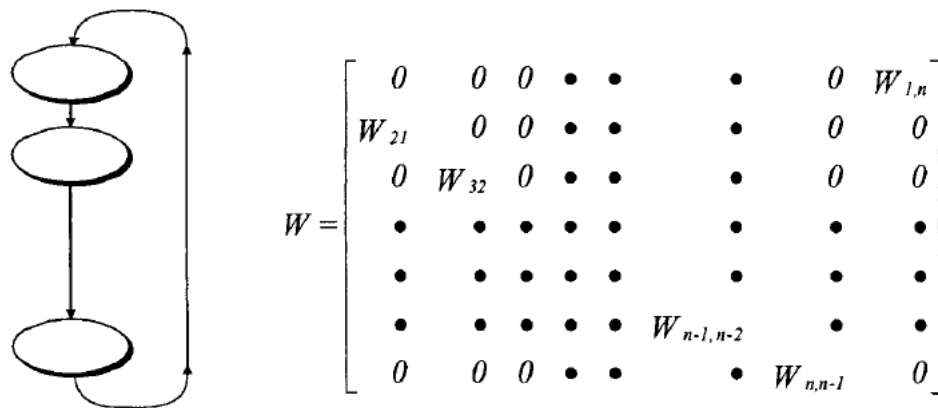
Figure 3.8 Structure and Supermatrix of a Holarchy

A network may be generated from a hierarchy by increasing the hierarchy's connections gradually so that pairs of components are connected as desired and some components have an inner dependence loop. (Saaty, Thomas L; Vargas, 2006)

3.1.4 AHP vs ANP

AHP and ANP have been used separately or in conjunction in many areas, such as industry, personal decision making, management, political, government, social, manufacturing, education, sports, military, tourism, service, etc.. The pairwise comparison is done using the same fundamental comparison scale.

The AHP/ANP delivers a way to make complex decisions in the most general structures encountered in real life. AHP it is used over ANP when there are not evident dependencies between decision elements or one can assume that such mutual influences are negligible. Also, when the problem can be soundly structured in the form of a linear hierarchy.

One of the drawbacks related to the AHP is the fact that it does not consider the interdependencies amongst elements. Thus, ANP has been used to overcome this drawback, it is a holistic approach in which all attributes and alternatives included, are connected in a network system that considers/includes the interdependencies. It also provides a non-linear analysis of strategies among the decision attributes. However, the ANP is not as intuitive as the AHP, the judgments to be made in a network system are also a much bigger of a problem in terms of complexity. (Saaty & Hall, 1999)

The ANP is a comprehensive decision-making technique that has the capability to include all the relevant criteria, which have some attitude when reaching a decision. AHP serves as the starting point of ANP. Generally speaking, the ANP is more accurate and gives better results than the AHP. (Zammori, 2010) Furthermore, the ANP provides a general framework to deal with decisions without making assumptions about the independence of higher level elements from lower level elements, in other words, ANP makes conceivable to deal with all kinds of dependence and feedback in a decision system. Consequently, anytime there are dependencies between criteria and/or alternatives, if one tries to model the problem as a linear hierarchy, the risk of getting an inconsistent result is considerably high.

Turning a hierarchy in a network (in order to capture the most number of possible influences between factors), significantly increases the complexity of the model. An example is provided by Saaty in this work (T. L. Saaty, 1999), where a hierarchy is converted into a network and it is shown that the number of judgments increases from 79 to 624. Another disadvantage of the ANP is that the comprehension of a network is not as intuitive as that of a linear hierarchy. In other words, when the problem is structured in a hierarchy of decision criteria the flow of influence is clear, as it proceeds outright from the top level (i.e. the goal of the problem) to the bottom level (i.e. the alternatives) moving through a series of intermediate levels, which represent the sub-criteria in which the goal is decomposed. The same is not true for a network, for in this case there is not an origin and neither an end and the relative influences between clusters and/or node are confounded and less detectable. Thus, making pairwise comparisons becomes more difficult and requires a deeper understanding of how the network has been built. As a consequence, whether the AHP permits one to develop the model before presenting it to a panel of experts (to gather the necessary judgments and for validation purposes), in the case of the ANP these two steps (i.e. building and validation) cannot be easily detached, and it is advisable to involve the experts from the very beginning of the development of the network (Zammori, 2009).

(T. L. Saaty, 2008), cite five types of criticisms of the AHP. One is the concern with illegitimate changes in the ranks of the alternatives, called rank reversal, upon changing the structure of the

decision. It was believed that rank reversal is legitimate only when criteria or priorities of criteria or changes in judgments are made. The second concern is about inconsistent and their effect on aggregating such judgments or on deriving priorities from them. The third criticism has to do with attempts to preserve rank from irrelevant alternatives by combining the comparison judgments of a single individual using the geometric mean (logarithmic least squares) to derive priorities and also combining the derived priorities on different criteria by using multiplicative weighting synthesis. The fourth criticism has to do which people trying to change the fundamental scale despite the fact that it is theoretically derived and tested by comparing it with numerous other scales on a multiplicity of examples for which the answer was known. The fifth and final criticism has to do with whether or not the pairwise comparisons axioms are behavioural and spontaneous in nature to provide judgments.

AHP and ANP have been proved that they are successful in many applications and in almost all the areas of management. Table 3.4 describes some of them:

Table 3.4 – AHP and ANP applications

Author	Contribution	Specific Area	Applications
(Gencer and Guerpinar, 2007) and (Sanayei et al., 2010)	Analytic network process in supplier selection: A case study in an electronic firm & Group decision-making process for supplier selection with VIKOR under fuzzy environment.	Supplier selection	Logistics
(Agarwal et al., 2006)	Modelling the metrics of the lean, agile and agile supply chain: An ANP-based approach	Maximizing supply chain performance in the FMCG industry	SCM
(Zammori, 2009)	The analytic hierarchy and network processes: Applications to the US presidential election and to the market share of ski equipment in Italy	Politics/Marketing	Presidential election / market
(Sagir & Ozturk, 2010)	Exam scheduling: Mathematical modelling and parameter estimation with the Analytic Network Process approach	Educational systems	Exam scheduling
Troutt & Tadisina, 1992)	The Analytic Hierarchy Process as a model base for a merit salary recommendation system	General	Salary processing
(Z. H. Yang & Zhang, 2006)	Environmental performance measurement for green supply chain: An ANP-based approach	GSCM	Green performance measurement
(Whitaker, 2007)	Validation examples of the Analytic Hierarchy Process and Analytic Network Process	World chess championship outcome validation/Market share for the airline industry	Sports outcomes / Marketing
(Dagdeviren et al., 2008)	Faulty behaviour risk in the work system by fuzzy AHP/ANP	Work safety	Engineering
(A. Agarwal et al., 2006)	Modelling the metrics of the lean, agile and supply chain: An ANP-based approach	SCM	Metrics modelling

4. Proposed Methodology

In the previous chapters, is possible to understand each one of the tools is used in this dissertation. Its definition, applicability, pros and cons and even some examples applied to the real life.

In fact, is the combination of some variables of these tools, applied to the bronze industry, that makes this procedure unique and helpful. The goal of this section is to propose a methodology to support strategic decisions, in order to assist managers when the time to explore new markets arrives. There are several models for decision making but, on this research, ANP, introduced by (Thomas L. Saaty, 2001) combined with SWOT and PESTLE have been selected.

The following diagram shows in a succinct way the proposed methodology:
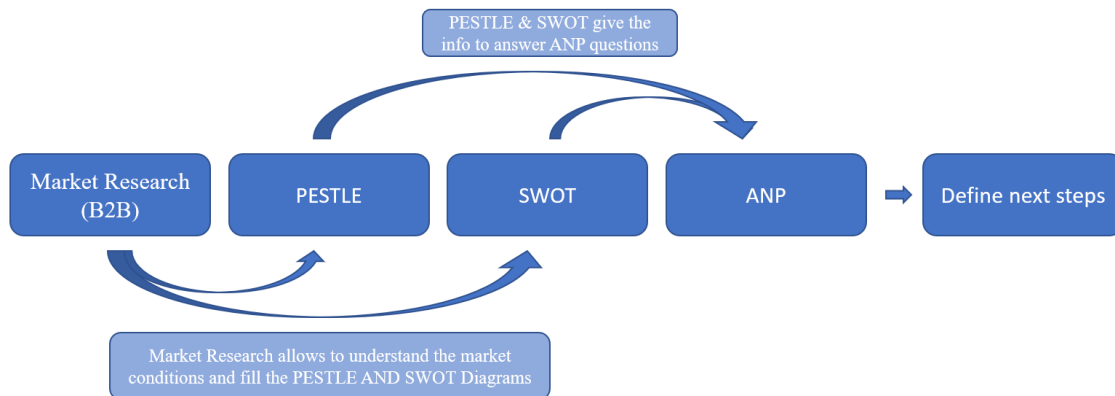
Figure 4.1 Proposed Methodology

4.1 Strategic Tools Appliance

To achieve the main goal of deciding next steps, four steps have been proposed in this research. The fact that Semi-finished bronze industries work in a B2B environment, it is important that companies are aware of some topics that are used in the market that they are willing to explore. As a first step and then start applying this methodology, it is important to do some research on the market and discover the following info:

- Best communication channel – Some cultures prefer to talk about business by phone, others by email (for example). Which one works the best for their particular case?
- Most spoken language – Depending on the market that is being explored, English can be used to communicate, which means that might not be necessary to have a native speaker working on the project. If by any chance, it is crucial to have a native speaker, that must be arranged.

- Technical terms and norms – In the bronze industry there are several legislations that are applied to the business. In order to communicate in the smoothest way, it is very important to be aware of this topic. Some markets work with the American legislation, some others European… If the market works with a different one, it is possible to convert to the one applied in the business.
- Benchmarking the market – Understand who are the players and identities in the market that are relevant and understand their connections and relationships.

This research must be made by online searching, reading newspapers, business magazines and contacting some of the market players. As mentioned in (Graça et al., 2016) sustained business relationships are crucial to boost the development of the company.

After identifying these four aspects it is possible to go to the next step. With already some details about the market, it is crucial to understand the macro-environmental factors. With the best communication channels identified, most spoken languages recognised, technical terms aligned and knowing who the players in the market are, it is possible to enrich the research about the market by using PESTLE Analysis. With this, it can be identified with the political, economic, social, technological, legal and environmental aspects of the market.

It is recommended that the outcome of this step are six paragraphs, each one of them with no more than five or six lines. Like this, it is presented a small summary of each aspect. Also, if possible, present a line that serves the purpose of being a title for each main aspect.

In the political part, it is essential to understand how the situation can influence the market and more specific, the bronze industry. In economic terms, understand how the market stability in financial issues is. Is it a market that is stable? If not, it can influence foundries and the bronze industry? Socially speaking, it is important to understand how the people feel and to comprehend if that can affect the business somehow. Regarding technology, it is essential to know how developed the market is and what is being done in terms of future. Specifically speaking, in the bronze industry is the technology a limitation or an advantage? In legal terms understand if there something that can influence norms, rules and bring instability (or improve) the bronze industry conditions. Last, the environmental aspects are important in a way that is necessary to comprehend if there is some characteristics or natural aspects that can influence somehow the bronze business and industry.

