**PONTIFICIA UNIVERSIDAD CATÓLICA DE VALPARAÍSO**

**FACULTAD DE CIENCIAS ECONÓMICAS Y ADMINISTRATIVAS**

**ESCUELA DE INGENIERÍA COMERCIAL**

# Business to Business market segmentation

**Theoretical and practical market segmentation in the pharmaceutical industry of Europe and the United States**

**Memoria para optar al grado de**

**Licenciado en Ciencias en la Administración de Empresas**

**y al título de Ingeniero Comercial**

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# ABSTRACT

Las empresas pueden ser caracterizadas como organizaciones enfocadas en el mercado de consumidores (Business to Consumers – B2C) o en el mercado de empresas (Business to Busines – B2B), dependiendo del tipo de cliente quieren satisfacer. Ambas organizaciones necesitan segmentar sus mercados para encontrar la forma más eficiente de asignar sus limitados recursos y maximizar los esfuerzos de marketing. Diferentes autores han focalizado sus esfuerzos en desarrollar modelos de segmentación específicos para los mercados B2B. En esta investigación, el autor va a presentar una aplicación teórica y práctica del "Nested Approach" (Enfoque de Nido o Jerarquizado) (Shapiro and Bonoma, 1983) en la industria farmacéutica. Al mismo tiempo, éste enfoque será complementado con el análisis cluster jerárquico; una metodología estadística que puede ser usada para segmentar mercados bajo parámetros estadísticos.

El autor desarrollará las diferencias entre mercados B2B y B2C, los procesos de segmentación de mercado y los diferentes modelos de segmentación para empresas B2B. Finalmente, el autor utilizará la información de investigación de mercado de una empresa farmacéutica alemana, usando el "Nested Approach" complementado con un análisis cluster jerárquico, para realizar una segmentación de mercado en el mercado farmacéutico de Europa y los Estados Unidos.

**Keywords:** Marketing, Segmentación, Investigación de mercados, Análisis Cluster, Modelos de segmentación, Industria farmacéutica, Business to Business, Marketing industrial

# ABSTRACT

Companies can be characterized as Business to Consumer (B2C) or Business to Business (B2B) organizations, depending on which kind of customer they want to satisfy. Both kinds of organizations need to segment their markets to find most efficient way to allocate their limited resources and maximize marketing efforts. For the same reason, different authors have focused their efforts to generate specific segmentation models for Business to Business markets. In this research, the author will present a theoretical and practical application of the Nested Approach (Shapiro and Bonoma, 1983) in the pharmaceutical industry. At the same time, the Nested Approach will be supported with a Hierarchical Cluster Analysis; a statistical methodology that can be used to segment markets under a statistical basis.

The author will develop the differences between B2B and B2C markets, the market segmentation process and different segmentation models for B2B companies. Finally, the author will use the market research information of a German pharmaceutical company to perform a market segmentation on the European and U.S. pharmaceutical markets, using the Nested Approach supported by the Hierarchical Cluster Analysis.

**Keywords:** Marketing, Segmentation, Market Research, Cluster Analysis, Segmentation Models, Pharmaceutical Industry, Business to Business Marketing, Industrial Marketing

# CHAPTER I: INTRODUCTION

In the first chapter, the author presents the personal reasons that motivate this investigation, formally states the research problem and defines its objectives. Finally, the author will present a brief profile of the company where the research took place, and the state of the art of topics related to Business to Business Markets.

## A. PERSONAL REASONS TO CHOOSE THE RESEARCH TOPIC

During the researcher´s undergraduate experience at the School of Business and Economics at the Pontificia Universidad Católica de Valparaíso, marketing was one of the disciplines that caught his attention both as a student as well as a teaching assistant of the Marketing courses. Throughout his undergraduate degree, Marketing courses were focused in Consumers Markets (B2C) with a theoretical and practical emphasis on subjects related to Market Research, Operative Marketing and Strategic Marketing. Although Business to Business (B2B) Marketing issues were discussed, revisions of these topics were not taught in the same depth as those in consumer markets.

As an exchange student at the European School of Business at the Reutlingen University (Reutlingen, Germany), the researcher had his first approach to Business to Business Marketing issues at a theoretical and practical level. Thereafter, during an international internship as Junior Product Manager for Gadovist®[1] in the Strategic Marketing department for the Magnetic Resonance Imaging (MRI) products at Bayer Healthcare AG[2] (Berlin, Germany), the author had the experience to live the particular problematic that affect the marketing activities and strategic planning in a B2B context.

Therefore, the author has a big personal interest in deepen in the topics related to B2B Marketing to keep improving his knowledge in this area before going out to the labor market. He also hopes that the information, techniques and knowledge written here, will be useful for later consult of the reader.

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[1]Gadovist® is a Magnetic Resonance Imaging (MRI) contrast agent marketed by Bayer HealthCare AG. An MRI scan is a radiology technique that uses magnetism, radio waves, and a computer to produce images of body structures. The contrast agents, also known as contrast media, are injected to the blood during medical imaging examinations to highlight specific parts of the body and enhance their contrast to have a better imaging quality.

[2] For more information about the company, see appendix N°1, p 133.

### B. MERIT FOR THE BUSINESS SCHOOL OF THE PONTIFICIA UNIVERSIDAD CATOLICA DE VALPARAISO

It seems to be a broad range of investigations about applications of cluster analysis techniques for market segmentation or customer typologies in consumer markets, but that is not the case for Business to Business markets. For the same reason, the author counted with fewer examples of this kind of statistical applications for B2B markets and few examples applied in the pharmaceuticals industry. It will be a merit for the Business School to develop an investigation in a less researched area.

The main idea of this research is to add a new investigation topic for future marketing dissertations in the Business School of the Pontificia Universidad Católica de Valparaíso and increase the awareness of its students regarding the importance and characteristics of marketing activities in a B2B environment. Furthermore, the undergraduate students would have new supporting material related to the Business to Business marketing for future dissertations and other activities related to the Business School.

### C. STATEMENT OF THE RESEARCH PROBLEM

In order to perform a diagnostic of the radiologists market and discover the positioning of Bayer´s MRI products in different markets according to different product´s attributes and other information, the Strategic Marketing department for MRI products of Bayer Healthcare AG hired, in September of 2011, an external company to perform a market research study in ten countries (Germany, France, Italy, Spain, Canada, South Korea, Mexico, United States, China and Brazil). Most importantly, the mentioned department wanted to analyze the actual status of the Bayer MRI product called "Gadovist®" in different markets.

During the study, 776 online interviews were performed to radiologists that personally performed or oversaw at least 10 enhanced MRI scan per week. The questions were classified in the followings topics: overall company image; awareness and usage of MRI agents; brand awareness; positioning; selection criteria for MRI agents; proof of concept for advertise images.

The current market segmentations performed by the Strategic Marketing for MRI department are based in the Portfolio theory[3]. They count with support of quantitative

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[3] "Relationship portfolio literature, based on financial investment theories, takes the view that customers and suppliers are often an organization's greatest asset and try to address a better management of buyer – seller relationship for a better allocation of human, technical and financial resources". Talwar, V., 2006,

information obtained from market reports conducted by external companies or market research activities performed by the company. Additionally, they count with qualitative information obtained from interviews applied to opinion leaders, focus groups and internal workshops with the MRI brand teams from different countries. However, they do not use statistical multivariate methods to support these segmentations. Nonetheless, the information obtained in the mentioned market research could be useful to perform these analyses. Giving the circumstances, the author proposed to use the collected data to explore the possibility to use a cluster analysis to segment the radiologist market.

Therefore, the following research do not seek to replace the actual segmentation process of the department, but to expand the spectrum of tools that can be used to identify different market segments. The multivariate methods could be determinant at the moment of dividing the market and analyzing the importance of variables assigned to each segment, becoming an important complement for the existing segmentation process performed at the Strategic Marketing for MRI department of Bayer Healthcare AG.

This study pretends to explore different customer's segmentation for the radiologist markets in different geographical configurations using statistical and multivariate methods, specifically, the hierarchical cluster analysis performed with the IBM SPSS v.19 computer program.

**Value Based Approach to Customer Relationship Portfolio Management: A Case Study from the UK Industrial Market Context**, England, Manchester Business School, Doctoral Program Paper, P. 2.

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## D. OBJECTIVES

- To conceptualize market segmentation differences between a B2B and B2C context according to the market segmentation and marketing literature.

- To identify models, variables and criteria applied in B2B contexts, as discovered in the B2B Marketing literature.

- To propose new segments / customers' classifications for the Strategic Marketing MRI department of Bayer Healthcare through a Cluster analysis.

- To conduct a Cluster Analysis based on a theoretical market segmentation framework for B2B markets, in order to compare the results with the outcome of the segmentation performed for Bayer Healthcare.

- To draw conclusions about the relevance of processes, criteria and variables for market segmentation and customer profiling according the comparison of the results.

## E. DESCRIPTION OF THE METHODOLOGY

### E.1. Design of the study

According to the classification made by Malhotra and Birks (2006, pp. 60-90), the following investigation corresponds to a descriptive and single cross-sectional study with a conclusive design.

This study is a conclusive - descriptive investigation, because it looks to measure different relationships and hypothesis with clearly defined information. This information comes from a large and representative sample, and it will be analyzed with a quantitative method. A Hierarchical Cluster Analysis will be performed with the information gathered by a survey the year 2011 to identify different customer profiles[4]. Data collected were obtained from the answers and opinions given by the interviewed in a non-controlled environment and without applying external stimulus to the respondents.

The investigation can also be classified as single cross sectional study, because the study gathered the information and data in an specific moment in time, without performing other evaluations to the variables used in this research, during an extended period of time.

In the next figure, the author pretend to provide to the reader with a better understanding of the steps and procedures used in this investigation to reach his conclusions about the exploration of different costumer's segmentation for the radiologist markets in different geographical areas with a B2B segmentation model and a Hierarchical Cluster Analysis. First, a theoretical segmentation procedure will be performed to discover what kinds of results can be expected using the B2B segmentation model with the clustering methodology. Afterwards, the information will be used to segment the radiologist´s market for a German pharmaceutical company.

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[4] For some examples, see: Punj, G., and Stewart, D., 1983, **Cluster Analysis in Marketing Research: Review and Suggestions for applications**, Journal of Marketing Research, vol. XX (May 1983), p. 137.

**Figure 1.1.Scheme for the research**

**E.2. Description of the population to study**

The universe of the population to study is composed by female and male radiologists that perform personally or oversee enhanced MRI exams in Germany, France, Italy, Spain, Canada, South Korea, Mexico, United States, China, United States[5] and Brazil.

### E.2.1. Sample selection

The sample selected for the following research is composed by 776 female and male radiologists working in a private practice or a hospital and perform personally or oversee at least 10 enhanced MRI scan per week in Germany, France, Italy, Spain, Canada, South Korea, Mexico, United States, China and Brazil.

**Table 1.1. Sample size per country**

| Country | Hospital-based | Office-based | Total | % |
|---|---|---|---|---|
| Germany | 44 | 40 | 84 | 10,8% |
| France | - | 70 | 70 | 9,0% |
| Italy | 70 | - | 70 | 9,0% |
| Spain | 70 | - | 70 | 9,0% |
| Canada | 50 | - | 50 | 6,4% |
| South Korea | 70 | - | 70 | 9,0% |
| Mexico | 40 | - | 40 | 5,2% |
| USA (radiologists) | 80 | 34 | 114 | 14,7% |
| USA (admins) | 43 | 24 | 67 | 8,6% |
| China (incl. boost) | 70 | - | 70 | 9,0% |
| Brazil (incl. boost) | 71 | - | 71 | 9,1% |
| TOTAL | | | 776 | 100,0% |

Source: Adapted from the MRI Tracking Study 2011

To ensure that the number of respondents reflects the number of performed enhanced MRI procedures in each country the data was weighted when calculating the total column in the following chart. The weighting factors are based on the number of enhanced MRI procedures performed in each country in 2010.

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[5] In the U.S. sample, it is possible to see radiologists and radiologists with administrative function (admnis)

**Table 1.2. Weighting Methodologies**

| Country | MRI proc. | % target | n | % is | Weight | Weighted n | |
|---------|-----------|----------|-----|--------|--------|------------|------|
| Brazil | 1000 | 5,65% | 54 | 7,41% | 0,763 | 41,20 | 41 |
| Canada | 305 | 1,72% | 50 | 6,86% | 0,251 | 12,56 | 13 |
| China | 1613 | 9,12% | 40 | 5,49% | 1,661 | 66,45 | 66 |
| France | 1496 | 8,45% | 70 | 9,60% | 0,880 | 61,63 | 62 |
| Germany | 3302 | 18,66% | 84 | 11,52% | 1,619 | 136,03 | 136 |
| Italy | 941 | 5,32% | 70 | 9,60% | 0,554 | 38,77 | 39 |
| Korea | 643 | 3,63% | 70 | 9,60% | 0,378 | 26,49 | 26 |
| Mexico | 120 | 0,68% | 40 | 5,49% | 0,124 | 4,94 | 5 |
| Spain | 634 | 3,58% | 70 | 9,60% | 0,373 | 26,12 | 26 |
| USA | 7642 | 43,18% | 181 | 24,83% | 1,739 | 314,82 | 315 |
| | 17696 | 100% | 729 | 100% | | | 729 |

Source: MRI Tracking Study 2011

The second column shows the MRI procedures per country (in thousands) and the third column shows the procedures share of each country in the sample. The "n" column shows the amount of radiologist interviewed in each country and the following column show the radiologist´s share of each country in the total sample. The weight column is the "% target" (% share of procedures) column divided by the "% is" column (% of radiologist). The two finals columns represent the weight of each country according to their procedures and radiologists share in the sample ("Weight" column x "n" column). This way is possible to address that each country amount of procedures are well represented in the radiologist's sample.

### E.3. Observation instrument[6]

The investigation instruments used in this research were 776 online individual questionnaires, which were conducted by a consumer´s insight agency specialized in the healthcare industry during the months of September and October of 2011. The survey was named as "MRI Tracking Study 2011". The questions were distributed in the following areas: company image, awareness and use of MRI contrast agents (methods contrast MRI) brand awareness, positioning, selection criteria for MRI agents.

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[6] See appendix N°2: Questionnaire for the MRI Tracking Study 2011, p. 138

### F.  STATE OF THE ART

For research purposes, the author needed to explore a vast range of literature in the field of B2B Marketing and Market Segmentation.  The goals of this research are to segment the radiologist market with the support of a B2B segmentation model and a cluster analysis. To the author's best understanding, there is no evidence of other studies referring the application of a hierarchical cluster analysis for market segmentation purposes in the pharmaceutical industry, as there are in other industries. For this reason, the author believe that will be a good exercise to try out this multivariate method to segment the radiologist market. In table 1.3 the author will present the most relevant literature used in this study.

#### F.1. Business to Business Markets

As marketing literature has been growing and evolving during the moderns years, there has been emerging different classifications to help to understand the business environments where the organizations and firms are conducting their activities. Coviello and Brodie (2001, p. 238) pointed out that such classifications suggest that marketing and business practices are different and variant according to some characteristics like "different types of customers (e.g. consumer vs business), different market offerings (e.g. goods vs services), different geographic scope (e.g. domestic vs international), or different size and age characteristics (e.g. small vs large, or newer vs more established firms)". The important classification for the purposes of this dissertation is the Consumer vs Business dichotomy.

Business-to-Business markets comprehend a series of specific characteristics compared to the consumers markets. The B2B markets are constituted by companies, governments and institutions that sell products and services that do not reach the final costumers in the consumer markets, but participate in the production of another products or services (Kotler, Armstrong, Saunders and Wong, 1999). For the same reason, these organizations can be buyers and suppliers at the same time.

The most important differences are related to the kind of customers composing each market and the way they buy and use the product (Hutt and Speh, 2010). While consumer markets are formed by individuals or families, in the B2B environment, the consumers are other organizations such as governments and institutions that need products and services to produce others products and services (Kotler et al., 1999). This situation was well exemplified by Webster (1991, p. 4) who defines the industrial marketing as "the marketing of goods and services for industrial and institutional consumers. These include

manufacturing firms, governments, public utilities, educational institutions, hospitals, wholesalers, retailers, and other formal organizations". Webster (1991, p. 4) also refers to the consumer marketing as "marketing to individuals, families and households purchasing goods and services for their own consumptions".

In general, the differences between consumer and business markets are widely accepted in the marketing literature and these dissimilarities are related to subjects such as: type of demand, buying behavior, relationship marketing practices, classification of customers and classification of goods use for production (Blythe and Zimmerman, 2005; Hutt and Speh, 2010; Kotler et al., 1999; Webster, 1991). These differences and other specific characteristics of the B2B markets will be addressed in the second chapter of this dissertation.

**F.2. Market Segmentation**

Market segmentation has been an important topic in marketing literature over the decades. More than 1,750 papers about market segmentation were published between 1956 and 2008 (Boejgaard and Ellegaard, 2010). Additionally, 610 papers were published in the 40 most important journals for the marketing community with the words segmentation, segmenting, segment, or segments in their title (Theoharakis and Hirst, 2002). There is no doubt about the importance given by marketing researchers to market segmentation related subjects.

The idea of segmentation, as a marketing related concept, can easily be traced down to 1956. Wendel Smith (1956, p. 6) introduced the concept of market segmentation as "viewing a heterogeneous market (one characterized by divergent demand) as a number of smaller homogenous markets in response to differentiate product preferences among important market segments". The objective of this paper was to differentiate the strategies of "product differentiation" and "market segmentation". The first one is an attempt of suppliers to bend the demand to the will of the supply (Smith, 1956, p. 5), while the second one shape the marketing efforts to consumers´ requirements, because the demand is not homogenous due to "different customs, desire for variety, or desire for exclusiveness or [...] user needs" (Smith, 1956, pp. 4 - 5).

The act of segmenting markets is based upon the assumption that due consumer´s behaviors and competitive environment, there is no product or service that will satisfy all consumers (Wind and Bell, 2008), making necessary for companies to divide the market in diverse groups of customers or market segments with similar internal requirements (Robertson and Barich, 1992).

**Table 1.3. Fundamental literature description**

| AUTHOR | YEAR | DESCRIPTION |
|--------|------|-------------|
| Wendell R. Smith | 1956 | In "Product differentiation and market segmentation as alternative marketing strategies" the concept of "Market Segmentation" was introduce for the first time. It is describe as a business strategy that seeks to shape products and marketing efforts to consumer requirements. |
| Yoram Wind and Richard Cardozo | 1974 | The authors describe in "Industrial Market Segmentation" a two step segmentation approach. They develop a Macrosegmetation based on overall characteristics of customers and a Micro segmentation based in the Decision-Making Units of B2B companies. |
| Jean-Marie Choffray and Gary L. Lillien | 1978 | Based on the Two Step Approach of Wind and Cardozo (1974), these authors develop an industrial market segmentation based on the purchasing process and influence of the participants in the Decision-Making Units of B2B companies. |
| Benson P. Shapiro and Thomas V. Bonoma | 1984 | In "How to segment industrial markets" published by the Harvard Business Review magazine, they develop their Nested Approach for B2B segmentation. The Nested approach segment the market according to 5 layers in the following sequence: Demographics, Operating Variables, Purchasing approach, Situational Factors and Personal Characteristics. |
| Thomas S. Robertson and Howard Barich | 1992 | The authors identify in "A successful Approach to Segmenting Industrial Markets" an effective market segmentation approach after segmenting the customers by the phase of the purchase decision process. |
| Russell Abratt | 1993 | In "Market Segmentation Practices of industrial Marketers" was published an empirical research to discover the practices of the industrial marketers. With a sample of 32 industrial South African´s companies, the author discovered different variables and criteria used for segmenting markets, select segments and marketing actions used to reach them. |
| Yoram Wind and Robert J. Thomas | 1994 | The authors describe in "Segmenting Industrial Markets" the industrial market segmentation as a decision process with five key interaction managerial decisions: Decision to Segment, Segment Identification, Segment Selection, Resource Allocation and Implementation. Wind is well known for his Two Step segmentation approach: Macro and Micro segmentation. |
| Stavros P. Kalafatis and Vicki Cheston | 1997 | In "Normative Models and Practical Applications of Segmentation in Business Markets" is published an empirical investigation in the UK pharmaceutical sector. The authors tried to identify the criteria applied by pharmaceutical companies at different stages of the segmentation process. They conclude that the approaches adopted by these companies are consistent with the academic proposed models. |
| Per Vagn Frytag and Ann Hojbjerg Clarke | 2001 | The authors discuss in "Business to Business Segmentation" the characteristics of industrial markets in relation to different market segmentation models. They also present a general segmentation model based on business relationships and networks. |
| Werner Reinartz and V. Kumar | 2002 | In "The Mismanagement of Customer Loyalty", author gives a better understanding of the link between loyalty and profits arguing that a loyal relationship is not always profitable. At the same time, they segment the customer un a 2x2 Profitability/Loyalty Matrix. |

Source: Made by the author.

In the next chapter, the author will present a deep review about differences, similarities and characteristics of B2B and B2C markets. Afterwards, an analysis of different issues related to market segmentation will be provided. At the end, different B2B market segmentation models will be introduced.

# CHAPTER II: THEORETICAL FRAMEWORK

In the second chapter, the author will develop the concepts, characteristics and theories around Business to Business markets, market segmentation and Business to Business models for market segmentation.

Business to Business and Business to Consumers markets have some different and unique characteristics that are important to compare and explain to address their importance in market segmentation activities and specific market segmentation models for B2B markets.

Some of these segmentation models will be explained to show their characteristics, differences, advantages and disadvantages during a market segmentation process.

## A. CHARACTERISTICS OF BUSINESS TO BUSINESS MARKETS

As it was pointed out Chapter I, the differences between consumer and business markets are widely accepted in the marketing literature. Some characteristics are unique in a B2B markets, as for example, the type of demand, buying behavior, relationship marketing practices, classification of customers and classification of goods use for production. These differences and other specific characteristics of Business to Business Markets will be addressed further in this chapter, especially those related to companies segmentation practices.

### A.1. Derived demand

Due to the nature of Business to Business markets, it is important to explain the concept of "derived demand". Unlike consumer markets, where the demand is "direct" (made directly from the consumer to the companies), B2B markets are more dependant from a "derived demand". When consumers demand products to companies, these companies have to demand production goods to other companies. Harrison, Hague and Hague (2010, p. 2) define the whole B2B markets around this concept saying that "Business-to-business marketing is therefore about meeting the needs of other businesses, though ultimately the demand for the products made by these businesses is likely to be driven by consumers in their homes". To exemplify this idea, it is good to think how cars are made. Cars are made by a variety of different parts such as motors, glasses, wheels and other materials. As consumers demand cars, there are companies that satisfy those consumers producing cars and these companies will buy to other companies' different components for producing those cars.

The "derived demand" reflects the core of Business to Business organizations. The consumers in B2B markets are looking for products and services that help them to produce their own products and services. For example, companies can buy cars too, but for their business activities. As Brennan, Canning and McDowell (2005, p. 8) clarify "business does not want fork-lift trucks or computerized logistics systems in the same way that consumer's want fashion clothing or computer games. The demand for fork-lift trucks and logistics systems is derived from the demand for products that they help to deliver". On the other hand, Blythe and Zimmerman (2005, p. 6) explain that "the consumer sales in most products consist of only one transaction compared to the several transactions that take places before that one final sale in the B2B world". For example, 18 business to business transactions were identified for the construction of a hairdryer (Blythe and Zimmerman, 2005, p. 6).

It is also important to address how this demand fluctuates depending on different market stimulus. The demand in the B2B markets is considered to be inelastic and fluctuating (Hutt and Speh, 2010; Kotler, 2002). An inelastic demand is not much affected by price changes in the short term, because producers are not able to do fast production changes. A fluctuating demand means that a small change on consumers´ demand can result on a big change on B2B markets demand.

## A.2. Buying behavior and decision process

The buying behavior is an important aspect that differentiates B2B markets from consumer markets. Kardes, Clonely and Cline (2011, p. 8) state that consumers´ behavior "entails all consumer activities associated with the purchase, use and disposal of goods and services". On the other hand, the organizational buying behavior is defined by Webster and Wind (1991, p. 13-14) as "a complex process (rather than a single, instantaneous act) and involves several persons, multiple goals, and potentially conflicting decision criteria". Buyers have to take decisions about the buying of a product or service, but variables that affect the buying process of the individual consumers and organizational buyers, are very different.

The buying process in consumer markets depends from one individual or a household, which are influenced by different factors such as culture (e.g. National or ethnic culture), social groups (e.g. friends or family), personal characteristics (e.g. age or lifestyle) or psychological factors (e.g. motivation or perceptions) (Kotler et al., 1999). Moreover, the buying process in B2B markets is affected by a large number of factors such as the formal structure of the organization and its influence in the buying process, the larger numbers of persons involved, complex technical and economic factors to be considered, the environment in which the company operates, large amounts of money involved in one transaction and larger time gaps between the start of the buying decision to its conclusion (Webster and Wind, 1972; Webster, 1991).

Organizations do not have to deal only with a diversity of external and internal factors that affects their buying behavior, but also with different purchasing situations that importantly affect them during their purchasing decisions (Blythe and Zimmerman, 2005; Kotler, 2002).

**Table 2.1: Types of purchasing decisions**

| STRAIGHT REBUY | MODIFIED REBUY | NEW TASK |
|---|---|---|
| • Buying situation of small complexity in which the purchasing is made in a routine basis. For example, buy the same product to the same supplier in the same amount of quantity every month. | • Buying situation that requires the buyer´s participation, because he wants to modify product´s prices, specifications or other characteristics and the seller, how has to agree if the modifications are possible and profitable. Modify rebuy can also imply a change of supplier. | • The buyer buys a product or hires a service for the first time. For that reason is a very complex buying situation that requires time and more effort of the participants in the buying decision making. |

Source: Adapted from Blythe and Zimmerman, 2005; Kotler, 2002

The factors and situations that affect the buying decisions in both markets are very different. In consumer markets, the decision is normally made by one individual, who can be influenced by different personal and environmental stimulus such as social groups or personality characteristics. On the other hand, in B2B markets, the decision depends from a group of persons, normally called "Buying Center", and from a large variety of factors which can make the buying decision more complicated than the consumers´ markets.

**A.3. Buying Center**

There are different opinions about the complexity of the buying process in B2C and B2B markets. It has been said that B2B buying process is much complicated and complex than a B2C buying process (Harrison, Hague and Hague, 2010; Webster, 1991), because all the dimensions that are involved. On the other hand, other authors say that B2B buying centers are formal and professional, because there are explicit decision-making practices in companies (Brennan, Canning and McDowell; 2005) or the amount of different departments and people involved in these processes can make it a very political practice trying to accord all interest (Morris, Pitt and Honeycutt, 2001).

All previous definitions are related to "Buying Center" in organizational buying. The "Buying Center" is the decision-making unit of a buying organization (Kotler, 2002). The "Buying Center", according to Webster and Wind (1972, p. 14), "includes all members of the organization who are involved in that process (buying process)". All these individuals can be categorized and divided in initiators, users, influencer, deciders, approvers, buyers, and gatekeepers (Kotler, 2002; Webster and Wind, 1972; Brennan, Canning and McDowell; 2005):

**Table 2.2. Buying Decision Center participants**

| INITIATORS | USERS | INFLUENCERS | DECIDERS | APPROVERS | BUYERS | GATEKEEPERS |
|---|---|---|---|---|---|---|
| Request the purchase item. Triggers the decision-making process. | Sometimes are also initiators and use or consume the product. | Contribute to the specifications and formulation of the purchase items. | Decide or make the purchase decision without being a formal authority. | People with power to authorize the proposed actions of the deciders and the buyers. | Purchase managers, they select and manage the buying process. | Control the flow of information between the participants of the decision process. |

Source: Adapted from Kotler, 2002; Webster and Wind, 1972; Brennan, Canning and McDowell, 2005

All these individuals can come from different departments, and have formal and informal roles within the organizations. Kotler (2002, p. 114) states "To target their efforts properly, business marketers have to figure out: Who are the major decision participants? What decisions do they influence? What is their level of influence? What evaluation criteria do they use?".

The goal of all purchases in a company is to help the company to develop their strategy, fulfill their objectives and deliver their products efficiently. On the other hand, the different interests from each department can enter into conflict during the process of selecting one supplier or product, making the buying process of organizations much more complex and time demanding than the buying process of households and individuals. Probably these interests affect not only the buying firm, but also the supplier which offers their product and services, because the supplier must satisfy the need of a complete organization and all the actors involved in one purchase. At the same time, companies have to be always aware of changes within the "Buying Centers".

It is important to address the characteristics of the "Buying Center" in B2B markets, because in some cases, it is the core component of some segmentation models. Sudharshan and Winter (1998, p. 10) pointed out that "it would appear that several approaches to the industrial segmentation are really attempts to better understand micro-industrial buyer behavior". This definition addresses the complexity of the market segmentation, as it is trying to link the market segmentation and the individual needs of the participants at the "Buying Center". The segmentation models for B2B markets will be discussed further in this paper.

As the "Buying Center" seems to add more complexity to the companies in their quest for satisfy the needs of their costumers, it seems imperative that B2B marketers must be

more involved with their customers' individual needs than in consumer markets, specially to adapt their products and services to the need of the organization they are serving (Blythe and Zimmerman, 2005). This situation proves that exist a more close relationship between the companies and the client than in the consumer markets (Elliot and Glynn, 2001). Hutt and Speh (2010, p. 29) stated that "Business marketing programs increasingly involve a customized blend of tangible products, service support, and ongoing information services both before and after sales. Customer relationship management constitutes the heart of business marketing".

In contrast with consumer markets, where consumers have a more passive attitude towards sellers, because they do not have a direct relationship with companies, in B2B markets, buyers and sellers have a more direct relationship. In much of the cases, they can be completely involved in the buying process. Hakansson (1982, p. 12) state that "industrial markets are characterized by stability and long-lasting relationships between buying and selling firms…In some situations, they are very complex, involving several people, functions and hierarchical levels in each firm. In contrast, other markets are characterized by simple relationships involving only a buyer dealing with a sales representative". Several B2B companies have been integrating their customers, suppliers or other partners to the organizational buying process or other marketing activities. Here is where the Relationship Marketing concept emerges for B2C and B2B market, but in different ways.

**A.4. Relationship Marketing**

Even if relationship marketing was not mentioned before as a distinct characteristic of the B2B markets, it is important to introduce the concept and how it affects differently to the B2B and B2C markets. For the Business to Business markets, Relationship Management activities are the core of their businesses, not only to reach the client, but to enhance their relationship with their suppliers. Regarding to this topic, Pick (1999) explain:

"This sector (industrial markets) has a tradition of reliance upon relationships, and a sophisticated approach to their development and maintenance, where key principles of relationship marketing, the importance of long term customer satisfaction, repeat business, close working relationships and collaboration with customers, have for several years been characteristic of this industry". (Pick, 1999, p. 263)

According to Berry (2002, p. 60), relationship management consist in "attracting, maintaining and--in multi-service organizations--enhancing customer relationships". On the other hand, after the revision of 5 different definitions of Relationship Marketing

(including Berry´s), Palmatier (2008, pp. 4-5) concludes that it is "the process of identifying, developing, maintaining, and terminating relational exchanges with the purpose of enhancing performance". Finally, Kotler et al. (1999, p. 483) expand the concept to "maintaining and enhancing strong relationships with customers and other stakeholders…focus on building value-laden relationships and marketing networks".

When companies start to conduct relationship management activities, they seek to increase their business performance creating long terms bonds with clients and suppliers. One of the most important disciplines for Relationships Management strategies is the Customer Relationship Management. This concept is defined by Palmatier (2008, p.7) as "the managerially relevant application of relationship marketing across an organization focused on customers, which leverages IT to achieve performance objectives". If Relationship Management is the science of long term relationships, Customer Relationship Management represents its application, which is supported by software and other IT or engineering applications, which help companies to address Relationship Marketing objectives.

In a normal basis, B2C companies try to get closer in their relationships with their customers in order to increase their loyalty over time and therefore, their profitability, arguing that keeping profitable costumers is cheaper than attracting new ones (Kotler et al., 1999). B2B companies try to be part of the buying process of their customers (buyers) or integrate their suppliers (sellers) to their buying decisions, creating a network of interaction between different parties to share flows of goods, information, financial resources or social exchanges (Grönroos, 1994). Such cooperation result in a close and interactive relationship between the value chain partners of the organization, creating a mutual interdependence between them (Sheth and Parvatiyar, 1995).

B2C companies can also apply relationship management with their supplier or other parties involved in their production processes to achieve differentiation or cost reduction strategies, but the difference is that in B2C markets the clients do not need their products as part of a production process. In the counterpart, B2B companies buy or sell products that are not always directed to the final consumer, but to complicated production chains. As Hakanson and Snehota (1995, p. 21) resume that "business enterprise looks more like a linking unit where its strategic attributes lie in how it connects other market participants to each other".

It is important to clarify the connection between Relationship Management and segmentation processes in B2B companies. Several authors have identified different

models for market segmentation focused on the value of customer loyalty. In these models, Relationship Marketing is one of the most important subjects. At the same time, Relationship Marketing importance increased in this models, because it is essential to keep long term relationships in this markets where the number of customers are just a few compared with the consumer markets (Zolkiewski and Turnbull, 2002; Brennan, Canning and McDowell; 2005).

**A.5. Classifications of products**

Other major characteristic in B2B organizations is the classification of products. As it was stated before, B2B companies offer products that other firms need to produce products and services. The biggest difference between B2B and B2C products is the reason why they are being bought (Brennan et al.; 2005; Kotler et al., 1999). Consumer products are bought by final consumers (families or individuals) for personal consumption, while industrial products are bought by organizations or individuals for further processing, manipulation or use in different process that helps to conduct a business or organization.

The classification for the consumers´ products are related to the shopping habits of consumers, if consumer buys them for different reasons, so they differ in how they are marketed (Kotler et al., 1999).

**Table 2.3. Classification for the consumers´ products**

| CONVENIENCE | SHOPPING | SPECIALTY | UNSOUGHT |
|---|---|---|---|
| Low priced and widely available consumer goods and services frequently purchased by the consumer, without a special effort in compare them with others. | Products less frequently purchased and consumers spend considerable time and effort in comparing them carefully with alternative brands. | Consumer goods with unique characteristics or brand identification for which a significant group of buyers is willing to make a special purchase effort. | Consumer goods that the consumer does not know that they exist or they know it, but normally they do not buy them. |

Source: Adapted from Kotler et. al., 1999

In B2B markets, products are classified in five different categories according to their participation in the production process of a product or service (Blythe and Zimmerman, 2005; Brennan et al., 2005; Kotler et al., 1999) and these five categories are grouped in three groups depending on how they affect the product or service cost structure and on

which part of the manufacturing process they participate (Blythe and Zimmerman, 2005; Hutt and Speh, 2010):

**Table 2.4. B2B classification for products**

| ENTERING GOODS | |
|---|---|
| Goods that become part of the finished product and are seen as a expense item in the manufacturing cost of the product. | |
| Raw materials | Manufactured materials and parts |
| Farm products and natural product that enter in the production process in their natural state, like natural minerals, potatoes or cotton. | They went through an initial processing, like textiles or sheet of steel. |

| FOUNDATION GOODS | |
|---|---|
| Capital goods. They are use up and they enter as a depreciation expense in the production process. | |
| Installations | Accessory Equipment |
| Long-term investment product which are the base of the manufacturing process, like buildings or fixed equipment. | Short-term and less expensive than the installations and are not considered as part of a fixed plant like portable drills or photocopying. |

| FACILITATING GOODS | |
|---|---|
| Suppliers and services that support the operations and processes of an organization without being part of the finished product or the production process. | |
| Suppliers | Services |
| Involve operating supplies or repair and maintenance items. | Different services that the companies cannot handle themselves, like reparation services, logistic, mobile phone services and more. |

Source: Adapted from Blythe and Zimmerman, 2005; Hutt and Speh, 2010

It is important to clarify that these classifications provide a good understanding about the nature of B2B markets, where most of the products do not reach the final consumer. Moreover, in B2B markets organizations are normally buyers and suppliers at the same time.

According to the previous product classifications, the MRI contrast agents can be considered "Entering Goods" (Manufactured materials and parts) as they are considered an expensive cost during the MRI exams or "Facilitating Goods" (Suppliers), because the hospitals or private practices do not produce these contrast agents and they need to buy them from different suppliers.

**A.6. Classification of costumers**

The same way that goods classification differs between B2C and B2B markets, customers have also a special classification in both markets. As it was said at the begging of this chapter, the costumer in B2C markets are individuals and households, while in the B2B markets, they are commercial enterprises (service firms, construction companies, resellers, manufacturers and more) governmental organizations and institutions (schools, healthcare's organizations, universities and more) (Kotler et al., 1999; Hutt and Speh, 2010).

From other approach, Hutt and Speh (2010) attempts to provide a special classification for the commercial enterprises grouping them in three categories (Users, Original Equipment Manufacturers and Dealers and Distributors), while Blythe and Zimmerman (2005) do something similar dividing them as Original Equipment Manufacturers,  Users and Aftermarket buyers. It is important to mention that these classifications can overlap one another.

**Table 2.5. Classification for the commercial enterprises**

| USERS | ORIGINAL EQUIPMENT MANUFACTURERS (OEM) | DEALERS AND DISTRIBUTORS | AFTERMARKET BUYERS |
|---|---|---|---|
| Purchase industrial products or services to produce others goods and services or help in the production process. These products are sold in the business or consumer markets. | Buy products that are included in the product or services they will sell in the business markets or in the consumer markets. | Include commercial enterprises that buy industrial goods for resale to users and OEMs. | They are involved in maintaining, repairing and overhauling (MRO) of products after they have been sold. |

Source: Adapted from Hutt and Speh (2010) and Blythe and Zimmerman (2005)

Governmental organizations, as customers, are very important in the Business to Business markets, because they have a large list of needs; from ensure national safety buying weapons or improve national welfare creating hospitals and schools (Kotler, et al., 1999). Furthermore, governments are very special customers. Their budgets are always at glance of public opinion; their buying process is professional, but very bureaucratic, because of laws and regulations. Much of the time, governments' institutions ask for tailored products and services. Moreover, it is normal for them to ask companies to bid for contracts, where usually the lower bidder gets the contract (Blythe and Zimmerman,

2005). Governmental organizations seem to act like commercial organization, but in a more bureaucratic way.

About institutional organizations, the institutional market consists of schools, hospitals, and any public (that have the characteristic of a governmental organization) or private (that share several similarities with the commercial organizations) entities that provide goods and services to people in their care where low budgets and captive patrons characterize these markets (Kotler, et al., 1999; Blythe and Zimmerman, 2005). Blythe and Zimmerman (2005), besides other authors, distinguish two important differences between this organization and the Commercial and Governmental organizations:

- Targeted strategy: Multiple buying influences can be found in several institutions, because of the variety of professionals they have involved. Sometimes these institutions count with purchasing agents or well organized purchasing departments, where there is a big possibility of conflicts between the purchasing and professional staff. For these reasons, B2B companies try to focus their marketing efforts not only to the people of the purchasing department, but to the professional staff too.

- Group purchasing: Corporative purchasing is a very well accepted practice in the institutional market. The institution can obtain discounts or special offers. This can be very complicated for B2B companies -that try to sell in these markets, because they have to face a very wide range of institutions with different criteria, composition and buying practices.

It is useful to identify and classify the different organizational buyers that exist in the B2B markets, because the three categories are constituted by several different groups with different behaviors in the market. An understanding of these differences between costumers will help to appreciate later which segmentations practices are better for enterprises, governmental or institutional markets.

Depending on the country where the MRI products are distributed, the customers can be classified as "Users" (direct sale to hospitals) or "Dealers and distributors" (pharmacist, wholesalers and others).

## B. SEGMENTATION AS A CONCEPT

There is a broad range of marketing literature agreeing that Wendell Smith (1956) introduced the concept of segmentation as a marketing strategy (Kalafatis and Cheston,

1997; Elliot and Glynn, 2000; Söllner and Rese, 2001; Harrison and Kjellberg, 2010). Consequently, the concept has been widely accepted since this pioneering article and not changed much since it conception (Wind and Bell, 2008). Therefore, it is important to define: what is a market segment and what implies the marketing segmentation as an activity?

**B.1. Market Segmentation**

Companies have to deal with the needs of a population of customer locally, regionally or in different countries. Besides that, they have to struggle with an increasing competition in national and international markets. American cars companies have to compete with European, Chinese, South Korean and Japanese cars manufacturers in the U.S. and in all the markets where their business activities coincide.

Referring to products and marketing mix, Kotler (2002, p. 143) state that the activity of segmenting a market is to "identify and profile distinct groups of buyers who might require separate products or marketing mixes". A broader definition comes from Freytag and Clark (2001, p. 473) defining market segmentation as the process of activities that comprehends "customer groups through their needs and wants, as well as determining which customers and needs will be addressed and with what manner and intensity". Market segmentation is clearly defined as an analytical activitiy that helps to research markets for the identification, evaluation, description and selection of defined groups of customers. Above all, good market segmentation gives the possibility to serve different segments with a specific marketing mix according to the needs of the clients and the firm. In other words, they can leave aside the segments that are not profitable or that the organization cannot serve well.

Wind and Cardozo (1974, p. 155) concludes that "the art of employing market segmentation, then, involves appropriate grouping of individuals customers into a manageable and efficient (in a cost/benefit sense) number of market segments, for each of which a different marketing strategy is feasible and likely profitable". It is possible to state that market segmentation is an analytical process, which helps companies to identify the needs and characteristics of the customers. It also distinguishes the amount of possible segments where companies can focus their marketing efforts in a cost/benefit sense. With this information marketers are able to start positioning activities and show those markets the benefits of their products and services.

**B.2. Market Segment**

A market segment can be defined as a group of present or potential customers with common characteristics, which are relevant to explain and predict their response to a supplier's marketing action (Wind and Cardozo, 1974). In contrast, a market segment is briefly defined by Pitt, Morris and Oosthuizen (1996, p. 1) as "homogenous sub-groups to which marketing efforts can be targeted" while Kotler (2002, p. 144) give a clearer definition about market segments and its characteristics defining them as "a large identifiable group within a market, with similar wants, purchasing power, geographical location, buying attitudes, or buying habits".

It is not hard to see that all author's opinions converge in recognizing a possible diversity within a market. Therefore, companies can found more than one subgroup of similar customers in every market. The characteristics surrounding each group, sug-groups or markets, will affect the marketing efforts of the companies.

As an example, a market segment can be disaggregated depending on how deep a company segment a whole market. Kotler (2002, p. 144) define the smaller markets as "niches" or "a more narrowly defined group, typically a small market whose needs are not being well served". Kotler (2002, p. 144) also state that inside the companies "marketers usually identify niches by dividing a segment into subsegments or by defining a group seeking a distinctive mix of benefits". This definition referring to marketing activities is also supported by other authors like Baines, Fill and Page (2008) while others state that companies are looking for smaller targets to target, focusing their effort in satisfy the "market of one" (Wind and Bell, 2008, p. 221).

In conclusion, the niche concept just confirms that market segments or sub segments affect marketing activities and efforts. A good summary come from Harrison and Kjellberg (2009, p. 784) referring at the nature of market segmentation as "the basic assumption is that there are groups of customers 'out there' in an existing market, with specific characteristics and responses to a marketing mix". For the same reason is important for companies to identify these groups.

Naturally, it is important for managers, independently whether they operate in a B2C or B2C context, to agree which are the levels of aggregation and criteria for a segmentation strategy in particular; the market can be segmented in a macro and a micro level.

## B.3. Macro Segmentation

The macrosegmentation is related to segmentation of industries (Porter, 1985). Industries are constituted by different buyers and products, where few or several firms market their products and services. Simultaneously, that does not necessarily mean that they are competing with each other, aiming to the same customers or distributing the same products. Segments in an industry can differ widely in their attractiveness and characteristics.

Porter (1985, p. 231) states that "crucial strategic questions facing a firm become (1) where in an industry to compete and (2) in what segments will focus strategies be sustainable because barriers can be built between segments". The macrosegmentation gives companies a first look of what are they facing in a competitive environment. Industry segments, according to Porter (1985, p. 234), are "form by the differences in the structural attractiveness and in requirements for competitive advantage among and industry's products and buyers". Those segments are also defined as "a combination of a product variety (or verities) and some group of buyers who purchase it" Porter (1985, p. 237). Macrosegmentation help companies to understand, according to their objectives and capabilities, which is the scope of their market within the industry, which subindustries are more attractive and how to serve them.

To capture the differences among producers and buyers, Porter (1985, p. 238) propose four kinds of self-explained segmentation variables to define strategically relevant segments: Product variety, Buyer type, Channel (immediate buyer) and geographic buyer location.

It is also important to address the value of industrial segmentation. Knowing the structure of competition, companies can understand how competition looks at the industry, the market and the consumers. Söllner and Rese (2001, p. 27) comment that "the structure of competition is considered to be helpful to the formation of segments, since it allows the utilization of knowledge about the structure of customers inherent in the positions of competitors". Somehow this segmentation approach helps to understand how the competition evaluates the market environment and situations.

Nevertheless, there are other perspectives about macro-egmentation. For example, regarding market segmentation in international markets, Wind and Douglas (1972, p. 18) state that macro-segments are "composed of individual or groups of countries". After the macro segmentation is conducted, the consumers in each macro-segment could be micro segmented by more specific consumer characteristics.

Similarly, but related to industrial market segmentation, Yoram and Cardozo (1974, p. 156) propose one of the first segmentation model for industrial markets, divided in a two-step approach. The first step consists to macro-segment the market according to the "characteristics of the buying organization and the buying situation". This way the marketers can divide the market looking at organizational similar characteristics of the customers as type of organization, industry size and geographic location. The Two Step Model will be discussed later.

The macrosegmentation gives companies a first and general overview about the actual markets where they are or they want to be. Two of the three authors presented, state that after a macrosegmentation, the market can still be segmented by micro-segmentation variables. A microsegmentation approach helps firms to better understand the composition and specific characteristics of macro-segments.

**B.4. Micro Segmentation**

The macrosegmentation helps companies to understand in a general way what kind of competition and consumer they are facing in a specific market situation. Microsegmentation tries to split these macrosegments in heterogeneous subgroups to get a better description of the market composition. About microsegmentation, it is easy to find, especially in a B2C context, four variables widely accepted (Kotler, 2002; Elliot and Glynn, 2003):

**Figure 2.1. Microsegmentation characteristics and variables in B2C**

| Geographic | •Divide the market into different geographical segments according to different geographical variables.<br>•Examples: Country, Region, Climate, Zip Code |
| --- | --- |
| Demographic | •Divide the market in different groups according to statistical characteristics of a population. These are easy variables to measure.<br>•Examples: Age and life-cycle stage, Gender, Family Size, Income, Education. |
| Psycographic | •Divide the market in differen groups according to personal traits and underlying motivation. These are variables hard to measure.<br>•Examples: lifestyle, personality, values or beliefs. |
| Behavioral | •Divide the maket according to the knowledge of the product, buying ocasions and behavior, attitud to the product and other responds towards the products and services.<br>•Examples: Occacions, Loyalty, usage-rate, user status, benefits. |

Source: Adapted from Kotler, 2002; Elliot and Glynn, 2003

Differently to macrosegmentation variables, that help to have a better overview of the industry and the market, microsegmentation variables seek to identify the characteristics of the customers that participate in the market: where they are, who they are, how do they live and how do they buy. It does not exist a specific order to segment the market or to use these variables. At the same time, they can be use simultaneously or by stages (Kotler, 2002, p. 52).

Going back to Wind´s and Cardozo´s (1974, p. 156) two step segmentation model for industrial markets; the second step involves a microsegmentation "dividing those macro-segments into micro segments based on characteristics of decision-making units [Buying Center]". Years later, Wind and Thomas (1994, p. 65) classified the variables according their importance:

**Table 2.6. Summary of Significant Industrial Market Segmentation Variables**

| Segmentation Variables | Serious Consideration | Moderate Consideration | Exploratory Consideration |
|---|---|---|---|
| **Buying Center** | • Composition<br>• Buying Situation<br>• Criteria used in buying decision<br>• Previous buying pattern | • Size<br>• Consensus<br>• Buying influence | • Years in the business<br>• Administrative staff ratio<br>• Bases of power<br>• Psychographics |
| **Individual** | • Education<br>• Perceived Risk | • Product-specific experience | • Age<br>• Experience<br>• Need for certainty |

Source: Adapted from Wind and Thomas (1994)

As these "decision-making units" are formed by different individuals as managers or directives, the microsegmentation variables like Demographic, Physiographic and Behavioral can also be applied. This model will be discussed later on this work as part of the B2B Segmentation Models.

**B.5. Segmentation related to marketing strategy**

When analyzing the definitions regarding market segments and marketing segmentation, it is worth noticing that all of them make references to marketing strategy or marketing mix. As a consequence, it is easy to conclude that marketing segmentation, marketing strategy and marketing mix are strongly related.

By tracing some references throughout the marketing literature, the researcher found different statements about relationship between marketing segmentation and marketing strategy. One of the first comments made about this topic, was made by Smith (1956, p.

56) referring to marketing segmentation as a "merchandising strategy" part of the marketing mix, because "merchandising being use here in its technical sense as representing the adjustment of market offering to consumer or user requirements".

Nevertheless, market segmentation has become something more than a merchandising strategy. It is not hard to find multiple definitions about marketing segmentation and business practices regarding to this subject. Some of them are related to products or needs, as Elliot and Glynn (2000) state that a market segmentation could be identified as a prerequisite for any organization endeavoring to create products or services fitting customers' needs. Moreover, Kotler (2002, p. 144) goes in the same direction commenting that "segment marketing allows a firm to create a more fine-tuned product or service offering and price it appropriately for the target audience". Finally, Robertson and Barich (1992, p. 5) identify that "Market segmentation enables the firm to recognize and meet the needs of the marketplace more precisely". All these points of view are related to the marketing mix of the company.

Besides the identification of needs or creation of new products or services, segmentation can also help to solve a resource allocation problem. It has been said that segmentation is the core of marketing strategies and resource allocation (Robertson and Barich, 1992), that marketers use it for not scattering their resources (Kotler, 2002; Baines, Fill and Page, 2008) and according to Crittenden, Crittenden and Muzyka (2002, p. 17) "market segmentation is important because it can increase the profitability of a firm´s market strategy". Market segmentation is not only useful to allocate resources, but to increase profitability.

In summary, segmenting a market in homogenous groups (very similar within them and different from other groups in the market) helps the firms to understand the needs and requirements of customers. These actions allow marketers to prepare business strategies to satisfy clients with the right mix of products and allocation of resources, increasing customer´s satisfaction and firm´s profitability. Jenkins and McDonald (1995) stated that "at a strategic level, market definition and segmentation become more closely linked to the capabilities and nature of the organization".

**B.6. Market segmentation as a managerial decision process**

It has been show how market segmentation can improve competitiveness, resource allocation and enhance the performance from any kind of organization. The competitive environment is constantly changing thanks to new technologies, internet, new business models and other factors. These changes pressure companies to improve their processes

and be more flexible to respond to a changing environment. This flexibility requires to be accompanied with accurate business processes that will help to weigh the cost and benefits of different business decisions and market segmentation is not an exception. Wind and Thomas (1994, p. 61-63) view the market segmentation as a decision process with five correlated managerial decision:

**Figure 2.2 Market Segmentation Process**

**DECISION TO SEGMENT: Should this industrial market be segmented?**
• *Depends on the ability to identify groups of organizations with similar response patterns and the ability to generate higher long terms returns from segmented strategy.*

**SEGMENT IDENTIFICATION DECISION: If so, how should the market be segmented?**
• *Through response and segmentation variables, that are differentially related by market responses to various marketing resources.*

**SEGMENT SELECTION DECISION: Which segments should be selected?**
• *Selection of target segments.*

**MARKETING RESOURCE ALLOCATION DECISION: What resources should be allocated to each segment?**
• *The allocation of marketing resources withing and across segments.*

**SEGMENT IMPLEMENTATION DECISION: Can a segmentation strategy be implemented?**
• *The design and implementation of a strategy based on marketing resource variables aimed at meeting the needs of the selected segment, subject to the objectives of the firms.*

Source: Adapted from Wind and Thomas (1994)

Through these set of questions and variables, it is possible to create guidelines that allow marketers of any industrial organization to segment the markets in an accurate and feasible way. Kotler (2002, p. 143) gives three steps to reach markets and segments: Market segmentation, targeting and positioning. Market segmentation and targeting has been explained, but positioning is "establish and communicate the product´s key distinctive benefits in the market". Market segmentation is the first step companies must accomplish to start having a better understanding of consumers and be able to reach them effectively according to their marketing strategy.

**Figure 2.3. The "STP" process**



| SEGMENTATION | | |
|---|---|---|
| Choose variables for segmenting market | Build a profile of segments | Validate emerging segments |

| TARGETING | |
|---|---|
| Decide on targeting strategy | Identify which and how many segments should be target |

| POSITIONING | | |
|---|---|---|
| Understand consumer perception | Positioning products in the mind of the consumer | Design appropiate marketing mix o communicate positioning |

Source: Adapted from Dibb (1998)

Both models are equally useful to determinate a segmentation process. While the five steps model from Wind and Thomas (1994) is more extensive than the model of Kotler (2002), both of them agree that there is a need to determinate the "bases" or criteria for segmentation, to choose which targets are going to be targeted and, that the implementation of the strategy is based on the understanding of the consumer. It is important to notice that Kotler (2002) does not give an emphasis on the "allocation of resources" and in the organizational capabilities of the company to segment a market, as Wind and Thomas (1994) do. On the other hand, the model of Kotler (2002) gives an especial importance to product positioning in the implementation of the marketing strategy after the segmentation process.

Independently of which process is preferred for marketers, there are two big questions to be answered: How can marketing manager identify market segments and under which criteria can they select them? To answer these questions, the following section will show some specific B2B segmentation models that can be used in any of the two mentioned processes.

### C. B2B MARKET SEGMENTATION MODELS

In previous sections, the author had already shown the different benefits of the market segmentation such as better allocation of resources, improve the marketing mix and understand the need of the customer. For this reason, two different segmentation processes were briefly explained to help in the understating in how the market

segmentation work. The idea of this section is to show different B2B segmentation models that will be helpful to any manager to identify and select segments to target.

## C.1. The Nested Approach

Shapiro and Bonoma (1984), state that consumer markets are much easier to segment that industrial ones. Both authors agree that the different applications that an industrial product could have and how greatly organizational customer differs from each other, are the important differences with B2C markets. On other hand, they believe that B2B marketers do not count with good instruments to determinate the best variables to segment the markets.

The Nested Approach is a "Multi Step" market segmentation model divided in five different layers or steps according to the amount of investigation and information required by the company to identify and evaluate different market segmentation criteria (Shapiro and Bonoma, 1984, p. 104).

**Figure 2.4. Nested Approach**



**PERSONAL CHARACTERISTICS**
**SITUATIONAL FACTORS**
**PURCHASING APPROACH**
**OPERATING VARAIBLES**
**DEMOGRAPHICS**
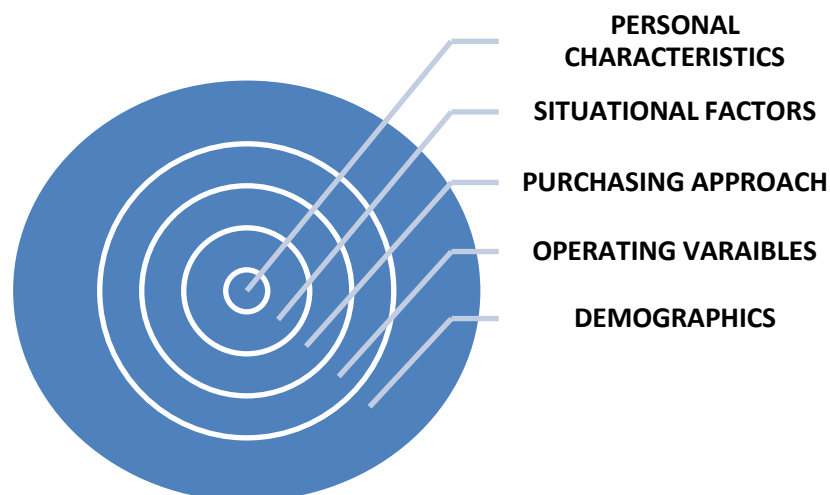
Source: Adapted from Shapiro and Bonoma (1984)

The Nested Approach has an established hierarchy. The principal idea of this model is to segment the market from the outer layers to the inner ones. The outside layers require less information than inner ones. As a consequence, the marketers can move from easily observable information to the more specific one, depending on the company´s capabilities to gather information of the market. Evidently, it may not be necessary to use every stage and is possible to skip irrelevant criteria (Shapiro and Bonoma, 1984, p. 105).

**Table 2.7. Nested Approach criteria, description and variables**

| CRITERIA | DESCRIPTION | VARIABLES |
|---|---|---|
| **DEMOGRAPHICS** | General and easy information of the company, customers and industry. Do not need to visit the customer or other complicated information sources. | • Industry Information<br>• Company Size<br>• Customer Location |
| **OPERATING VARIABLES** | Enables more precise information of customers within demographics categories. | • Technology<br>• Product and brand-use status<br>• Customer Capabilities |
| **PURCHASING APPROACH** | Involves the company philosophy, their purchasing method and Buyer Center. | • Purchasing function organization<br>• Buyer-seller relationship<br>• General purchasing policies<br>• Purchasing criteria<br>• |
| **SITUATIONAL FACTORS** | In this point is important the buying situation. These are operating variables, but are temporary and need a better understating of the customer | • Urgency of order<br>• Product application<br>• Size of order |
| **PERSONAL CHARACTERISTICS** | Segment the market according to the individuals involved in the purchasing process. | • Buyer motivation<br>• Individual perception<br>• Risk management strategies |

Source: Adapted from Shapiro and Bonoma (1984)

Shapiro and Bonoma (1984, p. 105) confirm that "Our approach using a hierarchical structure is easy to use. Marketers can, in most cases, work systematically from the outer nest to the inner nest…through the whole set of criteria and identify important factors that otherwise might be neglected". There isn´t a specific way to use this model. Managers can start in segmenting the market in any layer or, less probably, going from inside out.

However, some authors have different opinions about this model. Mitchell and Wilson (1998, p. 437) declare that the Nested Approach "pays very little attention to customer needs (except perhaps in the catch-all phase labeled situational factors) and is clearly driven by supplier convenience", but they also state that such illustrative models are helpful in providing some structure to the segmentation process and remind the different issues and aspects involve in the segmentation process (Mitchell and Wilson, 1998, p. 437). In some way, the model provides a conceptual starting point for a market research plan. On the other hand, Plank (1985) considered that this model just assume that the markets can be segmented and that is not real in all markets.

Nevertheless, these models give a good starting point for market segmentation. The outer layers help to have a good overview of what is happening in the market. At the same time, it is important to conduct an economical evaluation of the segments arising during the process (Wind and Thomas, 1994, p. 67). This way, managers will know when to stop segmenting, avoiding going further to the inner nest where the information required is more complicated and expensive to get.

## C.2. Portfolio Management Segmentation

There are several different portfolio segmentation models. Therefore, this section will give a good, but brief understanding about Portfolio Management. The portfolio theories come from the financial analysis of investment, specifically to reduce risk. The procedure of choosing the best portfolio may be divided into two different, but linked stages. Markowitz (1952, p. 77) stated that "the first stage starts with observation and experience and ends with beliefs about the future performances of available securities. The second stage starts with the relevant beliefs about future performances and ends with the choice of portfolio". The same concepts apply when the companies segment the customer as financial portfolios (Talwar, 2006, p. 2) especially to "address buyer seller dyadic relationship management and to understand the optimal allocation of resources". Portfolio Management is used to segment or manage customer or supplier according to their loyalty, value or other variables.

One good example is a model proposed by Shapiro, Rangan, Moriarty and Ross (1987). In this model, the authors demonstrate that managers have to manage their customers for profits, not sales (Shapiro, et al., 1987, p. 101). High sales volumes do not always mean high profitability. As profit is the difference between the net price and the actual cost to serve, the authors proposed to classify them accordingly. The two dimension of this model are based on the customer sensitivity to price and the cost to serve the clients.

**Figure 2.5. Customer Classification Matrix**
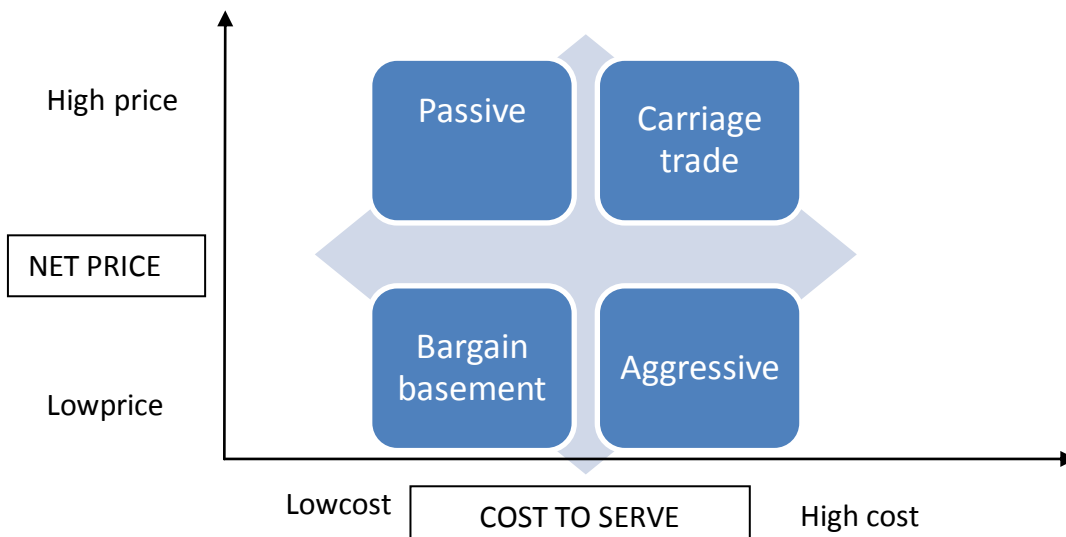


Source: Adapted from Shapiro, Rangan, Moriarty and Ross (1987)

The "Carriage trade" is an expensive customer to serve, but that pays accordingly. In the other side, there is the price sensitive "Bargain basement", who accepts low quality products for a very low price. The other two segments, Passive and Aggressive are constantly moving according to their demand and the prices of the suppliers.

This model is based under the assumption that companies can somehow determine all the cost of serving clients to determinate precisely the profit of each segment. Zolkiewski and Turnbull (2001) mentioned that the way in which pre and post sale costs are recorded can be extremely difficult to implement in a technically complex product situation.

Nonetheless, there is other ways to segment the marketing with portfolio theories. For example, Customer Relationship Management classifies customers accordingly to the profit they generate according to their loyalty over time. A good example is the two dimensional models of Elliot and Glynn (2000), and Pick (1999) based on relationship management.

**Table 2.8. Elliot and Glynn Segmentation Framework**

| | | BUYER LOYALY | |
|---|---|---|---|
| | | LOW | HIGH |
| VALUE TO SELLER | LOW | (1)Simple Exchange | (2)Buyer Exploitation |
| | HIGH | (3) Seller´s Over Investment | (4) Partnership |

Source: Elliot and Glynn (2000)

This matrix reflects the interests and practices of Buyers and Sellers. The interests of the buyers are primarily reflected in their degree of loyalty toward their vendors (for example, long or short terms relationship), while, on the other hand, vendors are interested in the potential benefits from a buyer.

For both parties is important to have the same expectations about the relationships. In this case, the quadrants N°1 and N°4 show symmetry in the relationship between buyer and seller. Quadrant N°1 exhibits low buyer loyalty (for example, a short-term or transactional relationship), and, as the seller believes that the buyer's value is low, the seller's interests are focused only on the present transaction reducing the cost and maximizing the value of the mentioned transaction.

The other two quadrants show a gap between the interests of both parties. In quadrant N°2, the low interest the seller have in the relationship compared to the high interest of the buyer, result in an abuse of the seller to the buyer, as he tries to take advantage of the other party, ruining their relationship. For quadrant N°3, the seller is willing to invest in a buyer that looks valuable, but has no interest in maintaining a long term relationship with the seller.

On the other hand, Pick (1999, p. 263) created a model based on the Customer-Supplier relationship in the electronic market and mentioned in his study that "This sector has a tradition of reliance upon relationships…the importance of long term customer satisfaction, repeat business, close working relationships and collaboration with customers, have for several years been characteristic of this industry". This is not only a classification of customer or suppliers, but for the whole industry, including the own organization.

**Table 2.9. Relationship positions**

| | | RELATIONSHIP ABILITY | |
|---|---|---|---|
| | | **HIGH** | **LOW** |
| **COMPANY PERFORMANCE** | **HIGH** | **(1)FORWARD THINKERS:**<br>• Approachable<br>• Relationship important<br>• Competitive offering<br>• Utilize relationships to develop competitive advantage. | **(2) CORPORATE EGOIST:**<br>• Respected<br>• Operationally professional<br>• Maintain strong strategic direction<br>• Expect high standards from self and partners |
| | **LOW** | **(3)INEFFECTIVE SYCOPHANTS:**<br>• Loyal partner<br>• Relationship is redeeming feature | **(4)INSENSITIVE NEGOTIATIORS:**<br>• Position caused by poor selection of partner<br>• Relationship advantages not developed or exploited |

Source: Adapted from Pick (1999)

This model is based upon the assumption that the best method of maintain and improve an association with a partner is by improving the performance of the firm in pleasing the needs of the partnering firm (Pick, 1999, p. 268). The Forward Thinkers (Box 1) look a competitive advantage in their relationship and seek to balance their need with the ones of the partner. The Corporate Egoist (Box 2) has a high performance and they do not value long term relationships if some new more profitable or efficient partner appears in the market. The Ineffective Sycophants (Box 3) are organizations that maybe are in a bad performance period and use their relationship to go back to a new position in the market. Finally, the Insensitive Negotiators (Box 4) are able to deliver what is required, but long relationships are of little value to them.

The models shown in this section are not the only segmentation techniques related to Portfolio and Relationship Management[7]. Generally, authors agree about the benefits of managing customer relationships. These benefits can be from reduce costs, have a better understanding of customer needs, improve sales and revenues, information for the development of new products and others[8].

In the same way, there are different opinions about this approach to manage customers. For example, Werner and Kumar (2002, p. 8) stressed, after a research in four different

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[7]See Pick (1999); Frytag and Clarke (2001); Reinartz and Kumar (2002); Johnson and Selnes (2004)
[8]See Johnson and Selnes (2004); Danaher, Conroy, and McColl-Kennedy (2008)

companies in B2C and B2B markets, that "no company should ever take for granted the idea that managing customer for loyalty is the same as managing them for profits". According to them, loyalty not always results in saving costs or charging higher prices.

On the other hand, Danaher, Conroy and McColl-Kennedy (2008, p. 55) concluded after studying customer-seller relationships in three different industries, that not all customers want long-term relationships with their sellers or providers. That means that companies have to do another effort to determinate which customer can be target for a long-term relationship to allocate resource accordingly.

Finally, when people talk about "Value" in a business environment, is difficult to address what is the meaning of "value" for the costumer and the company. Wilson and Jantrania (1994, p. 64) stated that "Value is a problematic concept" as it is a word use for different people in different ways in different areas.

**C.3. Buying process segmentation**

The characteristics and differences of the B2B and B2C markets were addressed in the first section of this chapter. One of these differences is that in B2B companies normally count with complex Buying Centers were different individuals interact to evaluate and perform a purchase. It makes sense that Frytag and Clark (2001, p. 477) mention that "The buyer´s perception of their own need and wants still are regarded as important variables of segment identification".

Taking account the importance of Buying Centers in B2B companies, it is also important to address the importance of the situational factors that can affect the purchasing of an industrial product.

Accordingly, Robertson and Barich (1992, pp. 6-7) came up with a successful approach to segment industrial markets according to buyer´s purchase decision process. They stressed that "the key is segmenting customers by the phase of the purchase decision process that they are currently experiencing. The approach identifies segments easily, characterizes different buying patterns, and suggests the benefits to emphasize in the sales call". According to the authors, a three-stage hierarchy is recommended for a meaningful segmentation to reach industrial markets.

In this three staged hierarchy approach, is possible to determinate three kinds of segments: First-Time Prospects, Novices and Sophisticates. In the next table, it is possible to see the characteristics of these three segments.

**Table 2.10. What buyers of industrial products look for**

| | FIRST-TIME PROSPECTS | NOVICES | SOPHISTICATES |
|---|---|---|---|
| **DOMINANT THEME** | "Take care of me" | "Help me make it work" | „Talk technology to me" |
| **BENEFITS SOUGHT** | <ul><li>Honest Sales Rep who knows and understand my business</li><li>A vendor who has been in business for some time</li><li>Sales rep who can communicate in an understandable manner</li><li>High training level</li></ul> | <ul><li>Easy-to-read manuals,</li><li>Technical support hot lines</li><li>A high level of training</li><li>Sales rep who are knowledgeable about their products and services</li></ul> | <ul><li>Compatibility with existing systems</li><li>Product customized to customer needs</li><li>Track record of vendor</li><li>Maintenance speed in fixing problems</li><li>Post-sales support and technical support</li></ul> |
| **WHAT´S LESS IMPORTANCE** | <ul><li>Sales rep´s knowledge of product and services</li></ul> | <ul><li>An honest sales rep,</li><li>A sales rep who knows and understand my business</li></ul> | <ul><li>Training</li><li>Easy manuals</li><li>Sales rep who can communicate in an understandable manner</li></ul> |

Source: Adapted from Robertson and Barich (1992)

The "First-Time Prospects" segments are buyers that are considering the purchase of a new product through the sales force of the new product. As new customers, they need to be guided through the benefits of the new product and prefer channels with lots of information and training. On the other hand, the "Novice" segment has purchased the product in the last three months and is moved by the performance of the product and prefers channels with lots of support and services. Finally, the "Sophisticated" are driven by long-term relationships and customization of products. The principal idea of this model is to facilitate the later strategically application at a sales force level. It is very useful and simple for high-tech industries.

One of the problems of this approach is that too focused in the product. In other words, it seems to be a benefit-based segmentation. It does not take in to account, for example, the complexity of the Decision Making Unit of the companies or nature of the competitive environment. In industries, where the participants have been always the same and the entrance barriers are too high, customers will probably fall in the "Sophisticated" segment and marketers will have to use more specific criteria to segment the market. Additionally, it does not give any guidelines to identify the important purchasing agent in the targeted segments.

From another perspective, Choffray and Lilien (1978) propose a segmentation process focused in the DMU (Decision-Making Unit) or Buying Center. They developed a "decision matrix" to measure the involvement of different parties in the buying process according to the phases of the purchasing process and categories of individuals involved in the process (Choffray and Lilien, 1978, p. 19). This is considered by the author as a micro-segmentation approach.

As a first step, using methods like surveys or interviews, the marketers can identify, according to the perception of the respondents, "the relative importance and influence of each decision category in specific phases of the decision process" (Choffray and Lilien, 1978, p. 19) to create the "Decision Matrix".

**Figure 2.6. Decision Matrix**

| Phases Purchasing Decision Process ╲ Decision Participant Categories | Description of Phase 1 | … | Description of Phase n |
|---|---|---|---|
| Decision Participant Category 1 | | | |
| … | | | |
| Decision Participant Category n | | | |

Source: Choffray and Lilien (1978)

The second step is to use "association coefficients" to define inter organizational similarity between the different participants in the Decision Making Process (Choffray and Lilien, 1978, p. 20). As a third step, is recommended to identify homogenous groups of organizations (according to their organizational buying structure) using a cluster analysis (Choffray and Lilien, 1978, p. 21). Following these steps, the marketers can indentify micro-segments according to the information given by the "Decision Matrix". Finally, it is important to recognize the pattern of involvement in the buying process within each microsegment (Choffray and Lilien, 1978, p. 21). The importance of this step relier on the identification of those categories of participants which are most likely to become implicated in the buying method of the firms belonging to each microsegment.

In comparison with the three stages model, the model from Choffray and Lilien (1978) seem to be more complete. It is not merely focused on the product´s benefits and

participation of the sales force, but it attempt to analyze the whole purchasing structure of the company to identify the important participants in the buying process and afterwards, identify their characteristics to determinate what benefits they seek on the products. On the other hand, it also includes the utilization of statistical procedures to give a quantitative base for the constitution and analysis of the segments.

One of these models will be chosen for the purposes of the present research. These models seem to be very helpful to give some structure to the segmentation process. At the same time, they are helpful to determinate different variables and criteria for market segmentation. The model chosen will be presented in the methodology chapter.

# CHAPTER III: METHODOLOGY ANALYSIS

In the third chapter, the author presents the methodology of the investigation, starting with the description and explanation of the methodological process. The methodological process can be divided in seven steps:

1. Segmentation model and selection of variables
2. Data Analysis
3. Cluster Analysis
4. Verification of the results
5. Final proposal
6. Model results
7. Feedback

## A. METHODOLOGY ANALYSIS

The instruments used for this research were 776 online individual questionnaires applied to radiologist from ten different countries. The questions were divided in the following areas: company image, awareness and use of MRI agents (methods contrast MRI) brand awareness, positioning, selection criteria for MRI agents. All the statistical analysis will be performed with the IBM SPSS v19. The research methodology developed for this investigation is divided in the following stages:

### A.1. Segmentation model and selection of variables

The segmentation models are very useful to keep in mind all the important variables and steps to follow during a market segmentation. Consequently, a segmentation model will be helpful to review the information needed for the segmentation process.

Kalafatis and Cheston (1997, pp. 519-530) studied which were the segmentation bases in the UK pharmaceutical sector. In this research, they discover that 26% of the pharmaceutical companies used two stages segmentation processes, while 31% used multi stage segmentation approaches (Kalafatis and Cheston, 1997, p. 524). Besides, they also discovered that in the first segmentation stage, 74% of the companies used macro variables as "Type of Industry" and 44% used organizational characteristics (geographical location, purchase frequency or volume, size of the buying company and others). In a second and third stage, respondents used organizational characteristics in a 74% and 76% respectively. Moreover, 45% used product related benefit segmentation bases (Kalafatis and Cheston, 1997, p. 526-527). This investigation provides some evidence that the Nested Approach and the variables proposed are not far away of the segmentation practices in the pharmaceutical sector.

The Nested Approach plus the expert opinion of the Marketing Research Team will be used to determinate which are the most important variables for the market segmentation. On the other hand, a theoretical application of the Nested Approach will be performed to have an approximation of what kind of results can be expected if this model is combined with the Hierarchical Cluster Analysis. Afterwards, a segmentation process will be developed for the Strategic Marketing MRI Team. Both results will be very helpful for later comparisons.

### A.2. Data analysis

The second step is to analyze the data with different statistical and descriptive analysis. According to Hair, Black, Babin and Anderson (2010) the purpose of the data examination

is to expose what is not evident looking to the raw data. Some unknowns effects of the composition of the data could be overlooked when the amount of information is too big. For the same reason, the following analyses will be made:

1. Univariate Analysis: This analysis will summarize information such as Minimum Value, Maximum Value, Sum, Range, Mean, Standard Deviation and Variance of the data.