Like is said by (Ho, 2014), the factors that PESTLE analysis evaluates, is beyond the direct influence of an organization, however, are crucial and have to be studied in order to understand how the market conditions are. The six paragraphs that come out from this analysis, can be

presented in a form of a table or simply as part of a global report that integrates several other analyses. This other analysis will also include the next step outcome, the SWOT analysis.

The third step of this methodology has now the objective of identifying the internal positive and negative aspects of the business towards the market that is being studied. For that, it used SWOT analysis where the strengths, weaknesses, opportunities and threats are identified.

The outcome of this step is similar to the previous step. Four paragraphs summarizing each topic but having in considerations that some of them can be longer than the other ones. For example, if the market is full of opportunities, it is quite common that this becomes the longest one. Important to mention that the info each paragraph can be presented also in a table, topics or even in a text form.

In the strengths topic, it is important to identify in which aspects is the business strong and then compare it with the market that is being studied. Regarding the weaknesses, it is identified as a crucial topic since is where the business needs to invest more of its time in order to fight and improve some aspects to become competitive. Opportunities show where the business can grow and threats where the business can lose the advantage. In the semi-finished bronze industry aspects like quality, technology, diameter produced, suppliers, buyers, the language of communication, currency, level of trust, time zone, partnerships between markets and important identities are the crucial topics that have to be analysed and distributed in one of each topic.

(Helms & Nixon, 2010) said that SWOT shows to be a tool for planning purposes and it has been extended beyond companies to countries and industries and is used it in virtually every published business case. It has been also used as a tool for consultants, trainers and educators, which proves that is an indispensable tool when it comes to strategic decisions.

Until now, the outcome of this methodology is a group of information that can be presented in several ways, although, it is highly recommended that the result of these three steps must be together in a report form. Like this, managers and decision makers can read and understand the market findings.

As a final step and in order to understand what the next steps are when exploring new markets in the semi-finished bronze industry, a conceptual ANP model is proposed in this dissertation. Due to the mutual dependencies, inner dependencies and feedback effects on some clusters, the ANP can be used to systematically evaluate the most suitable decision. The traditional AHP method, also introduced by (Saaty, 2008) was not used since is not suitable for the problem under study. The AHP neglects the mutual effect of different conflicting levels in the network. The ANP deals

with complex interrelationships between the criteria and decision levels and deals with the dynamic problem (Saaty, Thomas L; Vargas, 2006).

4.2 Decision Making Tool Appliance

Semi-finished bronze products and its characteristics are structured networks involving companies' characteristics, different markets, different types of companies… Within this chain, there are complex decision-making involving all the actors with the overall objective of helping managers taking decisions. Within this research work, the main objective is to examine the potential of ANP model in helping managers to select the best companies to work within the different markets and which action to take with each of them. ANP was selected because of its ability to deal with mutual dependencies, inner dependencies, and feedback effects on some clusters.

The first step in the ANP implementation is determining the clusters that build the network. Two particular cases of these clusters are the Alternatives (Companies) and Subcriteria (Market Characteristics Description). (Saaty & Hall, 1999) suggests maximum nine elements in each one of the clusters, which was taken into account for this ANP structure. In both of those clusters it is important to understand that it is possible to add other elements to the structure, but as it said before and based on the literature review, both were limited to nine elements. The various steps involved in the ANP model can be seen in Fig. 4.2:

Identify the Goal and all the Clusters

↓

Identify the Alternative Elements

↓

Build the Network

↓

Identify Relationships and Dependencies

↓

Supermatrix Formulation

↓

Score for each Cluster and Element
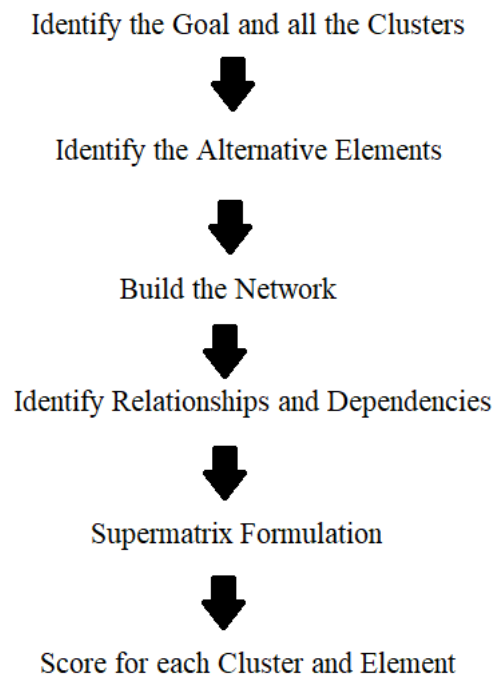
Figure 4.2 ANP Steps

Regarding the final step related to the score, and as mention before, the Super Decision software was used to support these results.

4.2.1 Proposed ANP Model

As mentioned before, the goal is to classify the companies of each market and understand the action to take with each one of them. It was easy to understand that instead of having a hierarchy structure, it would make more sense to have a network (ANP).

Firstly, the main goal, the main criteria and sub criteria were defined. To do this, it was necessary to comprehend the business and its main characteristics. It was crucial to understanding which positive aspects a client can bring to the company, which are the important features of a client and the major market characteristics where the client is acting. This also helps to define the elements, identities and alternatives of the model. After all these aspects being settled, the relationship between the clusters was established. With the objective and all the other clusters settled, the following ANP General Model was made:
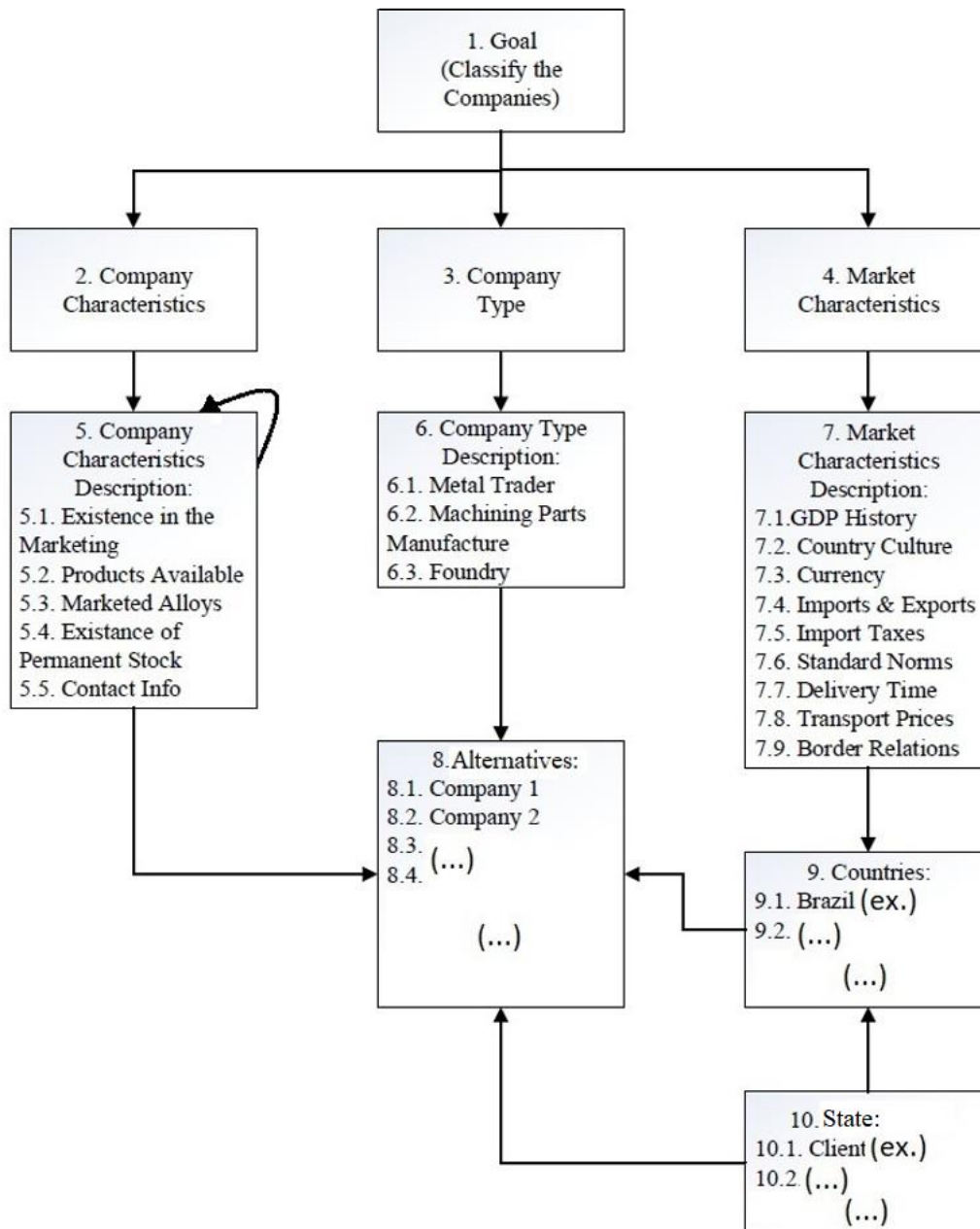
Figure 4.3 - ANP General Model

The model presents 10 different clusters and can be applied to all the semi-finished bronze foundries when they want to explore new markets and take decisions on what to do. By analysing this ANP General Model (Fig.4.3), it is important to mention that the three clusters that can be adapted to all businesses are the Alternatives (8), the Countries (9) and the State (10).

Goal: 1. Classify the companies – Since the objective of this methodology is help companies to make decisions about entering new markets by choosing potential new clients or potential representatives, the goal of this ANP Model is to classify the companies. When the contact is

made with a company, for example in Argentina, it starts a communication process that can have several ends. As previously described this connection is the one that will determine if the business should invest time and resources with the businesses that are being analysed.

Criteria: 2. Company Characteristics, 3 Company Type and 4. Market Characteristics – These three criteria emerge in order to understand what is more important to classify the companies. Are their specific characteristics? Is the type of company they are? Or is the market where they operate that the most important to rate them? As main criteria, it will give an overview over the companies that are being classified.

Sub Criteria: 5. Company Characteristics Description – In this sub criteria there are the elements that are important to classify the companies in terms of characteristics. After comprehending how the bronze semi-finished products foundry works and after talking with the staff from the sales department, it was possible to arrange a group of elements that are essential to evaluate the companies. The loop relation that exists in this sub criteria it is important since it is significant in this model to see how each characteristic can influence the others. For example, the marketed alloys are dependent on the products that are available, and this feature needs to be measured to evaluate the weight of this dependency.

Sub Criteria: 6. Company Type Description –After talking with the staff from the sales department, it was considered that it is important to point that is only possible to make business with three types of companies. These elements are also very significant since it is interesting to understand which of the company types are the most imperative.

Sub Criteria: 7. Market Characteristics Description – Since a new market is being analysed, it is important to establish some features that are comparable among them. After analysing several aspects that can describe a market and classified as relevant by the sales team, these characteristics are added as elements in the cluster 7. Important to mention, that some of the conclusions taken on the firsts steps of this methodology with the marketing tools, will influence managers classifying the relationships of this cluster.