2. Outliers analysis: The cluster analysis can be sensitive to the sample´s outliers (cases with extreme values). Outliers should be identified to see their effects on the final results. Hair et al. (2010) defined them as truly atypical observations that are not representative of the general population or representative observation of small or insignificant segment (undersampling). Depending from the results, they will be evaluated to see if they have to be removed. For identifying possible outliers, it is possible to use the standardized values of the data (Z-scores). The Z-score transformation standardizes variables to the same scale, producing new variables with a mean of 0 and a standard deviation of 1.

**Figure 3.1. Z-scores formula**

$$z = \frac{x - \mu}{\sigma}$$

$$\mu = \text{Mean}$$
$$\sigma = \text{Standard Deviation}$$

Source: IBM SPSS v19

When the data is normally distributed, it is possible to assume, that almost all the values will be within three standard deviations of the mean. For the same reason, when the Z-scores are used to identify outliers, it is recommended to treat any data with a z-score less than -3 or greater than +3 as an outlier (Anderson et. al., 2007). Independently if the data is distributed normally or not, it is possible to use this criterion to have a better understanding about possible extreme cases (Anderson et. al., 2007). Another graphical method to detect outliers is the boxplot.

**Figure 3.2. Outliers example in boxplots**
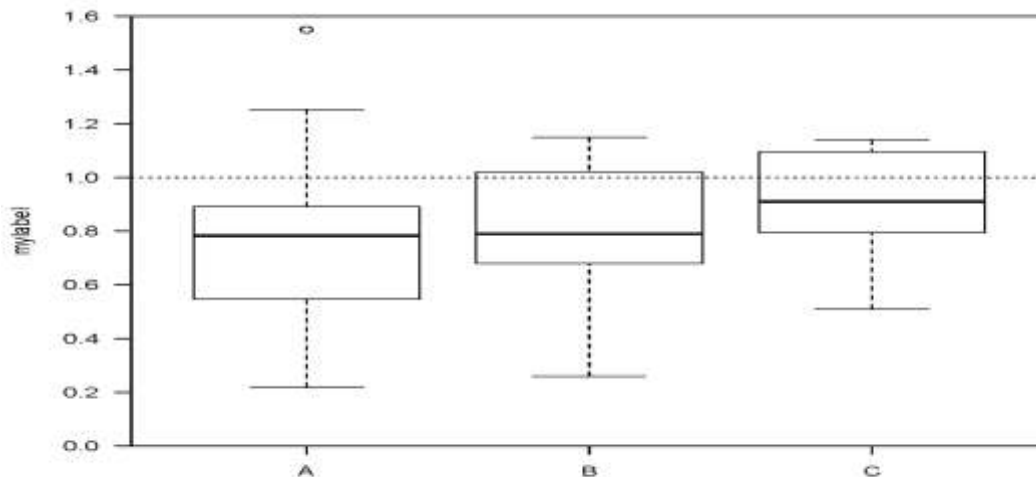


Source: Made by the author

The previous graph is a good example to understand what outliers are. A boxplot shows five statistics (minimum, first quartile, median, third quartile, and maximum). It is useful for displaying the distribution of a scale variable and pointing outliers. The middle box represents the 50% of the data values. A larger box represents the standard deviation of the observation and the middle line represents the median. The lines represent the distance to the smallest and the largest observations that are less than one quartile range from the box. In this case, the variable A has an outlier in the 1,6 value.

To avoid changes in the sample and not affect the sample representativeness, the author and the Market Research Team agreed to keep the outliers, if it is possible. The outliers will be identified to see how they affect the results of the cluster analysis and they will be removed only if it is necessary according to the author criteria.

3. Correlation Analysis: The correlation analyses will determinate relationships between variables. Multicollinearity represents a high intercorrelation or linear dependence between two or more variables and make "difficult to assess the relative importance of the independent variables in explaining the variation in the dependent variables" (Malhotra and Birks, 2006, p. 539). According to Hair et al. (2010), in the cluster analysis, the multicollinearity is a form of implicit weighting.

All variables are weighted the same and if there is two or more correlated variables, they will affect the similarity measure (measure of distances) of the cluster analysis. To avoid or fix multicollinearity there are different courses of action, such as: specific distance measures in the cluster analysis to reduce multicollinearity, delete cases until all variables are represented by the same amount of cases or perform a Factor Analysis.

The Factor analysis is a procedure that reduces and summarizes variables in one representative variable (Factor) according to their correlation values. In other words, "relationships among set of several interrelated variables are examined and represented in terms of a few underlying factors" (Malhotra and Birks, 2006, p. 572). The correlation will be analyzed under a significance level of 0.05 (2 tailed). Significance levels greater than 0.05 between two variables will indicate that they are not correlated. Additionally, the Pearson Correlation coefficient will help to measure the strength of the correlation between two variables.

**Figure 3.3. Pearson Correlation Coefficient ("n" is the number of pairs of data)**

$$r = \frac{n\sum xy - \left(\sum x\right)\left(\sum y\right)}{\sqrt{n\left(\sum x^2\right) - \left(\sum x\right)^2}\ \sqrt{n\left(\sum y^2\right) - \left(\sum y\right)^2}}$$

Source: IBM SPSS v19.

**Table 3.1. Correlation results example**

|  |  | VARIABLE 1 | VARIABLE 2 |
|---|---|---|---|
| **DEPENDANT VARIABLE** | Pearson Correlation | .107 | .290 |
|  | Sig. (2-tailed) | .067 | .000 |
|  | N | 294 | 294 |

Source: Adapted from IBM SPSS v19

The previous table shows an example of a correlation analysis. In this example, is possible to analyze the correlation between the dependant variable and the other two independent variables. The Pearson Correlation shows the direction of the correlation and the significance level establishes if there is any correlation. In this specific case, under a significance level of 0.05, the dependant variable is correlated with the "variable 2" and it is not correlated with the "variable 1".

In case of multicollinearity, it will be not necessary to delete cases until all variables are represented by the same amount of cases (to decrease the multicollinearity effect), because all the variables will be represented by the same amount of cases. The Factor analysis will be evaluated after the correlation analysis and will be made only if it is necessary.

## A.3. Cluster analysis

The third step will be the cluster analysis. The objective of cluster analysis is "to classify objects into relatively homogeneous groups based on the set of variables considered" (Malhotra and Birks, 2006, p. 596). On the other hand, segmentation models and the managerial opinions will set the criteria and variables to determinate different segments in the radiologist market. The idea is to classify radiologist in homogeneous groups (Clusters) according to those variables. The cluster analysis has shown to be useful for market segmentation purposes (Punj and Stewart, 1983, p. 134 – 148).

Depending on the analysis, the investigator can use a set of metric data, non-metric data or both. Additionally, it is also important to determinate the before mentioned "similarity measures"; they classify the clusters according to distance measures or correlation patterns between variables.

Several cluster analysis experiences exist in the B2B and B2C markets. Choffray and Lillien (1978, pp. 17 - 29), using the Two Stages Approach, segmented the air conditioned industries with a Hierarchical Cluster Analysis according to the characteristics of their buying making decision units. In other case, Dibb and Simkin (2010, p. 13) use the cluster analysis to judge the quality of customer segments in the Eastern European mobile phone market. In the same way, Robles and Sarathy (1986, pp. 1 – 12) identify two distinct market segments for the commuter aircraft market according to the characteristics of their fleet and buying decision processes.

For this specific research, the author will use the Hierarchical Cluster Analysis, because it is taught at the Pontificia Universidad Católica de Valparaíso and is commonly used to have a first approach to the amount of clusters that can be found in a specific data set (Hair et al., 2010). The hierarchical cluster propose different clusters configuration with a dendogram. The dendrograms can be used to assess the cohesiveness of the clusters and provide information about the appropriate number of clusters to keep.

**Figure 3.4. Dendogram example**
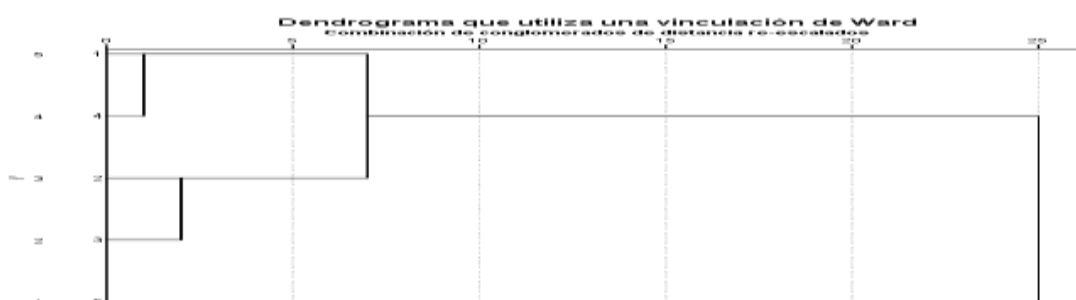


Source: Escárate, P., ICA 447-1 Introducción al Análisis Cluster

This graph is a visual representation of the steps in a hierarchical clustering solution. It shows the clusters being combined and the values of the distance coefficients at each step. Connected vertical lines designate joined cases. The dendrogram rescales the actual distances to numbers between 0 and 25, preserving the ratio of the distances between steps.

It is important to address that this method works measuring the distance of metric variables and for that reason the distances of the observations will be measure with the Square Euclidean Distance[9] which is the most commonly measure used for Hierarchical Clustering (Malhotra and Birks, 2006, p. 600).

**Figure 3.5. Square Euclidean Distance formula**

$$\sum_{j=1}^{k} (a_j - b_j)^2$$

Source: IBM SPSS v19

The variance within the clusters will be minimized with the Ward's procedure[10]. The Ward's Method minimizes the variance within groups and maximizes the variance between them increasing the possibilities to find good clustering configurations for segmentation purposes (Malhotra and Birks, 2006, p. 603).

**Figure 3.6. Ward's Minimum-Variance Method**

$$D_{KL} = \frac{\left\| \overline{x}_K - \overline{x}_L \right\|^2}{\left( \dfrac{1}{n_K} + \dfrac{1}{n_L} \right)}$$

Source: IBM SPSS v19

In Ward's minimum-variance method, the distance between two clusters is the sum of squares between the two clusters added up over all the variables. At each generation, the within-cluster sum of squares is minimized over all partitions obtainable by merging two clusters from the previous generation. The sums of squares are easier to interpret when

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[9] "The Euclidean distance is the square root of the sum of the squared differences in values for each variable". Malhotra and Birks (2006)
[10] "A variance method in which the squared Euclidean distance to the cluster means is minimized." Malhotra and Birks (2006)

they are divided by the total sum of squares to give proportions of variance (squared semi partial correlations).

If it is needed, the variables will be standardized directly by the cluster analysis in Z-scores. The Z-score transformation standardizes variables to the same scale, producing new variables with a mean of 0 and a standard deviation of 1. The standardization is helpful for solving issues related to the use of variables with different scales and more, but in the end, there is no single reason to use standardized variables versus unstandardized variables (Hair et al., 2010). The standardization should be based on empirical and conceptual issues. In this research will be only used of the metric variables have different measures or scales.

The criteria for the selection of the cluster configuration to analyze will be:

- <u>Representativeness</u>: They represent the reality according to the Market Research Team.
- <u>Simplicity:</u> No more than 5 clusters configuration.
- <u>Cluster composition:</u> Small clusters in comparison with all other clusters will be deleted (if the small cluster constituted less than the 10% or 15% of the sample).

**A.4. Verification of the results**

In this step, the researcher will make some different analysis of the results delivered by the cluster analysis.

<u>One Way ANOVA Test:</u> The ANOVA test is a statistical technique for examining the differences among means for two or more populations (Malhotra and Birks, 2006, p. 723). Comparing the means of each cluster is possible to identify if the variables selected for the cluster analysis make differences between groups, their main effect on the clusters and see if the difference between multiple sample means is significant. A P value less than 0.05 it is considered significant (Make difference between means).

**Figure 3.7. ANOVA test example**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| **DEPENDANT VARIABLE** | Between Groups | 9.819 | 1 | 9.819 | 4.562 | .041 |
| | Within Groups | 66.726 | 31 | 2.152 | | |
| | Total | 76.545 | 32 | | | |
| | The part of the total variability in the dependent variable that can be accounted for by differences in group means | The sum of square deviations about some quantity | The degrees of freedom used to obtain the observed significance level | The sum of square divided by the degrees of freedom | The ratio of two means squares | The conditional probability as strong as the one observed in the data would be present, if the null-hypothesis is true. A P value less than 0.05 it is considered significant |
| | The part of the total variability in the dependent variable due to error | | | | | |
| | Total variability | | | | | |

Source: Adapted from IBM SPSS v19

Post Hoc Test: Once the differences among means have been determined, post hoc range tests can determine which means differ between groups. Post Hoc test examine the dependent variable between all possible pairs or group of differences across specific groups for one or more dependent measures. This way, it is possible to identify specific differences comparing one cluster with another. The Scheffé test will be used, because is the most conservative and commonly used method (Hair et al., 2010). A significant value less than 0.05 it is considered significant (Make difference between means).

**Figure 3.8. Scheffé test example**

| Dependent Variable | (I) Ward Method | (J) Ward Method | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|---|
| Variable 1 | 1 | 2 | 8.733 | 23.871 | .987 |
| | | 3 | .101 | 31.920 | 1.000 |
| | | 4 | -243.058 | 32.165 | .000 |
| Variable 1 | Cluster 1 | Cluster 2 | The mean for one group minus the mean for the other group | It is the standard deviation of the sampling distribution for a statistic | The conditional probability as strong as the one observed in the data would be present, if the null-hypothesis is true. A value less than 0.05 it is considered significant |
| | | Cluster 3 | | | |
| | | Cluster 4 | | | |

Source: Adapted from IBM SPSS v19

K-Means Cluster Analysis: Other cluster analysis can be performed upon the results of the first cluster analysis, to verify, if the other cluster results could match similar outcomes. It is recommended to combine a hierarchical cluster with a non hierarchical cluster analysis. In this research, the nonhierarchical cluster analysis chosen, to compare results, is the K-Means.

The K-Means cluster analysis is an algorithm that work by portioning the data into a user-specified number of clusters and then iteratively reassigning observations to clusters until some numerical criteria is met (Ibidem). It is important to mention that the distances are computed using simple Euclidean distance. The procedure assumes that you have selected the appropriate number of clusters and that you have included all relevant variables.

**Figure 3.9. Simple Euclidean Distance formula**

$$EUCLID_{(X,Y)} = \sqrt{\sum_i (X_i - Y_i)^2}$$

Source: IBM SPSS v19.

Strategic Marketing MRI Team: The managerial opinion of the Strategic Marketing MRI and Market Research teams will help to evaluate the real consistency of the results given

by the cluster analysis performed for the company. Their opinion will be not relevant for the cluster results of the Nested Appoach theoretical application, as it will be only used to determinate what kind of results can be expected if it is applied with a Hierarchical Cluster Analysis.

**A.5. Final proposal**

After the cluster analysis, the author expects to deliver one or more segmentation proposals to the Strategic Marketing MRI Team to support the work of the SBU managers. To fulfill this objective, the Cross Tabs analysis will be use. This analysis will be helpful to cross the information of the clusters with other information obtained in the survey to create an understandable costumer profile for the management.

**A.6. Models results**

The Nested Approach theoretical results will be compared with the final proposal to draw different conclusions about the relevance of segmentation processes, criteria and variables for market segmentation and customer profiling. In this segmentation the Strategic Marketing MRI team will not be involve as this will me a merely theoretical exercise.

**A.7. Feedback**

It is possible to find errors or possible improvements in some steps of the research such as the inclusion of some other variable neglected a priori or exclusion of new variables. Some of these situations could proceed to change the methodology of the Cluster Analysis, among other possibilities. Feedback stages should help to correct or improve the investigation, if the author found that is the appropriate decision.

# CHAPTER IV: FINDINGS

The objective of this chapter is to describe all relevant findings for the achievement of the investigation objectives. The author will start with the selection of relevant variables for the study according to the Nested Approach Model (Shapiro and Bonoma, 1983) and the information gathered by the MRI Tracking Study. Furthermore, the analysis of all relevant data will be made, followed by the application Nested Approach with the cluster methodology and the verification of the results.

The first analysis will consist in a theoretical application of the Nested Approach to segment the U.S. market. This first analysis will be helpful to determinate which kind of results can be expected, if this segmentation framework is mixed with the cluster analysis. The results of this segmentation analysis will be helpful for later comparison with other segmentation analysis. The second analysis will consist in an "in company" application of the Nested Approach mixed with a cluster analysis to segment the U.S. and European market to find different radiologist segments.

**A. SELECTION OF BASES FOR THE MARKET SEGMENTATION**

The Nested Approach (Shapiro and Bonoma, 1983) model was selected to guide the segmentation process in this study. The Nested Approach count with five segmentation "nests"; each of them provide different variables for segmenting the market. The firsts "nests" are helpful to perform a macrosegmentation using general industry information, while the following "nests" need more specific information and are comparable with a microsegmentation. The model was built to segment the market from the outside layer to the inner ones, but it can be adapted to different situations. This model will be used to determinate which are the most important variables to consider for the cluster analysis.

**A.1. Demographic layer**

As it was said in the first chapter, for the segmentation procedure the MRI Tracking Study count with the information of 776 radiologists from the following 10 countries:

- Americas: Brazil, Canada, United States of America and Mexico
- Asia: China and South Korea
- Europe: Germany, France, Spain and Italy

Marketing Research Team state that the most important markets to analyze are: the U.S. and European markets, because these are the most important markets for Gadovist® and other MRI products. In the U.S. alone, 7.642.000 enhanced MRI procedures (43,18% of all procedures represented in the survey´s sample) were performed in 2010, while 6.373.000 procedures (36,01% of all procedures represented in the survey´s sample) were performed in the European region (Germany, France, Spain and Italy). It is also important to address that, Gadovist® still needs to be approved in several other countries.

**Table 4.1. Enhanced MRI procedures in 2010 per country**

| Country | MRI proc. (in 000) | % |
|---------|--------------------|---|
| USA | 7642 | 43,18% |
| Brazil | 1000 | 5,65% |
| Canada | 305 | 1,72% |
| Mexico | 120 | 0,68% |
| **TOTAL AMERICA** | **9067** | **51,23%** |
| Germany | 3302 | 18,66% |
| France | 1496 | 8,45% |
| Italy | 941 | 5,32% |
| Spain | 634 | 3,58% |
| **TOTAL EUROPE** | **6373** | **36,01%** |
| China | 1613 | 9,12% |
| Korea | 643 | 3,63% |
| **TOTAL ASIA** | **2256** | **12,75%** |
| **TOTAL** | **17696** | **100%** |

Source: MRI Tracking Study 2011

Countries like Brazil and Mexico are still emerging markets (1.000.000 -5,65%- and 120.000 -0,68%- enhanced MRI procedures in 2010) . The level of sales and the uncertainty surrounding these markets, make them not important enough at the moment of this research. On the other hand, in countries such as China and South Korea (1.613.000 9,12% - and 643.000 -3,63%- enhanced MRI procedures in 2010), the generics products are problematic for their low price compared to branded products. For the same reason, it is complicated for any branded product to compete with them. Simultaneously, these four countries are having less enhanced MRI procedures in 2010 compared to the U.S. and Europe.

In this study, the author proposed to segment only the important markets, dividing them in America (Canada and U.S.) and Europe (Germany, France, Spain and Italy). This proposal was made under the idea of maintaining the representativeness of the sample in each group for the later cluster analysis and taking into account the importance these markets have in procedures numbers. Germany represent 10,8% of the whole sample, while the other European countries represent 9% each. If all European countries are considered as a group, they represent 37,8% of the whole sample. Canada and U.S. represent 29,5% of the sample, representing 23,1% and 6,4% each.

Besides this, the Marketing Research Team proposed this geographical segmentation stressing that under the European Union regulations, products can be submitted to the European Health Authorities and approved in all the European countries at the same time. Independently that exist some differences between European countries for the distribution of these products, the experience of the Strategic Marketing MRI Team has demonstrated that is reasonable to assume that the European radiologist can be segmented as one market. The marketing strategies are developed globally. However the local managerial teams must adapt them to their markets.

Afterwards, it was proposed to take out Canada of the segmentation. Canada (305.000 -1, 72% - enhanced MRI procedures in 2010) is not considered an important market. On the other hand, Gadovist® is a 2$^{nd}$ generation MRI contrast agent introduced in Canada in 2004, while in the U.S. was introduced in 2011. In this moment Canada and the U.S. are in different industry and product life cycle, what make them difficult to compare. As a consequence, the market was segmented geographically in the following way:

**Table 4.2. Markets to be segmented**

| MARKETS | NUMBER OF PROCEDURES | SHARE |
|---|---|---|
| **United States** | 7.642.000 | 43,18% |
| **Europe** | 6.373.000 | 36,01% |
| **Total** | 14.015.000 | 79,19% |

Source: Made by the author

The market could also be segmented by "private practices" and "public hospitals". The U.S. sample is divided in radiologist coming from private practices and public hospitals. France is the only EU country that is strategically analyzed separately between these two kinds of practices, while Germany has also representatives from public hospitals and private practices, but they are not analyzed separately. Spain´s and Italy´s samples do not count with private practices.

**Table 4.3. Representation of Hospital-based and Office-based in the MRI Tracking study**

| COUNTRY | HOSPITAL-BASED | % SHARE | OFFICE-BASED | % SHARE | TOTAL |
|---|---|---|---|---|---|
| GERMANY | 44 | 14,33% | 40 | 23,81% | 84 |
| FRANCE | - | 0% | 70 | 41,66% | 70 |
| ITALY | 70 | 22,80% | - | 0% | 70 |
| SPAIN | 70 | 22,80% | - | 0% | 70 |
| USA (RADIOLOGISTS) | 80 | 26,06% | 34 | 20,24% | 114 |
| USA (ADMINS) | 43 | 14,01% | 24 | 14,29% | 67 |
| TOTAL | 307 | 100% | 168 | 100% | 776 |

Source: Made by the author

For the theoretical application of the Nested Approach, the U.S. market will use the public hospital/private practice (Type of hospital) as a demographic segmentation variable, because it will not be compared with a segmentation analysis of other regions. On the other hand, as this approach will be only theoretical, there is no need to take into account all business needs.

It will be different for the company´s segmentation. To use the four European countries in the European analysis, it was decided to not do a differentiation between practices. For the U.S. analysis was decided the same, as for the time being, this kind of segmentation is not considered relevant for business purposes and will help to make comparable the U.S. and European markets.

**A.2. Operating Variables**

The Nested Approach proposed to keep segmenting the market according to the customer technologies, product/brand use status and customer capabilities.

The only question regarding to "hospitals´ technologies", was question N° 34 about brand use of different "Power Injectors" (intravenous automated injectors) for MRI products. The information could not be use, because it was recollected as nominal variables. They were going to be analyzed after the cluster analysis, but the Market Research Team stressed that this information was not relevant at this moment, as it is still a new area in this business unit. Originally it was asked to obtain some market information for the management team, because Bayer Healthcare was going to merge the former "Diagnostic

and Imaging" business unit with Medrad, a U.S. subsidiary that offers contrast agent injector devices and other services, into a newly created "Radiology and Interventional" business unit (DOTmed.com, 2012).

About the "product use" variables, it is not a relevant characteristic for this study, because all the respondents perform at least 10 MRI exams per week. All radiologist that didn´t performed exams with MRI contrast agents were not take into account for the MRI Tracking Study.

On the other hand, five questions (S5, S6, S7, S9 and S10) were made regarding to the operational capabilities (MRI exams per week) of hospitals and radiologists, which helped to determinate the following operational variables for this study:

**Table 4.4. "Operational" variables selected for this study**

| | OPERATIONAL VARIABLES (MRI EXAMS / WEEK) | | | | |
|---|---|---|---|---|---|
| **VARIABLES** | MRI examinations per week performed in the practice / hospital | MRI examinations per week with CM performed in the practice / hospital | CE-MRI examinations per week performed personally | CE-MRI LIVER examinations per week performed personally | CE-MRI Breast examinations per week performed personally |
| **DESCRIPTION** | Number of MRI examination per week in the hospital/practice | Number of examinations made with contrast agents | Enhanced MRI scans/ week performed or overseen personally by the radiologist | Liver examinations per week among all enhanced MRI scans | Breast examination per week among all enhanced MRI scans |

Source: Made by the author

These variables can help to determinate the importance of the hospitals/radiologist number of procedures with or without MRI contrast agents for successfully segmenting the market. At the same time, these variables would be carefully analyzed, because there is a big dispersion in the data obtained. It is possible to find very big hospitals which make more than 2000 MRI procedures per week and others that reach only 100 MRI procedures per week. For the same reason, this data will be analyzed to determinate if there are outliers or extreme cases, and how these cases affect the cluster analysis.

For any U.S. segmentation (theoretical or "in company"), the only "Operational" variables that can be used are the "MRI examinations per week performed in the practice /

hospital" and "MRI examinations per week with CM performed in the practice / hospital". The other three "Operational" variables are related to questions that were not answered by all radiologists from the U.S. sample. On the other hand, this is not the case for the European segmentation, where all "Operational" variables will be used.

**A.3. Purchase approach**

The only two questions related to the "purchasing approach" were made to radiologists based at public hospitals. Question N°33 (nominal) asked if the hospital belonged to a purchasing group or purchase individually. Question N°19 (metric) asked about the amount of sales representative´s visits (sales force) in the last three months before the interview. The information obtained in both questions was left out of the study, because it's not relevant information for market segmentation according to the Market Research Team. No "Purchase approach" variables will be included in the cluster analysis.

**A.4. Situational factors**

The situational factors suggested by Shapiro are "Urgency of order fulfillment", "product application" and "size of the order". The only two questions related to "product application" are questions N° 22 (For what kind of MRI examinations is Gadovist® use?) and N° 23 (Only in the U.S.: Bottle/vial sizes of Gadovist® use in the past three months?). As it was mention in the first chapter, the non-specific MRI agents can be used to diagnostic different problems in different body parts. Sometimes these products are used off-label (the MRI contrast agent do not count with the approval of the health authorities) or are used according to the limitation imposed by the health authorities. These questions were left out of this study for being nominal variables and not relevant for segmentation criteria according to the Market Research Team (all radiologists examine all body parts, but, for different organs, they could use different or specific MRI contrast agents). The Bottle/Vial question is also not relevant for market segmentation and it is only applicable for the U.S. market. No "Situational Factors" variables will be included in the cluster analysis.

**A.5. Buyer personal characteristics**

The radiologists have their own perception about the importance of different attributes of the MRI contrast agents. Depending on the purchase structure of hospitals, radiologist can take the purchasing decision or it can be taken from a commission. Normally, the opinion of the radiologists or the chief of radiologists can be important in the buying process.

Question N° 7 present several different criteria that may affect their choice for an appropriate MRI contrast agent. The radiologist had to evaluate this criteria from 1 (Less Important) to 10 (Very Important) according to "how important they think this criteria can affect their choice of a particular contrast agent". The fourteen variables used for this question were related to MRI contrast agents attributes. All this fourteen attributes will be used in the cluster analysis duo their relevance to determinate the importance that radiologist give these different attributes. Moreover, all of them are scale variables.

**Table 4.5: Criteria to choose a contrast agent (Buying Criteria)**

| CRITERIA | DESCRIPTION |
|---|---|
| Excellent tissue contrast/excellent detection of pathological tissue | Improve image quality to determinate pathological tissue. |
| Can be used universally for the whole body | The product is approved to diagnostic safely all the parts of the body. |
| Advantageous for angiographic examinations | The product give certain advantages for angiographic examinations (examinations of arteries) |
| Can be used for children | The product is approved to use safely in children under 7 or under 2 years old. |
| High concentration/half volume | With a higher concentration of their active compound they can be used in smaller doses. |
| Can be used at lower gadolinium doses | Can be used at lower gadolinium doses (active compound of several MRI contrast agents) |
| High relaxivity | Relaxivity improve the contrast of the image and helps to study tissue specific areas where the contrast agent better diffuses |
| Good tolerability | Good tolerability |
| Different bottle sizes to meet daily requirements | Different bottle sizes |
| Good availability / no supply problems | Good availability / no supply problems |
| Long personal experience with the product | Long personal experience with the product |
| Cost effective compared to other agents | Cost effective compared to other agents |
| Macrocyclic structure | The structure of the molecules can be lineal or macrocyclic. The last one is considered more stable and safe. |
| Lower risk for NSF | Lower risk for NSF (Nephrogenic systemic fibrosis)[11] |

Source: Made by the autho

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[11] "Is a condition that, to date has occurred only in people with kidney disease. Cause fibrosis of the skin and internal organs. Over the past several years, researchers have correlated the development of NSF with the increasing use of gadolinium-based MRI contrast agents in patients with kidney disease." Official site of the Nephrogenic Systemic Fibrosis (NSF) Registry, http://www.icnfdr.org/.

**A.6. Partial conclusion**

In conclusion, for the theoretical application of the Nested Approach, the author will segment the U.S. market using Demographic (Type of hospital), Operational (MRI and CM MRI[12] exams per week in the hospital setting) and Buying Characteristics (Buying Criteria/attributes).

On the other hand, in the segmentation analysis for the company, a macrosegmentation was made according to the Market Research Team criteria. The markets to be analyzed are the U.S. and European (Germany, Italy, France and Spain) markets. To analyze these markets, nine teen variables were selected thanks to the data collected through the MRI Tracking Study. The "Operational variables" represent the 26,32% of all the variables, while the "Buying Criteria variables" represent the 73,68% of all the variables that will be used for this study. It is important to mention that only the information of six questions was selected from this study. That represents only the 15% of the information obtained in the survey, but other questions are going to be used for other kinds of analysis such as the Cross Tabulation analysis.

**Table 4.6. Demographic variables (only for the Theoretical application of the Nested Approach)**

| QUESTIONS | OPERATIONAL VARIABLES |
|---|---|
| S1:     Do you work at a private practice or a hospital? | Private practice |
| | Public Hospital |

Source: Made by the author

The previous variables are only going to be used for the theoretical application of the Nested Approach, because the theoretical approach that will be only performed with the U.S. sample will not be compared with a segmentation analysis of other regions.

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[12] MRI exams with contrast media

**Table 4.7. Operational variables selected for the cluster analysis**

| QUESTIONS | OPERATIONAL VARIABLES |
|---|---|
| S5: Approximately how several MRI examinations per week are performed in your practice / hospital department? | MRI scans / week |
| S6: Approximately how several MRI examinations per week in your practice / hospital are performed with contrast agents? | Enhanced MRI scans / week |
| S7: And how several contrast enhanced MRI examinations per week do you perform or oversee personally? | Personally enhanced MRI scans / week |
| S9: Approximately how several of the _____ (Progr.: Insert answer to S7) weekly contrast enhanced MRI scans which you personally perform or oversee are LIVER examinations? | LIVER examinations per week (among all enhanced MRI scans) |
| S10: Approximately how several of the _____ (Progr.: Insert answer to S7) weekly contrast enhanced MRI scans which you personally perform or oversee are BREAST examinations? | BREAST examinations per week (among all enhanced MRI scans) |

Source: Made by the author

Regarding to the operational variables previously mentioned, there are some differences to address between the European and the U.S. sample. In the U.S. sample, there were radiologists that did not answered the five questions, as many of them, having administrative functions in the hospital or private practice, they did not performed personally MRI scans per week. This radiologist only answered the first two questions regarding to the hospital patient load. In the European sample, this situation was not given.

**Table 4.8. "Buying Criteria" (Characteristics) variables selected for the cluster analysis**

| QUESTION N°9 | CRITERIA | VARIABLE NAME |
|---|---|---|
| Here is the list of attributes again which you classified by importance. For each attribute could you please now rate the performance of the different contrast agents. Please use a 5-point scale, where 1 means "does not describe at all" and 5 means "describes completely" to indicate what you think of the performance of each product on the first attribute. Of course, you may also use any number between 1 and 5. | Excellent tissue contrast / excellent detection of pathological tissue | Excellent contrast |
| | Can be used universally for the whole body | Whole Body |
| | Advantageous for angiographic examinations | MRA |
| | Can be used for children | Children |
| | High concentration/half volume | HighConcentration/ HalfVolume |
| | Can be used at lower gadolinium doses | Low GD |
| | High relaxivity | High relaxivity |
| | Good tolerability | Good tolerability |
| | Different bottle sizes to meet the daily requirements | Sizes |
| | Good availability / no supply problems | Good availability |
| | Long personal experience with the product | Personal Experience |
| | Cost effective compared to other agents | Cost effectiveness |
| | Macrocyclic structure | Macrocyclic |
| | Lower risk for NSF | Low NSF |

Source: Made by the author

In the next sections, the author will perform different analysis to the recollected data. The data analysis and the cluster analysis of each region will be performed separately.

**B. DATA SCREENING**

In this section the author will describe the results obtained in the data analysis of the U.S. and European sample. The analysis performed; consist in a basic descriptive analysis, z-scores analysis for outlier's detection and Multicollinearity analysis. Afterwards, the author, will present the results of the cluster analysis performed to the U.S. (theoretical and "in company") and to the European sample (only "in company") according to the Nested Approach segmentation model.

## B.1. U.S. data analysis[13]

### B.1.1. Operational variables

First is important to address that, in the "Operational" variables, there are 43 missing cases in the "Personal exams", "Breast Exams" and "Liver Exams" variables. Those 43 radiologists belonged to hospital settings and had only administrative functions. Even if these radiologists do not perform or oversee MRI exams, they have an important influence in the buying decision of the MRI contrast agents. For the same reason, and taking in to account that the product Gadovist® has not been approved for Breast MRI (and in the U.S. does not exist a Whole Body approval as in Europe), the author and the Marketing Research Team decided only to use the "Buying Criteria" variables for segmenting the market. Nevertheless, a Skewness, Kurtosis and outlier analysis was made to analyze these variables for their possible application in the theoretical model.

The Skewness and Kurtosis analysis of the five "Operational" variables, it is possible to see that the distribution of the data is not normal. Both values are high in all the variables. The high positive Skewness values mean that the data is left-skewed and the high positive Kurtosis values mean that the data is mostly distributed around the arithmetic mean, but not evenly. On the other hand, the number of "MRI scans / week" are distributed in a wide range of data (from 25 to 1000 MRI exams x week) with a very high standard deviation and a very small mean in comparison with the minimum and maximum values. With these two analyses, it is possible to say that some outliers could be found.

After performing z-scores and boxplots analysis to determinate the presence of outliers, it was possible to identify seven outliers in different "Operational" variables. For example, the cases 141 and 139 represent Academic Teaching hospitals, where more than 1000 MRI and enhanced MRI[14] scans are performed every week. The Academic Teaching Hospitals have a greater load of patients than any other hospital setting in the U.S. and it is not unreasonable to find Academic Teaching hospitals with really high patient load. These extreme cases will be kept to not affect the representativeness of the sample. They will be taken out, if they show to have a considerable effect in the clustering results,.

Regarding to multicollinearity, it is not hard to understand that the "Operational" variables could be correlated. All the "Operational" variables represent MRI scans per

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[13] To see the complete analysis, see appendix N°3, p. 160
[14] MRI exams performed with MRI contrast agents.

week, but in different situation. While "MRI scans / week" and "Enhanced MRI scans / week" represent the MRI scans performed in the hospital, the other variables represent the MRI scans performed directly by the radiologist, and this information should be analyze separately.

### B.1.2. Personal characteristic variables

It is important to mention, according to the Market Research Team, that in the Healthcare industry, including the radiology or diagnostic imaging business, is very reasonable that all the radiologist or medics answered under the assumption or perception that every product´s attribute is important. This effect is related to the risks that exist in the medical profession where, product´s secondary effects or misscare of patients can result in sickness or death.

The Skewness and Kurtosis analysis give an interesting overview of the distribution of the data. There are no variables symmetrically distributed. For the same reason, it is possible to conclude that no variables of the set are normally distributed.

After a z-score and boxplot analysis, was easy to identify the extreme cases. Any radiologist scoring less than four points in an attribute will be away from the mean.. It is possible to count twenty five different cases (without counting the ones which repeat themselves in more than one variable). These extreme cases will be kept in the cluster analysis to not affect the representativeness of the sample. They will be taken out only if they show to have a considerable effect in the clustering results,

Regarding to multicollinearity, several "Buying Criteria" variables are correlated. In this case, it is possible to link the "Everything is important" opinion from the radiologists in the moment of answering the survey.

## B.2. Europe data analysis[15]

### B.2.1. Operational variables

The number of "MRI scans / week" is distributed in a wide range of data (from 12 to 2000 MRI exams x week) with a very high standard deviation and a very small mean in comparison with the minimum and maximum values. The same can be seen in all the

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[15] To see the whole analysis, see appendix N°14, p. 193

others "Operational" variables. A Kurtosis and Skewness analysis also showed that the distribution is not "normal". The data is left-skewed and the high positive Kurtosis values mean that the data is mostly distributed around the arithmetic mean, but not evenly. These could indicate that is very possible to find some hospitals or radiologists that perform a very high numbers MRI scans per week compare with what the sample try to represent. It is possible that these cases do not represent the population according to their extremes values and could be considered outliers.

After performing z-scores and boxplots analysis to determinate the presence of outliers or extreme cases, it was possible to identify at least fourteen outliers in different "Operational" variables. For example, the cases 46 and 211 represent hospitals, where more than 1000 MRI and enhanced MRI[16] scans are performed every week. Case 46 is a Spanish radiologist who worked in a not classified hospital, where 2500 MRI and 1000 enhanced MRI scans are performed per week.

The case 211 is a German radiologist who worked in a private hospital where more than 1000 MRI and 500 enhanced MRI scans are performed per week. Both cases surpass by far the 174 MRI and 82 enhanced MRI scans mean per week. This review gives a good example of how are behaving the outliers in the "Operational" variables. Taking out cases 46 and 211, it is possible to identify other extreme cases like cases 30, 50, 54 (Spain), 133 (Italy), 171, 174, 191, 192, 213, 219 (Germany), 277 and 286 (France). These fourteen outliers represent the 4,8 % of the whole European sample. For the clustering method, the outliers will be left out depending on how much they affect the clustering results.

On the other hand, it is also important to identify how the data is represented in each country. To identify certain patterns in each European country, it will be helpful to compare these results with the cluster´s results to see the effect of each country´s data in each cluster.

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[16] MRI exams performed with MRI contrast agents.

**Figure 4.1. Analysis of "Operational" variables per country**
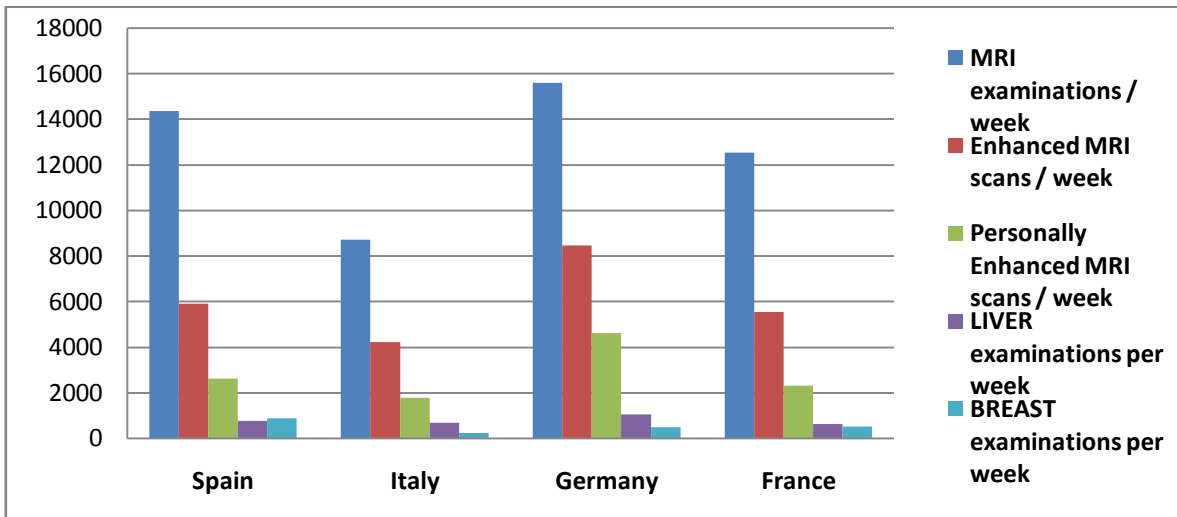


Source: Made by the author

Certain patterns can be identified in each country. For example, it is clear that Germany has the higher amount of procedures of the region followed by Spain. This information is consistent with the "outlier" analysis, in which nine outliers were found in these countries. In the other hand, Italy has a very small numbers of procedures in comparison with each country. France is in the middle.

Regarding to multicollinearity, as in the U.S. analysis, it is not hard to understand why the "Operational" variables could be correlated. All the "Operational" variables represent MRI scans per week, but in different situation. While "MRI scans / week" and "Enhanced MRI scans / week" represent the MRI scans performed in the hospital where the radiologists work, the other variables represent the MRI scans performed directly by the radiologist.

### B.2.2. Personal characteristic variables

Regarding to the "Buying Criteria" variables is easy to see that the means of all variables are above seven points, except for High Concentration/Half Volume and Macrocyclic variables. On the other hand, after a Skewness and Kurtosis analysis, it was found that mostly all variables tend to be negative and asymmetrically distributed (Curve to the right side of the mean) and leptokurtic distributed (mostly distributed around the arithmetic mean, but not evenly). HihCon/HalfVol and High Relaxivity are the only variables that are normally distributed. With this information it is possible to say that, if there are any outliers, they will be cases with very low scores in each variable.

After a z-scores and a boxplot analysis it was easy to identify twenty one extreme cases; any radiologist answering less than four points will be very far away from the mean. To keep the representativeness of the sample, any extreme value found in these variables will be kept in the analysis.

As the market will be analyzed as a region, it is important to review each country´s behavior regarding to the characteristic variables. In the next chart, the attributes are sorted by importance (from most important to less important) according to the European mean in each attribute. According to the European mean and the Box Plot in each attribute (all means are around 7 and 8 points) all the attributes are very important. For that reason, the next graph will measure the importance of each attribute according to how several radiologist in each country score 8, 9 or 10 points in an attribute (3 Top Boxes). This way, it is easy to see which variable are the most and less important for the European radiologist.

**Figure 4.2. Importance of attributes in the EU countries for MRI contrast agents**
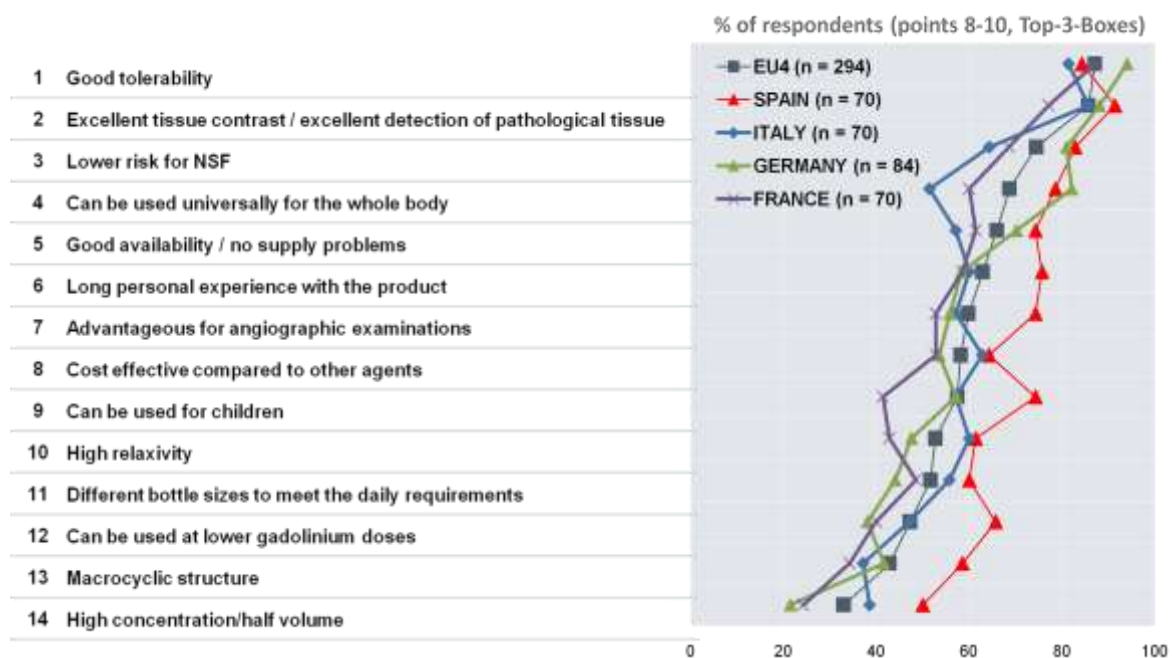


Source: Made by the author

From this analysis it is possible to infer that the Spanish radiologists have more demanding requirements for MRI products as they give a big importance to all the attributes. On the other hand, German radiologists are equally demanding, but only in the five first attributes, all related to efficacy, safety and one indication (Whole Body approval). Italians radiologists give more importance to "operational" attributes such as "Cost Effectiveness", and "Bottle sizes", and to efficacy and safety variables such as "Excellent Contrast", "High

Relaxivity" and "Macrocyclic" structure. French radiologists give a high importance to "Good Tolerability", but it is not as important for them as for the Spanish or German radiologist. All the other attributes are equally or less importance in comparison with the general European opinion.

All "Buying Criteria" variables are correlated with the exception from "Excellent Contrast" and "Children". In this case, again, it is possible to point out the "Everything is important" opinion from the radiologists in the moment of answering the survey. As it was visible before in the boxplots and in the descriptive analysis, all variables have scores over seven points in all the variables.

### C. U.S. NESTED APPROACH THEORETICAL SEGMENTATION

As the European region has four countries with different realities regarding to private practices and public hospitals, the US market was chosen for the Nested Approach theoretical application. The United States has a big sample representativeness for one country, what helps to simplify the analysis. The idea of this section is to perform a market segmentation following the Nested Approach process for a later comparison with the other analyses.

**Table 4.9. Layers and variables for the Nested Approach**

| LAYER | CRITERIA |
|---|---|
| DEMOGRAPHIC | Type of hospital |
| OPERATIONAL | Operational variables |
| CHARACTERISTICS | Attributes perceptions |

Source: Made by the author

As it was mentioned before, the author will keep the number of cluster between three and four, and the variables will be standardized only if they are measure in different scales. It was decided to not leave out extreme cases for not affecting the representativeness of the sample.

For this analysis, the author will use "Demographic", "Operational" and "Characteristics" variables; in that order specifically. For the Demographic segmentation, the author will use "Type of Hospital" information; University, Academic, Community and Private Hospitals. For the "Operational" and "Characteristics" layers, the author will use: "MRI scans x week", "Enhances MRI scans per week" and product´s attributes.

### C.1. Segmentation with demographic variables

The U.S. market can be segmented in four different types of hospitals without using a cluster analysis: University, Academic Teaching, Community and Private Hospitals. Each different hospital setting could be considered as a different segment.

**Table 4.10. Number of cases per "Type of hospital"**

| CLUSTER CONFIGURATION | NUMBER OF CASES | SHARE |
|---|---|---|
| UNIVERSITY HOSPITALS | 4 | 2,2% |
| ACADEMIC TEACHING | 25 | 13,9% |
| COMMUNITY HOSPITAL | 94 | 51,9% |
| PRIVATE PRACTICE | 58 | 32% |

Source: Made by the author

The "Academic Teaching hospitals" provide clinical education and training to future and current doctors, nurses, and other health professionals, in addition to delivering medical care to patients. When they are affiliated to Universities, they are called "University hospitals". "Community hospitals" are defined as "all nonfederal, short-term general and other special hospitals" (The American Hospital Association, 2013). Finally, the "Private" practices "are organized in a corporate model where the physicians are shareholders, or where one or more physicians own the practice and employ other physicians or providers" (Whaley, 2011).

**Table 4.11. Descriptive analysis for the "Operational" variables**

| VARIABLE | TYPE | N | MEAN | STD. DEVIATION | MIN | MAX |
|---|---|---|---|---|---|---|
| S5) MRI scans / week | University Hospital | 4 | 187,50 | 131,498 | 50 | 300 |
| | Academic Teaching | 25 | 318,60 | 266,699 | 50 | 1000 |
| | Community Hospital | 94 | 136,86 | 110,103 | 25 | 680 |
| | Private | 58 | 131,05 | 97,632 | 26 | 500 |
| S6) Enhanced MRI scans week | University Hospital | 4 | 110,00 | 100,995 | 10 | 250 |
| | Academic Teaching | 25 | 131,20 | 129,665 | 20 | 500 |
| | Community Hospital | 94 | 61,23 | 63,456 | 10 | 450 |
| | Private | 58 | 61,86 | 48,813 | 15 | 200 |

Source: Made by the author.

The University hospitals are the smaller group from the whole sample. They represent only the 2,2% of the sample and for the same reason, it is hard to draw conclusion from

this group. On the other hand, The Academic Teaching hospitals are the second smaller group, but they have the biggest means for both variables. They have a really high patient load. On the other hand, Community hospitals and Private practices are similar.

**Table 4.12. ANOVA test results for "Buying Criteria" in "Type of hospital" segmentation**

| VARIABLE | SIGNIFICANCE LEVEL | VARIABLE | SIGNIFICANCE LEVEL |
|---|---|---|---|
| MRI Scans / week | .000 | High relaxivity | .197 |
| Enhanced MRI scans / week | .000 | Good tolerability | .998 |
| Excellent contrast | .844 | Bottle Sizes | .501 |
| Whole Body | .336 | Good availability | .881 |
| MRA | .248 | Personal Experience | .708 |
| Children | .603 | Cost effectiveness | .628 |
| HighConcentration/HalfVolume | .009 | Macrocyclic | .307 |
| Low GD | .044 | Low NSF | .465 |

Source: Made by the author

The ANOVA test showed that only three variables make differences between groups; "MRI scans / week", "Enhanced MRI scans / week", "Low GD" and "HighConcentration/HalfVolume". All other variables do not make differences between groups. For that reason, the Demographic segmentation is not a good segmentation criterion.

Under this segmentation layer, it is possible to conclude, that the different levels of patients load from each hospital make differences between them, but, if mostly all "Buying Criteria" variables do not make differences between groups, the segmentation lacks from value for segmenting the market with the Characteristics layer of the Nested Approach.

This market segmentation did not give a good overview of the market. For the same reason, looking for more useful segmentation results, this segmentation layer will be left out of the analysis and the author will try to segment the market only through the "Operational" and "Characteristics" (Buying Criteria) layers.

### C.2. Segmentation with operational variables

In the U.S. market, the only "Operational" variables that can be used are: "MRI scans per week" and "Enhanced MRI scans per week". The other three "Operational" variables such as "Personally enhanced MRI scans / week", "Liver scans /week" and "Breast scans /

week" were taken out of the study in the U.S. market, because not all the radiologists answered the questions related to these variables.

A first dendongram suggested a two, three and four clusters configurations. The problem of the three clusters configuration is that one of its clusters has only four cases (2,2% of the sample). On the other hand, the four clusters configuration is formed by well distributed clusters, but the ANOVA test shows that both variables make no differences between groups.[17] After taking out four extreme cases, the dendogram suggested a two clusters and a three clusters configurations. In the following table, it is possible to see the number of cases in each cluster.

**Table 4.13. Number of cases per cluster[18]**

| CLUSTER CONFIGURATION | 2 CLUSTERS | 3 CLUSTERS |
|---|---|---|
| CLUSTER 1 | 142 | 103 |
| CLUSTER 2 | 33 | 39 |
| CLUSTER 3 | _ | 33 |

Source: Made by the author

Looking at the means of each cluster in both cluster configurations, it is possible to say that the two clusters configuration has a "Big Hospital" and a "Small Hospital" clusters. Moreover, under the same criteria, the three clusters configuration is formed by "Big hospitals", "Medium Size Hospitals" and "Small Hospitals", as it is shown in the following figure.

**Table 4.14. Means analysis for "Operational" variables**

| | S5 MRI scans / week | | S6 MRI Enhanced Scans / week | |
|---|---|---|---|---|
| CLUSTER | 2 CLUSTER | 3 CLUSTER | 2 CLUSTER | 3 CLUSTER |
| 1 | 102,12 | 75,64 | 47,00 | 37,95 |
| 2 | 336,21 | 172,05 | 138,79 | 70,90 |
| 3 | | 336,21 | | 138,79 |

Source: Made by the author

According to the ANOVA test, both variables made differences between groups. From the both configurations, the author decided to keep the three cluster configuration as it clearly divide the clusters as; "Big hospitals", "Medium Size Hospitals" and "Small

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[17] To see the complete analysis, see appendix N°4, p. 169
[18] To see original dendogram, see appendix N°5, p. 171

Hospitals". The Scheffe´s test showed that all the differences between groups were significant.

**Table 4.15. ANOVA test result for "Operational" variables without four extreme cases**

| Variable | Two cluster configuration | Three cluster configuration |
|---|---|---|
| | SIGNIFICANCE LEVEL | |
| S5: MRI scans per week | .000 | .000 |
| S6: Enhanced MRI scans per week | .000 | .000 |

Source: Made by the author

According to these results, the author decided to segment the market following the last three clusters configuration; "Big hospitals", "Medium Size Hospitals" and "Small Hospitals". This distinction is performed according to their MRI scans per week with-and without contrast agent (Enhanced MRI scans). Another cluster analysis will be conducted to each cluster, but including the "Buying Criteria" variables.

**C.3. Segmentation with personal characteristics variables**

**C.3.1. Small Hospitals Cluster**

After including the "Buying Criteria" variables to the "Small Hospital" cluster, the dendogram suggested a two, three and four cluster configuration.

**Table 4.16. Number of cases per cluster[19]**

| CLUSTER CONFIGURATION | 2 CLUSTERS | 3 CLUSTERS | 4 CLUSTER |
|---|---|---|---|
| CLUSTER 1 | 42 | 42 | 22 |
| CLUSTER 2 | 61 | 35 | 35 |
| CLUSTER 3 | _ | 26 | 20 |
| CLUSTER 4 | _ | _ | 26 |

Source: Made by the author

According to the ANOVA test, all variables make difference between groups in all configurations.

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[19] To see original dendogram, see appendix N°6, p. 172

**Table 4.17: ANOVA test result for Operational variables in the Small Hospitals cluster**

| VARIABLE | SIGNIFICANCE | | | VARIABLE | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|
| Cluster configuration | 2 | 3 | 4 | Cluster configuration | 2 | 3 | 4 |
| Excellent contrast | .003 | .001 | .003 | Good tolerability | .000 | .000 | .000 |
| Whole Body | .000 | .000 | .000 | Bottle Sizes | .000 | .000 | .000 |
| MRA | .003 | .001 | .002 | Good availability | .000 | .000 | .000 |
| Children | .000 | .000 | .000 | Personal Experience | .042 | .000 | .000 |
| HighConcentration/HalfVolume | .000 | .009 | .000 | Cost effectiveness | .000 | .000 | .000 |
| Low GD | .000 | .000 | .000 | Macrocyclic | .000 | .000 | .000 |
| High relaxivity | .000 | .000 | .000 | Low NSF | .007 | .001 | .003 |

Source: Made by the author

In the three clusters configuration is possible to distinguish a "Demanding", "Average" and "Less Demanding" clusters. The "Demanding" cluster gives the greater importance to all the attributes, the "Less Demanding" give the lower importance to all the attributes and the "Average" cluster is in between. According to the Scheffé´s test results, they have the same opinion regarding some attributes, but in general, it is easy to distinguish their differences. In the next graph it is possible to see how each "Buying Criteria" variable behave in this "Small Hospital" cluster. The variables are sorted according to the general perception of the U.S. radiologist about these attributes (the first variable has the higher mean from the whole sample and so on). The green globes show the Scheffe´s test results (No difference between means).

**Figure 4.3. "Buying Criteria" means in the "Small Hospital" cluster**



Means of each group per attribute

| | |
|---|---|
| 1 | Excellent tissue contrast/excellent detection of pathological tissue |
| 2 | Lower risk for NSF |
| 3 | Good tolerability |
| 4 | Cost effective compared to other agents |
| 5 | Good availability / no supply problems |
| 6 | Can be used universally for the whole body |
| 7 | Can be used at lower gadolinium doses |
| 8 | Advantageous for angiographic examinations |
| 9 | High relaxivity |
| 10 | Long personal experience with the product |
| 11 | Can be used for children |
| 12 | Different bottle sizes to meet the daily requirements |
| 13 | High concentration/half volume |
| 14 | Macrocyclic structure |

Group 1=42
Group2= 35
Group 3= 26

Source: Made by the author

In general, the clusters are well differentiated. It is not rare that all the clusters share similar opinion about the "Excellent Contrast" variable as it is critical for good quality imaging. The "Less demanding" cluster showed specially a low concern for "Children" and "Macrocyclic" variable. This could mean that these radiologists do not perform several MRI scan for children and do not use macrocyclic MRI contrast agents (safer than linear MRI contrast agents). On the other hand, they also give some importance to the "Whole Body" variable, what could mean that they are only interested in basic attributes regarding efficacy and safety, and that the MRI product of their choice could be used in multiple body parts.

Moreover, it is also possible to say that the "Average" radiologists it is not completely interested in the last four attributes, where "Children" and "Macrocyclic" are included. This cluster gives a notorious importance to the first eight variables. They are not only interested in the basic efficacy and safety attributes such as "Low Risk for NSF" or "Excellent Contrast", but they are also interested in MRI contrast agents with different indication approved (Whole Body and MRA), good availability and low gadolinium doses.

### C.3.2. Medium Size Hospital Cluster

The first dendogram suggested a two, three and five clusters configurations. The five clusters configuration is not a good result, because all the clusters are too small for a good analysis. On the other hand, the two and three clusters configurations are more suitable

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for a more in-deep analysis. In the three clusters configuration, the cluster N°2 has only six cases, but they represent the 15% of the sample[20]. The two cluster configuration has a cluster which represent the 84,6% of the sample. In the three cluster configuration this percentage is divided in other two groups.

**Table 4.18: Number of cases per cluster[21]**

| CLUSTER CONFIGURATION | 2 CLUSTERS | 3 CLUSTERS | 4 CLUSTER |
|---|---|---|---|
| CLUSTER 1 | 33 | 17 | 17 |
| CLUSTER 2 | 6 | 16 | 10 |
| CLUSTER 3 | _ | 6 | 6 |
| CLUSTER 4 | _ | _ | 6 |

Source: Made by the author.

According to the ANOVA test, not all variables make differences between groups in the two (Children, High Relaxivity and Low NSF) and three (High Relaxivity) clusters configurations. The three clusters configurations was chosen for the segmentation process, because it follows the same pattern as the previous analysis and only one variable will be left out of the analysis (High Relaxivity)[22].

**Table 4.19. ANOVA test results for Operational variables without High Relaxivity variable for Medium Hospitals cluster**

| VARIABLE | SIGNIFICANCE | | | VARIABLE | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|
| Cluster configuration | 2 | 3 | 4 | Cluster configuration | 2 | 3 | 4 |
| Excellent contrast | .000 | .000 | .000 | Bottle Sizes | .145 | .002 | .007 |
| Whole Body | .006 | .001 | .002 | Good availability | .000 | .000 | .000 |
| MRA | .000 | .001 | .003 | Personal Experience | .058 | .026 | .062 |
| Children | .004 | .000 | .000 | Cost effectiveness | .000 | .000 | .000 |
| HighConcentration/HalfVolume | .002 | .010 | .027 | Macrocyclic | .010 | .001 | .000 |
| Low GD | .013 | .000 | .000 | Low NSF | .000 | .000 | .000 |
| Good tolerability | .000 | .000 | .000 | | | | |

Source: Made by the author

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[20] To see the complete analysis, see appendix N°7, p. 173
[21] To see original dendogram, see appendix N°8, p. 175
[22] To see original dendogram, see appendix N°8, p. 175

The ANOVA test showed that the three clusters configuration is the only configuration where all the variables make differences between groups. For that reason, this solution was chosen for the following analysis. In the next graph the green globes shows the Scheffe´s test results (No difference between means).

**Figure 4.4. "Buying Criteria" means in the Medium Hospital cluster**
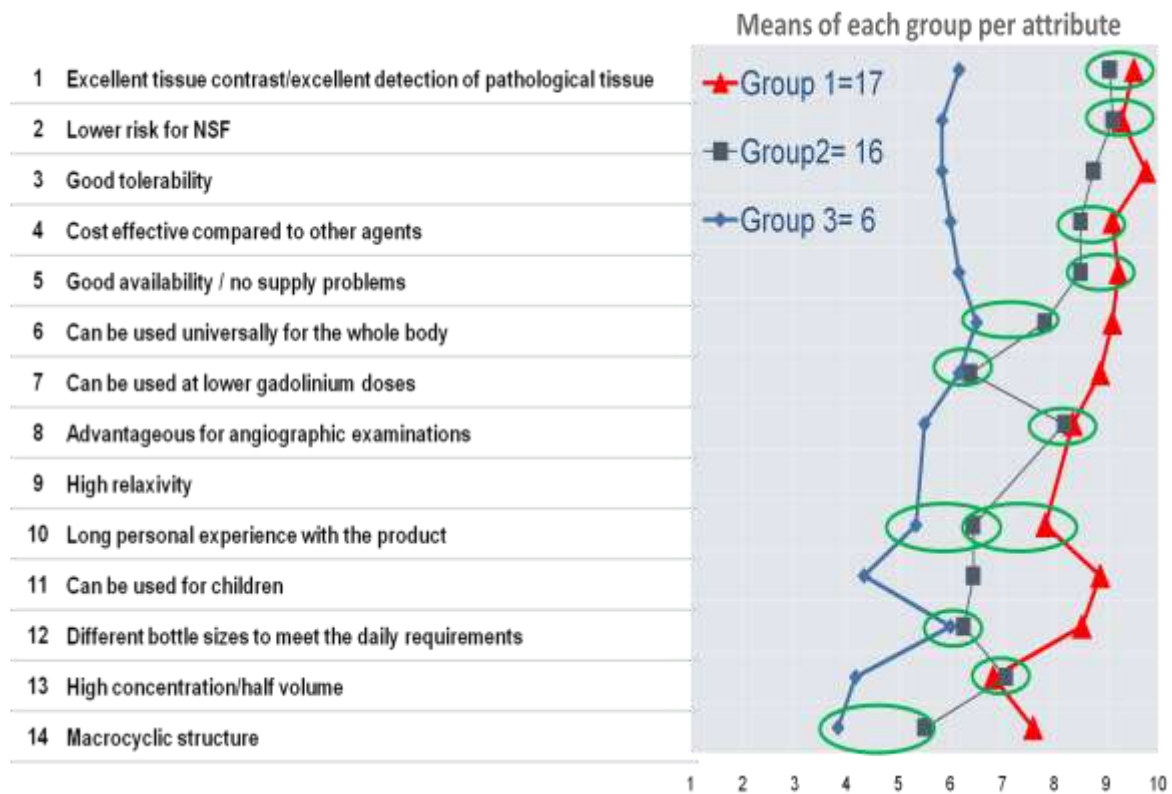
The cluster 1 (Demanding) and 3 (Indifferent) are easy to distinguish. The cluster 3 has been called "Indifferent" as the differences with the "Demanding" cluster are notorious. On the other hand, the clusters share several similarities with each other. The cluster 2 (Less demanding) is as demanding as the cluster 1, but just in the first four attributes and "Angiographic exams (MRA)". At the same time, the "Indifferent" and the "Less Demanding" radiologist are not to concern about macrocyclic agents; new contrast agents which are safer than linear contrast agents, because of their molecular stability.

The "Indifferent" radiologist is less interested in mostly all variables in comparison with the other clusters, except for "Whole Body". This could mean that they are only looking normal contrast agents which can be used mostly all situation. Moreover, the "Less Demanding" is mostly concern of the basic safety and efficacy attributes of the MRI products.

### C.3.3. Big Hospitals

The results given by three different cluster analyses were not satisfactory. For the first cluster analysis results, the ANOVA test shows that five variables did not make differences between groups. For that reason, that five variables were left out of the analysis and another cluster analysis was performed. In this second cluster analysis, the ANOVA test shows that more variables did not make differences between groups and the same for the next cluster analysis. Finally, the author took the decision that the operational cluster "Big Hospitals" is not a good candidate for a Hierarchical Cluster Analysis using the "Buying Criteria" variables, because the emerging cluster showed no differences between them. [23]

**Figure 4.5. "Buying Criteria" means in Big Hospitals cluster**
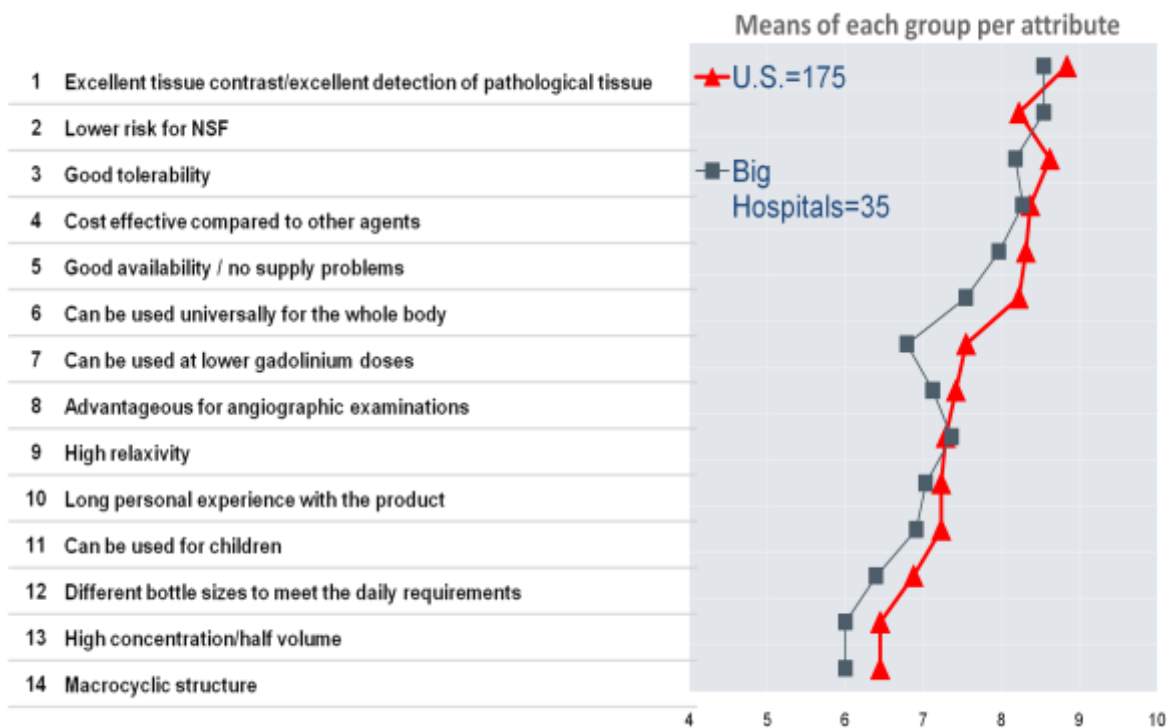


Source: Made by the author

In the previous graph is possible to see that this "Big Hospital" cluster has lower means in all attributes with the exception of "Lower Risk for NSF" while "Cost Effectiveness" and "High Relaxivity" behave as the U.S. mean. Taking this into account, it is possible to state that this group has a "normal" concern for efficacy and prices, and a "high" interest for safety attributes.

### C.4. Partial conclusion

Following in an strictly manner the Nested Approach proposed by Shapiro and Bonoma in 1983, the author was able to find, through a Hierarchical Cluster Analysis, three groups of

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[23] For the complete analysis, see appendix N°9, p. 176

hospitals according to their "Operational" variables. After this, the author performed another Hierarchical Cluster Analysis on the three hospitals clusters using the "Buying Criteria" variables (product attributes perception) giving the following results:

**Table 4.20. Partial Conclusion**

| HOSPITAL CLUSTERS | | SMALL HOSPITALS | | MEDIUM SIZE HOSPITALS | | BIG HOSPITALS | |
|---|---|---|---|---|---|---|---|
| n=175 | %=100 | 103 | 58,9% | 39 | 22,2% | 33 | 18,9% |
| | | | | | | | |
| RADIOLOGISTS CLUSTERS | | Demanding (40,8%) | | Demanding (43,6%) | | None | |
| | | Average (34%) | | Less Demanding (41%) | | | |
| | | Less Demanding (25,2%) | | Indifferent (15,4%) | | | |

Source: Made by the author

The difference between the "Less Demanding" and the "Indifferent" radiologist in the "Medium Size Hospitals" is that the "Less Demanding" is that the "Less Demanding" share similarities in the most important variables of the U.S. Market with the "Demanding" cluster.

In the "Big Hospitals" cluster, all the clusters analysis and ANOVA tests performed indicated that the most important variables for the U.S. market did not make differences between the emerging clusters. For this reason, the author preferred to not use the clustering results obtained in this cluster.

With these results, the author has the possibility to have a good glance of what can be expected from the application of the Nested Approach with the cluster analysis in the segmentation analysis for the company. The "Operational" variables will divide the sample from "Higher procedures" cluster to "Fewer procedures clusters", while the "Characteristic" variables (Buying Criteria) will segment the market from "Demanding" to "Less demanding" radiologist. On the other hand, it is also possible that, in some cases, the cluster analysis will not give satisfactory results for further segmentation analyses.

### D. U.S. CLUSTER ANALYSIS SEGMENTATION FOR THE COMPANY

After all the data review in the lasts sections, the author and Marketing Research Team decided to segment the U.S. market using the "Operational" ( MRI scans / week and Enhanced MRI scans / week) and "Buying Criteria" variables. As the analysis has to deal with different measuring units, the variables were standardized (Z-scores) directly through

the cluster analysis. The criteria for the selection of segments after the clustering results will be: the segments should be no more than four or five and they should be simple to identify and understandable for the managerial team.

After two clusters analyses using "Operational" and "Buying Characteristic" variables without satisfactory results, the author decided to leave out the two "Operational" variables from the clustering methodology. The first results were affected by the outliers coming from the "Operational" variables forming very small cluster (less than the 10% of the sample). After taking out the extreme cases, the author was able to find a consistent three cluster configuration. [24]

The problem of this configuration was that, even if the ANOVA analysis shows that all the variables make differences between groups, after a Scheffé test, the author was able to find that only two groups were really differentiated. The other group shared many similarities with both groups, making very difficult to find a managerial use to this segmentation. This cluster configuration was not so clear and hard to understand. It is not helpful to determinate three groups, which two of them are really hard to differentiate in some aspect with the other clusters.

Looking for a better understanding of the market and for a cluster configuration useful for the managerial team, the "Operational" variables were taken out of the analysis and another cluster analysis was performed only with the "Buying Criteria" variables. The "Buying Criteria" variables are in the same scale and for that reason, they were not standardized.

The dendogram shows the possible groups using only the fourteen "Buying Criteria" variables. The dendongram suggested a two, three and five clusters configurations. The two cluster configuration will be left out of the analysis, because there is no reason to only have two segments. This way the other two configurations will be evaluated.

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[24] To see the complete analysis, see appendix N°10, p. 182

**Table 4.21. Number of cases per cluster** [25]

| CLUSTER CONFIGURATION | 3 CLUSTERS | 5 CLUSTERS |
|---|---|---|
| CLUSTER 1 | 84 | 61 |
| CLUSTER 2 | 60 | 53 |
| CLUSTER 3 | 35 | 23 |
| CLUSTER 4 | _ | 35 |
| CLUSTER 5 | _ | 7 |

Source: Made by the author

The five cluster configuration has a very small group with seven cases, representing the 4% of the whole sample. For the same reason, this cluster configuration was taken out of the analysis. Cluster 5 is composed by four Academic and three Community hospitals. The outliers will be kept, because they are not part of the Cluster 5 and they belong to the Cluster 4, which is the cluster with lower mean in all variables.

**Table 4.22: Example of Means, Minimum and Maximum values analysis for "Buying Criteria" variables in the five cluster configuration in the U.S.** [26]

| VARIABLE | CLUSTER | MEAN | MIN | MAX | VARIABLE | CLUSTER | MEAN | MIN | MAX |
|---|---|---|---|---|---|---|---|---|---|
| EXCELLENT CONTRAST | 1 | 8,77 | 7 | 10 | GOOD TOLERABILITY | 1 | 8,28 | 5 | 10 |
| | 2 | 9,43 | 5 | 10 | | 2 | 9,53 | 7 | 10 |
| | 3 | 9,57 | 8 | 10 | | 3 | 9,74 | 8 | 10 |
| | 4 | 7,46 | 2 | 10 | | 4 | 7,06 | 2 | 10 |
| | 5 | 9,43 | 8 | 10 | | 5 | 8,71 | 6 | 10 |
| WHOLE BODY | 1 | 7,52 | 2 | 10 | SIZES | 1 | 6,02 | 1 | 10 |
| | 2 | 9,23 | 7 | 10 | | 2 | 8,51 | 5 | 10 |
| | 3 | 8,83 | 5 | 10 | | 3 | 7,78 | 1 | 10 |
| | 4 | 7,46 | 2 | 10 | | 4 | 5,20 | 1 | 9 |
| | 5 | 9,00 | 7 | 10 | | 5 | 8,71 | 6 | 10 |

Source: Made by the author

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[25] To see original dendogram, see appendix N°11, p. 188
[26] To see original table, see appendix N°12, p. 189

In the previous figure it is possible to see how the different clusters are composed. As all of them have the same behavior in all the variables, the previous figure just show some of them. The Cluster 4 represents the lower means from the entire analysis, while the Cluster 5 is always between the first or second cluster with higher means and has no minimums score between one and four.

**Table 4.23: ANOVA test result for three and five clusters configurations for the "Buying Criteria**

| VARIABLE | SIGNIFICANCE LEVEL | VARIABLE | SIGNIFICANCE LEVEL |
|---|---|---|---|
| Excellent contrast | .000 | Good tolerability | .000 |
| Whole Body | .000 | Bottle Sizes | .000 |
| MRA | .000 | Good availability | .000 |
| Children | .000 | Personal Experience | .000 |
| HighConcentration/HalfVolume | .000 | Cost effectiveness | .000 |
| Low GD | .000 | Macrocyclic | .000 |
| High relaxivity | .000 | Low NSF | .000 |

Source: Madeby the author.

The three clusters configuration is more interesting. After the ANOVA test, it is possible to see that all variables make differences between groups. There are three groups going from a very "Demanding" to other two that are "Less demanding". These segments are much easier to analyze and understand. In the next graph, the green globes represent the Scheffé test results (No differences between means).

**Figure 4.6: "Buying Criteria" means in each cluster**

| | |
|---|---|
| 1 | Excellent tissue contrast/excellent detection of pathological tissue |
| 2 | Lower risk for NSF |
| 3 | Good tolerability |
| 4 | Cost effective compared to other agents |
| 5 | Good availability / no supply problems |
| 6 | Can be used universally for the whole body |
| 7 | Can be used at lower gadolinium doses |
| 8 | Advantageous for angiographic examinations |
| 9 | High relaxivity |
| 10 | Long personal experience with the product |
| 11 | Can be used for children |
| 12 | Different bottle sizes to meet the daily requirements |
| 13 | High concentration/half volume |
| 14 | Macrocyclic structure |

Means of each group per attribute

Group 1= 84
Group2= 60
Group 3= 35

Source: Made by the author

In the previous graph, it is not only the position of the clusters regarding to their opinion for each attribute, but also the means that make no differences between the cluster 1 and the other two groups. The groups 1 and 2 indicate that the differences between the means of both clusters are significantly different. On the other hand, the cluster 1 shows that six variables make no difference with the Cluster 3, but in attributes that are under the top 5 (most important ones according to the U.S. mean). This configuration was satisfactory for the Marketing Research Team.