Identities: 8. Alternatives – Since the goal is directly related with the companies in order to classify them and take actions accordingly, the identities of this model are the companies that are having contact with the business. During all the process, it is important to identify several players in the market in order to understand their business model and identify the nine that are worth to evaluate. It is recommended to choose equally the amount of companies in each market.

Sub Criteria: 9. Countries – The markets that are being analysed may show (or not) similar global characteristics, however, it is important to study of each one of them since they may have differences that are significant to examine. For that, it was created the cluster with the countries that allows having an overview of the most significant country market. Like cluster number 7, cluster number 9 is also one of the clusters that will be the results influenced by the results gathered on the first steps of this dissertation. When managers start to classify the comparisons from these relationships, they will have in mind the results from the marketing tools.

Alternatives: 10. State – In this cluster are the elements that are the options to classify the companies. Since the objective of this methodology is to help the sales department in taking decisions when it comes the time to decide in which market to act and what to do, the way how the companies are classified it is an important step of it. The alternatives are defined according to the conclusion that wants to be taken if it is necessary to understand if the Alternatives on Cluster 8 will be partners, competitors, clients…

The arrows show the relationships between elements in one cluster with elements in other clusters. Important to mention that the only cluster that has arrows going in, is the cluster number 8 since the Alternatives is the only cluster that has this characteristic (Saaty, Thomas L; Vargas, 2006).

The validation of this proposed ANP model will be made by being applied to a case study in a real-world presented in the next chapter.

5. Case Study: Company X

The purpose of this case study is to validate the decision support methodology described in the previous chapters. The corroboration of the procedure is accomplished by developing the case study in a real bronze semi-finished products foundry context. The data collection is conducted for this objective and the results are described in the next subchapters.

In order to maintain the confidentiality of the company, it will be mentioned in this document as Company X. All the official names related with the business will be modified with the intention of protecting characteristics and information related with the enterprise.

The company X belongs to the Z Group. This one is an internationally successful player in the market for automotive components and defence equipment. With more than 20.000 employees, it is one of Europe's leading providers of army technology and also detains a global supplier position in engine components and systems.

Company X offices are in Germany, has around 500 employees and belongs to the hard parts division from the engine components and systems from Z Group within the bearings department. It produces metallic bearings, metal-polymer bearings and continuous casting profiles. The continuous casting department works with several bronze alloys. The foundry division is responsible for this last section and has already a long history of continuous casting producing.

Figure 5.1 – Continous Cast Semi Finished Bronze Products

With the German quality guarantee, it is well known for the good foundry service, strict quality inspection and strong partnerships with its customers. Inside the group, it is the only identity responsible to cast bronze bars, tubes and special profiles using the continuous casting process.

The company X uses in its foundry the vertically continuous cast method to produce its bronze products. Like this, they have inherent competitive technical advantages over their competitors since it is possible to guarantee the highest quality and most cost-efficient products available. The

method has advantages like improving the mechanical properties which assure a longer product life and a greater ability to handle loads, for example.
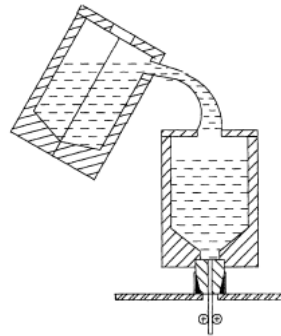
Figure 5.2 – Continous Casting Process

The process is simple. The metal is spilt into the metal unit and flows to a water-cooled die at the bottom of the container. When passes through the die, the solidification of the alloy occurs. The rollers smoothly downward the cast product until the right sized is cast and the saws cut the bar (Wilson, 2000).

The Company X can produce a diverse range of bronze alloys in its facilities. However, the core business is focused in two of them, the alloy K and G. In the company business model they have always available in the warehouse a varied size range of these two alloys in the semi-finished product models that they sell, bars, tubes and special profiles. If the client wants to buy, they just need to consult the standard products available and the company X has the product prepared to be shipped and send.

There are some clients that need special measures or alloys that are not immediately available in the warehouse. In this case, and depending on the alloy and size, the Company X evaluates the inquiry and if it is possible to do it, informs the client how long it will take to be ready. After it depends on the customer if he accepts the offer or not.

To corroborate this decision support methodology when entering new markets for a semi-finished products foundry, the Company X had the interest to apply it in four markets where they did not have any information at all: Brazil, Argentina, Chile and Mexico. Since the company has the intention to grow and constantly be at the forefront of its business, exploring new markets is a point that belongs to its business model.

5.1 Data Gathering

In order to better understand the business, comprehend which are the important factors, to make the pairwise comparison and determine the importance between elements and clusters in the ANP model, it was necessary to consult the sales team from the Company X. Like this, it was possible to take the best of their knowledge, experience in the field, skills and perception of what is really important in this area. Firstly, it was also planned to involve the chief of sales since he had permanent and daily contact with the other team members and had the full capacity to provide the information needed. Unfortunately, that was not possible because after more than 10 years in the company he left to a different one. The research was still in an early stage, so part of the data that was gathered had the essential help from the sales department team members.

Since this methodology is directly related with research about new markets, the experts from the sales area were the most suitable for the job. They are used to have contact with all the markets that the company has contact with and know which are the main characteristics that matter when it comes the moment to find new customers.

The insights about country characteristics, market aspects, companies contact to create a B2B relationship and even the Company X features to create the SWOT analysis it was made by online investigation and daily experiences that allowed this research to grow.

5.2 Decision Support Methodology

As described in the chapters before, the decision support methodology when entering new markets for a semi-finished products foundry starts with understanding the business and in which areas it acts. This is important because in this type of companies it is possible to have diverse kinds of businesses. They can operate as a bronze foundry like Company X or even operate as foundries that work with multiple types of metals like aluminium and brass at the same time.

In order to demonstrate the decision support methodology when entering new markets for a semi-finished products foundry, as mentioned before, it was applied this practice to four different markets within the Company X context: Brazil, Argentina, Chile and Mexico. Since it would be very extensive to show how the methodology was applied to the four countries, it will be presented in this thesis the results that were obtained from Brazil.

5.2.1 Business to Business – B2B

Since the Company X deals with semi-finished products, its customers are always other businesses. The companies that deal with these type of products have this characteristic. For

example, if a bronze bar with 50 mm diameter and 100 mm length is produced, one of the possibilities is that machining parts manufacturer becomes the client. It will be the responsible for machining, cut the piece and produce the final part that can be sold to the final customer, or not. The Company X business is focused on selling products to other companies by trading the semi-finished products to other enterprises.

Even though the example above mentions machining parts manufacturer, it can also be sold to a different company type. Due to several conversations with the sales department members, it was possible to understand in which areas the Company X is acting and whit which kind of customers it is used to deal with. With the markets that are operating nowadays, it is possible to distribute the clients into three groups: machining parts manufacturer, foundries and metal traders. This distribution will be developed further on in this document.

With the Company X clients' well defined, it was possible through online research to find companies contacts and start the communication process. This type of communication between the two companies allowed to establish a strong customer and client relationships.

The first contact with the other companies was made by a phone call and had the objective of introducing the Company X and at the same time open a channel of communication between the two identities. After this first approach, three things could happen.

a) the call was pass to the purchasing department which allowed to speak directly with the person in charge of this section which transformed the process in an easier communication procedure.

b) the person who answered the phone gave the email of the person in charge of the purchasing department which allowed the communication to continue by email.

c) the company did not show interest in maintaining a conversation with the Company X. It was important to establish connections with the purchasing department of the foreign companies since they are the responsible for new clients' acquisition.

This communication process with possible clients was very important. Through this process, it was possible to ask questions, comprehend how they communicate and to realise how the companies are reacting to the economy and social status of the country. In terms of the metal industry, it was possible to understand how the businesses operate, the technology that is available, the most common alloys in the market, the quality norms that are used and all the technical characteristics related with the business.

5.2.2 PESTLE Analysis

The PESTLE Analyse gives an overview of the Political, Economic, Social, Technological, Legal and Environmental characteristics of a market, in this specific case from Brazil. It is a tool that allowed to get an insight into emerging trends that could support, strengthen or disrupt the activities that the company is planning to implement. It also helped to understand and measure the political and business environment and operational risks.

After a deep investigation into the Brazilian market characteristics, it was possible to compact all the data and presented it in a PESTLE scheme, which allows having an easier visualization of the nowadays market features.

Table 5.1 PESTLE Analysis

Political Corruption Scandals	The Brazilian Senate voted to open an impeachment trial for President Dilma Rousseff. Vice President Michel Temer took over the position provisionally. People have hope on Timer, but his party (Partido do Movimento Democrático Brasileiro, PMDB) is fractured in its support, so there is no guarantee that Timer will be able to unify the party to carry out what is likely to be highly publicly unpopular measures.
Economical Shaken Economy	In the next months, Temer wants to take the economic policy in a more centrist direction. Nevertheless, the economy´s significant issues are external and structural, which will not be easy to fix. As a result, Brazil is unlikely to see a rapid exit from the recession, meaning that they will probably take years to get a sustainable growth again.
Social Widespread Public Unrest	After the political scandals and the economic situation, people are anxious. Without knowing what to expect from the future, many of them are angry and want justice. In another hand, there are also the ones who have hope with the changes that the Vice President Temer will do.
Technological Repair the Old	Due to the country situation, a lot of people are not interested in new technology, new methods or better quality. If the process that they are using works, then there is no concerning in improvement. For example, if there are machines with problems, they fix it until it is possible. Do not buy new. New technology costs money and now there is no budget available for it.
Legal Some Changes Ahead	Former President Dilma Rousseff belongs to Partido dos Trabalhadores (PT) which is one of the most important left parties from Latin America. Now replaced for Michel Temer from PMDB which follows a centrist political orientation, Brazil will suffer some law changes in different areas.
Environmental The Land of the Palm Trees	Brazil has conductive weather between 25 and 30 degrees Celsius and it is the fifth largest country in the world and has the largest arable land. 90% of the country is within the tropical type of climate and the levels of precipitation can vary widely. The environmental problem that attracts most international attention is the deforestation of the Amazon rainforest. Brazil has 66% of it.

(Monitor, 2016; Report, 2015)

After analyzing the PESTLE diagram, it is possible to have a framework of macro environmental factors to be taken into consideration. It helps to have an overlook over the market growth or decline business position, potential and direction of the company while acting in those markets.

5.2.3 SWOT Analysis

To complement the previous analysis, it is important to explore in more detail in order for organisations to analyse their performance and compare themselves with the surrounding market. Since SWOT Analysis allows to evaluate external and internal characteristics, comes to complement a point of view that was missing. Like this, when managers have to fulfil the inquiries for the multi-criteria decision making, they are fully aware and able to answer in the best way possible.

When analysing the strengths, weaknesses, opportunities and threats of Company X, the following topics were described:

- **Strengths**
    - Compared with the Brazilian, Argentine, Chilean and Mexican market, Company X is stronger in technology, knowledge, quality and product reliability. Once the German technology is better when compared to South America, it is clearly a strong assent that is identified as an advantage.
    - The produced size and the ease of transport material can be two competitive assets. Company X can produce up to 5m diameter semi-finished products which are really different from all the solutions available in the market.
- **Weaknesses**
    - Company X is in Europe. Because of this, the standard quality norms, the measurement system and the most popular alloys are not the same. These four possible new markets are located in South and North America, which make them be integrated into the USA metal market rules.
    - Currency and language are definitely three aspects that can difficult business.
- **Opportunities**
    - If being in Europe brings negative aspects, it certainly brings positives too. The fact that is a German company working in the metal industry gives it a lot of power and name in the market. South and North American companies respect the quality of a German foundry a lot.

- o Without a doubt, the quality of the product attracts a lot of potential clients. The alloys that are produced, contain a better and healthier alloy when compared with the competitors.
  - o Adding the fact that the size range of the semi-finished bronze products is unique, makes Company X a differentiator in the market.
  - o Also, during the analyses that were made, the Brazilian showed interest in looking for new suppliers.

- **Threats**
  - o While doing the market study, the time difference was definitely a struggle.
  - o Since South America holds an agreement between countries (Mercosul and Mexico also have an agreement with them), companies look for cheaper partnerships.
  - o It was identified that the main European competitor it was already operating there.
  - o Also, the Chinese market already has some power within the bronze trade.

When the SWOT analysis was made, it gave a better and clear perception of what is happening in the market. The managers agreed that helped them to organise the info in order to reply to the inquiries (that will be shown in the next point). Also, during the application of this toll, it was interesting to observe how the team collaborated in order to understand what was really important for their department. This has revealed to be a crucial stage since it helped a lot to determine the goal and criteria's of the multi-criteria decision-making.

5.2.4 Analytic Network Process

One of the steps of this methodology is to analyse the results of the ANP model applied in the context of the Company X. The goal is to suggest a conceptual decision-making model support the sales department in taking decisions. In this case, it is necessary to classify the companies that have been communicating with the Company X in terms of being potential clients, representatives in their countries or if in the end, they are not interesting at all.

In order to start to develop the ANP Model, it is crucial to determine the clusters that are important in the network. The task of understanding the business and how it works was crucial for this stage of the methodology. It is essential that the clusters of the model make sense and that elements and connections between them fit and sustenance to reach a conclusion.

5.2.4.1 ANP Model

The ANP model that is described in chapter 3.2.1 it is now applied to Company X case. The Countries will be the markets that are being analysed. The Companies to insert in the Cluster 8 will not show the real name because Company X asked for it, but each one of them represents companies that showed to be relevant to explore.

In order to test this model and its applications, it was applied to Company X and its questions:
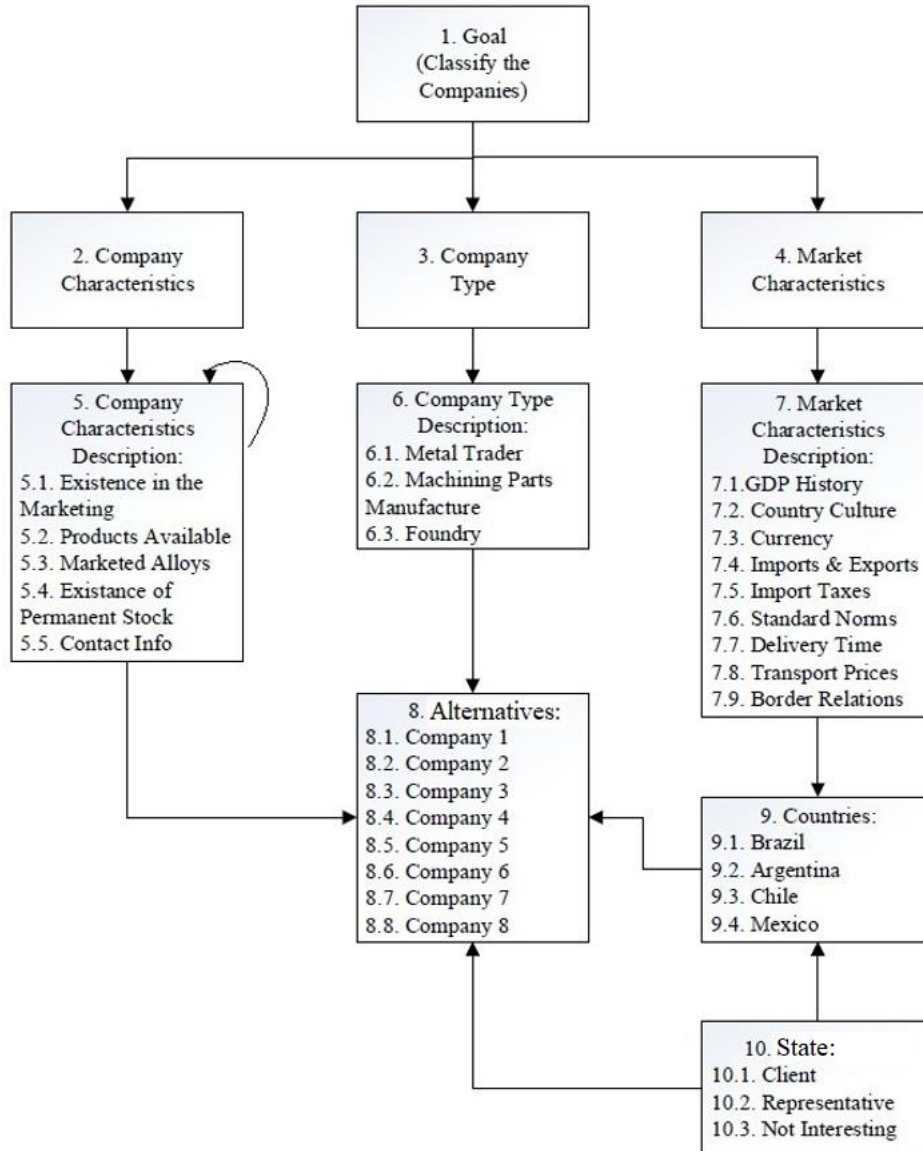
Figure 5.3 – ANP Model

Goal: 1. Classify the companies – The outcome of this model will be the next steps that company X has to do. Several companies from four markets were identified and what action to take with each one of them it will hold with this model. It will help in to decide if Company X should invest

time and resources in the businesses in Brazil, Argentina, Chile or Mexico, or even if they can act in several at the same time.

Criteria: 2. Company Characteristics, 3 Company Type and 4. Market Characteristics & Sub Criteria: 5. Company Characteristics Description & Sub Criteria: 6. Company Type Description – In these three criteria and two sub criteria, when applied to Company X, managers when classifying the pairwise comparisons, have to be in mind which is more important for their business.

Sub Criteria: 7. Market Characteristics Description – Once the companies are operating in different markets, in these specific cases in Brazil, Argentina, Chile and Mexico, these are the markets and its characteristics that are considered.

Identities: 8. Alternatives – After examining all the contacts that were being made, two companies from each market were chosen to have in total 8 elements in this cluster. Having two identities from each market in the model it is only a suggestion that was taken into consideration by the sales department. Of course, another choice could have been made, but since the four markets that were being studied had a lot of characteristics in common and none of them stood out, it was decided that having a balance between them was the best option.

Sub Criteria: 9. State – Since company X is exploring and having in consideration Brazil, Argentina, Chile and Mexico, these are the countries that are considered.

Alternatives: 10. Alternatives –In this case, the companies can be classified with the alternatives of being a potential client, a potential representative or if they are not interesting at all. These options were decided after talking with the sales team and evaluating what could be the best options to work with.

It is important to state that this ANP model makes sense when applied to the Company X case study, where the markets that were being evaluated were Brazil, Argentina, Chile and Mexico and the companies that were being contacted were those 8 companies. If another company wants to apply this ANP model to its market study, it must adapt by changing the cluster 9 for the other countries and cluster 8 for the other companies.

5.2.4.2 Data Gathering and Inquiries

The next step after having the ANP model ready is to ask the direct collaboration of the sales department staff by delivering the inquiries where the questions related to the ANP model are asked. It is part of the analytic network process to do the pairwise comparison between elements

and clusters of the model, and for that, the participation from the sales department by answering the questions is crucial.

It is recommended that all the info necessary must be gathered in a form that is easy to interpret by all the team members and in a form already based on the elements of the clusters from the ANP model. In order to answer the questions, it was delivered at the same time all the info necessary to answer the questions. A team member is responsible to make all the research needed and to present it to the other team members with the purpose of informing them of all the data.

For example, since it is necessary to know which companies are being classified and which characteristics they have, a report about each company was made. Here is the summary of each one of it:

Table 5.2 Company 1 Characteristics

Company 1	
Country	Brazil
Localization inside the country	Santa Catarina
Type	Machining Parts Manufacturer
Existence	+ 47 years
Products	Bushes, Wheels, Tires, Bearings, Discs, Special Bolts, Springs, among others.
The existence of Permanent Stock	Yes
Main alloys	(Bushes) • SAE 660 / CuSnPbZn • SAE 68 B / CuAl10Fe (similar)
Name	XXX
Email	XXX
Phone Number	XXX
Contact Info	Detains 65% of the Brazilian market in spare parts for bulldozers. Has around 700 employees and its main segments are mining, construction, forestry, agricultural and assemblers. It has 23 affiliated societies all over Brazil. Nowadays is importing from

Asia and commented that our prices are higher than his current supplier.

Table 5.3 Company 2 Characteristics

Company 2	
Country	Brazil
Localization inside the country	São Paulo
Type	Trader
Existence	Not Specific, but apparently shows already some years in the market
Products	Bars, Connection Cables, Electrodes in several copper alloys
The existence of Permanent Stock	Yes
Main alloys	• CuCr1Zr • CuCo2Be • CuNi2Be • CuNi2
Name	XXX
Email	XXX
Phone Number	XXX
Contact Info	The small company recognized in Brazil, Chile and Argentina. Its primary segments are automotive, mining and metallurgy. It is looking for a partnership since is receiving orders that cannot attend.

Table 5.4 Company 3 Characteristics

Company 3	
Country	Argentina
Localization inside the country	Córdoba
Type	Trader
Existence	Since 1980
Products	Bars, Sheets, Strips, Flat Bars, Tubes and Wires in Aluminium, Copper, Bronze, Brass, Lead and others. Provides cut services.
The existence of Permanent Stock	Yes
Main alloys	• SAE 64 / CuSnPb • SAE 65 / CuSn • SAE 68 / CuA110Fe
Name	XXX
Email	XXX
Phone Number	XXX
Contact Info	High presence in online publicity. Cautious when it comes to giving business information. The product is delivered in less than 24 hours all over the country.

Table 5.5 Company 4 Characteristics

Company 4	
Country	Argentina
Localization inside the country	Buenos Aires
Type	Foundry (Continuous Casting, Centrifugal, Molding)
Existence	Since 2004
Products	Bars, Dowels, Tubes, Bushings in Bronze
The existence of Permanent Stock	Yes
Main alloys	Phosphorous bronze. The website is being renewed with the characteristics of the product and by phone, they were very shy in saying the main alloys.
Name	XXX
Email	XXX
Phone Number	XXX
Contact Info	Interested in knowing our products. Cautious when it comes to giving business information. He wants to maintain the contact in case of needing something.