It is always good to perform another cluster analysis based on the results of the first cluster analysis to see if the results are consistent. In this case, the author performed a K-Mean cluster analysis. Differently to the Hierarchical Cluster Analysis, the K-Mean do not propose different cluster configuration, it is author´s responsibility to choose the number of cluster. As the variables have been already decide and the three configuration cluster has been accepted, the author performed a K-Means to form three groups. The K-Mean classified all the cases in three groups.[27]

The K-means´ results are not equal to the results of the Hierarchical Cluster Analysis, but the three groups show some similarities with the previous clustering results. The three clusters are also sorted by the level of importance that the radiologists give to the products attributes. In this specific case, the biggest group is more "Demanding" (3), the smaller one is the "Indifferent" (2) and the "Average" (1) is just two cases smaller than the

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[27] To see the complete analysis, see appendix N°13, p. 192

"Demanding". This does not mean that the first cluster analysis useful for managerial decision or for market segmentation. Nevertheless, the K-Mean was able to confirm the results of the previous cluster analysis could be optimal.

**D.1. U.S. Cross Tabulation**

According to Malhotra (2006, p. 481) the "cross-tabulations are tables that reflect the joint distribution of two or more variables" and are indispensable to have a basic picture of the interrelation between two variables. In this case, the dependant variables will be the cluster membership and the independent variables will be all other nominal variables that came up from the MRI tracking study.

The Cross Tabulation analysis will help to understand the different characteristics of the different clusters. The next graph will show the position of the groups according to the "Top 3-boxes". One point in the chart will represent all the radiologist of that group that scored between 8 and 10 (three higher scores; 8, 9 and 10) points. Taking into account the "everything is important" effect in the healthcare industry, this graph will be more helpful to really address the differences between groups and the U.S. mean according to their criteria to choose contrast agents.

**Figure 4.7. 3 Top Boxes for attributes according cluster classification**
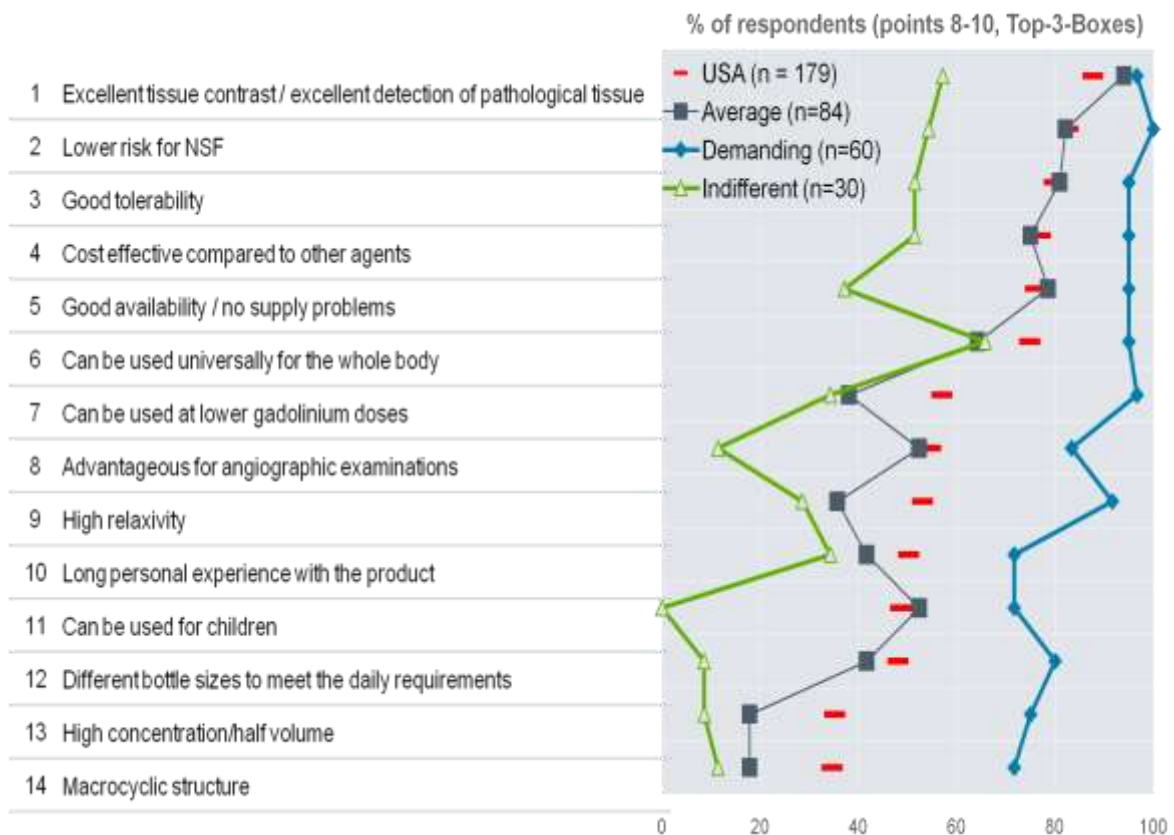


Source: Made by the author

Taking into account these differences, the following graphs were made according to the cross tabulations results. With this information, it is easier to identify certain characteristics in each group.

- Demanding radiologist: Give a greater importance to all the attributes.
- Average EU Radiologist:  They have a behavior close to the European average.
- Less Demanding or Indifferent radiologist: Give low importance to all the attributes.

**Figure 4.8. Hospital representation in each group**
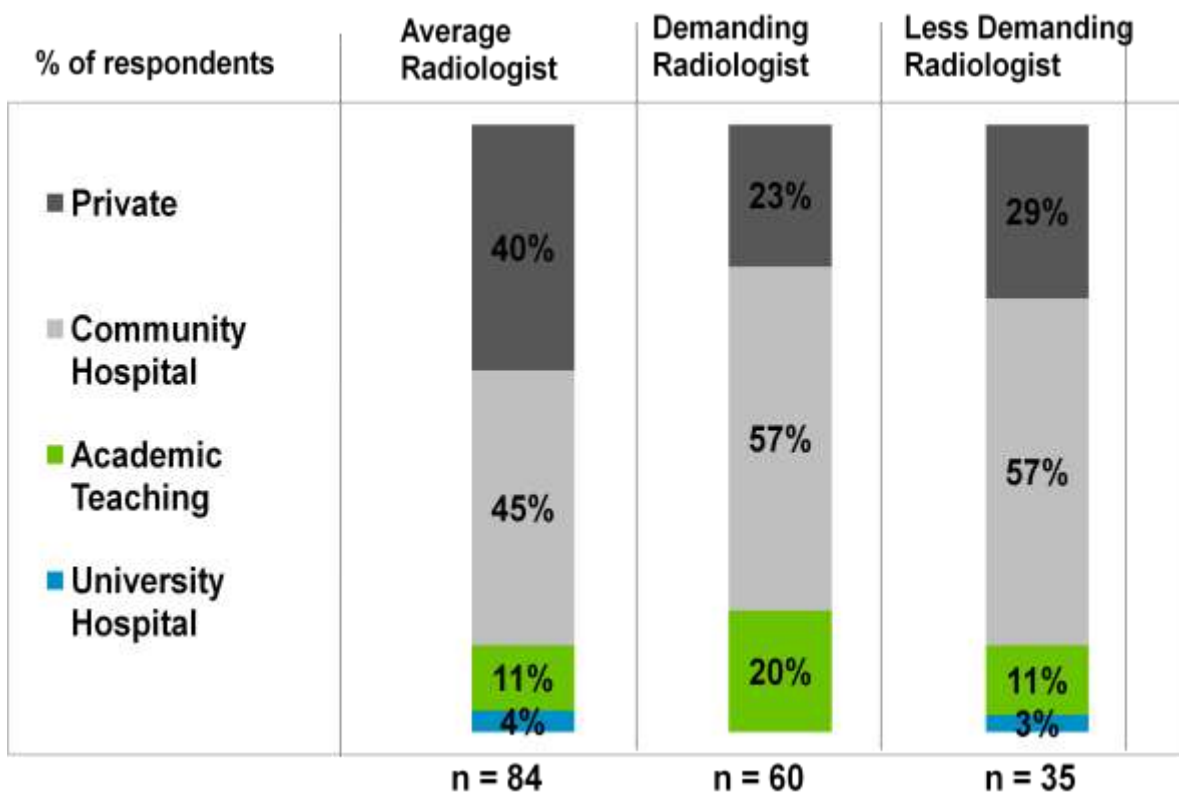


Source: Made by the author

In the previous graph is possible to identify how the clusters are composed according to their hospital setting. The "Average" radiologists are better represented in private practices in comparison with any other group, while the "Demanding" radiologists are the less represented in this hospital setting. The "Demanding" radiologists have no presence in University hospitals. The "Demanding" radiologists and the "Indifferent" radiologists are equally represented in the community hospitals.

**Figure 4.9.   Contrast agents offering the best combination of diagnostic efficacy and safety**
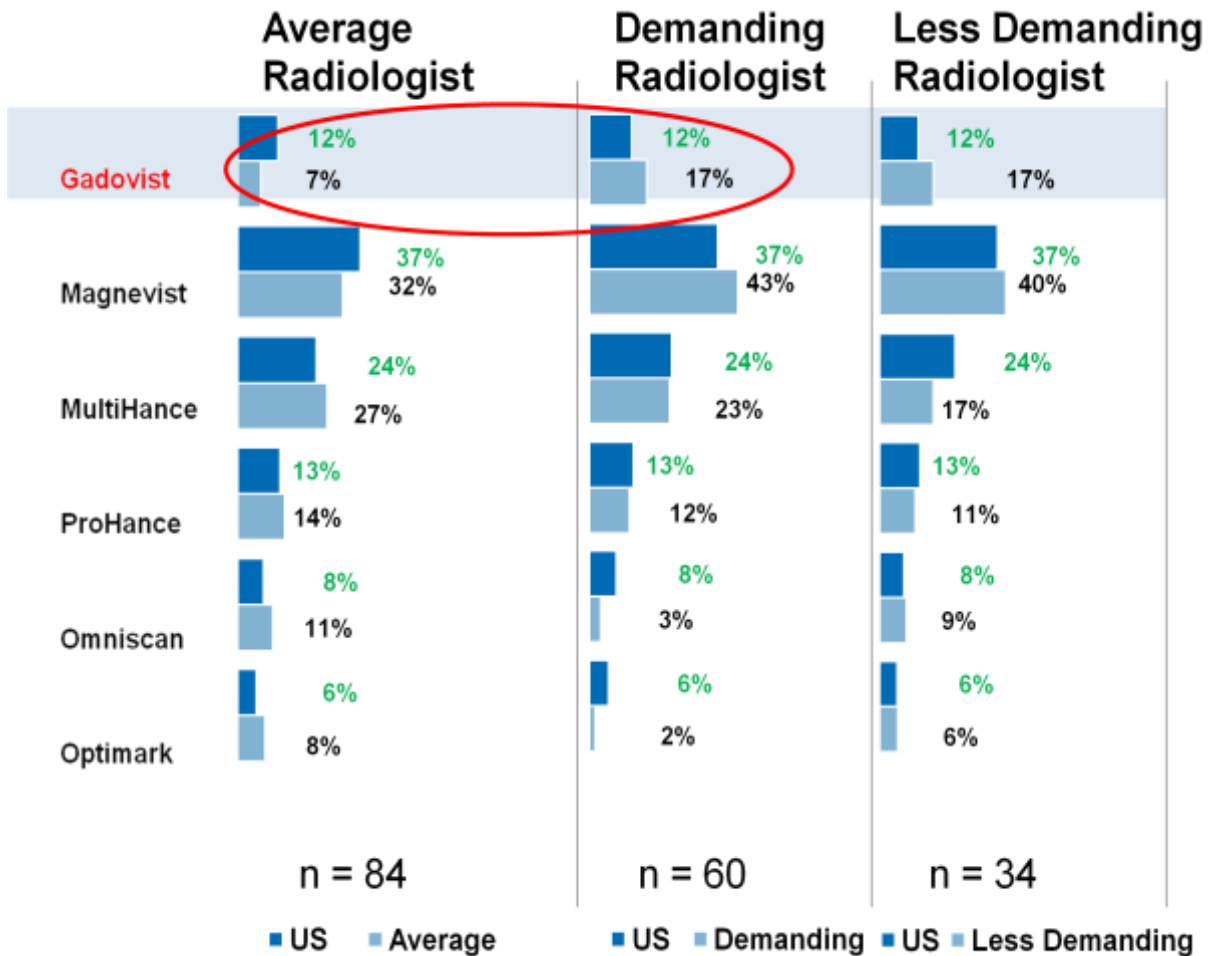


Source: Made by the author

The previous graph shows the overall opinion for each brand regarding to efficacy and safety in comparison with the U.S. mean. The "Demanding" and the "Less Demanding" clusters have an overall good opinion about Gadovist® and Magnevist® (Bayer). The non-Bayer products are better evaluated by the "Average" cluster. At the same time, in this "Average" cluster, the competition products are better evaluated in comparison with the other clusters.

**Figure 4.10. Contrast agents used in the past 3 months before September 2011**
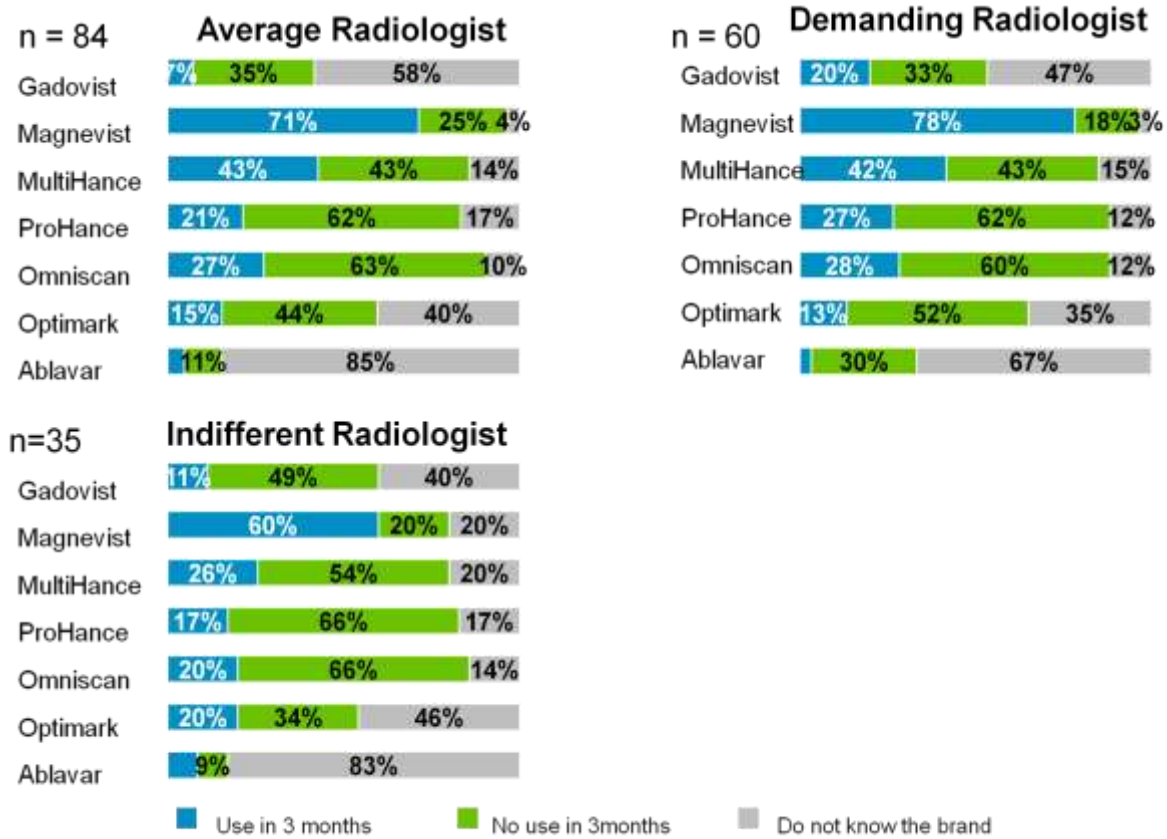


Source: Made by the author

In the previous graph is possible to see if the radiologist used the product in the last three months, if not or if they do not know the brand. The "Average" cluster has the worst awareness from Gadovist® in comparison with the other groups, while Magnevist® is the most used product from all the brands. On the other hand, in all the clusters, Multihance® seems to be the closest competitor against Bayer products. It is understandable that Gadovist®, as an expensive and modern product, is well know and use by the "Demanding" cluster and less know and use by the "Average" cluster, but is not as understandable for the "Less Demanding" cluster.

## D.2. Partial conclusions

After the cluster analysis, the author was capable to classify the radiologist, according the importance they give to the MRI attributes and the patient load per week, in following groups:

| Demanding Radiologist | • This group was identified according to the high means that the group has in comparison with the others groups. They seem to be very exigent in expecting the best of every contrast agent. |
|---|---|
| Less Demanding Radiologist | •These radiologists are the group with the lower scores in all the attributes. Taking in consideration the "everything is important" effect, just having a mean 1 or 2 points lower in all attributes in comparison with the other groups seem to represent that they care, but not so much as the demanding group. |
| Average EU Radiologist | •This group is in the middle of the demanding group and the less demanding group. On the other hand, they have scores close to the European average. |

After the cluster-and cross tabulations analysis, it is was possible not only to identify different cluster configurations, but also to determine some of the characteristics of each of them.

The most interesting conclusion comes from the product analysis. It is easy to see that Gadovist® is surpassed by the competition, as a good efficacy and safety combination, in the biggest cluster; the "Average" cluster. The "Average" radiologists have a better opinion about the competition than about Gadovist®; this could mean some positioning problem for reaching the "Average" radiologists in different hospitals settings. Independently of that, Magnevist® still has the grater usage rate from all the MRI brands.

On the other hand, it is important to mention that the "Demanding" cluster has a very good opinion for Gadovist® performance as a good efficacy and safety combination. Gadovist®, as a new generation MRI product, is more expensive than others MRI products, but have characteristics that make it a safer and better product. For that reason, it is important to mention that Gadovist® is reaching the "Demanding" cluster. At the same time, the "Demanding" cluster represents the higher usage rate for Gadovist® in all the clusters.

The "Less Demanding" cluster is more difficult to understand, as they have a higher usage rate for Gadovist® than the "Average" cluster. On the other hand, they are heavy user of Omniscan® and Optimark®, but, besides being also a heavy user of Magnevits®, as all the other groups, this cluster is not easy to characterize by cluster´s brand preferences.

After the cluster- and Cross Tabulations analysis is was possible not only to identify different cluster, but also to determine some of the characteristics of each of them.

**Figure 4.11. Clusters results for U.S.**



**Average Radiologist (Size: 48% US sample)**

*They give an average importance to the 5 most important attributes*

• Come from Community Hospitals and Private Practices.
• High users of Magnevist and Multihance, lower use of Gadovist.
• They have the highest approval for Magnevist and Multihance as a good efficacy and safety combination.
• Besides Safety and Efficacy attributes, average opinions for Low Risk NSF, Cost effectiveness and Good Availability



**Demanding Radiologist (Size: 34% US sample)**

*They expect an outstanding performance in the product they use in all the attributes.*

• Come from Community, Teaching and Private Hospitals.
• Higher use of Gadovist and Magnevist from all the groups.
• High approval for Gadovist and Multihance as a good efficacy and safety combination.
• Higher importance to all the attributes, specially to safety and efficacy attributes with Low Gd and High Relaxivity



**Less Demanding Radiologist (Size: 17% US sample)**

*They give less importance to all the attributes compared with the USA mean*

• They come from Community Hospitals and Private Practices.
• High approval for Magnevist and Gadovist, while Multihance has the lowest approval as a good efficacy and safety combination.
• Worried about Whole Body and Long Personal Experience.

Source: Made by the author

With all this information obtained, the author can also do different assumptions taking into account the different market segmentation models presented in the Chapter II. All the models presented were created under different business situation, but some of them could be possibly used to segment the radiologists markets.

**Figure 4.11. Customer Classification Matrix**
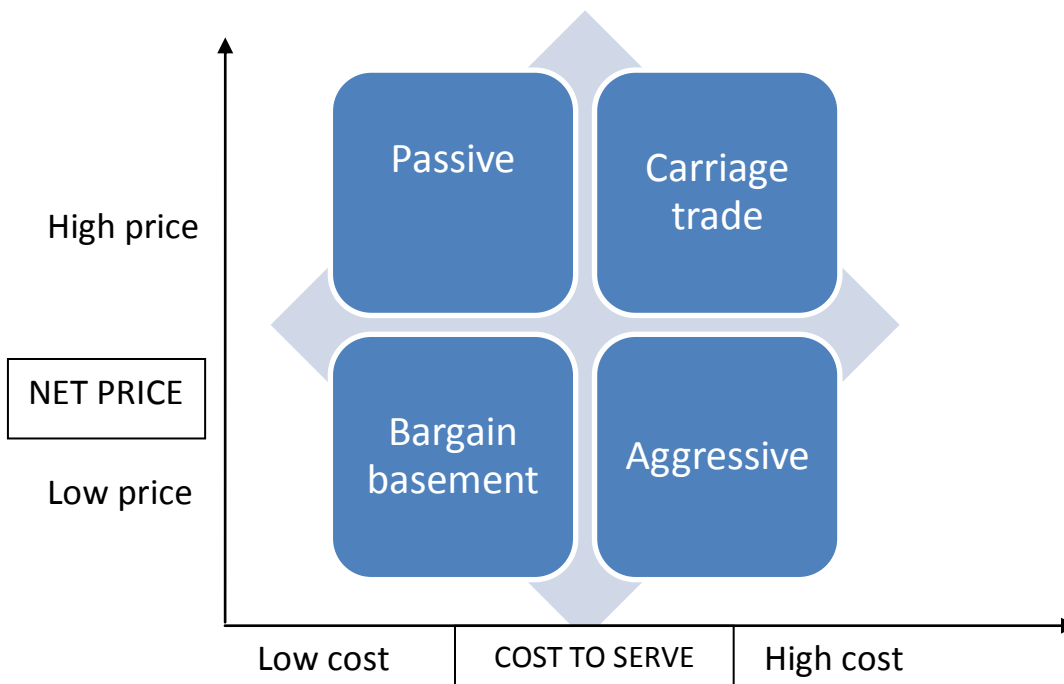


Source: Adapted from Shapiro, Rangan, Moriarty and Ross (1987)

With the information obtained in the cluster analysis, it is not yet possible to identify in where to assigned the new cluster in this model. There is not financial information in this study, which could help to do this work.

Nevertheless, it is possible to make some assumptions thanks to the "Buying Criteria" analysis. The "Less Demanding" cluster presents a very low concern for "Cost Effectiveness". This means that they are not interested in all kind of MRI products, but the cheaper ones according to the importance they give to other attributes. As they are mostly concern about "Excellent Contrast" and "Good Tolerability", there are a lot of MRI products which could satisfy their needs. For this reason, they can be considered "Bargain Basement", as they could easily reach with generic or old MRI product.

On the other side, the "Demanding" group can easily be assigned as a "Carriage trade". They expect a high performance of the MRI products of their choice and, for that reason; they can be easily pay a higher price for a better and new MRI product. At the same time, as a "Demanding" as they are, the marketing efforts should be greater to show them the benefits of a costly new MRI products, especially in the U.S., where Gadovist® is new product in comparison with the Europe market. The "Average" cluster does not have sufficient information to be assigned to one of these segments.

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**Table 4.24. Elliot and Glynn Segmentation Framework**

| | | BUYER LOYALY | |
|---|---|---|---|
| | | LOW | HIGH |
| VALUE TO SELLER | LOW | (1)Simple Exchange | (2)Buyer Exploitation |
| | HIGH | (3) Seller´s Over Investment | (4) Partnership |

Source: Elliot and Glynn (2000)

For the Elliot´s and Green´s model, other assumptions can be made: In which one of these segments should be assigned the different clusters for the benefit of the company? The "Demanding" cluster could be assigned in the "Partnership" segment. This cluster seems to be willingly to try expensive and modern MRI products. The company should make different efforts to increase the loyalty of this cluster. Moreover, the "Less Demanding" cluster could be in the "Seller´s Over Investment" segment, as they have a good opinion for Gadovist®, but they are not willingly to buy it for its price. The "Average" cluster could be present in the "Simple Exchange". They have a good opinion about Gadovist®, but they have a high usage rate for Magnevist® and, at the same time, they distribute some usage rate in other MRI products. As they are not extremely demanding regarding the most important MRI contrast media attributes, they are already being reached with other kinds of products.

For the other segmentation models, it is difficult to make more assumptions. In the case of the "Customer-Supplier relationship" from Pick (1999), there is not financial information to determinate the business performance of the new clusters.

Taking into account that Gadovist® is a new product in the U.S. market in comparison with Europe, it is possible to make some assumptions over the segmentation proposal made by Robertson and Barich (1992). The "Average" and "Demanding" clusters demonstrated that they are using Gadovist®, but the usage rate of Magnevist® is still predominant. Gadovist® is a new MRI product in the U.S. market and both clusters could be considered a "First Time Prospects" or "Novices". They could be expecting a high level of training for the use of a new MRI product to start getting familiarized with its benefits.

The "Decision Matrix" made by Choffray and Lilien (1978) is very similar to the actual segmentation performed by the Strategic Marketing MRI team. On the other hand, the MRI tracking study does not have information regarding the participants in the buying process of the MRI products.

### E. EUROPEAN CLUSTER ANALYSIS FOR THE COMPANY

After all the data reviewed in the lasts sections, the author and Marketing Research Team agreed to segment the European market using the "Operational" and "Buyer Criteria" variables. These variables should help to segment the market according to the amount of procedures (MRI scans) per week and product attribute perception. This way the researcher expects to determinate the perception of product´s attribute in each cluster plus the amount of MRI scan represented in each of those groups. As all the "Operational" and "Buyer Criteria" variables were measure in different scales, they will be standardized (z-Scores) automatically during the clustering process.

After three different clustering results, a four cluster configuration, with all the outliers included, was chosen as a good segmentation result. The most important criteria to select one specific cluster configuration (solution) were their simplicity and how understandable could they be for the managerial team. Finally, it is important to only identify four or five clusters to avoid over segmenting the market. At the same time, a cluster analysis was made without the fourteen outliers, but the results were not satisfactory[28].

**Table 4.25. Number of cases per cluster[29]**

| CLUSTER CONFIGURATION | 4 CLUSTERS | 5 CLUSTERS |
|---|---|---|
| CLUSTER 1 | 72 | 72 |
| CLUSTER 2 | 139 | 139 |
| CLUSTER 3 | 42 | 42 |
| CLUSTER 4 | 41 | 40 |
| CLUSTER 5 | _ | 1 |

Source: Made by the author

The dendogram of this analysis propose four or five clusters segmentations. The five cluster configuration has one group with only one case. This case is the extreme case 46; it is a Spanish radiologist who worked in a not classified hospital, where 2500 MRI and 1000 enhanced MRI scans are performed per week. It is important to remember that the case 211 is very similar; it is a German radiologist who worked in a private hospital where more than 1000 MRI and 500 enhanced MRI scans are performed per week. Both cases have the greater amount of MRI scans per week in comparison to all the cases according to the descriptive analysis. The case 211 is part of the fourth cluster.

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[28] To see the complete cluster analysis, see appendix N°15, p. 205
[29] To see the original dendogram, see appendix N°16, p. 207

For the same reason, it is possible to conclude that all the cases with greater amount of MRI scans can be found in the fourth cluster in both clustering results. This analysis is represented in the following table, were it is possible to compare the means of MRI scans per week in each "Operational" variable.

**Table 4.26. Means´ analysis of the four cluster configuration**

| Cluster N° | N | MRI Scans / week | Enhanced MRI scans / week | Personal MRI scans /week | Liver MRI scans / week | Breast MRI scans / week |
|---|---|---|---|---|---|---|
| | | Means | | | | |
| 1 | 72 | 144.63 | 63.96 | 31.04 | 7.44 | 10.49 |
| 2 | 139 | 135.89 | 65.23 | 28.17 | 8.25 | 3.92 |
| 3 | 42 | 144.52 | 58.88 | 28.88 | 7.74 | 4.21 |
| 4 | 41 | 387.68 | 194.51 | 96.71 | 26.22 | 14.90 |

Source: Made by the author

After performing an ANOVA test to both proposals, all the variables are significant. That means that all variables make differences between groups, because all of them have a P value under 0.05.

**Table 4.27. ANOVA test for all fourteen variables in the four cluster configuration**

| VARIABLE | SIGNIFICANCE LEVEL | VARIABLE | SIGNIFICANCE LEVEL |
|---|---|---|---|
| MRI Scans / week | .000 | Low GD | .000 |
| Enhanced MRI scans / week | .000 | High relaxivity | .000 |
| Personal MRI scans /week | .000 | Good tolerability | .000 |
| Liver MRI scans / week | .000 | Bottle Sizes | .000 |
| Breast MRI scans / week | .000 | Good availability | .000 |
| Excellent contrast | .000 | Personal Experience | .000 |
| Whole Body | .000 | Cost effectiveness | .000 |
| MRA | .000 | Macrocyclic | .000 |
| Children | .000 | Low NSF | .000 |
| HighConcentration/HalfVolume | .000 | | |

Source: Made by the author

Looking at Scheffe´s test results of all groups from the four cluster configuration, it is easy to see that some variables are significantly different between some groups, but not between all of them. The Scheffé test compares the mean´s difference of a variable between two clusters. In the following table, there is a resume from the Scheffés test results. The "X" will indicate no significant difference for a variable (significance level greater than 0.05) between one group and another, while the "√"will indicate significance difference for a variable between one group and another (P value lower than 0.05).

**Table 4.28. Scheffe´s multiple comparisons for the four cluster configuration**

| VARIABLE | CLUSTERS | 1 | 2 | 3 | 4 | VARIABLE | CLUSTERS | 1 | 2 | 3 | 4 | VARIABLE | CLUSTERS | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MRI scans / WEEK | 1 | | X | X | √ | Whole Body | 1 | | √ | √ | X | Good Tolerability | 1 | | X | √ | X |
| | 2 | X | | X | √ | | 2 | √ | | √ | √ | | 2 | X | | √ | X |
| | 3 | X | X | | √ | | 3 | √ | √ | | √ | | 3 | √ | √ | | √ |
| | 4 | √ | √ | √ | | | 4 | X | √ | √ | | | 4 | X | X | √ | |
| Enhanced MRI scans / WEEK | 1 | | X | X | √ | MRA | 1 | | √ | √ | X | Sizes | 1 | | √ | √ | X |
| | 2 | X | | X | √ | | 2 | √ | | √ | √ | | 2 | √ | | √ | X |
| | 3 | X | X | | √ | | 3 | √ | √ | | √ | | 3 | √ | √ | | √ |
| | 4 | √ | √ | √ | | | 4 | X | √ | √ | | | 4 | X | X | √ | |
| Personal MRI scans / WEEK | 1 | | X | X | √ | Children | 1 | | X | √ | X | Availability | 1 | | √ | √ | X |
| | 2 | X | | X | √ | | 2 | X | | √ | X | | 2 | √ | | √ | X |
| | 3 | X | X | | √ | | 3 | √ | √ | | √ | | 3 | √ | √ | | √ |
| | 4 | √ | √ | √ | | | 4 | X | X | √ | | | 4 | X | X | √ | |
| LIVER MRI scans / WEEK | 1 | | X | X | √ | HighCON/ HalfVOL | 1 | | √ | √ | √ | Personal Experience | 1 | | √ | √ | X |
| | 2 | X | | X | √ | | 2 | √ | | X | √ | | 2 | √ | | √ | X |
| | 3 | X | X | | √ | | 3 | √ | X | | √ | | 3 | √ | √ | | √ |
| | 4 | √ | √ | √ | | | 4 | √ | √ | √ | | | 4 | X | X | √ | |

Source: Made by the author

**Table 4.28. Scheffe´s multiple comparisons for the four cluster configuration**

**Breast MRI scans / WEEK**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | | √ | X | X |
| 2 | √ | | X | √ |
| 3 | X | X | | √ |
| 4 | √ | √ | √ | |

**Low GD**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | | √ | √ | X |
| 2 | √ | | √ | √ |
| 3 | √ | √ | | √ |
| 4 | X | √ | √ | |

**Cost Effectiveness**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | | √ | √ | X |
| 2 | √ | | √ | X |
| 3 | √ | √ | | √ |
| 4 | X | X | √ | |

**Excellent Contrast**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | | √ | √ | X |
| 2 | √ | | √ | X |
| 3 | √ | √ | | √ |
| 4 | X | X | √ | |

**High Relaxivity**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | | √ | √ | X |
| 2 | √ | | √ | √ |
| 3 | √ | √ | | √ |
| 4 | X | √ | √ | |

**Macrocyclic**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | | √ | √ | √ |
| 2 | √ | | √ | √ |
| 3 | √ | √ | | √ |
| 4 | X | √ | √ | |

**Low Risk NSF**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | | √ | √ | X |
| 2 | √ | | √ | √ |
| 3 | √ | √ | | √ |
| 4 | X | √ | √ | |

Source: Made by the author

These trends are mostly maintained in all the "Operational" variables and in several "Buying Criteria" variables. Independently that the "Operational" variables show differences according to the ANOVA test, the Scheffé test helped to determinate which groups are really being characterize by a specific variable. The fourth group is gathering all cases with a high number of MRI exams per week and is the only group that shows mean´s differences between all groups in this variable. With this information is possible to say that the fourth group is a "High through put" (High patient load) group. Moreover, according to the "Buying Criteria" variables, the fourth group is very similar to the first group. They only show a significance difference in "HighConcentration/HalfVolume" and "Macrocyclic" variables. Looking at the following figure is easier to the see how the groups behave according to the "Buying Criteria" variables. The variables are sorted from the most important to the less important according to the opinion of the European radiologists.

**Figure 4.12. Means of "Buying Criteria" variables per cluster**



| | | Means of each group per attribute |
|---|---|---|
| 1 | Good tolerability | |
| 2 | Excellent tissue contrast / excellent detection of pathological tissue | |
| 3 | Lower risk for NSF | |
| 4 | Can be used universally for the whole body | |
| 5 | Good availability / no supply problems | |
| 6 | Long personal experience with the product | |
| 7 | Advantageous for angiographic examinations | |
| 8 | Cost effective compared to other agents | |
| 9 | Can be used for children | |
| 10 | High relaxivity | |
| 11 | Different bottle sizes to meet the daily requirements | |
| 12 | Can be used at lower gadolinium doses | |
| 13 | Macrocyclic structure | |
| 14 | High concentration/half volume | |

Group 1=72 — Group 2=139 — Group 3=42 — Group 4=41

Source: Made by the author

In the previous figure is easy to see the mean´s differences between groups for the "Buying Criteria" variables. As it was stated in the Scheffé analysis, the Cluster 1 has similar means with the Cluster 4, especially in the first five variables. It is possible to say that both groups are the most "Demanding" clusters, as they assigned more importance to all the attributes in comparison with the other two clusters. On the other hand, the Cluster 4, is very different regarding to the "Low GD" variable, in comparison with the Cluster 1 and share more similarities with the other two Clusters. The Cluster 2 share similarities with the Cluster 1 and 4 regarding to the first two variables (Good Tolerability and Excellent Contras)", but in the less important variables, the Cluster 2 share more similarities with the Cluster 3. The Cluster 4 seems to be closer to the Cluster 1 than any other Clusters, but it is possible to differentiate them, as the Cluster 4 has the higher mean regarding to MRI exams from all the groups.

It is always good to perform another cluster analysis based on the results of the first cluster analysis to see if the results are consistent. In this case, the author performed a K-Mean cluster analysis. Differently to the Hierarchical Cluster Analysis, the K-Means do not propose different cluster configuration, it is the author´s responsibility to choose the number of cluster to be calculated by this method. As the variables have been already decided and the four cluster configuration has been accepted, the author performed a K-

Means to form four groups. All variables were standardized before the application of the K-Means cluster analysis. With the ANOVA test of this clustering method, the researcher was able to confirm that all the variables make differences between groups.

The K-Mean was not able to successfully confirm the results of the previous cluster analysis as several extreme cases were needed to left aside of the analysis to find similar results in the clusters composition. On the other hand, the composition of the groups is very different in comparison with the first clusters results.[30]

**E.1. Europe Cross Tabulation**

In the next chart, the idea is to show the position of the groups according to the "Top 3-boxes", that mean that one point in the chart will represent all the radiologist of that group that scores between eight and ten points each variable. Taking into account the "everything is important" effect in the healthcare industry, this graph will be helpful to address the differences between the groups and the European mean (red points) according to their criteria to choose contrast agents.

**Figure 4.13. 3 Top Boxes for attributes according to the cluster classification**
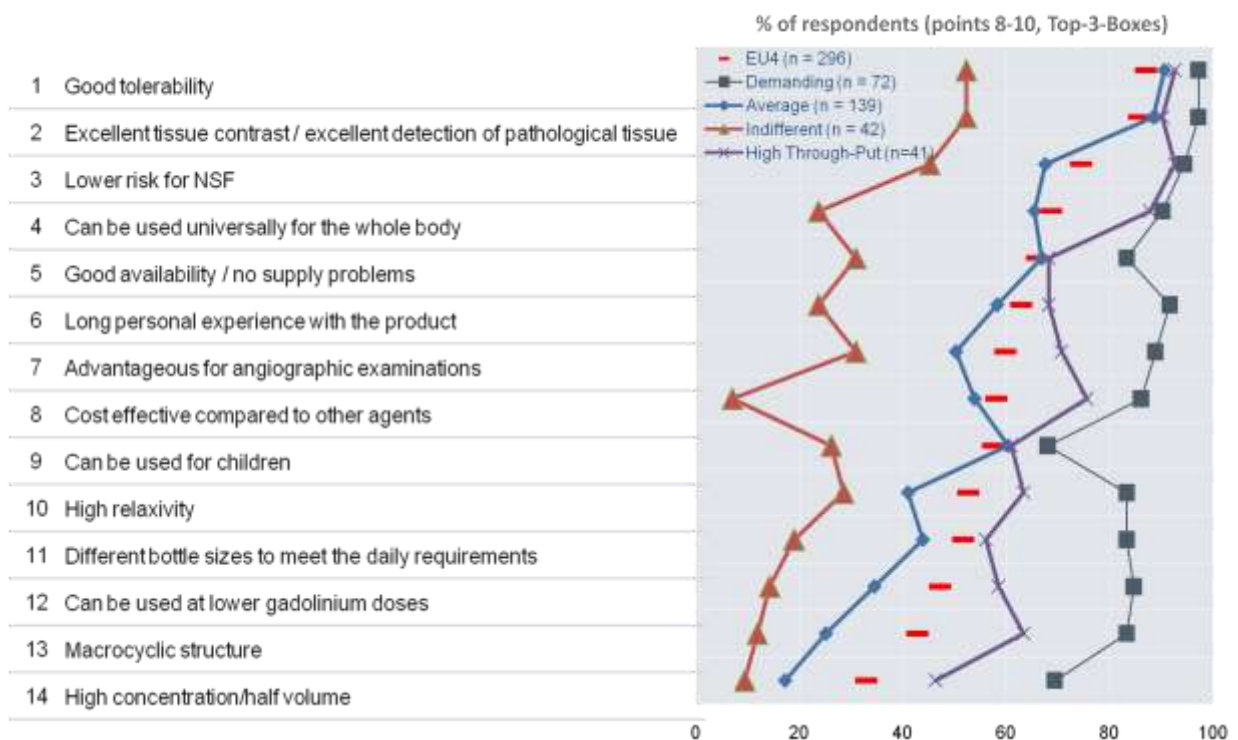


Source: Made by the author

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[30] To see the complete analysis, see appendix N°17, p. 208

Taking these differences in consideration, applying the cross tabs over the clusters will be useful to understand this groups in a better way. In the previous chart, is possible to distinguish the four clusters obtained as:

- Demanding radiologist: Give a greater importance to all the attributes.
- Average EU Radiologist:  They have a behavior closer to the European average.
- Less Demanding or Indifferent radiologist: Give lower importance to all the attributes.
- High Throughput Group: Share similarities with two clusters, especially with the "Demanding" one, but they have by far the highest load of patient from all the groups.

**Figure 4.14: Country distribution in all clusters**
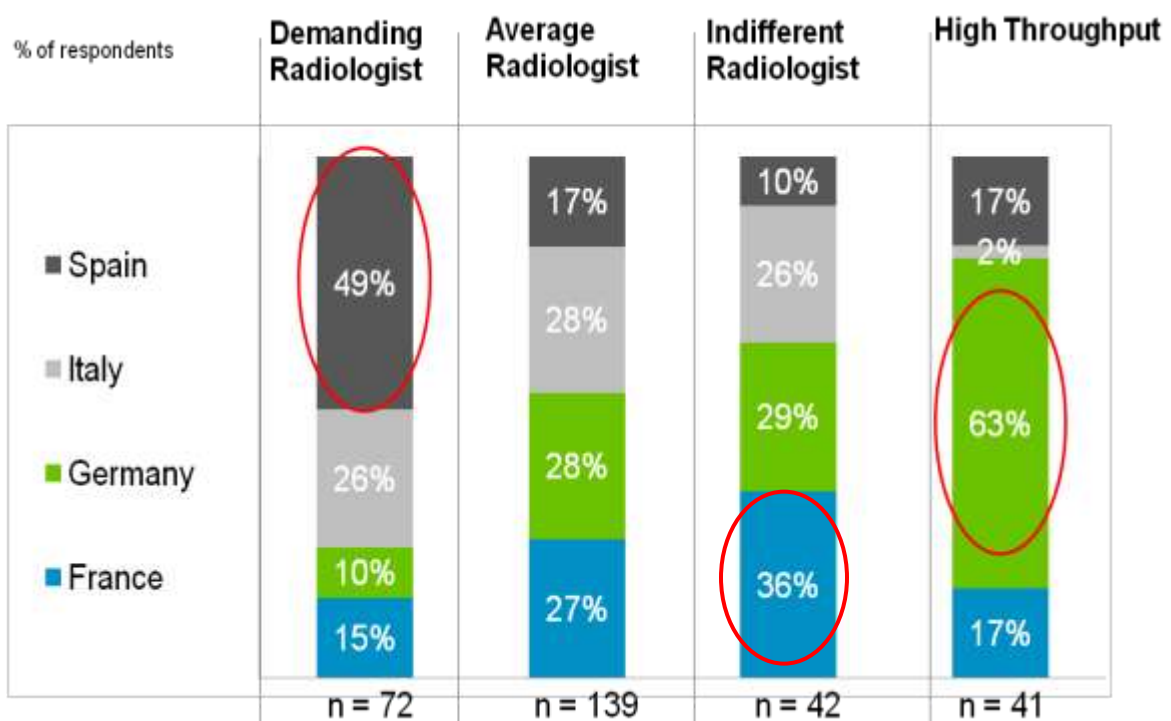


Source: Made by the author

In the previous chart, is possible to see in which European country is more likely to find different radiologist. For example, the Spanish radiologists are highly represented in the "Demanding" cluster, while the "High throughput" group is mostly situated in the Germany. The "Average" radiologists honor they name being almost equally represented in all countries, while the "Indifferent" Radiologist are very unlike to appear in Spain, but they are well establish in France.

**Figure 4.15. Hospital representation in each group**
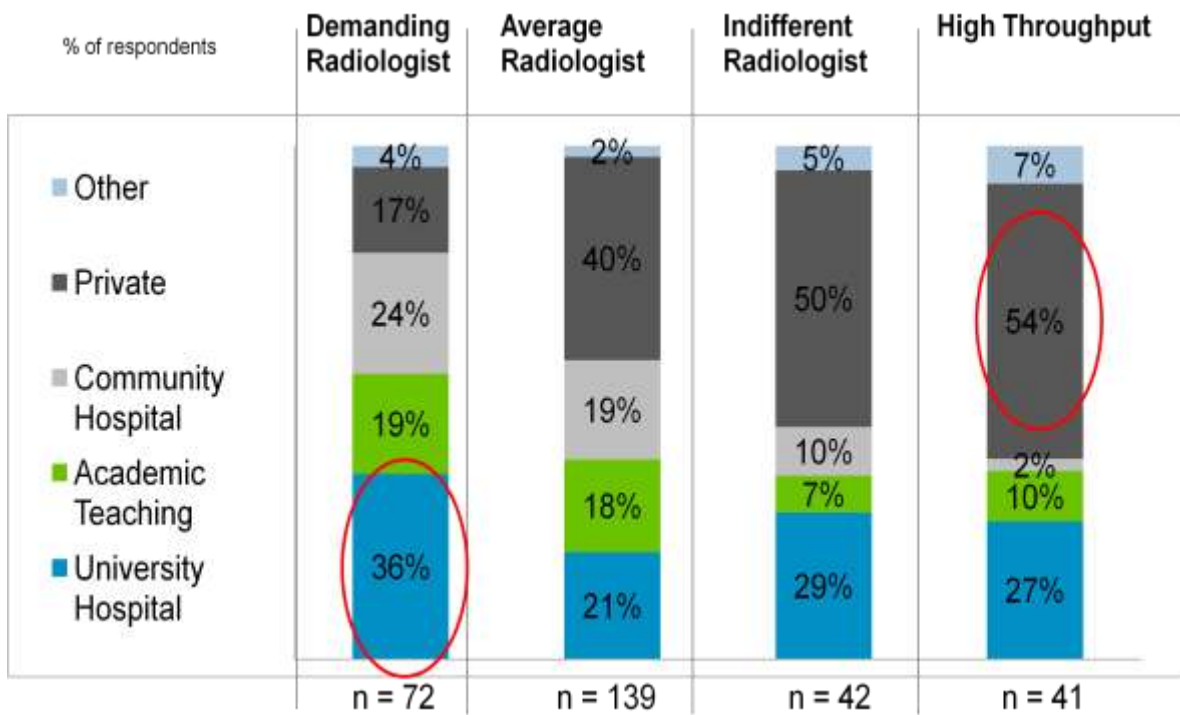
The "High through put" cluster contains a high representation of the private hospitals coming from Germany. On the other hand, the demanding group dominated by Spanish radiologist has a great proportion of university hospitals. France and Germany are the only two countries that have private hospitals cases in the sample. It is easy to see that the more demanding private hospitals are in the "High through put" cluster while the indifferent ones are in the third group. The "Average" clusters have an almost 50%/50% representation of public and private hospitals.
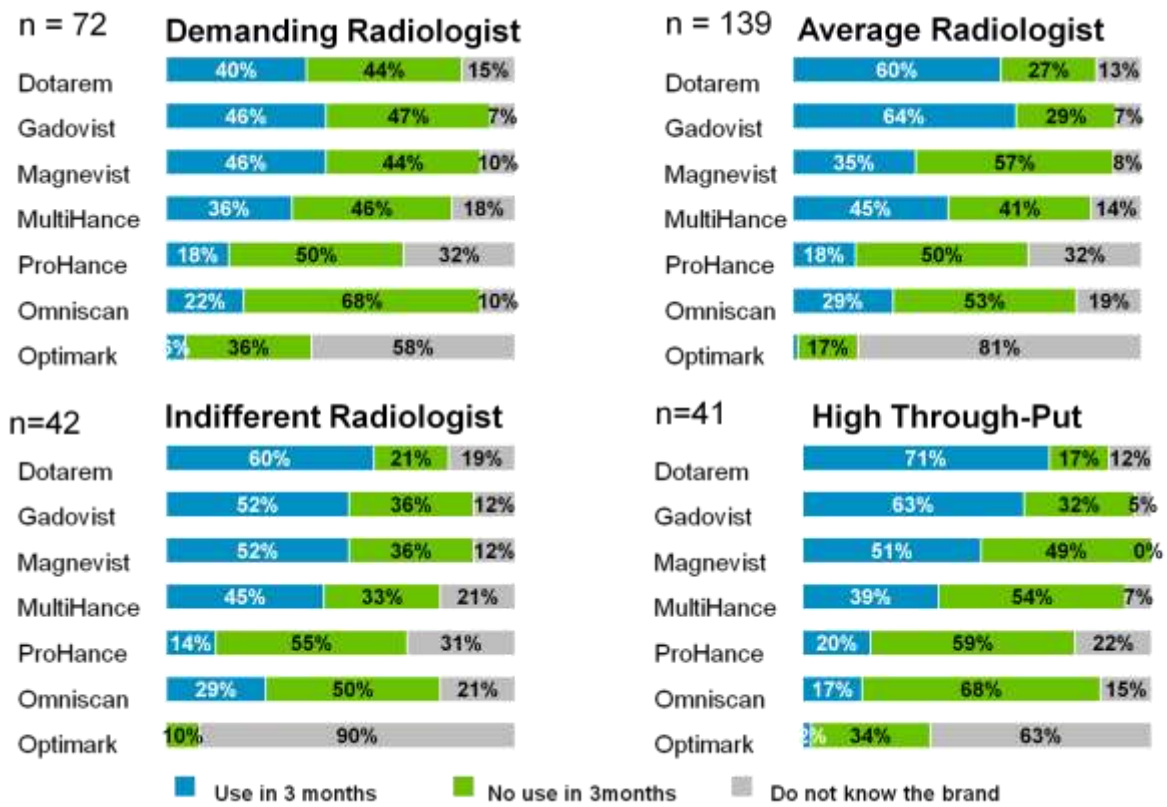
**Figure 4.16. Contrast agents offering the best combination of diagnostic efficacy and safety**
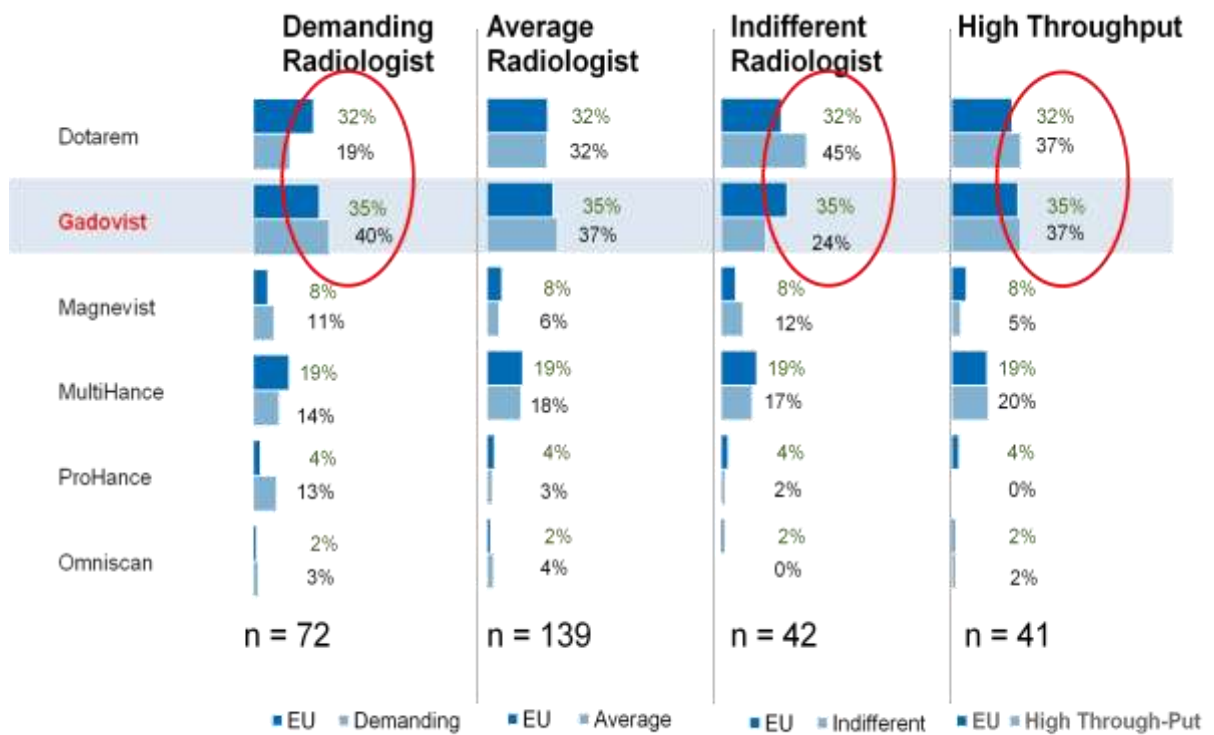


Source: Made by the author

Finally, it is important to address the opinion each group have according to which contrast agents offers the best combination of diagnostic efficacy and safety. This way is possible to determinate the overall opinion each group have of the company's products (Magnevist® and Gadovist®), against the competition. They graph also helps to compare the opinion of the groups with the European mean. All the groups have a good opinion about Gadovist®, except for the "Indifferent" group, that have a better opinion about Dotarem®, what makes sense, because it is a French product. They have a 13% better opinion about Dotarem® that the European average and 8% better opinion in comparison with the "High through put" cluster (which is the closer one in opinion regarding that product). French are well known to give preferences to products made in their own countries.

**Figure 4.17. Contrast agents used in the past 3 months before September 2011**



**n = 72 Demanding Radiologist**

| | Use in 3 months | No use in 3 months | Do not know the brand |
|---|---|---|---|
| Dotarem | 40% | 44% | 15% |
| Gadovist | 46% | 47% | 7% |
| Magnevist | 46% | 44% | 10% |
| MultiHance | 36% | 46% | 18% |
| ProHance | 18% | 50% | 32% |
| Omniscan | 22% | 68% | 10% |
| Optimark | 6% | 36% | 58% |

**n = 139 Average Radiologist**

| | Use in 3 months | No use in 3 months | Do not know the brand |
|---|---|---|---|
| Dotarem | 60% | 27% | 13% |
| Gadovist | 64% | 29% | 7% |
| Magnevist | 35% | 57% | 8% |
| MultiHance | 45% | 41% | 14% |
| ProHance | 18% | 50% | 32% |
| Omniscan | 29% | 53% | 19% |
| Optimark | 17% | 81% | |

**n=42 Indifferent Radiologist**

| | Use in 3 months | No use in 3 months | Do not know the brand |
|---|---|---|---|
| Dotarem | 60% | 21% | 19% |
| Gadovist | 52% | 36% | 12% |
| Magnevist | 52% | 36% | 12% |
| MultiHance | 45% | 33% | 21% |
| ProHance | 14% | 55% | 31% |
| Omniscan | 29% | 50% | 21% |
| Optimark | 10% | 90% | |

**n=41 High Through-Put**

| | Use in 3 months | No use in 3 months | Do not know the brand |
|---|---|---|---|
| Dotarem | 71% | 17% | 12% |
| Gadovist | 63% | 32% | 5% |
| Magnevist | 51% | 49% | 0% |
| MultiHance | 39% | 54% | 7% |
| ProHance | 20% | 59% | 22% |
| Omniscan | 17% | 68% | 15% |
| Optimark | 2% | 34% | 63% |

■ Use in 3 months   ■ No use in 3months   ■ Do not know the brand

Source: Made by the author.

In the previous graph is possible to see if the radiologists used MRI branded products in the last three months, if not used them or if they don´t know the brand. The "Demanding" cluster have an equally use rate for Gadovist® and Magnevist® fallowed by Dotarem® and Multihance®. The "Average" cluster shows also a good usage rate for Gadovist® and Dotarem®, while Gadovist® is surpassed by Multihance®. The "Indifferent" indicates that Dotarem® is widely preferred than the other brands and Multihance® is also quite used. In the other hand, Gadovist® and Magnevist® are still important products. The "High through put" cluster has a very notable preference for Dotarem®.

## E.2. Partial conclusions

After the cluster analysis, the author was capable to classify the radiologist, according the importance they give to the MRI attributes and the patient load per week, in following groups:

| Demanding radiologist | • This group was identified according to the high means that the group has in comparison with the others groups. They seem to be very demanding in expecting the best of every contrast agent. |
|---|---|
| **High Through Put Group** | • This group is very exigent in some attributes, but what makes them very different to the other groups, is that they have by far the highest load of patient from all the groups. |
| **Less Demanding or Indifferent radiologist** | • These radiologists are the group with the lower scores in all the attributes. Taking in consideration the "everything is important" effect, just having a mean 1 or 2 points lower in all attributes than the average seems to represent that they care, but not so much as the demanding group. |
| **Average EU Radiologist** | • This group is in the middle of the demanding group and the less demanding group. In the other hand, they have a behavior close to the European average behaviour. |

After the cluster-and cross tabulations analysis is was possible not only to identify different cluster configurations, but also to determine some of the characteristics of each of them.

It is possible to conclude that the national characteristic of the most represented country in each cluster, have a great impact in the cluster characteristics. Spanish radiologists give the highest importance to all the attributes of a MRI contrast media and they heavily represented in the "Demanding" cluster. German radiologists have the higher Patient Load of all the countries and they are heavily represented in the "high through put" cluster. Finally, the "Indifferent" group is heavily represented by French radiologists, who give lower importance to all the attributes for a MRI contrast agents.

The hospital representation in each cluster is also heavily influenced by the most represented country in each cluster. The "High through put" and the "Indifferent" groups are importantly represented by private practices, which can be only found in the French and German sample from the MRI Tracking study. The other two groups have a better distribution of the hospitals representation, but in the "Demanding" cluster, there is no to a big sample of private practices.

Regarding the opinion of each cluster about which contrast agents offer the best combination of diagnostic efficacy and safety, there is a high consent that Dotarem® and Gadovist® give the best combination of diagnostic efficacy and safety in all clusters.

Looking at the brand use rate of all products at each cluster, still Dotarem® and Gadovist® are heavily use. It is important to address that Magnevist® is still heavily use by all clusters. On the other hand, the "Demanding" and the "Average" clusters have a high use rate of Gadovist®, what is the contrary in the "Indifferent" and "High Through put" clusters, where Dotarem® is more dominant.
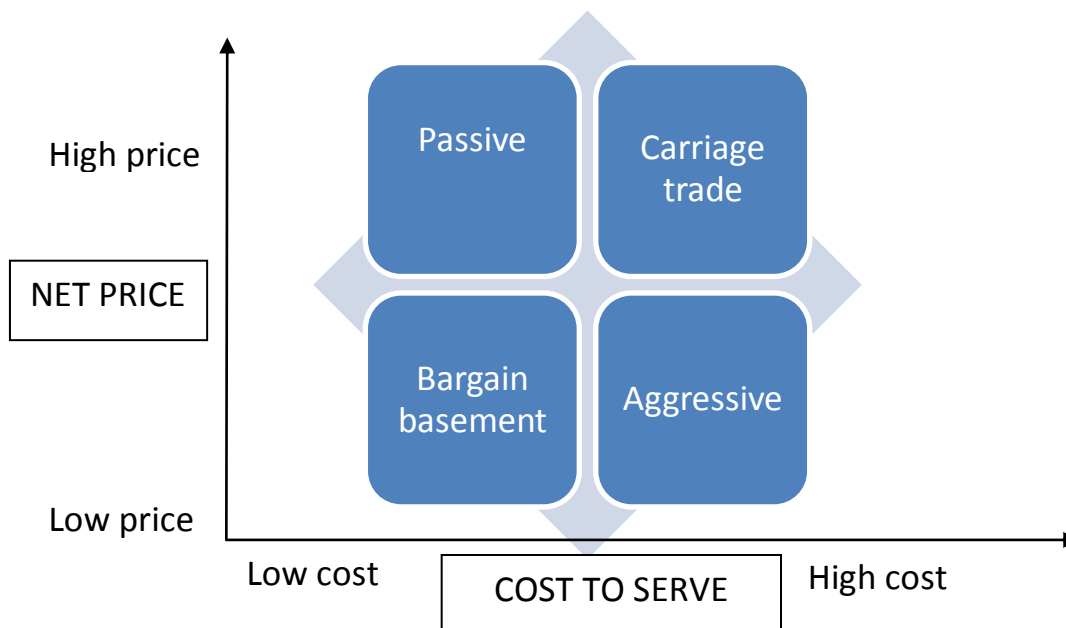
**Figure 4.18. Clusters results for Europe**



**Demanding Radiologist (Size: 25%)**

*They expect an outstanding performance in the product they use in all the attributes.*

• Spanish and Italians radiologist that belong to University and Community Hospitals.
• They show the highest approval for Gadovist regarding to a good efficacy and safety combination.
• Specifically driven by safety and efficacy attributes + Whole Body indication
• High user of Bayer (Magnevist and Gadovist) products.

**High Through - Put Radiologist (Size: 14%)**

*Highest Enhancement Rate, load of patients and injector use per week.*

• Mostly Germans belonging to private and public hospitals (mostly University Hospitals).
• Mostly worried about the efficacy and safety attributes + Whole Body and Cost effectiveness.
• Equal rating for Gadovist and Dotarem as a good efficacy and safety combination.
• Higher users of Dotarem over Gadovist and Magnevist.

**Average EU Radiologist (Size: 47%)**

*Present in all countries and give an average importance to the 5 most important attributes*

• Distributed equally in private practices and public hospitals.
• Good availability and Children are specially important while Low Risk for NSF is less important.
• High rating for Gadovist, followed close for Dotarem as a good efficacy and safety combination.
• Multihance is more use than Magnevist and Gadovist is more use than Dotarem.

**The indifferent Radiologist (Size: 14%)**

*They give less importance to all the attributes compared with the European mean*

• Mostly in French belonging to private practices and University Hospitals.
• Highest rating for Dotarem and lower for Gadovist as a good efficacy and safety combination compared to all the clusters.
• They give less importance to all the attributes compared with the European mean.
• Worried about efficacy and safety attributes and the lowest concern for Cost Effectiveness from all the groups
• Dotarem is more use than Gadovist. Multihance is very close to Magnevist.

Source: Made by the author

With all this information obtained, the author can also do different assumptions taking into account the different market segmentation models presented in the Chapter II. All the models presented were made under different business situation, but some of them could be possibly used to segment the radiologists markets.

**Figure 4.19. Customer Classification Matrix**



Source: Adapted from Shapiro et al. (1987)

With the information obtained in the cluster analysis, it is not yet possible to identify in which of these segments could, the new clusters, being assigned. There is not financial information in this study, which could help to do this work.

Nevertheless, it is possible to make some assumptions thanks to the "Buying Criteria" analysis. The "Indifferent" cluster presented a very low concern for "Cost Effectiveness". This means that they are not interested in all kind of MRI products, but the cheaper ones according to the importance they give to other attributes. As they are mostly concern about "Excellent Contrast" and "Good Tolerability", there are a lot of MRI products which could satisfy their needs. For this reason, they can be considered "Bargain Basement", as they could easily reach with generic or old MRI product. On the other side, the "Demanding" group can easily be assigned as a "Carriage trade". As they expect a high performance of the MRI products of their choice, they can be easily being charge a higher price for a better and new MRI product. At the same time, as a "Demanding" as they are, the marketing efforts should be greater to show them the benefits of costly new MRI products. This analysis does not differ too much in comparison with the U.S. analysis.

The "High through put" cluster can be considered an "Aggressive" segment, as they give a high importance to "Cost Effectiveness", but they do not give a big importance to all MRI products as the "Demanding" cluster. Probably they are also a good target for costly new MRI products, but at a lower price compared to the "Demanding" group, because they do not show the need of using a perfect MRI product in all attributes; just in the important ones regarding efficacy and safety. The "Average" cluster does not have sufficient information to assign it to one of these segments.

**Table 4.29. Elliot and Glynn Segmentation Framework**

| | | BUYER LOYALY | |
|---|---|---|---|
| | | LOW | HIGH |
| VALUE TO SELLER | LOW | (1)Simple Exchange | (2)Buyer Exploitation |
| | HIGH | (3) Seller´s Over Investment | (4) Partnership |

Source: Elliot and Glynn (2000)

Whit the Elliot´s and Green´s model, other assumptions can be made: In which one of these segments should be assigned the different clusters for the benefit of the company? The "Demanding" and the "High troughput" cluster could be assigned in the "Partnership" segment. Both clusters seem to be willingly to try expensive and modern MRI products. The problem relies in the "High through put" cluster, which has a better preference for Dotarem®. The company should increase the loyalty for both clusters. Moreover, the "Indifferent" cluster could be in the "Seller´s Over Investment" segment, as they have a good opinion for Gadovist®, but they are not willing to buy it for its price. The "Average" cluster could be present in the "Simple Exchange". They have a good opinion about Gadovist®, but they have a high usage rate for Gadovist® and Dotarem® and, at the same time, they distribute some usage rate in other MRI products. As they are not extremely demanding regarding the most important MRI product´s attribute, they could be reached with other kinds of products.

For the other segmentation models, it is difficult to make more assumptions. In the case of the "Customer-Supplier relationship" from Pick (1999), there is not financial information to determinate the business performance of the new clusters. Similarly, the segmentation proposal made by Robertson and Barich (1992) need more information about the time each cluster has been on the market. This information is difficult to obtain as is almost impossible to determinate the time on the market from all the radiologist or hospitals in the sample.

The "Decision Matrix" made by Choffray and Lilien (1978) is very similar to the actual segmentation performed by the MRI team. On the other hand, the MRI tracking study does not have information regarding the participants in the buying process of the MRI products.

# CHAPTER V: CONCLUSIONS

In the chapter V the author present the conclusions and recommendations derived from this research. The main idea of the recommendations is to open doors for new lines of investigations.

The conclusions of this study are presented individually according to each objective, which were presented in the first chapter. At the end, the author will give a general conclusion that summarized the most important facts of each conclusion.

## A. CONCLUSION

### A.1. Objective 1

*"To conceptualize market segmentation differences between a B2B and B2C context according to the market segmentation and marketing literature"*

This objective was achieved in the Chapter I and II as the author presented the theoretical concepts related to Business to Business Markets and Market Segmentation. Different characteristics were given concerning to Business to Business Markets and Business to Consumer Markets that could be helpful to determinate differences for future market segmentation approaches depending on which market the firms are involved.

B2C and the B2B have several differences such as type of demand, buying behavior, marketing mix, customer´s classification, classification of goods and more. The marketing literature is very clear on showing different classifications for several characteristics for both types of markets. These differences are the key to define different market segmentation approaches according to the characteristics of the market.

B2B firms can have different roles depending on the markets they are involved: they can be sellers, partners, suppliers and, at the same time, customers. This way, B2B organizations are implicated in a big and complex network of customers and sellers. B2B customers are also firms and organizations running businesses and, in several occasions, there is a close relationship between sellers and clients for combined development of specific products and services. Normally, in B2C markets, the clients do not have a direct relationship with sellers. At the moment of buying, the buying behavior of organizations is affected by the buying organizations and management teams behind them, which can represent a very complex network between departments, managers and directives. In B2C markets, this same pattern exists as the clients belong to different socials groups as families or friends, but again, the companies do not have a direct relationship with these groups.

The most important differences between both markets are the relationship between organizations and their customers. The volume of sales and money involved in a normal B2B transaction makes the buying decision, a very complex process. This last characteristic force B2B organizations to have a more direct relationship with their clients at the moment of generating a sell. B2C organization can also have a close relationship with their client if they want or need, but it seems to be not as mandatory or necessary as they can use the mass media. At the same time, the B2C firms have to make marketing efforts for

millions and millions of customers in comparison with the B2B companies, which can be involved in markets, where only a few clients can be found.

From the perspective of market segmentation, it is possible to address, that the fundamental importance of the market segmentation process is equal in both markets, especially, in very heterogeneous markets. The market segmentation process is the best way that companies have to allocate their financial and human resources according to the importance for each market segment. Each segment can have different importance, depending on strategies, capabilities and objectives developed by companies. In both markets, it is possible to find macro and micro segmentation approaches and different variables depending on situations, clients, locations and buying behavior. A market segmentation process can be used in any kind of organizations, independently if they are in a B2B or B2C environment.

The author conclude that B2B and B2C markets and organizations are different in several aspects, but regarding to market segmentation process, they share several similarities, in which they can be very different according the segmentation approach they want to apply in their marketing strategies. B2C companies can segment the market according different criteria, such as the influence of family members over the final consumer. Similarly, B2B companies can segment the market according the influence that different participants have over the buying decision process of any organization. These approaches are similar, but they have to be applying in very different ways. Moreover, the importance of the market segmentation process is equal in all kind of market, as it is the best way companies have to focus their limited capabilities.

## A.2. Objective 2

*"To identify models, variables and criteria applied in B2B contexts, as discovered in the B2B Marketing literature"*

This objective was achieved in the chapter II. In this chapter, a brief comparison was made between B2B and B2C market segmentation criteria. Additionally, three different market segmentation approaches were presented for B2B markets. These approaches were related to Multistep Segmentation, Portfolio Management and Relationship Management.

As a multistep segmentation model, the Nested Approach was presented. This model was created in a time, where it was considered that B2B marketers did not count with a good segmentation criteria in comparison with B2C marketers. The particularity of this segmentation process is the proposed mixture of different criteria for the application of a

segmentation strategy. The process started with the most simple, cheaper and general segmentation criteria (Demographics) to the most expensive and complex criteria (Personal characteristics of the Buying Center participants) going through operational, purchasing and situational factors. This model is criticized, because it pays little attention to customer needs and is driven by supplier convenience, but at the same time, it is considered a very good model to provide some structure to the segmentation process.

The segmentation approaches based on Portfolio Management are used to segment customers or suppliers according to their loyalty, value or other variables. Shapiro´s model (1987) segmented the clients according to the "net price" charged to the client and the costs that the company has to address to serve them. This model helps to identify the difference between high sales volumes and profits, but it is difficult to implement specially in companies with very complex cost structures or technically complex products.

On the other hand, other two segmentation frameworks were presented based on the buyer loyalty and the value of the companies to the seller. These models are good for the implementation of relationship marketing strategies, but at the same time, the companies have to be very clear how they are measuring the value and loyalty of the customers. Elliot´s and Green´s model (2000) do not give a clear statement about how should be measured the "Value to the seller" while the loyalty is highly related to a long-term relationship. Pick´s model (1999) was build upon Customer-Supplier relationship and was specially made to identify which kind of relationship the companies are looking for (loyal in long term, short term or no relationship at all). In this specific model, companies are segmented according to their company performance (Value) and relationship ability. These models are problematic as some authors considered that loyalty is not always related to future greater profitability and not all companies are willing to build relationships with their sellers. More problematic is to determine and measure ambiguous concepts as "Value" and "Loyalty". All companies will measure these concepts in different ways according to the reality of their business.

Finally, market segmentation models based on buying decision processes were presented. Normally, companies have "Buying Centers" or "Decision Making Units" composed by different individuals involved in the buying decision. The model of Robertson and Barich (1992) is focused on segmenting the market by the phases of the purchase decision process that customers are currently experiencing to direct sales´ force efforts. Moreover, Choffray and Lilien (1978) proposed a segmentation process focused in the "Decision Making Unit". They developed a decision matrix to determine which participants are the

most important influencers in the buying decision process. This way companies can focus their marketing efforts on these specific individuals.

The author concluded that there is not a unique solution for segmenting a market in business to business environment. All models showed different benefits and problems for different business situations and needs. The selections of any of these models depend on companies´ environments, strategies, organizations and capabilities. These models give a certain preference for specific criteria to segment the market and the organizations can benefit from these criteria finding different approaches, structures and variables to perform a market segmentation as good as they can.

**A.3. Objective 3**

*"To propose new segments / customers' classifications for the Strategic Marketing MRI department of Bayer Healthcare through a Cluster analysis"*

This objective was achieved in the chapter III and IV. In the chapter III, the author presented the methodology that was applied in order to find different market segments in the radiologist market for the Marketing Strategic MRI business unit from Bayer Healthcare AG. In the Chapter IV, the data analysis was presented and findings of the methodology proposed. The research about different segmentation models were useful to determine the importance of different variables for market segmentation in a B2B environment.

Through the information obtained in the MRI Tracking Study 2011 and a Hierarchical Cluster Analysis, the author was able to find four different radiologists segments in the European market (Spain, Italy, Germany and France) using "Operational" and "Buying Criteria" variables, and three different radiologist segments in the U.S. market only using "Buying Criteria" variables. These segmentations were presented to the Strategic Marketing MRI team. The EU Market was segmented in "Demanding", "Average", "Less Demanding" and "High Through Put" radiologists. The U.S. Market was segmented in "Demanding", "Average" and "Less Demanding" radiologists.

According to the Strategic Marketing MRI team, the results of the EU cluster analysis are satisfactory. Segmenting the radiologist according to their preferences for MRI products and patients load in the EU market with a cluster analysis was a new approach for them. They are aware of the differences and characteristics of European countries, but not about how the levels of preferences of the radiologists are represented in each country and what kinds of segment can be found using the perception of product attributes. At the

same time, they stated that the segmented proposed are very close to reality. They considered that segmenting the market this way was an interesting approach.

For some members of the Strategic Marketing MRI team, it was surprising that the "Demanding" radiologists are mostly present in Spain and Italy. About the "High through put " group, Germany is well known as the country with higher amount of procedures or patient load from the EU market, but this cluster showed the importance of the "Cost effectiveness" attribute and the equal preference the radiologists have for Gadovist® and Dotarem®. This was an important finding, because Dotarem® is a cheaper product in comparison with Gadovist® in EU countries. It was also important to address that they also give a high importance (As the "Demanding" group does) to "Good Tolerability", "Excellent Contrast", "Low NSF" and "Whole Body" attributes.

On the other hand, it was interesting to determine that there was something as an "Average" radiologist that represented almost the 50% of the EU market and have a very good opinion of Gadovist. The "Indifferent" radiologists were also a very interesting cluster for discussion. They are highly represented in France, where radiologists preferred French products over products from other countries, what can explain the higher preference for Dotarem® over Gadovist® in this cluster, but it was very interesting to know that these radiologists are also highly represented in Germany.

The Strategic Marketing MRI Team found very interesting this segmentation approach for the U.S. market. The "Demanding" cluster has a good usage rate and opinion for Gadovist® while the "Average" clusters for Magnevist®. On the other hand, the Strategic Marketing Team found weird the lower opinion from the "Less Demanding" cluster for Mutihance®. They believe that this analysis was much more valuable for the U.S. market than for the European market, because Gadovist® is a much newer product in the U.S. in comparison with the EU market.

Other comments arise from the clusters results. It was mentioned that could be good to add new variables for a next market research like, for example, "Local products" to determinate the importance the radiologists give to the precedence of MRI products. It was a general perception that Gadovist® is good positioned in the "Demanding" (EU/US) clusters, what is expected for a new and more efficient product, but for some members of the Marketing Team was worrying to see that unique attributes from Gadovist like "Higher Concentration/Half Volume", "Can be used at lower gadolinium doses" and "Macrocyclic structure" were the less important attributes for the EU radiologists. The same concern arises for the U.S. market where "Can be used at lower gadolinium doses" is the seventh

most important attribute for radiologists. This information was already knew by the team after the presentation of the MRI Tracking Study 2011, but as no cluster showed a special concern about these attributes, this concern increased. One member of the team even commented that the marketing team was not doing a good job promoting the benefits of these characteristics (specially the benefits related to the safety of the patients).

As a final point, all agreed that the new approval for the "Whole Body" indication in Europe should improve the position of Gadovist® in all EU cluster especially in the "Demanding" and "High through put" clusters (They show the highest interest in this attribute). The same effect should not have place in the U.S. market, as the U.S. market does not concede a "Whole Body" approval; different body parts have to be approved independently. The "Pediatric" indication (approved after the MRI Tracking Study 2011) should improve the position of Gadovist® in the all the EU clusters expect for the "Less Demanding" one.