Table 5.6 Company 5 Characteristics

Company 5	
Country	Chile
Localization inside the country	Santiago
Type	Metal Trader
Existence	+ 35 years
Products	Bars, tubes and special pieces in Bronze. Also works with brass; steel, aluminium, plastics. Provides cut services.
The existence of Permanent Stock	Yes
Main alloys	• SAE 64 / CuSnPb • SAE 640 / CuSn12Ni2 (similar) • SAE 660 / CuSnPbZn
Name	XXX
Email	XXX
Phone Number	XXX
Contact Info	Its main segments are metallurgy, mining and general industry. Although nowadays it is ordering the alloys SAE 640 and SAE 660 (around 5 Ton per month) from Spain, has an interest in knowing our prices.

Table 5.7 Company 6 Characteristics

Company 6	
Country	Chile
Localization inside the country	Santiago
Type	Foundry (Continuous Casting, Centrifugal, Molding)
Existence	Since 1955
Products	Bars, Tubes, Bushes, Ingots and special pieces in Bronze. Also works with Brass, Aluminium, Zinc and Steel.
The existence of Permanent Stock	Yes
Main alloys	• SAE 64 / CuSnPb • SAE 640 / CuSn12Ni2 (similar) • SAE 660 / CuSnPbZn
Name	XXX
Email	XXX
Phone Number	XXX
Contact Info	Already bought from Company X in the past and now bought again (5 tons). Its main concern is product quality and does not have any problems to import.

Table 5.8 Company 7 Characteristics

Company 7	
Country	Mexico
Localization inside the country	Guadalajara
Type	Trader
Existence	+ than 40 years
Products	Bushings, bearings, pistons, accessories for steam, anodes, and others in several metal alloys
The existence of Permanent Stock	Yes
Main alloys	• SAE 64 / CuSnPb • SAE 62 / CuSn10Zn • SAE 68 / CuA110Fe
Name	XXX
Email	XXX
Phone Number	XXX
Contact Info	They know a familiar from Company X in Mexico and came to visit us in Germany. The bronze business represents 25& of their business. They employ 28 people and already imported from Italy, Austria and the USA several products.

Table 5.9 Company 8 Characteristics

Company 8	
Country	Mexico
Localization inside the country	San Luis Potosi
Type	Foundry (Continuous Casting, Centrifugal, Molding)
Existence	Since 1982
Products	Bronze: Bars, bushings, special pieces
The existence of Permanent Stock	Yes
Main alloys	• SAE 64 / CuSnPb • SAE 62 / CuSn10Zn • SAE 65 / CuSn • SAE 660 / CuSnPbZn • SAE 68 / CuA110Fe
Name	XXX
Email	XXX
Phone Number	XXX
Contact Info	The experienced company in the Mexican market with the will of investing in quality products. Receives constant inquiries from Latin America and says that is a good market to be explored together with the USA. Has an interest in representing our brand in Mexico.

When this kind of information is presented to the other team members, it is important to present the info in a way that is easy to connect the data with the ANP model. The elements that are present in the cluster 5 are existence in the market, products available, marketed alloys, the existence of permanent stock and contact info. All these topics are present in the company profile together with some extra information, like localization and the contact of the person from the company.

Similar to this situation of presenting the companies to the team members, the same circumstance happens when it comes the moment to present the markets. Like the previous example, it is also important here to show the information with the same topics as the elements of each cluster. It was made a report like the one above for each market:

Brazil

GDP History:

Gross Domestic Product - Current Prices

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GDP	892,1	1108	1396	1695	1667	2209	2613	2412	2391	2347	1800
Growth	3,15%	4,00%	6,01%	5,02%	-0,24	7,57%	3,92%	1,76%	2,74%	0,15%	-3,80
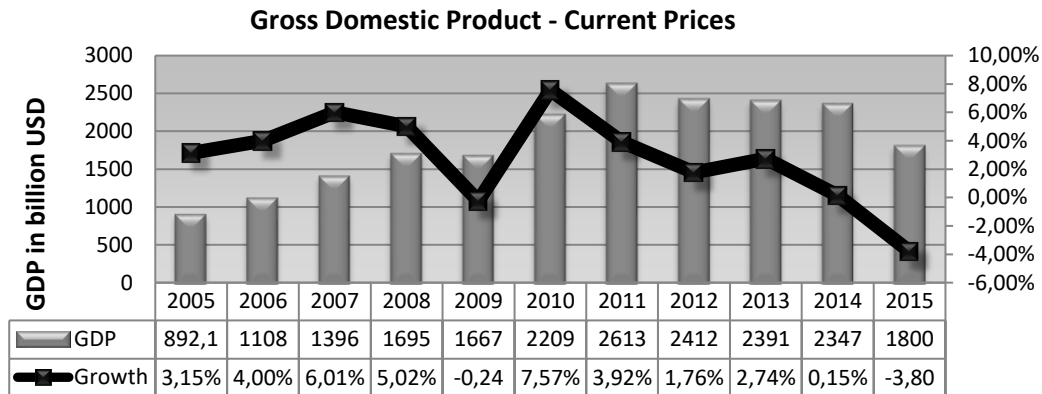
Note: In economic terms, Brazil is living in hard times. According to to the economists, the recession that Brazil is in is the result of the internal political problems, rising unemployment, the consequence of decreasing in consumption and a decrease of external investors.

Country Culture: Due to the economic situation, Brazilian people are passing through challenging times. It is well known that the country has a very good energy and that the people are always positive when facing adversities. Since the political situation reached the high point, this optimism has been shaken. Businesses are more cautious when it comes to investing in themselves. A few of them are still looking for new solutions, some prefer to work or reformulate the old options, and there are even the ones who do not invest in any changes at all. Importing from Europe it is still seen as a difficult option.

Currency: Real (R$)   1 € ~ 3.8502 R$

Imports & Exports:

	IMPORTS	2015 (JAN - MAR) USD (Thousands, FOB)	2016 (JAN - MAR) USD (Thousands, FOB)	Var
Top Countries	TOTAL	48.324.685.198	32.185.573.729	**-33,40%**
1	CHINA	9.664.648.889	5.945.304.248	-38,48%
2	UNITED STATES	7.114.087.704	5.347.640.685	-24,83%
3	ARGENTINA	2.739.717.000	2.128.759.650	-22,30%

Top 5 Imported Products:
1. Crude Oil
2. Diesel
3. Naphtha for Petrochemical Industry
4. Boats – Headlights, Cranes, Docks, Floating Dike
5. Turbojets and Turboprops Parts

	EXPORTS	2015 (JAN - MAR) USD (Thousands, FOB)	2016 (JAN - MAR) USD (Thousands, FOB)	Var
Top Countries	TOTAL	42.775.243.863	40.573.159.018	**-5,15%**
1	CHINA	6.189.769.494	6.965.479.115	12,53%
2	UNITED STATES	5.824.198.945	5.054.636.199	-13,21%
3	ARGENTINA	3.071.650.709	3.060.387.387	-0,37%

Top 5 Exported Products:
1. Soy
2. Grand Corn
3. Crude Oil
4. Non-Agglomerated Iron Ores
5. Cane Sugar

Import Taxes:

Tax Name / Product Code	7411 29 00	7403 22 00
TEC – Tarifa Externa Comum *(Common External Tariff)*	14%	6%
IPI – Imposto sobre Produtos Industrializados *(Taxes over Industrialized Products)*	5%	-
PIS Importação *(Social Contributions)*	2,1%	2,1%
COFINS Importação *(Social Contributions)*	9,65%	9,65%
Total	**30,75%**	**17,75%**

Standard Norms: More common: ASTM, UNS, SAE

Delivery Time, Transportation Price:

Country	Port	Transit Time (From X)	1 container 20'' (16 ton) CFR	1 container 40'' (24 ton) CFR
Brazil	Santos	X days	X €	X €

Insurance is calculated by the goods value plus the transportation cost.

Border Relations: Brazil has borders with Argentina, Bolivia, Colombia, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, and Venezuela. In economic terms, since Brazil is a member country from Mercosul together with Argentina, Paraguay, Uruguay and Venezuela the change of goods between these countries is easier and with lower taxes. Brazil has deep connections, especially with Argentina.

After sharing this information with the team members about the companies and markets that are being studied, they are now capable of answering the inquiries related to the ANP model. For example, the first group of connections of the model it is translated into this question:

1.   The following question intends to evaluate the most important criteria in order to classify the companies as potential Clients, Representatives or Not interesting:

Table 5.10 Example of Question 1

In order to Classify the Companies, which is the most important Criteria?		Evaluate the degree of importance								
		Equal Importance (1)	(2)	Moderate Importance (3)	(4)	Strong Importance (5)	(6)	Very Strong Importance (7)	(8)	Extreme Importance (9)
Company Characteristics □	Company Type □	●	□	□	□	□	□	□	□	□
Company Characteristics ●	Market Characteristics □	□	□	□	□	●	□	□	□	□
Company Type ●	Market Characteristics □	□	□	□	□	●	□	□	□	□

As shown before in the literature review, it is made a pairwise comparison between the elements of the clusters and given a weight to this relationship. In the example above, it is made a comparison between the three criteria of the model in order to understand which of it is more important and to which degree.

Another example can be the relationship between cluster 3 and 5:

The following question intends to evaluate which the most important Company Type is:

Table 5.11Example of Question 2

In order to Classify the Companies, which is the most important Company Type?		Evaluate the degree of importance								
		Equal Importance (1)	(2)	Moderate Importance (3)	(4)	Strong Importance (5)	(5)	Very Strong Importance (7)	(8)	Extreme Importance (9)
Metal Trader □	Machining Parts Manufacture □	□	□	□	□	□	□	□	□	□
Metal Trader □	Foundry □	□	□	□	□	□	□	□	□	□
Machining Parts Manufacture □	Foundry □	□	□	□	□	□	□	□	□	□

It is important to remember that all the data collected came from the same department since their professionals are responsible for dealing with potential clients, they were the ones that best fit. The stage of data gathering was the longest process because there were a lot of questions to do.

5.2.4.3 Pairwise Comparison

After answering all of the quizzes, the answers were inserted into the software. Super Decisions software was used in conducting the pairwise comparisons. The software was developed by Thomas L. Saaty and designed by William J.L. Adams.

The way to a better interpretation of the inquiries, is to make the following questions: with respect to a specific factor, which of a pair of factors is more important? After this question, is necessary to evaluate the degree of importance of the factor more important in relation to less important. For example, regarding the Company Type, which one is more important, Metal Trader or Foundry? Having that in consideration, how much important?

In order to know how many comparisons needed to be made, the following formula can be applied:

$$N \times \frac{n(n-1)}{2}$$

where *N* delineates the number of matrices in the cluster to be compared and *n* delineates the number of elements in the origin cluster.