Finally, it is important to mention that, under several assumptions, the author tried to compare the different clusters found with the segments proposed by other theoretical segmentation models. It is clear that more information is needed, to enhance the usefulness of these segmentation models.

In conclusion, the author could identify the following "Key Learning" for both markets:

- It is possible to classify the radiologists by attributes preferences and patient load: Demanding cluster (EU/US), High Through put cluster(EU only), Average cluster(EU/US), Less Demanding cluster(EU/US)
- It is possible to identify their characteristics: Country and hospitals representativeness, MRI product preferences and opinion, Patient Load, Product use rate and more.
- The "Demanding" (EU) cluster is highly represented in Spain and Italy.
- The "High through put" (EU) cluster is highly represented in Germany, they are also a "Demanding" group, but they have a far higher patient load from all the groups.
- Gadovist has a good position in the "Demanding" cluster (EU/US) and in the "High through put" cluster (EU).
- In the "High through put" group (EU), Gadovist is losing a "price battle" against Dotarem.
- In the U.S. market, all clusters have a good opinion about Bayer products.
- Dotarem is the closest competence for Bayer products in Europe, while in the U.S., Bayer has a strong position with Magnevist and Gadovist.

- The Whole Body (approval granted in august 2012) + Pediatric approval (approval gave a few months after the MRI Tracking Study 2011) will strengthen the position in all the EU clusters.

The key learning's presented are very important to guide future managerial implications. The segments profiles discovered can help the MRI Management Team to focus their marketing efforts in groups that they considered more important. For example, the "Demanding" (US/EU) clusters seems to be a very good client for Gadovist®, taking into account what these radiologists are looking in an MRI product and what has Gadovist® to offer. On the other hand, the MRI patient load can be a very good criteria to determinate the future volumes of sales that this cluster can reach.

The MRI Marketing Team has to take some decisions regarding the "High through put" cluster in Europe. They have a very high patient load, what makes them a very profitable group, but the high costs of Gadovist® in comparison to Dotarem® (or some other reasons, not presented in this research) are making very difficult a better penetration on this cluster.

In the U.S. market, Gadovist® is a new product (compared to the European market), but thanks to Magnevist®, Bayer Helathcare count with a very strong position. The most important objective in this market is switching Magnevist® for Gadovist®. Thanks to the analysis conducted in this research, it is possible to see that in all the U.S. clusters, Magnevist® still counts with a high participation share. It will be very important to make sufficient marketing efforts to retain the Magnevist® users of the "Average" group, as they are the biggest cluster. On the other hand, it is still very difficult to characterize the "Less Demanding" cluster. More information is needed to know how to approach to this cluster. The "Demanding" cluster seems to be embracing Gadovist® in a good way, but they stills have a high usage rate of Magnevist®.

This analysis has not being perfect. The "Less Demanding" group in the U.S. has showed to be more confusing than useful. On the other hand, more financial information is needed in order to do a better assessment regarding the importance of each cluster. As the MRI tracking study has not relevant or valuable information about the buying process of the hospitals, there will be difficulties to know how to direct all the marketing efforts.

Other subjects arise after the presentation of the segmentation results:

- How can the sales force identify the different segments?
- It is necessary to add more product attributes to a future survey?

- The "Indifferent" or "Less demanding" groups are really less demanding or they only have other preferences?
- How will develop the U.S. clusters with the switch from Magnevist to Gadovist?
- How will develop the U.S. clusters with the future approval of new indications?

**A.4. Objective 4**

*"To conduct a Cluster Analysis based on a theoretical market segmentation framework for B2B markets, in order to compare the results with the outcome of the segmentation performed                    for                 Bayer                 Healthcare"*

This objective was achieved in the chapter IV. For the fulfillment of this objective, the author used the U.S. sample to perform a segmentation process according to the Nested Approach B2B segmentation model.

The U.S hierarchical analysis resulted in three different clusters sorted by the perception they have about the importance of different attributes for MRI products. This way the author was able to find the "Demanding", "Average" and "Less Demanding" clusters in the U.S. Market. The "Operational" variables were also used, but after some analysis, they were left aside. The "Operational" variables were clustering the radiologist in only two different groups; "Big Hospitals" and "Small Hospitals", where small hospitals where "Less Demanding" than the "Big Hospitals". This proposal has not useful, as there is no need for statistical method to understand these results. Taking out the "Operational" variables and only using the "Buying Criteria" variables, the author was able to find a better cluster result for business use.

On the other hand, using the Nested Approach, the author was able to use the "Demographic" variables, which were not used in the cluster analysis performed for the company, as they were considered not relevant for the analysis. The "Type of Hospital" variable was not useful for market segmentation, because, between the four types of hospitals, no differences were found concerning the "Buying Criteria" variables.

Afterwards, as the Nested Approach encourages to segment the market going from a "macro" criteria to a "micro" criteria, the U.S. market was segmented trough a Hierarchical Cluster Analysis using the "Operational" variables. This way, the author was able to find three different segments; "Small", "Medium size" and "Big" hospitals. The "Operational" variables could be considered "macro" variables in this case.

Afterwards, another cluster analysis was performed in each of the hospital clusters using the "Buying Criteria" variables of the radiologist. This way the author was able to find different groups of radiologist in the "Small" and "Medium" hospitals clusters. These groups were sorted according to their preferences for different contrast agents attributes from a "Demanding" cluster to a "Less demanding" or "Indifferent". The "Big" hospital cluster was not able to be segmented using the "Buying Criteria" variables. Comparing the results of both processes (one dominated by the company´s needs and other one using the Nested Approach) the author can come up with different conclusions.

The first U.S segmentation can give a very good understanding about how a company can divide the radiologist according to their perception about different attributes, but it cannot tell in which hospitals they are. Several assumptions can be made; for instance, a cluster that is highly represented in Academic Teaching Hospitals (Hospitals with big amounts of patient loads) can be presented in big hospitals, but this cannot be 100% accurate.

Moreover, the cluster analysis performed through the Nested Approach provides to the author a better understanding about the radiologist market. The radiologist was able to be segmented according to their perception, but they also can be identified in how big and in which hospital setting (according to the MRI procedures per week) they are working.

It is important to address that this analysis is also dependant of the hierarchical cluster procedures. The Hierarchical Cluster Analysis was able to find three understandable clusters in the "Small" and "Medium" hospitals, but was unable to do the same in the "Big Hospitals". At the same time, perform different Hierarchical Cluster Analysis, as well as the ANOVA, Scheffe´s test and other procedures can be a very long and careful process, where several assumptions have to be made.

Some managerial implications were given for the U.S. and Europe segmentation results in the previous section. After this analysis, it is important to mention, that having a better understanding of the buying structure behind the different hospitals settings could give a greater value to these results. With these results, any managerial team wills easily determinate in which kind of hospitals are the radiologist they want to address, but the question is: How can be influenced to increase the purchase of MRI products? At the same time, the sales representatives could be organized according to which hospital setting they are going to sale, which message could they bring with them and which sales approach could fit better to reach different hospitals.

Nevertheless, the author can conclude that perform a Cluster analysis using the Nested Approach give a much precise understanding of the U.S. market than the first cluster analysis performed for the company. However, the cluster analysis made under the company´s criteria give also a very good understanding about the radiologist perception in the U.S. Market.

**A.5. Objective 5**

*"To draw conclusions about the relevance of processes, criteria and variables for market segmentation and customer profiling according the comparison of the results"*

Summarizing all the exposed conclusions from the research´s objectives, the author can state that the combination of the Hierarchical Cluster Analysis and different segmentation approaches can be a very effective recipe for B2B companies, in order to develop new market segments and customer profiles.

The B2B market segmentation models offer a wide range of options and ideas to develop tailored segmentation processes for different companies. The firms need to be aware of their capabilities and strategies before start developing a segmentation process, as these factors can be determinant in the moment to choose the most adequate segmentation approach for a brand, business unit or company. The disadvantages of these models are that not all of them will fit in all business realities, industries and firms. For the same reason, the researcher has to be very conscious about the objectives that these models try to accomplish and under what reality they were developed.

Additionally, the B2B market segmentation models can be very helpful in the moment of planning the segmentation of a market. They offer valuable segmentation criteria and variables for different business realities For example, in this research, the Nested Approach from Shapiro and Bonoma (1984) was not only used to perform the segmentation process, but was very helpful to determinate which variables should the author look for in order to do a good market segmentation.

Nevertheless, some of these models are very good structured and are part of complete processes; they are not only concern about segmentation criteria, but also from planning and implementation of the market segmentation. Moreover, these models give a wide range of criteria and variables, which could be very helpful for any researcher. The adequate market model application plus the market researcher experience in a specific market can be a very powerful mixture to come up with accurate segmentation results.

Finally, it is important to address the role of the statistical multivariate methods in a market segmentation process. Independently that the cluster analysis and other statistical methods need to accomplish several requirements to be reliable, using them combined with a B2B segmentation model and the experience of an skilled market researcher from a specific industry, they are a useful tool that provides the segmentation process with the most possible objectives results. The disadvantage of the Hierarchical Cluster Analysis is that the final selection of the number of clusters is completely dependent from the market researcher and that can give some inaccurate results. For the same reason, the author makes emphasis about the importance of the former experience of the market researcher to take the most important decision during a marketing segmentation process.

**A.6. Final conclusion**

Finally the author can make different conclusion regarding to the results of this study. The B2B and B2C market literature has demonstrated that exist several differences between these markets. As they also share similarities, in general, these differences leave they mark in the strategies and actions of B2C and B2B companies.

The segmentation activities and strategies are one of the most important subjects in any kind of firms that is developing their businesses in heterogeneous markets. They are very important at the moment of determinate were to allocate different resources. The distinction of different costumers and their profiles are determinant at the moment of implement different marketing strategies and marketing mixes.

The differences between B2B market models were explained after a carefully research. All the models presented are composed by different criteria and variables for segmenting a market. Simultaneously, these models where built according to different business realities (Business-supplier, Buyer-Seller, in different industries and more) giving the market researcher a wide range of options for marketing segmentation.

On the subject studied, according to the involved company, the author was able to define, through a Hierarchical Cluster Analysis, four segments for the radiologist European market (Demanding, Average, Less demanding and High through put radiologist). This segmentation was done using the Hierarchical Cluster Analysis with variables regarding the perception of the radiologist about fourteen different contrast agents' attributes and other five operational variables regarding to the patient load of hospitals and radiologist. In the other hand, for the U.S. market, three segments could also be found (Demanding, Average and Less demanding radiologist). For this segmentation, the only variables used, were the ones regarding to products attributes perceptions. The operational variables

were left out of the analysis as they did not give a valuable segmentation results for the Market Research Team. These segmentation proposals had a good reception for the Strategic Marketing MRI team, specially the one for the U.S. market.

Finally, for comparison purposes, the same segmentation process was conducted according to the Nested Approach from Shapiro and Bonoma (1984) using a Hierarchical Cluster Analysis, but only to the U.S. market. This segmentation process was performed also using the operational and characteristics variables according to the stages proposed by the model. The first segmentation was made to a hospital level. Three segments of hospitals were achieved: Small, Medium and Big Hospitals. In the second stage, the author proceeds with another cluster analysis to each one of these hospitals cluster using the characteristics variables. The author was able to find different groups of radiologist in the "Small" and "Medium" hospitals clusters. These groups were also sorted according to their preferences for different contrast agents attributes from "Demanding" cluster to "Less demanding" or "Indifferent" radiologist. The "Big" hospital cluster was not able to be segmented using the characteristic variables. This segmentation process was more precise in comparison to the first U.S. market analysis and was able to take advantage of more variables for a better market segmentation.

## B. LIMITATIONS OF THE STUDY

1. The researcher was not part of the planning of the MRI Tracking Study 2011 and the design of the questionnaire was not specifically planned for a later application of a hierarchical cluster analysis. Only the information gathered by a few questions was use, because not all the questions were created to fulfill the requirements of the mentioned analysis.

2. The analysis of the data and results of the study are limited to the information gathered in this MRI Tracking Study giving the researcher no possibilities to add more data to the database given.

3. The MRI Tracking Study was performed in September and October of the year 2011 and the present investigation has been performed between July and December from the year 2012. For the same reason, the results could be outdated or not being fully representative of the actual market situation.

## C. RECOMMENDATIONS

- For similar investigations in the future, the author recommends to perform a market research survey made accordingly for the later application of a hierarchical cluster analysis or a specific segmentation model. All models need different information to exploit their advantages. For example, the segmentation models from Pick (1999) and Elliot et al. (2000) classified customers accordingly to the profit the customer's generate according to their loyalty. Both models will need to investigate how much profit generates each kind of customer and how they can measure the loyalty of them to perform market segmentation according to these models.

- In case of future surveys in European countries, it will be important to include new variables to the MRI product attributes such as "Product nationality", as some radiologists seems to chose contrast agent according to the manufacturer nationality. According to the Strategic Marketing MRI team, this is a very good known characteristic of the French MRI market.

- In case of any future market research, it is important to not forget relevant financial variables that could help the researcher to assign or understand the commercial value of the segmenting results. Better managerial decision could be made if the researcher is able to understand how profitable a segment can be.

- It is also recommendable to try the cluster analysis in other segmentation models. For example, in this research, several B2B segmentation models were presented, but the cluster analysis was only performed over one of them (Nested Approach), as the information obtained in the MRI tracking study, was more suitable for this segmentation approach. Maybe in this market, it will be more important to address the importance of loyalty for the loyalty (Pick, 1999; Elliot et al. 2000) based segmentation approached. On the other side, gathering more information about the buying center of different hospital setting would help to do a better segmentation according the buying decision matrix from Choffray and Lilien (1978).

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### D. WEBSITES OF INTEREST

1. **B2B International:** http://www.b2binternational.com

2. **Bayer Healthcare Radiology**: http://www.imaging.bayer.com

3. **Industrial Marketing and Purchasing Group:** www.impgroup.org

4. **Nephrogenic Systemic Fibrosis (NSF) Registry**: http://www.icnfdr.org/.

# APPENDIXES

## APPENDIX N°1: Profile of the company

### 1. Bayer Group and Bayer HealthCare AG

Bayer AG is a company initially founded in Germany in the year 1863 as a manufactory company that marketed synthetic dyes. A yers later, Bayer AG turned itself in an international chemical company, which major business were the synthetic dyes, until the discovering of the "Drug of the Century" in the laboratories of Bayer in Wuppertal-Elberfelf, the Aspirin. The commercialization of the Aspirin started in 1899, what favors the creation of a Pharmaceutical Department.

Today, the mission of the Bayer Group is based in his principal statement: Science for a Better Life. Bayer is described in the company's Annual Report as a "global enterprise with core competencies in the field of health care, nutrition and high-tech materials. As an inventor company, we set trends in research-intensive areas. Our products and services are designed to benefit people and improve their quality of life. At the same time we aim to create value through innovation, growth and high earning power. We are committed to the principles of sustainable development and to our social and ethical responsibilities as a corporate citizen."

The research presented on this document has been developed within the Strategic Marketing for Magnetic Resonance Imaging (MRI) department of the Radiology and Interventional business unit. This unit reports to the Medical Care division of Consumer Health that belongs to Bayer HealthCare subgroup.

**Figure: Bayer Group Structure**
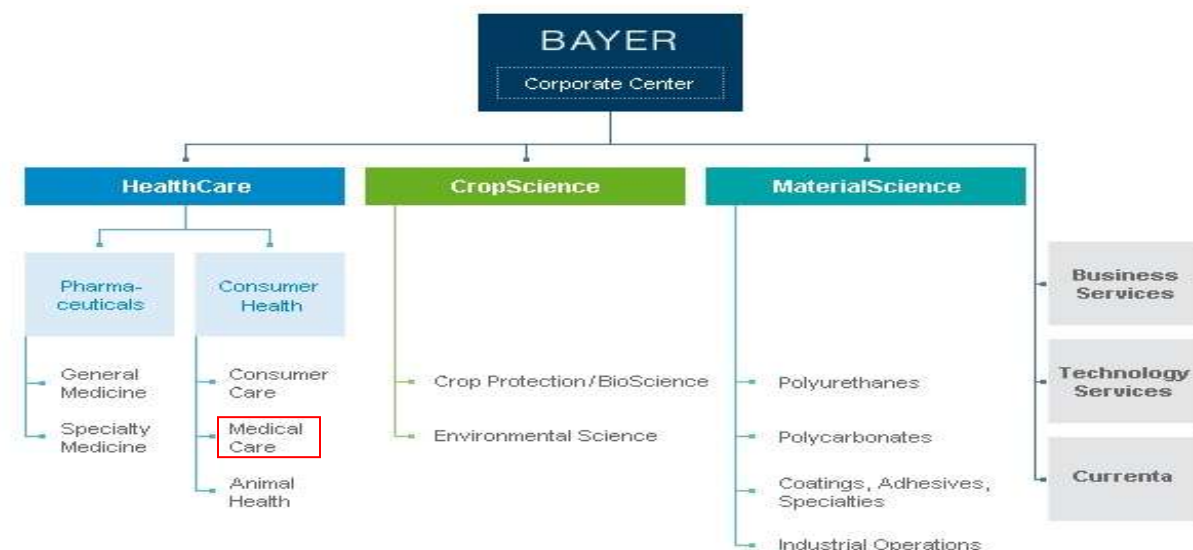


Source: Bayer Annual Report 2011, p. 59

### 1.1. Bayer AG financial information

Bayer AG is an international Holding that focuses its efforts in the areas of healthcare, nutrition and crops, and high-technology materials. Besides, Bayer counts with 3 services companies that support the Bayer subgroup´s in their operations. The following tables will describe to the reader the respective business areas of the Bayer Group with their divisions, sales, EBIDTA, R&D Expenses and number of employees for the sake of give him an idea of the sizes of the businesses where the Bayer Group is involved:

**Table: Business areas financial description**

| Business Area | Description | Divisions | Sales (mio) | EBIDTA (mio) | R&D expenses | Employees |
|---|---|---|---|---|---|---|
| Bayer Healthcare | Pharmaceutical and medical products | Animal Health; Consumer Care; Medical Care; Pharmaceuticals | €17,169 | €4,702 | €1,948 | 55,700 |
| Bayer Crop Science | Crop protection and non-agricultural pest control | Crop Protection/ Bio Science; Environmental Science | €7,255 | €1,654 | €723 | 21,000 |
| Bayer Material Science | High-performance materials and systems solutions | Polyurethanes; Polycarbonates; Coating, Adhesives, and Specialties along with the Industrial Operations unit | €10,832 | €1,171 | €237 | 14,800 |
| Services companies | Serves Bayer subgroup´s operations | Business Services; Technology Services; Currenta | | | | 14,500 |

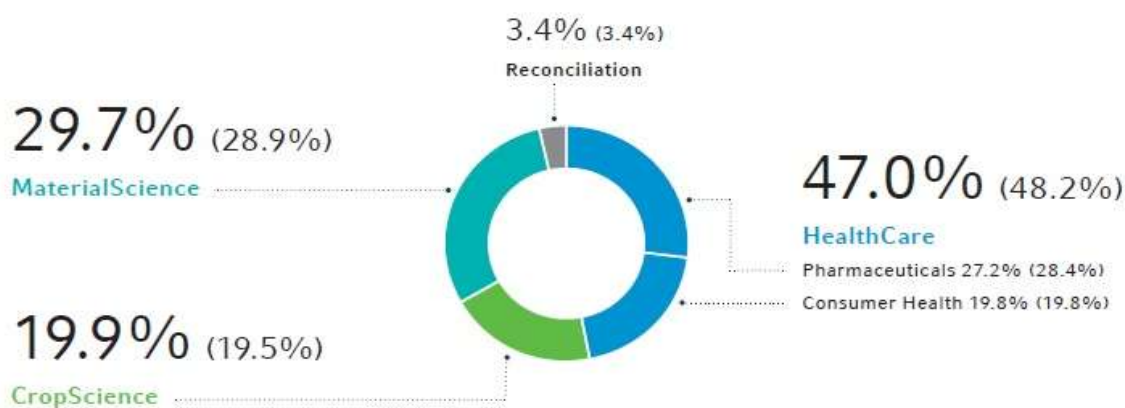| Services Companies | Services | Specific Services | Employees |
|---|---|---|---|
| Bayer Business Services | IT and business services | IT infrastructure and applications, Procurement and logistics, HR and management services and finance and accounting | 6,400 |
| Bayer Technology Services | Technological solutions for processes, plants and products | | 2,700 |
| Currenta | Services for the chemical industry | Utility supply, waste management, infrastructure, safety, security, analytics and vocational trainings | 5,400 |

Source: Made by the author based on "Names I Figures I Facts 2012/2013" P. 16-29

**Figure: Sales and sales from Bayer Healthcare by Region and Division**

| Division | Sales 2011 (mio) | Share | Region | Sales 2011 (mio) | Share |
|---|---|---|---|---|---|
| Animal Health | € 1,186 | 7% | Europe | € 6,376 | 37% |
| Consumer Care | € 3,534 | 21% | North America | € 4,360 | 25% |
| Medical Care | € 2,500 | 15% | Asia/Pacific | € 3,656 | 21% |
| Pharmaceuticals | € 9,949 | 58% | Latin America/Africa/Middle East | € 2,777 | |
| | | | | | 16% |
| Bayer Healthcare | € 17,169 | 100% | Bayer Healthcare | € 17,169 | 100% |

Source: Made by the author based on the Bayer Healthcare Names – Figures – Facts 2012 document

**Figure: Share of Sales by Segment 2011 (2010 in parentheses)**



3.4% (3.4%)
Reconciliation

29.7% (28.9%)
MaterialScience

47.0% (48.2%)
HealthCare
Pharmaceuticals 27.2% (28.4%)
Consumer Health 19.8% (19.8%)

19.9% (19.5%)
CropScience

Source: Bayer Annual Report 2011, p. 60

### 1.2. Bayer MedicalCare - Radiology and Interventional Business Unit[31]

The aim of Bayer HealthCare is to research, develop, manufacture and market innovative products that will improve the health of people and animals all over the world assuring the diagnosis, prevention and treatment of diseases to enhance quality of life. The MedicalCare unit generated €2,500 million on sales in the year 2011 (15% of the sales generated by the HealthCare subgroup).

Bayer HealthCare´s Medical Care Division is comprised of two business units – Radiology and Interventional (R&I) and Diabetes Care. The R&I unit, established on January 1st of 2012, merged Bayer HealthCare´s contrast agent and medical devices businesses.

Radiology and Interventional develop and manufacture contrast agents used in X-ray[32], computed tomography (CT)[33] and magnetic resonance imaging (MRI)[34], as well as injection

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[31] Based on Bayer HealthCare Names – Figures – Facts 2012
[32] An X-ray is a radiology test that involves exposing the body briefly to radiation to produce an image of the body and the internal organs of the patient.
[33] Computerized (or computed) tomography is an X-ray procedure that combines several X-ray images with the aid of a computer to generate cross-sectional views and, if needed, three-dimensional images of the internal organs and structures of the body.

systems for diagnosis and therapeutically medical procedures in CT, MRI and cardiovascular and peripheral vascular disease.

The unit also provides service support for the systems as well as medical data management products. Product examples from the business unit include the following contrast agents: Ultravist (X-ray), Magnevist (MRI), Gadovist® (MRI; Gadavist in USA) and Primovist (Specific MRIagento for Liver; USA: Eovist); injection systems for contrast agents and informatics platform. The products are marketed to cardiologist, radiologist and vascular surgeons in hospitals and out-patient[35] clinical sites through a global direct sales organization, supplemented in some locations by local distributors.

Outside Europe, these products are generally sold to customers through pharmacies, drugstores, mass merchants, hospitals or wholesalers. In Europe, they are sold mainly through pharmacies.

### 1.3. Gadovist®

Magnevist®, the first intravenous contrast agent to become available for clinical use, is commercialized by Bayer Healthcare and, until 2010, it was the worldwide market leader with more than 110 million doses sold worldwide (ProPublica, 2010). It has been the most successful MRI contrast agent in recent years for Bayer´s radiology business and had reached the status of market leader in several countries. Magnevist's® patent has been expiring in several countries over the years giving space in the market for the entry of generic products and other competition. For the same reason, the Radiology and interventional Unit focuses to market Gadovist®, a newer and safer MRI contrast agent, which has received the marketing authorization in several countries worldwide for various indications.

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[34] An MRI (or magnetic resonance imaging) scan is a radiology technique that uses magnetism, radio waves, and a computer to produce images of body structures.

[35] An outpatient (or out-patient) is a patient who is not hospitalized for 24 hours or more, but who visits a hospital, clinic, or associated facility for diagnosis or treatment. Treatment provided in this fashion is called ambulatory care.

Gadovist® plays a major role in Bayer's MRI portfolio. Is the natural successor of Magnevist® and is promoted as the most modern, safer and general purpose extracellular MR contrast agent. Gadovist® 1.0 is a contrast agent approved for a broad range of indications in both adults and children aged 2 years and older including contrast enhancement for:[36]

- Cranial and spinal Magnetic Resonance Imaging,

- MRI of liver or kidneys in patients with high suspicion or evidence of having focal lesions, to classify these lesions as benign or malignant,

- Magnetic resonance angiography (MRA),

- Imaging of pathologies of the whole body. Gadovist® facilitates visualization of abnormal structures or lesions and helps in the differentiation between healthy and pathological tissue.

The most important competitors in the non-specific MRI Contrast Media market for Bayer (Magnevist® and Gadovist®) are: GE Healthcare (Omniscan®), Bracco (ProHance® and MultiHance®), Guerbet (Dotarem®), Covidien formerly Tyco/Mallinckrodt (Optimark®) and other generic companies like Agfa Healthcare, Sanochemia/Helm, Ratiopharm, and others.

In the MRI Tracking Study, several questions were made to determinate the awareness of the radiologists regarding to the benefits of Gadovist®. On the other hand, there was a question to determinate the opinion of the radiologists about different MRI brands (including Gadovist®) according to fourth teen different products attributes.

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[36] Bayer Healthcare Radiology: **http://www.imaging.bayer.com**

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# MRI Tracking Study 2011
## Questionnaire v5

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Weighting factors (base: enhanced MRI procedures in 2010)

Brazil: 1000
Canada: 305
China: 1613
France: 1496
Germany: 3302
Italy: 941
Korea: 643
Mexico: 120
Spain: 634
USA: 7642

# Recruitment Questions

Thank you very much for agreeing to take part in this online survey. The purpose of this survey is to gain a better understanding of the use of contrast agents in MRI (magnetic resonance imaging) and what your requirements are.

Before starting the questionnaire, please answer the following screening questions to find out if you belong to the target group of this survey.

S1)    Do you work at a private practice or a hospital?

   **1**  ☐    Primarily private practice          ➔ *Observe ratio.*

   **2**  ☐    Primarily hospital                   ➔ *Observe ratio.*

S2)    *If hospital-based doctor (code 2 in S1):* What is your function at the hospital?

   **1**  ☐    Radiologist

   **2**  ☐    other                                ➔ *END*

S3)    Which of the following diagnostic imaging procedures are used in your practice / in your radiology department?

   **1**  ☐    Conventional X-ray radiology

   **2**  ☐    CT (computed tomography)

   **3**  ☐    MRI (magnetic resonance imaging)     ➔ *END if MRI is <u>not</u> used.*

S4)   ***If hospital-based doctor (code 2 in S1):***
      Which of the following categories does your hospital belong to?

      **1** ☐   University hospital ➜ ***Observe ratio. At least 10% of hospitals with university hospitals***

      **2** ☐   Academic teaching hospital (ATH)

      **3** ☐   Community hospital (not ATH)

      **4** ☐   Other

S5)   Approximately how many MRI examinations per week are performed in your practice / hospital department?

      |_____ _____ _____|      MRI examinations / week

S6)   Approximately how many MRI examinations per week in your practice / hospital are performed with contrast agents?

      |_____ _____ _____|      Enhanced MRI scans / week

***Progr.: Must not exceed # in S5)***
***Progr.: If less than 10: END***

S7)   And how many contrast enhanced MRI examinations per week do you perform or oversee personally?

      |_____ _____ _____|      Enhanced MRI scans / week personally performed or overseen

***Progr.: Must not exceed # in S6)***
***Progr.: If less than 10: END***

S9)   Approximately how many of the _____ (***Progr.: Insert answer to S7***) weekly contrast enhanced MRI scans which you personally perform or oversee are LIVER examinations?

      |___ ___ ____|      LIVER examinations per week among all enhanced MRI scans

      ***Progr.: Must not exceed # in S7)***

S10)  Approximately how many of the _____ (***Progr.: Insert answer to S7***) weekly contrast enhanced MRI scans which you personally perform or oversee are BREAST examinations?

      |___ ___ ____|      BREAST examinations per week among all enhanced MRI scans

      ***Progr.: Must not exceed # in S7)***

# Main Questions

1) In this study we investigate the use of extracellular (=non-specific) contrast agents in MRI. Which non-specific contrast agents in MRI have you ever heard or read about?

_____

_____

2) *{Prog.: USA only:}* What new MRI contrast agents are you aware of that are in development for the U.S.?

_____

_____

_____

**99** ○    Don't know

3) *{Prog.: USA only, skip if "Don't know" in previous question, for all mentions:}* Are you aware which company will manufacture *{Prog.: response from Q2}*?
   *{Prog.: Randomize Items}*

   **1** ☐    Bayer

   **2** ☐    Bracco

   **3** ☐    Covidien

   **4** ☐    GE

   **5** ☐    Guerbet

   **6** ☐    Lantheus

   **7** ☐    Other (please specify) _____

   **99** ○    Don't know

4) Have you ever heard or read about the following MRI contrast agents, even if you have not used them yet?
*Progr.: Multiple responses possible*

*Shown in which countries?*

### *Non-specific contrast agents:*

| | | | |
|---|---|---|---|
| 1 | ☐ | Dotarem | *(all but USA, Canada)* |
| 2 | ☐ | Gadovist *{Prog.: USA: Gadavist}* | *(all)* |
| 3 | ☐ | Magnevist | *(all)* |
| 4 | ☐ | MultiHance | *(all but Brazil, Mexico)* |
| 5 | ☐ | ProHance | *(all but China, Brazil, Korea, Mexico)* |
| 6 | ☐ | Omniscan | *(all)* |
| 7 | ☐ | Optimark | *(all but China, France)* |
| 8 | ☐ | Ablavar | *Canada, US* |
| 9 | ☐ | Primovist *{Prog.: USA: Eovist}* | *(all but France, Brazil, Mexico)* |

### *Generic MR contrast agents:*

| | | | |
|---|---|---|---|
| 10 | ☐ | Generic MR contrast media (Magnograf, MR-Lux, Magnegita) | *(Germany, France - Magnegita only)* |
| 11 | ☐ | Generic MRI Contrast Media (MRbester, MegaRay, Vono-I) | *(Korea)* |
| 12 | ☐ | Generic MRI Contrast Media (local Chinese product) | *(China)* |
| 13 | ☐ | Generics (Viewgam) | *(Brazil)* |
| 14 | ☐ | Generics (Magnegita, Megascan) | *(Mexico)* |

*5)* Which of the following contrast agents have you used in the past 3 months?
**Progr.: Show all products known in previous question.**
**Multiple responses possible**

*Shown in which countries?*

| | | | |
|---|---|---|---|
| **1** | ☐ | Dotarem | *(all but USA, Canada)* |
| **2** | ☐ | Gadovist *{Prog.: USA:* Gadavist*}* | *(all)* |
| **3** | ☐ | Magnevist | *(all)* |
| **4** | ☐ | MultiHance | *(all but Brazil, Mexico)* |
| **5** | ☐ | ProHance | *(all but China, Brazil, Korea, Mexico)* |
| **6** | ☐ | Omniscan | *(all)* |
| **7** | ☐ | Optimark | *(all but China, France)* |
| **8** | ☐ | Ablavar | *Canada, US* |
| **9** | ☐ | Primovist *{Prog.: USA:* Eovist*}* | *(all but France, Brazil, Mexico)* |

**Generic MR contrast agents:**

| | | | |
|---|---|---|---|
| **10** | ☐ | Generic MR contrast media (Magnograf, MR-Lux, Magnegita) | *(Germany, France - Magnegita only)* |
| **11** | ☐ | Generic MRI Contrast Media (MRbester, MegaRay, Vono-I) | *(Korea)* |
| **12** | ☐ | Generic MRI Contrast Media (local Chinese product) | *(China)* |
| **13** | ☐ | Generics (Viewgam) | *(Brazil)* |
| **14** | ☐ | Generics (Magnegita, Megascan) | *(Mexico)* |

6) For each of the following non-specific contrast agents used in MRI scans, what percent of the total volume of all non-specific contrast agents is currently accounted for by each product in YOUR practice / hospital. The total must add to 100%. **Progr.: Show all products selected in previous question (set all products NOT used in previous question to the value of 0).**

| | Current use in percent of MRI examinations with non-specific contrast agents | Shown in which countries? |
|---|---|---|
| Dotarem | \|___ ___ ___\| % | (all but USA, Canada) |
| Gadovist {Prog.: USA: Gadavist} | \|___ ___ ___\| % | (all) |
| Magnevist | \|___ ___ ___\| % | (all) |
| MultiHance | \|___ ___ ___\| % | (all but Brazil, Mexico) |
| ProHance | \|___ ___ ___\| % | (all but China, Brazil, Korea, Mexico) |
| Omniscan | \|___ ___ ___\| % | (all) |
| Optimark | \|___ ___ ___\| % | (all but China, France) |
| Generic MR contrast media (Magnograf, MR-Lux, Magnegita) | \|___ ___ ___\| % | (Germany, France - Magnegita only) |
| Generic MRI Contrast Media (MRbester, MegaRay, Vono-I) | \|___ ___ ___\| % | (Korea) |
| Generic MRI Contrast Media (local Chinese product) | \|___ ___ ___\| % | (China) |
| Generics (Viewgam) | \|___ ___ ___\| % | (Brazil) |
| Generics (Magnegita, Megascan) | \|___ ___ ___\| % | (Mexico) |
| | **SUM=100%** | |

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7) You will now see several criteria that may affect your choice of an appropriate contrast agent for magnetic resonance imaging.
For each criterion, please indicate how important you think it is in affecting your choice of a particular contrast agent. Please answer on a scale of 1 to10, where 1 means "not at all important" and 10 means "extremely important". You can use the numbers between to graduate your response.
***Progr.: Rotate order of attributes***

| | | Not important at all | | | | | | | Very important | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | Excellent tissue contrast / excellent detection of pathological tissue | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 | Can be used universally for the whole body | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 | Advantageous for angiographic examinations) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 | Can be used for children | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 | High concentration/half volume | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 | Can be used at lower gadolinium doses | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 | High relaxivity | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9 | Good tolerability | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 | Different bottle sizes to meet the daily requirements | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 | Good availability / no supply problems | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12 | Long personal experience with the product | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 | Cost effective compared to other agents | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 | Macrocyclic structure | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 | Lower risk for NSF | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

8) ***Progr.: Hospital-based physicians only:***
Can you please rate the influence of your hospital's purchase management on your choice of MRI contrast agents used.
For each time period (3 years ago = 2008, today = 2011, in the next 3 years = 2014), please indicate how strongly you think the hospital's purchase management affects your choice of particular contrast agents. Please answer on a scale of 1 to 10, where 1 means "no influence at all" and 10 means "extremely strong influence". You can use the numbers between to graduate your response.
***Progr.: For today: Insert answer of previous question***.

**Influence of the hospital's purchase management on my choice of particular MRI contrast agents**

|  |  | No influence at all |  |  |  |  |  |  | Extremely strong influence |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | Today (2011) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 | 3 years ago (2008) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 | Expected influence in the next 3 years (2014) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

9) Here is the list of attributes again which you classified by importance. For each attribute could you please now rate the performance of the different contrast agents. Please use a 5-point scale, where 1 means "does not describe at all" and 5 means "describes completely" to indicate what you think of the performance of each product on the first attribute. Of course, you may also use any number between 1 and 5.
Once you have rated each product on the first attribute, please continue with the rest of the attributes.
***Progr.: Rotate attributes, show all known products mentioned in Q4***

***{ Prog.:***
***Test only three products for Europe: Dotarem, Gadovist, Multihance***
***In USA and Canada: Gadavist, Magnevist, Multihance, Omniscan***
***In Korea: Gadovist, Omniscan, Dotarem***
***In Brazil and Mexico: Gadovist, Magnevist, Dotarem, Omniscan***
***In China: Gadovist, Magnevist, Omniscan, Generic MRI Contrast Media (local Chinese product)}***

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| 1 | Excellent tissue contrast / excellent detection of pathological tissue | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 2 | Can be used universally for the whole body | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 3 | Advantageous for angiographic examinations) | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 4 | Can be used for children | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 6 | High concentration/half volume | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | Can be used at lower gadolinium doses | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 8 | High relaxivity | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 9 | Good tolerability | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 10 | Different bottle sizes to meet the daily requirements | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 11 | Good availability / no supply problems | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 12 | Long personal experience with the product | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 13 | Cost effective compared to other agents | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 14 | Macrocyclic structure | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |
| 15 | Lower risk for NSF | \|__\| | \|__\| | \|__\| | \|__\| | \|__\| |

10) Which of the following non-specific contrast agents offers the best combination of diagnostic efficacy and safety, i.e. which offers the best tissue contrast with lowest safety risk for the patients?
*Progr.: Show all products known Q4. Only one answer allowed!*

*Shown in which countries?*

### Non-specific contrast agents:

| | | | |
|---|---|---|---|
| 1 | ☐ | Dotarem | *(all but USA, Canada)* |
| 2 | ☐ | Gadovist *{Prog.: USA: Gadavist}* | *(all)* |
| 3 | ☐ | Magnevist | *(all)* |
| 4 | ☐ | MultiHance | *(all but Brazil, Mexico)* |
| 5 | ☐ | ProHance | *(all but China, Brazil, Korea, Mexico)* |
| 6 | ☐ | Omniscan | *(all)* |
| 7 | ☐ | Optimark | *(all but China, France)* |

### Generic MR contrast agents:

| | | | |
|---|---|---|---|
| 8 | ☐ | Generic MR contrast media (Magnograf, MR-Lux, Magnegita) | *(Germany, France - Magnegita only)* |
| 9 | ☐ | Generic MRI Contrast Media (MRbester, MegaRay, Vono-I) | *(Korea)* |
| 10 | ☐ | Generic MRI Contrast Media (local Chinese product) | *(China)* |
| 11 | ☐ | Generics (Viewgam) | *(Brazil)* |
| 12 | ☐ | Generics (Magnegita, Megascan) | *(Mexico)* |

11) *{Prog. USA only:}* Are you familiar with the following distinction between linear and macrocyclic molecular structures of MRI contrast agents? *{Prog. Show picture}*
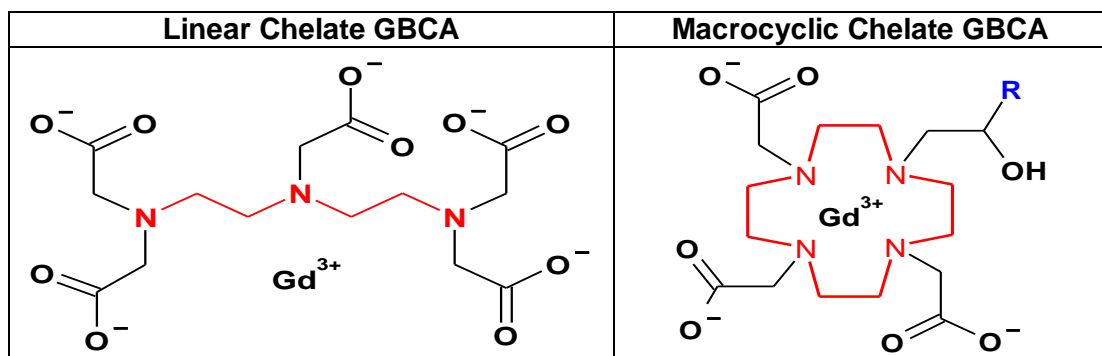
**1** ☐ Yes, very familiar

**2** ☐ Yes, somewhat familiar

**3** ☐ Yes, but heard very little about it

**4** ☐ No, never heard of it

*Progr.: Only one answer allowed*

12) *{Progr.: USA only:}* What benefits, if any, do you associate with a macrocyclic molecular structure?