Let's now analyse one example of how that comparison was made in detail. When looking at the ANP model, we can identify three different criteria: Company Characteristics, Company Type and Market Type. They have a direct connection with the goal and, looking to the direction of the arrow, we can see that the goal depends on them. The following table shows the pairwise comparisons between the three criteria with respect to the goal, judged by the responsible of the sales department.

Table 5.12 Criteria pairwise comparison with respect to Goal

Goal	Company Characteristics	Company Type	Market Characteristics
Company Characteristics	1	2	3
Company Type	1/2	1	2
Market Characteristics	1/3	1/2	1

At the table is possible to see that Company Characteristics is equally moderately more important than the Company Type and is moderately more important than the Market Characteristics. Company Type is equally to moderately more important than the Market Characteristics.

When introducing these values on the Software, the results were the following:

Table 5.13 Node Comparisons to Respect to Goal

Company Characteristics (CC)	0.546
Company Type (CT)	0.287
Market Characteristics (MC)	0.167
Inconsistency: 0.0052	

The criteria that got the highest score was Company Characteristics, followed by Company Type and Market Characteristics. This means that the criteria that have the lowest impact on the goal are the Market Characteristics, which actually makes sense. In fact, because of all the markets that are being evaluated belong to South America (except Mexico, but has similar characteristics), this makes them look similar in very aspects. The Company Characteristics is the one that is going to influence the most in the decisions. The inconsistency value is less than 0.1, which validates this comparison. According to with (Saaty, Thomas L; Vargas, 2006), inconsistency may be considered a tolerable error in measurement and should be less than 10%.

In order to understand how the software reached Table 5.13, it is going to be demonstrated by this example how those values appeared. With the other pairwise comparisons, only the conclude tables will be shown.

When analysing Table 5.13, it is possible to calculate the scores and the inconsistency. When doing the calculation manually, the first step is working with the normalised criteria pairwise comparison matrix with respect to the goal. For example, in order to fulfil the first slot (right left corner), we must look to the correspondent number in Table 3.3 (in this case, 1) and divide by the sum of the correspondent column. It is possible to see this first slot and others in the next table.

Table 5.14 Normalised criteria pairwise comparison

Goal	CC	CT	MC
CC	$\dfrac{1}{1+\frac{1}{2}+\frac{1}{3}} = 0.546$	0.571	0.500
CT	0.272	0.287	$\dfrac{2}{3+2+1} = 0.333$
MC	0.182	$\dfrac{\frac{1}{2}}{2+1+\frac{1}{2}} = 0.142$	0.167
Sum	1	1	1

To be possible to calculate the inconsistency, we need first to calculate the relative weights and consistency vector. For that, we need to use the values from the table above. For the relative weight, we sum the values of the rows, use this summed value to divide by the sum of the sum that was made before. To find the consistency vector, we work with the summed values and divide it by the relative weights. Table 5.15. shows how was it done:

Table 5.15 Consistency Vector Table

Goal	CC	CT	MC	Sum	Relative Weights	Consistency Vector
CC	0,546	0.571	0,500	$0,546 + 0,571 + 0,500 = 1,617$	$\dfrac{1,617}{1,617+0,892+0,491} = \dfrac{1,617}{3} = 0,539$	$\dfrac{1,617}{0,539} = 3,000$
CT	0.272	0.287	0,333	0,892	0,297	3,003
MC	0.182	0,142	0,167	0,491	0,163	3,012

The next step is to *calculate* the maximum eigenvalue (λ_{max}). It is given by the average of the values of the consistency vector:

$$\lambda max = \frac{3,000 + 3,003 + 3,012}{3} = 3,005$$

It is now possible to calculate the Consistency Index (CI), that is given by this formula:

$$CI = \frac{\lambda max - n}{n - 1}$$

n is the matrix size, which in this case is 3, so:

$$CI = \frac{3,005 - 3}{3 - 1} = 0,003 \ (0,0025)$$

To get the Consistency Ratio (CR) (Inconsistency is how it is called on the software), it is still needed the Random Consistency Index (RI):

$$CR = \frac{CI}{RI}$$

RI is given by Table 5.16.

Table 5.16 Random consistency index (Saaty, Thomas L; Vargas, 2006)

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49

$$CR = \frac{CI}{RI} = \frac{0,003}{0,58} = 0,0052$$

As shown with the calculus above and the value of the Super Decisions Software, the desired value of CR is less than 0,10, so the judgment in this matrix is consistent. Each matrix has its own value that will be shown in the following tables.

The rest of the pairwise comparison is shown and commented below. All the questionaries' answers available in annexes.

Node Comparisons with respect to Companies Characteristics:

Table 5.17 Comparisons between Company Characteristics node and Company Characteristics Description cluster

Contact Info	0,040
Existence in the Market	0,087
Existence of Permanent Stock	0,293
Marketed Alloys	0,293
Products Available	0,285
Inconsistency: 0,0645	

Node Comparisons with respect to Companies Type:

Table 5.18 Comparisons between Company Type node and Company Type Description cluster

Foundry	0,240
Machining Parts Manufacture	0,209
Metal Trader	0,549
Inconsistency: 0.0175	

Node Comparisons with respect to Market Characteristics:

Table 5.19 Comparisons between Market Characteristics node and Market Characteristics Description cluster

Border Relationship	0,032
Country Culture	0,019
Currency	0,031
Delivery Time	0,183
GDP History	0,047
Import Taxes	0,159
Imports % Exports	0,157
Standard Norms	0,183
Transport Prices	0,183
Inconsistency: 0,0625	

Node Comparisons with respect to Existence in the Market:

Table 5.20 Comparisons between Existance in the Market node and Alternatives cluster

Company 1	0,140
Company 2	0,063
Company 3	0,132
Company 4	0,132
Company 5	0,132
Company 6	0,132
Company 7	0,132
Company 8	0,132
Inconsistency: 0,0015	

Table 5.21 Comparisons between Existence in the Market node and Company Characteristics Description cluster:

Contact Info	0,072
Existence of Permanent Stock	0,157
Marketed Alloys	0,613
Products Available	0,157
Inconsistency: 0,0578	

Node Comparisons with respect to Products Available:

Table 5.22 Comparisons between Products Available node and Alternatives cluster

Company 1	0,022
Company 2	0,022
Company 3	0,159
Company 4	0,159
Company 5	0,159
Company 6	0,159
Company 7	0,159
Company 8	0,159
Inconsistency: 0	

Table 5.23 Comparisons between Products Available node and Company Characteristics Description cluster

Contact Info	0,074
Existence in the Market	0,137
Existence of Permanent Stock	0,272
Marketed Alloys	0,514
Inconsistency: 0,0891	

Node Comparisons with respect to Marketed Alloys:

Table 5.24 Comparisons between Marketed Alloys node and Alternatives cluster

Company 1	0,138
Company 2	0,115
Company 3	0,124
Company 4	0,124
Company 5	0,124
Company 6	0,124
Company 7	0,124
Company 8	0,124
Inconsistency: 0,0047	

Table 5.25 Comparisons between Marketed Alloys node and Company Characteristics Description cluster

Contact Info	0,082
Existence in the Market	0,480
Existence of Permanent Stock	0,218
Products Available	0,218
Inconsistency: 0,0933	

Node Comparisons with respect to Existence of Permanent Stock:

Table 5.26 Comparisons between Permanent Stock node and Alternatives cluster

Company 1	0,066
Company 2	0,133
Company 3	0,133
Company 4	0,133
Company 5	0,133
Company 6	0,133
Company 7	0,133
Company 8	0,133
Inconsistency: 0	

Table 5.27 Comparisons between Permanent Stock node and Company Characteristics Description

Contact Info	0,051
Existence in the Market	0,206
Marketed Alloys	0,297
Products Available	0,444
Inconsistency: 0,0823	

Node Comparisons with respect to Contact Info:

Table 5.28 Comparisons between Contact Info node and Alternatives cluster

Company 1	0,048
Company 2	0,048
Company 3	0,121
Company 4	0,121
Company 5	0,121
Company 6	0,294
Company 7	0,121
Company 8	0,121
Inconsistency: 0,0202	

Table 5.29 Comparisons between Contact Info node and Company Characteristics Description cluster

Existence in the Market	0,076
Existence of Permanent Stock	0,307
Marketed Alloys	0,307
Products Available	0,307
Inconsistency: 0	

Node Comparisons with respect to Metal Trader:

Table 5.30 Comparisons between Metal Trader node and Alternatives cluster

Company 2	0.062
Company 3	0.312
Company 5	0.312
Company 7	0.312
Inconsistency: 0	

Node Comparisons with respect to Foundry:

Table 5.31 Comparisons between Foundry node and Alternatives cluster

Company 4	0,195
Company 6	0,493
Company 8	0,31
Inconsistency: 0,05156	

Node Comparisons with respect to GDP History:

Table 5.32 Comparisons between GDP History node and Countries cluster

Argentina	0,168
Brazil	0,367
Chile	0,095
Mexico	0,367
Inconsistency: 0,0578	

Node Comparisons with respect to Country Culture:

Table 5.33 Comparisons between Country Culture node and Countries cluster

Argentina	0,152
Brazil	0,124
Chile	0,461
Mexico	0,261
Inconsistency: 0,0656	

Node Comparisons with respect to Currency:

Table 5.34 Comparisons between Currency node and Countries cluster

Argentina	0,208
Brazil	0,095
Chile	0,487
Mexico	0,208
Inconsistency: 0,05787	

Node Comparisons with respect to Imports and Exports:

Table 5.35 Comparisons between Imports and Exports node and Countries cluster

Argentina	0,168
Brazil	0,367
Chile	0,095
Mexico	0,367
Inconsistency: 0,0578	

Node Comparisons with respect to Imports Taxes:

Table 5.36 Comparisons between Imports Taxes node and Countries cluster

Argentina	0,051
Brazil	0,051
Chile	0,666
Mexico	0,231
Inconsistency: 0,1896	

Node Comparisons with respect to Standard Norms:

Table 5.37 Comparisons between Standard Norms node and Countries cluster

Argentina	0,25
Brazil	0,25
Chile	0,25
Mexico	0,25
Inconsistency: 0	

Node Comparisons with respect to Delivery Time:

Table 5.38 Comparisons between Delivery Time node and Countries cluster

Argentina	0,223
Brazil	0,286
Chile	0,095
Mexico	0,394
Inconsistency: 0,0578	

Node Comparisons with respect to Transport Prices:

Table 5.39 Comparisons between Transport Prices node and Countries cluster

Argentina	0,182
Brazil	0,278
Chile	0,095
Mexico	0,443
Inconsistency: 0,0536	

Node Comparisons with respect to Border Relationship:

Table 5.40 Comparisons between Transport Prices node and Countries cluster

Argentina	0,367
Brazil	0,367
Chile	0,168
Mexico	0,095
Inconsistency: 0,0578	

Node Comparisons with respect to Brazil:

Table 5.41 Comparisons between Brazil node and Alternatives cluster

Company 1	0,800
Company 2	0,200
Inconsistency: 0	

Node Comparisons with respect to Argentina:

Table 5.42 Comparisons between Argentina node and Alternatives cluster

Company 3	0,500
Company 4	0,500
Inconsistency: 0	

Node Comparisons with respect to Chile:

Table 5.43 Comparisons between Chile node and Alternatives cluster

Company 5	0,250
Company 6	0,750
Inconsistency: 0	

Node Comparisons with respect to Mexico:

Table 5.44 Comparisons between Mexico node and Alternatives cluster

Company 7	0,750
Company 8	0,250
Inconsistency: 0	

Node Comparisons with respect to Client:

Table 5.45 Comparisons between Client node and Alternatives cluster

Company 1	0,058
Company 2	0,043
Company 3	0,121
Company 4	0,121
Company 5	0,121
Company 6	0,29
Company 7	0,121
Company 8	0,121
Inconsistency: 0,0330	

Table 5.46 Comparisons between Client node and Countries cluster

Argentina	0,166
Brazil	0,166
Chile	0,333
Mexico	0,333
Inconsistency: 0	

Node Comparisons with respect to Representative:

Table 5.47 Comparisons between Representative node and Alternatives cluster

Company 1	0,044
Company 2	0,120
Company 3	0,134
Company 4	0,134
Company 5	0,134
Company 6	0,163
Company 7	0,134
Company 8	0,134
Inconsistency: 0,0123	

Table 5.48 Comparisons between Representative node and Countries cluster

Argentina	0,140
Brazil	0,239
Chile	0,339
Mexico	0,280
Inconsistency: 0,0223	

Node Comparisons with respect to Not Interesting:

Table 5.49 Comparisons between Not Interesting node and Alternatives cluster

Company 1	0,163
Company 2	0,268
Company 3	0,094
Company 4	0,094
Company 5	0,094
Company 6	0,094
Company 7	0,094
Company 8	0,094
Inconsistency: 0,0285	

Cluster Comparisons with respect to Criteria:

Table 5.50 Comparisons between Criteria Cluster

SB: Company Characteristics	0,177
SB: Company Type	0,518
SB: Market Characteristics	0,303
Inconsistency: 0,0175	

Cluster Comparisons with respect to Company Characteristics Description:

Table 5.51 Comparisons between Company Characteristics Description Cluster and Alternatives cluster

Alternatives	0,500
SB: Company Characteristics	0,500
Inconsistency: 0	

Cluster Comparisons with respect to State:

Table 5.52 Comparisons between State Cluster

Alternatives	0,750
SB: Countries	0,250
Inconsistency: 0	

5.2.4.4 Super Matrix formulation and Analysis

In the previous step, the values obtained from pairwise comparisons are being used to form the Super Matrix. This matrix represents the influence of a given set of elements within a component on another element in the system to show a local priority vector derived from the paired comparisons. Also, it shows the interdependency and relative importance of each previously-defined element. In order to get the stochastic or weighted Super Matrix, the initial Super Matrix must be transformed to a matrix where its columns sum up to unity, then this matrix must be normalized using the weight of the cluster to achieve the unit columns (L. Saaty & G. Vargas, 2006)

The Super Matrix is computed in three stages. The first stage is the unweighted Super Matrix created directly from all local priorities derived from pairwise comparisons among elements influencing each other. The second stage is the weighted Super Matrix which is calculated by multiplying the values of the unweighted Super Matrix with their affiliated cluster weights. The last step is the composition of a limiting Super Matrix, which is created by raising the weighted Super Matrix powers until it stabilizes. Stabilization is achieved when all the columns in the Super

Matrix corresponding to any node have the same values. (Promentilla, Furuichi, Ishii, 2008) All the stages in the ANP model were made using Super Decision software.

After achieving the Limit Super Matrix, the moment to rank all the elements of the model arrived and like this, is possible to understand its priorities. Fig. 5.4 shows the final score for each element that was considered (important to mention that is only showed the relevant values, all the elements that don't appear in Fig. 5.4 had value 0).

Icon	Name		Normalized by Cluster	Limiting
No Icon	Company 1		0.09618	0.018034
No Icon	Company 2		0.08365	0.015685
No Icon	Company 3		0.13497	0.025306
No Icon	Company 4		0.13497	0.025306
No Icon	Company 5		0.13497	0.025306
No Icon	Company 6		0.14534	0.027251
No Icon	Company 7		0.13497	0.025306
No Icon	Company 8		0.13497	0.025306
No Icon	Comp Charact		0.00000	0.000000
No Icon	Comp Type		0.00000	0.000000
No Icon	Goal		0.00000	0.000000
No Icon	Market Charact		0.00000	0.000000
No Icon	Contact Info		0.06018	0.003761
No Icon	Existance in the Market		0.21872	0.013670
No Icon	Existance of Permanent Stock		0.17909	0.011193
No Icon	Marketed Alloys		0.32996	0.020622
No Icon	Products Available		0.21205	0.013253
No Icon	Foundry		0.00000	0.000000
No Icon	Machining Parts Manufacter		0.00000	0.000000

Figure 5.4 - Priorities

While analysing Figure 5.4, it can reach two different conclusions. First, understand which one of the criteria is the most important and the weights between them. From the several options, Marketed Alloys showed to be the one with most value, followed by Products Available tied up with Existence in the Market, then Existence of Permanent Stock and last, Contact Info. This

means that when Company X is dealing with a new company in the new market, the first characteristic that they need to analyse is the alloy that they work with. Marketed alloys are in fact a very important topic since the technology, quality and price can be almost automatically analysed by knowing that. The metal industry is very developed in Germany, one of the bests in the world, which makes them have a lot of knowledge about competitors, markets… just by knowing the alloy that identities work with. Contact Info showed to be the least important one. This makes sense since it is something that can be investigated after the strategy and decision are settled.

The second conclusion is related with the cluster Companies and the priority of each company. When analysing which one should Company X to interact first, we can see that Company 6 takes the lead. Regarding company 3,4,5, 7 and 8, all of them show up in the second place, followed by number 1 and last, number 2.

Interesting to see that the priorities are related to the conclusions also taken from the Weighted Super Matrix:

Cluster Node Labels		SB: Market Characteristics					State		
		GDP History	Import Taxes	Imports % Exports	Standard Norms	Transport Prices	Client	Not Interesting	Representative
Alternatives	Company 1	0.000000	0.000000	0.000000	0.000000	0.000000	0.044023	0.122598	0.033536
	Company 2	0.000000	0.000000	0.000000	0.000000	0.000000	0.032651	0.201270	0.090520
	Company 3	0.000000	0.000000	0.000000	0.000000	0.000000	0.091075	0.071022	0.100609
	Company 4	0.000000	0.000000	0.000000	0.000000	0.000000	0.091075	0.071022	0.100609
	Company 5	0.000000	0.000000	0.000000	0.000000	0.000000	0.091075	0.071022	0.100609
	Company 6	0.000000	0.000000	0.000000	0.000000	0.000000	0.217953	0.071022	0.122901
	Company 7	0.000000	0.000000	0.000000	0.000000	0.000000	0.091075	0.071022	0.100609
	Company 8	0.000000	0.000000	0.000000	0.000000	0.000000	0.091075	0.071022	0.100609

Done

Figure 5.5 - Weighted Super Matrix

By analysing Fig. 5.5, it is possible to identify a State with each company. The number with a higher value is the one that identifies which state will have each alternative. According to Figure 5.4 where the priorities can be seen and now the figure 5.5 with the Weighted Super Matrix, Company X should act as follows on the next table:

Table 5.53 Company X next steps

Order	Company	State
1º	Company 6	Client
2º	Company 3	Representative
2º	Company 4	Representative
2º	Company 5	Representative
2º	Company 7	Representative
2º	Company 8	Representative
3º	Company 1	Not interesting
4º	Company 2	Not Interesting

As a final conclusion, Company X can start dedicating its time to Company 6 by trying to get them as a client. The mix of all the studied characteristics and features makes this company the one where to act next. Regarding Company 3, 4, 5, 7 and 8, since they all show the same priority and the State Representative, it is recommended to analyse the company characteristic that also showed to be a very important asset, Marketed Alloys. Since Company X has this feature from all of them, it is a way to prioritize each one of them. Company 1 and 2 that show on the bottom of the table, Company X will not invest time with these two. Having in consideration all the important aspects of the semi-finished products industry and markets being studied, these two revealed not to be interesting.

6. Results Discussion

An intensive study was applied and with the help of the professionals from Company X, it was possible to implement this methodology in its business in order to test it.

With the first steps of this methodology, while analysing the market, one of the main difficulties that Company X could find in the markets Brazil, Argentina, Chile and Mexico is the language barrier. Some of the players in the markets were able to communicate in English, but the majority showed a lot of difficulties. The beginning of the relationship with the market players was always the hardest part. When the first contact was made, the person on contact was always at the bottom of the hierarchy of the company. When the relationship started to be stronger and the point of contact was the decision maker, the communication always become smother. Regarding communication channels, doesn't seem a problem between the two markets. Email and phone calls showed to work very well to communicate.

The results with the PESTLE analysis, shown the blueprint of each market conditions and how each country is holding on in a macro perspective. Generally, and one of the biggest conclusions for Company X, it was to discover that Mexico is the most attractive company to work with and that Brazil is passing through rough times at several levels. This influenced a lot of the professionals while answering the questionnaires of the pairwise comparison of the ANP. They knew that companies from Brazil were unattractive when compared to another market and the opposite whit Mexico, they were always more attractive.

In terms of the business itself, and analysing the results from the SWOT analysis step, this methodology helped to understand that Company X has interesting technological advances. Germany is on top of metal technology and quality. The way that the products are produced and the alloys itself were superior to all the four markets. Every time a contact was made, just by the fact that is mentioned that Company X is German, the interest on establishing contact was big. This was identified as a big strength. At the same time, some other competitors are already on the move to also take over those markets. While investigating, it was identified that players like China or Spain are already present in these four markets. China can compete with the price, but Spain produces really similar products with the same quality. It was identified that Company X has space to compete, but it has to make a move. It must to be fast and take advantage of the strengths that it has. These recommendations were all delivered in a form of a final report.

In the specific case of Company X, the ANP model suited very well. At the beginning of the study, it was not clear what to do in the South America market and what to do with its players.

By applying the ANP it was possible to figure out the next steps. When analysing the Fig. 5.4 Priorities, it possible to see that Company 6 is the one that needs the first action, which makes sense when crossing results with Fig. 5.4. Company 6 is the one to take action and to have it as a client. From all the alternatives had into consideration, Company 6 was the only one that got together all the characteristics to be a client. Company 3, 4, 5, 7 and 8 gathered all the features to be a representative of Company X in their markets. Having in the consideration that the German companies are very well seen in Brazil, Argentina, Chile and Mexico, Company X becoming a representative there it is well seen in these markets. Last, Company 1 and 2 ended up not being interesting to invest time and resources.

The fact that Company 1 and Company 2 belong to Brazil and both showed up no to be interesting it might be correlated. When analysing the results of PESTLE analyses, the businesses managers commented how unstable was Brazil and how risky it would be to move there. This fact influenced a lot of their answers when comparing these two companies with other markets.

Because companies in Brazil ended up not being interesting and Company 6 classified to be a client, it leaves Company 3, 4, 5, 7 and 8 all in the same level, to be representative. In order to know what to do first, businesses managers suggested analysing the most important characteristic for them. By looking to the Fig. 5.4. Priorities, it is possible to see that the Marketed Alloys is the most important characteristic. This can be explained by the fact that in Germany, the quality of the products is very important. It was possible to see during the development of the project that Company X gives a lot of importance to the alloys used in the products. One of the main differences that were commented at the end of the project, was the fact that South America still uses a lot of lead in their products. European companies have now norms that control the percentage of lead since it was identified as a cause of cancer. Because of this, the Marketed Alloys showing up as the main characteristic for the Company X, was already expected.

The companies that work with the same alloys that Company X, are the ones where they should act first and try to get them as representative.

The fact that the exact names and details of the companies used in the study and all the details of Company X cannot be disclaimed in this research, made that the practical results presented in here have some limitations. Company X did not allow to share all the information, which made the dissertation limited in some aspects.

7. Conclusions and Recommended Future Work

It is clear that if companies want to be successful and competitive within the market they operate, the strategy is without a doubt on top of their concerns. The processes implemented must be optimized and help the business to move forward. In order to be a step ahead from the competition, there is the need to predict or to decide what do as the next move. As written in this dissertation, studying new markets and have the possibility to expand to new countries is for sure in the minds of a lot of top managers. Specifically, in the industry of semi-finished bronze industry, the time frame to act and to be competitive is quite short. The industry in Europe is dominated by the German market, but for example, the Chinese one is clearly stepping forward. This is a sample of why companies want to predict their moves and find guidance on what to do. They want to be in the front line. The market is hard, and the profit is always dependent on the value of the metals in the stock exchange.

This research attempts to cover the lack of a methodology that semi-finished bronze foundries have in terms of strategy to explore new markets. The combination of several tools, putting them in a strategic order with a tactic point of view and completely adapted to the characteristics of the industry, gives to top managers the ability to better organized a plan, share with the team, have substantiated arguments and implement the strategy.

First, it is proposed a contact through different channels with peer to peer businesses and professionals of the area in order to get the first feeling of the environment. Also, it showed to be a good first step because it helps to understand how people communicate in that market in term of technical concepts, answer time frames and which channels work better (phone, email…). Second, by applying PESTLE Analysis as next step, it helps to understand the way of leaving and conditions that people have. Getting an overview of the characteristics of the market, gives the macro information that is necessary to understand mindsets, population stability, among other important facts that determines if it is a good move to invest the business in that market or not. Third, after the macro analysis, SWOT showed to be the logical next stage. Like this is possible to analyse performance and have a comparison from the business with the surrounding market to comprehend what can be improved to get an advantage. One of the most important information that can be taken from this step, is the fact that allows to relate the business that is being studied with the ones already existing in the new market and like this, get a better insight of the positive and negative aspects about it.

The fourth and final step is to apply the Analytic Network Process. This stage was the one that took longer to adapt to this market. The outcome of this experience was the ANP General Model

that can now be applied to any semi-finished bronze foundries in the world. This tool proved to be a powerful decision-making method to prioritize the best factors in this kind of foundries industry and to put in one diagram all the features and items that are shown to be important to evaluate. It helps and supports, without a doubt, decision makers in making choices. Important to mention again that the variable factors that are different when applying this ANP Model to another context are the Countries, the Alternatives and the State. One of the disadvantages that are identified in this tool, is the large number of pairwise comparisons that is necessary, which can take a bit of time to complete it and also has the risk of having inconsistency with the responses. If that happens, the answers must be reviewed by the person who did it under the guidance of the person that is conducting the study.

During the development of this thesis, some limitations were identified. The fact that the sales department only had two professionals available to answer the quiz related with the pairwise comparisons limited the amount answers. Also, opinions and professional experience on which factors are crucial and essential to a semi-finished bronze products foundry were also limited by the two professionals available. It would be interesting to have at least a team of four were more points of view would be taken into consideration. Although only two people answered the questionnaire, some inconsistency was present. The judgments had to be reviewed by both the intervenient to solve this problem. After this review everything was consistent, and the model computation was conducted.

Future work will be necessary to expand corroborations and to include more input into this methodology. More studies about the semi-finished bronze products should be analysed. It would be interesting to develop and validate the model with other foundries, not only bronze but also (for example) steel to compare those findings with the ones reported here.

Another thing that could be explored is the ANP model itself. Adding more variables to the equation and more clusters could be a way of getting more precise answers. Also, the fact that the information of the ANP was based in two strategic tools, leaves room for more work to be done. Other strategic tools can be added to the methodology or even substitute the ones used in this one.

In this methodology was not a rule, but the fact that it was only available tree states to classify the alternatives (client, representative and not interesting), it ended up giving a result where the alternatives ended up with the same state. Like it was recommended by the business managers, it is necessarily something that can help in to decide the next step. The recommendation that was given, it could be added as a step in this methodology. Every time an alternative is classified with

the same state, it is taken into consideration the alternative that has the most convenient characteristic.

Finally, some of the aspects that could be explored are the fact that the ANP clusters were created based on the feedback from the sales team. It would be interesting to test and edit the ANP model where the main criteria would be based on the Strengths, Weaknesses, Opportunities and Threats of the business and like that create a SWOT-ANP based strategic management model.

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9. Annexe

Results of the Pairwise Comparison Inquiries:

Figure 9.1 - Comparisons between Company Characteristics node and Company Characteristics Description cluster

Figure 9.2 - Comparisons between Company Type node and Company Type Description cluster

Figure 9.3 - Comparisons between Market Characteristics node and Market Characteristics Description cluster

Figure 9.4 - Comparisons between Existence in the Market node and Alternatives cluster

Figure 9.5 - Comparisons between Existence in the Market node and Company Characteristics Description cluster

	Left	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Right
1.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 2
2.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 3
3.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 4
4.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 5
5.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 6
6.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
7.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
8.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 3
9.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 4
10.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 5
11.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 6
12.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
13.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
14.	Company 3	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 4
15.	Company 3	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 5
16.	Company 3	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 6
17.	Company 3	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
18.	Company 3	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
19.	Company 4	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 5
20.	Company 4	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 6
21.	Company 4	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
22.	Company 4	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
23.	Company 5	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 6
24.	Company 5	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
25.	Company 5	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
26.	Company 6	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
27.	Company 6	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
28.	Company 7	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8

Figure 9.6 - Comparisons between Products Available node and Alternatives cluster

	Left	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Right
1.	Contact Info	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Existance in th~
2.	Contact Info	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Existance of Pe~
3.	Contact Info	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Marketed Alloys
4.	Existance in th~	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Existance of Pe~
5.	Existance in th~	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Marketed Alloys
6.	Existance of Pe~	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Marketed Alloys

Figure 9.7 - Comparisons between Products Available node and Company Characteristics Description cluster

Figure 9.8 comparison matrix (Marketed Alloys node and Alternatives cluster). Each row shows a comparison scale: >=9.5 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | >=9.5 | No comp.

#	Left	Right
1.	Company 1	Company 2
2.	Company 1	Company 3
3.	Company 1	Company 4
4.	Company 1	Company 5
5.	Company 1	Company 6
6.	Company 1	Company 7
7.	Company 1	Company 8
8.	Company 2	Company 3
9.	Company 2	Company 4
10.	Company 2	Company 5
11.	Company 2	Company 6
12.	Company 2	Company 7
13.	Company 2	Company 8
14.	Company 3	Company 4
15.	Company 3	Company 5
16.	Company 3	Company 6
17.	Company 3	Company 7
18.	Company 3	Company 8
19.	Company 4	Company 5
20.	Company 4	Company 6
21.	Company 4	Company 7
22.	Company 4	Company 8
23.	Company 5	Company 6
24.	Company 5	Company 7
25.	Company 5	Company 8
26.	Company 6	Company 7
27.	Company 6	Company 8
28.	Company 7	Company 8

Figure 9.8 - Comparisons between Marketed Alloys node and Alternatives cluster

Figure 9.9 comparison matrix (Marketed Alloys node and Company Characteristics Description cluster). Each row shows a comparison scale: >=9.5 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | >=9.5 | No comp.

#	Left	Right
1.	Contact Info	Existance in th~
2.	Contact Info	Existance of Pe~
3.	Contact Info	Products Availa~
4.	Existance in th~	Existance of Pe~
5.	Existance in th~	Products Availa~
6.	Existance of Pe~	Products Availa~

Figure 9.9 - Comparisons between Marketed Alloys node and Company Characteristics Description cluster

1.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 2
2.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 3
3.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 4
4.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 5
5.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 6
6.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
7.	Company 1	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
8.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 3
9.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 4
10.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 5
11.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 6
12.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
13.	Company 2	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
14.	Company 3	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 4
15.	Company 3	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 5
16.	Company 3	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 6
17.	Company 3	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
18.	Company 3	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
19.	Company 4	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 5
20.	Company 4	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 6
21.	Company 4	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
22.	Company 4	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
23.	Company 5	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 6
24.	Company 5	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
25.	Company 5	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
26.	Company 6	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 7
27.	Company 6	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8
28.	Company 7	>=9.5	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	>=9.5	No comp.	Company 8

Figure 9.10 - Comparisons between Permanent Stock node and Alternatives cluster

Figure 9.11- Comparisons between Permanent Stock node and Company Characteristics Description

Figure 9.12 - Comparisons between Contact Info node and Alternatives cluster

Figure 9.13 - Comparisons between Contact Info node and Company Characteristics Description cluster

Figure 9.14 - Comparisons between Metal Trader node and Alternatives cluster

Figure 9.15 - Comparisons between Foundry node and Alternatives cluster

Figure 9.16 - Comparisons between GDP History node and Countries cluster

Figure 9.17 - Comparisons between Country Culture node and Countries cluster

Figure 9.18 - Comparisons between Currency node and Countries cluster

Figure 9.19 - - Comparisons between Imports and Exports node and Countries cluster

Figure 9.20 - Comparisons between Import Taxes node and Countries cluster

Figure 9.21 - Comparisons between Standard Norms node and Countries cluster

Figure 9.22 - Comparisons between Delivery Time node and Countries cluster

Figure 9.23 - Comparisons between Transport Prices node and Countries cluster

Figure 9.24 - Comparisons between Border Relationship node and Countries cluster

Figure 9.25- Comparisons between Brazil node and Alternatives cluster

Figure 9.26 - Comparisons between Argentina node and Alternatives cluster

Figure 9.27 - - Comparisons between Chile node and Alternatives cluster

Figure 9.28 - Comparisons between Mexico node and Alternatives cluster

Figure 9.29 - Comparisons between Client node and Alternatives cluster

Figure 9.30 Comparisons between Client node and Countries cluster

Figure 9.31 Comparisons between Representative node and Alternatives cluster

Figure 9.32 Comparisons between Representative node and Countries cluster

Figure 9.33 - Comparisons between Not Interesting node and Alternatives cluster

Figure 9.34 - Comparisons between Criteria Cluster

Figure 9.35 - Comparisons between Company Characteristics Description Cluster and Alternatives cluster

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1. Alternatives | >=9.5 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | >=9.5 | No comp. | SB: Countries

Figure 9.36 - Comparisons between State Cluster