*Please list all coming to mind…*

_____

_____

_____

13) For certain risk patients (e.g. patients with renal diseases), what type of contrast media would you prefer in MRI?

**1** ☐ Macrocyclic contrast media

**2** ☐ Linear contrast media

**3** ☐ No preference for risk patients

*Progr.: Only one answer allowed*

**14)** *Progr.: For any drugs known in Q4:*
Regarding the following contrast agents: Please state if you consider them to be a linear or a macrocyclic compound.

| | | Dotarem* | Gadovist (USA: Gadavist) | Magnevist | MultiHance** | Omniscan |
|---|---|---|---|---|---|---|
| **1** | Linear compound | ☐ | ☐ | ☐ | ☐ | ☐ |
| **2** | Macrocyclic compound | ☐ | ☐ | ☐ | ☐ | ☐ |
| **9** | *Don't know* | ○ | ○ | ○ | ○ | ○ |

\* not in Canada* not in Canada, USA, ** not in Brazil, Mexico

15) *{Prog.: IF ≥5 Breast MRI per week in S10:}* If you consider your **last** 100 breast MRIs: What percent of all performed breast examinations is accounted for by the following kinds of examinations?

| | | |
|---|---|---|
| MRI after a suspicous result in the X-Ray mammography screening | \|___ ___ ____\| % | *Last 100 breast MRIs* |
| Screening program of patients with high risk of breast cancer | \|___ ___ ____\| % | *Last 100 breast MRIs* |
| Monitoring after breast surgery | \|___ ___ ____\| % | *Last 100 breast MRIs* |
| Planning of breast surgery | \|___ ___ ____\| % | *Last 100 breast MRIs* |
| Others, please specify: _____ | \|___ ___ ____\| % | *Last 100 breast MRIs* |

**SUM=100%**

16) *{Prog.: IF ≥5 Breast MRI per week in S10:}* How would you expect these numbers to be in the **future**? How would they increase, decrease or stay the same? What percent of all performed breast examinations is accounted for by the following kinds of examinations **in 5 years time**?

| | | |
|---|---|---|
| MRI after a suspicous result in the X-Ray mammography screening | \|___ ___ ____\| % | *in 5 years time* |
| Screening program of patients with high risk of breast cancer | \|___ ___ ____\| % | *in 5 years time* |
| Monitoring after breast surgery | \|___ ___ ____\| % | *in 5 years time* |
| Planning of breast surgery | \|___ ___ ____\| % | *in 5 years time* |
| Others, please specify: _____ | \|___ ___ ____\| % | *in 5 years time* |

**SUM=100%**

17) *{Prog.: IF ≥5 Breast MRI per week in S10:}*
How confident are you in your expectations about the volume of your performed breast examinations in 5 years?

Please answer on a scale of 1 to 10, where 1 means "very low level of confidence" and 10 means "very high level of confidence" to use this agent more frequently.

| | very low | | | | | | | | | very high |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Confidence about breast examinations in 5 years time | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

18) *Progr.: Ask for any category which increases by more than 20% (Q15)- Q16):* You indicated that the percentage of *{Prog.: insert category}* will increase by *{Prog.: Difference (Q15)- Q16)}* percentage points.

Could you please give a reason for the expected growth?

_____

_____

**98** ○ None

**99** ○ Don't know

19) **Progr.: Ask for all products mentioned in Q4**)**:** Now please think about sales rep visits for MRI contrast agents. How often have you been visited by a representative for the following contrast agents in the PAST THREE MONTHS (and having TALKED ABOUT THIS AGENT with the sales rep)?
**Progr.: Rotate attributes, show all known products mentioned in Q4**

| | | | *Shown in which countries?* |
|---|---|---|---|
| Dotarem (Guerbet) | |___ ___ ___| | Sales rep visits/ past three months | *(all but USA, Canada)* |
| Gadovist {Prog.: USA: Gadavist} (Bayer) | |___ ___ ___| | Sales rep visits/ past three months | *(all)* |
| Magnevist (Bayer) | |___ ___ ___| | Sales rep visits/ past three months | *(all)* |
| MultiHance (Bracco) | |___ ___ ___| | Sales rep visits/ past three months | *(all but Brazil, Mexico)* |
| ProHance (Bracco) | |___ ___ ___| | Sales rep visits/ past three months | *(all but China, Brazil, Korea, Mexico)* |
| Omniscan (GE Healthcare | |___ ___ ___| | Sales rep visits/ past three months | *(all)* |
| Optimark (Covidien) | |___ ___ ___| | Sales rep visits/ past three months | *(all but China, France)* |
| Generic MR contrast media (Magnograf, MR-Lux, Magnegita) | |___ ___ ___| | Sales rep visits/ past three months | *(Germany, France - Magnegita only)* |
| Generic MRI Contrast Media (MRbester, MegaRay, Vono-I) | |___ ___ ___| | Sales rep visits/ past three months | *(Korea)* |
| Generic MRI Contrast Media (local Chinese product) | |___ ___ ___| | | *(China)* |
| Generics (Viewgam) | |___ ___ ___| | | *(Brazil)* |
| Generics (Magnegita, Megascan) | |___ ___ ___| | | *(Mexico)* |

20) Which pharmaceutical company ~~manufacturing contrast agents~~ would you nominate as being best regarding the overall image?

_____

_____

**21) *Progr.: For any drugs known in Q4) ask:***
Please indicate for what kinds of MRI examinations the following contrast agents are labeled for.

|  |  | Dotarem* | Gadovist (USA: Gadavist) | Magnevist | MultiHance** | Omniscan |
|---|---|---|---|---|---|---|
| 1 | Central nervous system (CNS) MRI | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 | Angiography / MRA | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 | Liver MRI | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 | Kidney MRI | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 | Whole body / all MRI | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 | MRI in children | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 | Breast MRI | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9 | *Don't know* | ○ | ○ | ○ | ○ | ○ |

\* not in Canada, USA, ** not in Brazil, Mexico

**22) Progr.: If Gadovist/Gadavist was used in the past 3 months (Q5)**: You indicated that you currently use Gadovist. In what kinds of MRI examinations do you use this particular contrast agent?
*{Progr.: multiple answers possible}*

**1** ☐ Cranial / cerebral MRI

**2** ☐ Angiography / MRA

**3** ☐ Spinal MRI

**4** ☐ Liver MRI

**5** ☐ Kidney MRI

**6** ☐ GI tract / abdominal MRI

**7** ☐ Clinical studies

**8** ☐ Whole body / all MRI

**9** ☐ Breast MRI

**10** ☐ Others, please specify: _____

**23) Progr.: Only USA - If Gadovist/Gadavist was used in the past 3 months (Q5)**: Which of the following bottle / vial sizes of Gadavist do you use?
*{Progr.: multiple answers possible}*

**1** ☐ 7.5 ml

**2** ☐ 10 ml

**3** ☐ 15 ml

**4** ☐ 30 ml

**5** ☐ 65 ml

**99** ○ Don't know

**24) *Progr.: Only USA If Gadovist/Gadavist was used in the past 3 months (Q5)*:**
Looking at the larger bottle/syringe/vial sizes of Gadovist (Prog: USA: Gadavist): For how many procedures/patients do you typically use one of the different bottle/ vial sizes?
***Progr. Ask for respective vial size selected in Q23:***

| | Number of procedures: | 1 | 1-2 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Don't know |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ~~15 ml~~ | ⊟ | ⊟ | ⊟ | ⊟ | ⊟ | ⊟ | ⊟ | ⊟ | ⊟ | ⊟ | ⊟ | ⊖ |
| 2 | 30 ml | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ○ |
| 3 | 65 ml | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ○ |

**25) *Progr.: If hospital-based doctor (code 2 in S1) AND if respondent is aware about Gadovist/Gadavist (Code 2 in Q4)*:** Do you have Gadovist (Prog: USA: Gadavist) in stock at your hospital?

1   ☐   yes

2   ☐   no

***Profile test only for launch countries (USA, Brazil, China):*** In the remaining part of the interview, we want to discuss the use of Gadovist in more detail.

To ensure that all respondents in this survey have the same information, please read the following text about Gadovist:

> **Background information on GADOVIST (Prog: USA: Gadavist):** Gadovist (Prog: USA: Gadavist) is a neutral (non-ionic), macrocyclic Gadolinium-chelate. It is a second generation extracellular contrast media for MRI. Due to its combination of high concentration (1mmol/ml) and high relaxivity, Gadovist offers better image quality. The high concentration also allows for a 50% reduction in injected volume..
>
> Approved indications of Gadovist (Prog: USA: Gadavist) are:
> - Contrast enhanced cranial MRI
> - Contrast enhanced spinal MRI
> - ***Progr.: next sentence not in USA:*** Contrast enhancement in Magnetic Resonance Angiography
> - ***Progr.: next sentence in Brazil:*** Contrast enhanced MRI of liver or kidneys in patients with high suspicion or evidence of focal lesions to classify these lesions as benign or malignant
> - ***Progr.: next sentence not in Brazil:*** Paediatric patients, aged from 2 years, and older

Features:
- second generation ECCM, with broad range of approved indications
- highest available T1- shortening per injected mL, providing excellent contrast
- small injection volumes
- stable, macro-cyclic complex
- high concentration (i.e. fast, compact bolus)
- Cost per examination: About (USA: 10%) higher cost than other, first-generation 0.5molar MR agents

26) *{Prog.: USA, China, Brazil:}* What do you like about this product?

_____

_____

27) *{Prog.: USA, China, Brazil:}* What do you not like?

_____

_____

28) *{Prog.: USA, China, Brazil:}* Please rate your overall motivation on a scale of 1 to 10, whereby 1 means "I am not motivated at all to use it", and 10 means "I am very motivated to use it".

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I am not motivated at all to use it | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | I am very motivated to use it |

☐ don't know

*{Prog.: USA, China, Brazil:}* Here you see a picture used in the information material about Gadovist (Prog: USA: Gadavist). Have you ever seen this picture?

*Progr.. Show Gadovist key visual*

**1** ☐ yes

**2** ☐ no

29) *{Prog.: USA, China, Brazil:}* How well does this ad fit Gadovist(Prog: USA: Gadavist)? Please use a scale from 1 to 10 where 1 equals "it does not fit the product at all" and 10 equals "it fits the product very well".

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |   |
|---|---|---|---|---|---|---|---|---|---|----|---|
| Does not fit at all to Gadovist (Prog: USA: Gadavist) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Fits very well to Gadovist (Prog: USA: Gadavist) |

**30){Prog.: EU and Korea and only if respondent is aware of Gadovist:}**
**Bayer is assuming to get for Gadovist the label for Whole Body.** In the following you will see several pictures regarding Gadovist's whole body campaign. Please rate each picture regarding its

**uniqueness** (1="Not unique at all", 10="Very unique"),
**eye catchiness** (1="Not eye-catching at all", 10="Very eye-catching") and regarding how well the picture
**fits to the aspect** that Gadovist now newly has approval to be used in **whole body** (all indications / all purpose) (1="Does not fit at all to whole body indication", 10="Fits very well to whole body indication").
*{Prog.: Show pictures of whole body campaign}*

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |   |
|---|---|---|---|---|---|---|---|---|---|----|---|
| Not unique at all | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Very unique |

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |   |
|---|---|---|---|---|---|---|---|---|---|----|---|
| Not eye-catching at all | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Very eye-catching |

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |   |
|---|---|---|---|---|---|---|---|---|---|----|---|
| Does not fit at all to whole body indication | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Fits very well to whole body indication |

31) *{Prog.: EU and Korea:}* Now again have a look at the pictures. Please rate the **advertising slogan (tagline)** that comes with each picture regarding

how **understandable** the slogan is (1="Not understandable at all", 10="Very understandable"),

how well the slogan **fits to the picture** (1="Does not at all fit to the picture", 10="Fits very well to the picture")

How well the slogan **fits to the whole body indication** (1="Does not fit at all to whole body indication", 10="Fits very well to whole body indication")
*{Prog.: Show pictures of whole body campaign}*

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |   |
|---|---|---|---|---|---|---|---|---|---|----|---|
| Not understandable at all | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Very understandable |

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |   |
|---|---|---|---|---|---|---|---|---|---|----|---|
| Does not at all fit to the picture | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Fits very well to the picture |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Does not fit at all to whole body indication | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Fits very well to whole body indication |

32) *{Prog.: EU and Korea}* All in all: Which of the pictures of the Gadovist whole body campaign would you prefer the most?

*{Prog.: Show overview pictures of whole body campaign}*

**1**  ☐  …

**2**  ☐  …

**3**  ☐  …

**4**  ☐  …

**5**  ☐  …

**6**  ☐  …

33) *Progr.: Hospital-based physicians only:*
Does your hospital belong to a group purchasing organization or does it purchase individually?

**1** ☐ Buys within a purchasing group

**2** ☐ Buys Individually

**9** ☐ Don't know


34) Which company is the power injector from that you use for MRI?
*{Progr.: multiple answers possible}*

**1** ☐ Covidien/Mallinckrodt

**2** ☐ Medtron

**3** ☐ Medrad

**4** ☐ Nemoto

**5** ☐ Ulrich

**6** ☐ Bracco

**10** ☐ Others, please specify: _____

**11** ○ Don't know


35) How often do you use the power injector for MRI per day?
**Progr.: Show all products selected in previous question**


Use of power injector |__ ____| times per day


36) *{Prog.: only if respondent is conducting CTs according to S3:}* Which company is the power injector from that you use for CT?
*{Progr.: multiple answers possible}*

**1** ☐ Covidien/Mallinckrodt/Tyco

**2** ☐ Medtron

**3** ☐ Medrad

**4** ☐ Nemoto

**5** ☐ Ulrich

**6** ☐ E-Z EM / ACIST / Bracco

**10** ☐ Others, please specify: _____

**11** ○ Don't know

**12** ○ Don't have a CT injector

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37) *{Prog. USA only:}* Are you familiar with the role of **high relaxivity** in the creation of contrast enhanced images?

1 ☐ Yes, very familiar

2 ☐ Yes, somewhat familiar

3 ☐ Yes, but heard very little about it

4 ☐ No, never heard of it

***Progr.: Only one answer allowed***

38) *{Prog. USA only:}* Are you familiar with **high T-1 shortening's** value in the creation of contrast enhanced images?

1 ☐ Yes, very familiar

2 ☐ Yes, somewhat familiar

3 ☐ Yes, but heard very little about it

4 ☐ No, never heard of it

***Progr.: Only one answer allowed***

DEMOGRAPHICS – General questions

39) Gender

| 1 | ☐ | Male |
|---|---|------|
| 2 | ☐ | Female |

40) Your age:

|___ ___| years

**Thank you for the interview!**

# APPENDIX N°3: U.S Data Analysis

In this section the author will describe some analysis made to the data recollected by the MRI Tracking Study like a basic descriptive analysis, outlier's detection, Multicollinearity effect and other subjects will be evaluated.

## A. Descriptive analysis and outlier's detection

It is important to perform a small descriptive analysis of the variables, because it will give a general overview about the behavior of the information collected in those variables. Just by doing this simple analysis, the author could determine some information that will be helpful for the next analysis.

**Figure: Descriptive analysis of the five operational variables in the U.S. Sample**

|  | S5:MRI scans / week | S6: Enhanced MRI scans / week | S7: Personally Enhanced MRI scans / week | S9: scans LIVER per week | S10: BREAST scans per week |
|---|---|---|---|---|---|
| **Valid Cases** | 181 | 181 | 138 | 138 | 138 |
| **Missing Cases** | 0 | 0 | 43 | 43 | 43 |
| **Mean** | 161.22 | 72.18 | 41.86 | 8.96 | 8.26 |
| **Std. Error of Mean** | 11.300 | 5.690 | 3.816 | 1.001 | 1.935 |
| **Median** | 100.00 | 50.00 | 30.00 | 5.00 | 3.50 |
| **Mode** | 100[a] | 40 | 20 | 5 | 0 |
| **Std. Deviation** | 152.027 | 76.545 | 44.831 | 11.764 | 22.725 |
| **Variance** | 23112.284 | 5859.191 | 2009.774 | 138.392 | 516.442 |
| **Skewness** | 2.826 | 3.329 | 4.219 | 4.237 | 9.056 |
| **Std. Error of Skewness** | .181 | .181 | .206 | .206 | .206 |
| **Kurtosis** | 10.648 | 13.823 | 23.476 | 27.051 | 94.861 |
| **Std. Error of Kurtosis** | .359 | .359 | .410 | .410 | .410 |
| **Range** | 975 | 490 | 340 | 100 | 250 |
| **Minimum** | 25 | 10 | 10 | 0 | 0 |
| **Maximum** | 1000 | 500 | 350 | 100 | 250 |
| **Sum** | 29181 | 13064 | 5776 | 1236 | 1140 |

Source: Made by the author

First is important to address the missing cases in the "Personal exams", "Breast Exams" and "Liver Exams". Those 43 radiologists belonged to hospital settings and had only administrative functions. Even if these radiologists do not perform or oversee MRI exams they have an important influence in the buying decision of the MRI contrast agents. For the same reason and taking in to account that the product Gadovist® has not been

approved for Breast MRI (and in the U.S. does not exist a Whole Body approval as in Europe), the author and the Marketing Research Team decided only to use the "Buying Criteria" variables for segmenting the market. Nevertheless, a Skewness, Kurtosis and outlier analysis will be made to analyze these variables for their possible application in the theoretical model.

As it was stated in the European analysis, the distribution measurements allow the researcher to identify how the data is separated or agglomerated according to its graphical representation. For this analysis is important to analyze the Skewness (data is distributed evenly around the arithmetic mean) and Kurtosis (the degree of concentration values presented in the central region of the distribution) values[37]. Its usefulness lies in the ability to identify the characteristics of the distribution without having to generate the graph.

Looking at the Skewness and Kurtosis values of the five "Operational" variables, it is possible to see that the distribution of the data is not normal. Both values are very high in all the variables. The high positive Skewness values mean that the data is left-skewed and the high positive Kurtosis values mean that the data is mostly distributed around the arithmetic mean, but not evenly. These distribution characteristics can be seen in the following example regarding to the "MRI scans / week" variable.

**Figure: MRI examinations / week histogram**



**Histogram**

Mean = 161.22
Std. Dev. = 152.027
N = 181

Source: IBM SPSS v19

The number of "MRI scans / week" are distributed in a wide range of data (from 25 to 1000 MRI exams x week) with a very high standard deviation and a very small mean in comparison with the minimum and maximum values. The same can be seen in all the

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[37] When the data distribution has a skewness (g1 = ± 0.5) and a coefficient of kurtosis (g2 = ± 0.5), is called the Normal Curve.

others "Operational" variables. These could indicate that it is very possible to find some hospitals or radiologists that perform a very high numbers MRI scans per week compare with what the sample try to represent. It is possible that these cases do not represent the population according to their extremes values and could be considered outliers.

**Figure: Z-scores greater than +3 for the "Operational" variables in the U.S.**

| | S5:MRI examinations / week | S6: Enhanced MRI scans / week | S7: Personally Enhanced MRI scans / week | S9: LIVER examinations per week | S10: BREAST examinations per week |
|---|---|---|---|---|---|
| Cases > +3 | 4 | 5 | 3 | 3 | 1 |
| % | 2,3% | 2,9% | 2,1% | 2,1% | 0,7% |
| Cases | 139, 141, 50, 104 | 104, 141, 50, 92, 5 | 50, 141, 123 | 50, 139, 141 | 50 |

Source: Made by the author

In the previous figure, it is possible to see the amounts of cases (in Z-scores) greater than +3. No Z-score was under -3. This information gives a first glance regarding the possible outliers in the sample. There are some cases in each variable than can be considered outliers according to the Z-scores analysis. In the following graph it is possible to confirm the cases than can be considered outliers.

**Figure: Analysis of extreme cases for operational variables**
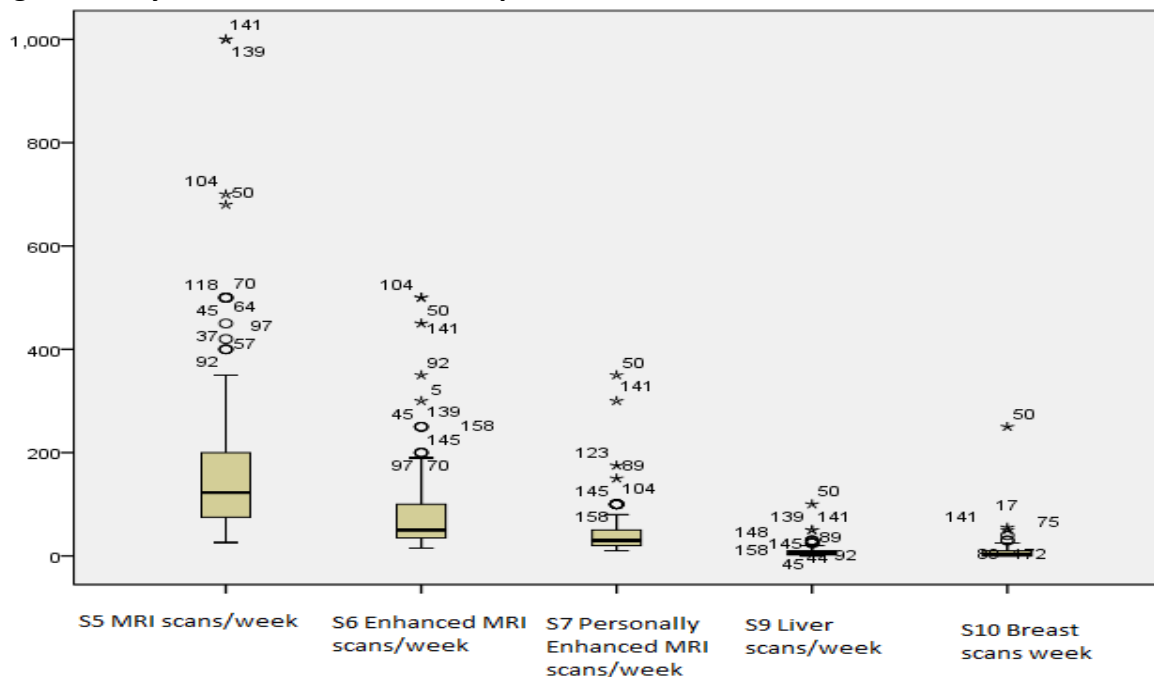


Source: IBM SPSS v19. Descriptive analysis

With the previous graphic representation of the variables, is easy to identify a few extreme cases in these five operation variables. The cases 141, 139, 104 (Academic teaching hospitals) and 50 (Community hospital) are good candidates to be outliers. The

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Academic Hospitals have a greater load of patient than any other hospital settings in the U.S. and it is not unreasonable to find Academic Teaching hospitals with really high patient load. Taking out the possible outliers, it can be concluded that the other cases upper the box can be possible outliers too.

**Table: Descriptive analysis of the 14 "Buying Criteria" variables in the U.S.**

|  | N | Minimum | Maximum | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|
| **Excellent contrast** | 179 | 2 | 10 | 8.84 | .109 | 2.137 |
| **Whole Body** | 179 | 2 | 10 | 8.24 | .127 | 2.891 |
| **MRA** | 179 | 1 | 10 | 7.44 | .147 | 3.854 |
| **Children** | 179 | 1 | 10 | 6.74 | .214 | 8.217 |
| **HighCon/HalfVOL** | 179 | 1 | 10 | 6.49 | .159 | 4.498 |
| **Low GD** | 179 | 1 | 10 | 7.59 | .153 | 4.175 |
| **High relaxivity** | 179 | 1 | 10 | 7.32 | .153 | 4.196 |
| **Good tolerability** | 179 | 2 | 10 | 8.61 | .119 | 2.530 |
| **Sizes** | 179 | 1 | 10 | 6.93 | .169 | 5.124 |
| **Good availability** | 179 | 3 | 10 | 8.32 | .123 | 2.715 |
| **Personal Experience** | 179 | 1 | 10 | 7.24 | .156 | 4.330 |
| **Cost effectiveness** | 179 | 3 | 10 | 8.38 | .121 | 2.641 |
| **Macrocyclic** | 179 | 1 | 10 | 6.13 | .188 | 6.360 |
| **Low NSF** | 179 | 2 | 10 | 8.75 | .129 | 2.973 |

Source: Adapted from IBM SPSS v19

Regarding to this fourth teen variables, it is easy to determinate by the "everything is important" effect. The U.S. sample have four variables (Children, HighCon/HalfVol, Sizes, Macrocyclic) with means under 7 points. Independently of that, all other variables show high means over 7 points. These high scores can be related with the "everything is important" effect in the healthcare industry. This effect is related to the risks that exist in the medical profession, where product´s secondary effects or misscare of patients can result in sickness or death.

**Figure: Skewness and Kurtosis analysis of the 14 "Buying Criteria" variables**

| | Skewness | | Kurtosis | |
|---|---|---|---|---|
| | Statistic | Std. Error | Statistic | Std. Error |
| Excellent contrast | -1.800 | .182 | 4.199 | .361 |
| Whole Body | -1.172 | .182 | 1.353 | .361 |
| MRA | -.973 | .182 | 1.078 | .361 |
| Children | -.634 | .182 | -.729 | .361 |
| HighCon/HalfVOL | -.152 | .182 | -.552 | .361 |
| Low GD | -.857 | .182 | .481 | .361 |
| High relaxivity | -.795 | .182 | .543 | .361 |
| Good tolerability | -1.313 | .182 | 1.702 | .361 |
| Sizes | -.588 | .182 | -.301 | .361 |
| Good availability | -.980 | .182 | .475 | .361 |
| Personal Experience | -.624 | .182 | -.109 | .361 |
| Cost effectiveness | -1.013 | .182 | .407 | .361 |
| Macrocyclic | -.425 | .182 | -.649 | .361 |
| Low NSF | -1.768 | .182 | 3.183 | .361 |

Source: Adapted from IBM SPSS v19

The Skewness and Kurtosis analysis give an interesting overview of the distribution of the data. There are no variables symmetrically distributed. For the same reason, it is possible to conclude that no variables of the set are normally distributed. All variables tend to be negative and asymmetrically distributed (Curve to the right side of the mean). Regarding to the Kurtosis analysis, four variables are mesokurtic (evenly distributes around the mean). These variables are Low Gd, Sizes, Good Availability, Personal Experience and Cost effectiveness. Six other variables (Excellent Contrast, Whole Body, MRA, High Relaxivity, Good Tolerability, Low NSF) tend to be leptokurtic distributed (mostly distributed around the arithmetic mean, but not evenly). On the other hand, Children, HighCon/HalfVol and Macrocyclic variables are platykurtic distributed (Low Concentration of values). This analysis gives a clear overview regarding the behavior of these fourth teen variables.

**Figure: Z-scores smaller than -3 for "Buying Criteria" variables in the U.S. market**

| | CASES < -3 | % | CASES |
|---|---|---|---|
| Excellent contrast | 4 | 2,2% | 137, 110, 119, 150 |
| Whole Body | 2 | 1,1% | 64, 110 |
| MRA | 3 | 1,7% | 54, 64, 117 |
| Children | 0 | 0% | - |
| HighCon/HalfVOL | 0 | 0% | - |
| Low GD | 2 | 1,1% | 41, 164 |
| High relaxivity | 3 | 1,7% | 71, 99, 140 |
| Good tolerability | 1 | 0,6% | 140 |
| Sizes | 0 | 0% | - |
| Good availability | 2 | 1,1% | 110, 181 |
| Personal Experience | 1 | 0,6% | 138 |
| Cost effectiveness | 2 | 1,1% | 150, 162 |
| Macrocyclic | 0 | 0% | - |
| Low NSF | 3 | 1,7% | 64, 65, 119 |

Source: Made by the author

The Z-score analysis has been helpful to determinate seven teen outliers. On the other hand, the other variables show between one to three extreme cases except for the "Excellent Contrast" variable, which has four extreme cases. By the same reason, it will be easy to understand the formation of the Boxplots in the next figure. Moreover, it is easy to identify the extreme cases; any radiologist answering less than four points will be very far away from the mean. To keep the representativeness of the sample, any extreme value found in these variables will be kept in all the analysis.

**Figure: Analysis of extreme cases in the EU sample for the 14 characteristic variables**
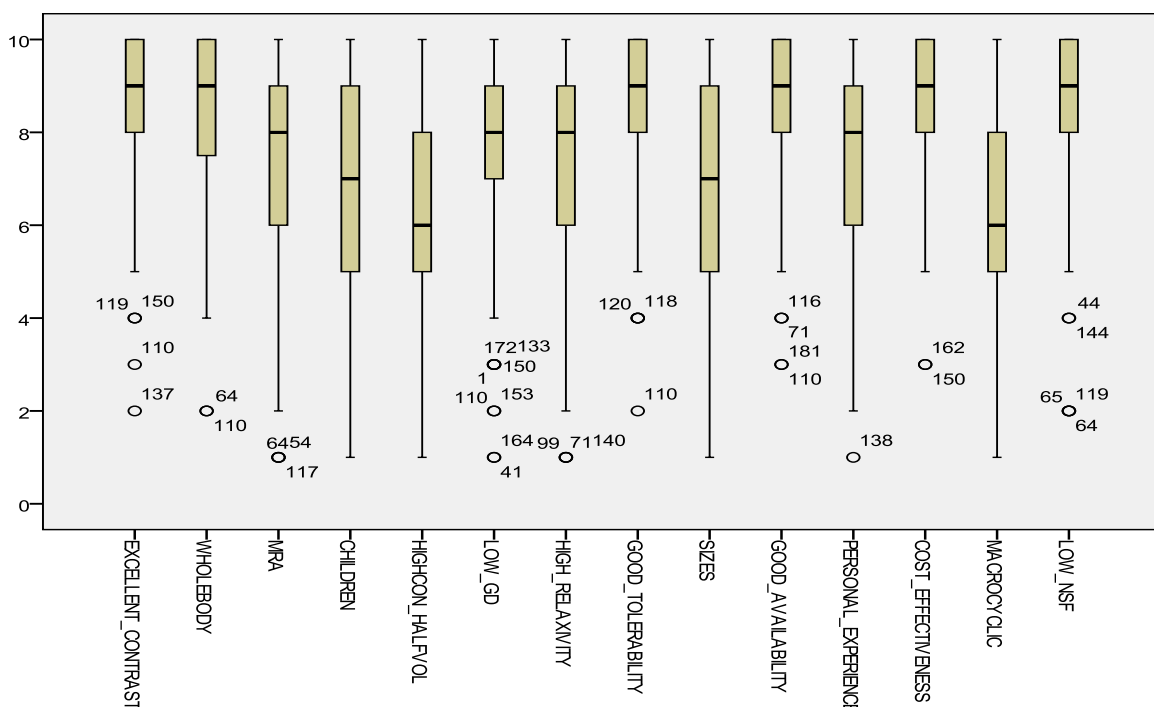


Source: IBM SPSS v19

Looking at the boxplot figure, all the extreme cases are radiologists who score three points or less to the "Buyer Criteria" variables It is possible to count twenty five different cases (without counting the ones which repeat themselves in more than one variable). These extreme cases will be kept to not affect the representativeness of the sample, if they show to have a considerable effect in the clustering results, they will be taken out.

## B. Multicollinearity

If the "Operational" variables and "Buyer Criteria" variables are analyzed separately, is easy to see that do not exist much multicollinearity between the both sets of variables at a significant level of 0.05 (2-tailed). This will be represented in the following figure.

**Figure: Correlation (Sig. levels) between "Operational" and "Buying Criteria" variables**

| | S5:MRI examinations / week | S6: Enhanced MRI scans / week | S7: Personally Enhanced MRI scans / week | S9: LIVER examinations per week | S10: BREAST examinations per week |
|---|---|---|---|---|---|
| **S5:MRI examinations / week** | | ,000 | ,000 | ,000 | ,000 |
| **S6:Enhanced MRI scans / week** | ,000 | | ,000 | ,000 | ,000 |
| **S7:Personally Enhanced MRI scans / week** | ,000 | ,000 | | ,000 | ,000 |
| **S9:LIVER examinations per week** | ,000 | ,000 | ,000 | | ,000 |
| **S10:BREAST examinations per week** | ,000 | ,000 | ,000 | ,000 | |
| **Excellent contrast** | ,698 | ,782 | ,983 | ,207 | ,309 |
| **Whole Body** | ,059 | ,332 | ,963 | ,830 | ,537 |
| **MRA** | ,844 | ,348 | ,075 | ,144 | ,108 |
| **Children** | ,797 | ,099 | ,010 | ,614 | ,068 |
| **HighCon/HalfVOL** | ,728 | ,872 | ,020 | ,078 | ,189 |
| **Low GD** | ,591 | ,997 | ,248 | ,707 | ,277 |
| **High relaxivity** | ,071 | ,059 | ,036 | ,167 | ,574 |
| **Good tolerability** | ,103 | ,473 | ,867 | ,354 | ,725 |
| **Sizes** | ,597 | ,137 | ,005 | ,024 | ,074 |
| **Good availability** | ,855 | ,568 | ,491 | ,661 | ,928 |
| **Personal Experience** | ,270 | ,717 | ,350 | ,794 | ,245 |
| **Cost effectiveness** | ,954 | ,469 | ,583 | ,902 | ,632 |
| **Macrocyclic** | ,625 | ,407 | ,136 | ,135 | ,733 |
| **Low NSF** | ,709 | ,574 | ,733 | ,964 | ,989 |

Source: Made by the author

It is not hard to understand why the "Operational" variables could be correlated. All the "Operational" variables represent MRI scans per week, but in different situation. While "MRI scans / week" and "Enhanced MRI scans / week" represent the MRI scans performed in the hospital where the radiologists work, the other variables represent the MRI scans performed directly by the radiologist. Independently of the statistic correlation of these

variables, it is important to analyze them separately for the different relevant information these variables can give to the researcher. On the other hand, it is understandable the correlation between the variable "Sizes" with "Personally Enhanced MRI scans / week" and "Liver scans /week" as for different body parts, the radiologists will need different doses. There is not a visible explanation for the other correlations found. Regarding the "Buying Criteria" variables is possible to see some correlation under the significance level of 0.05.

**Figure Correlation (Significance levels) between "Buying Criteria" variables**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1) Excellent contrast | | ,000 | ,003 | ,000 | ,003 | ,000 | ,000 | ,000 | ,001 | ,000 | ,089 | ,000 | ,030 | ,000 |
| 2) Whole Body | ,000 | | ,007 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 |
| 3) MRA | ,003 | ,007 | | ,000 | ,000 | ,001 | ,023 | ,000 | ,000 | ,000 | ,026 | ,002 | ,006 | ,001 |
| 4) Children | ,000 | ,000 | ,000 | | ,000 | ,002 | ,001 | ,000 | ,000 | ,000 | ,170 | ,000 | ,003 | ,003 |
| 5) HighCon/HalfVOL | ,003 | ,000 | ,000 | ,000 | | ,000 | ,000 | ,025 | ,000 | ,000 | ,000 | ,001 | ,000 | ,000 |
| 6) Low GD | ,000 | ,000 | ,001 | ,002 | ,000 | | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 |
| 7) High relaxivity | ,000 | ,000 | ,023 | ,001 | ,000 | ,000 | | ,000 | ,000 | ,000 | ,006 | ,000 | ,000 | ,030 |
| 8) Good tolerability | ,000 | ,000 | ,000 | ,000 | ,025 | ,000 | ,000 | | ,000 | ,000 | ,002 | ,000 | ,000 | ,000 |
| 9) Sizes | ,001 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | | ,000 | ,021 | ,000 | ,000 | ,038 |
| 10) Good availability | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | | ,003 | ,000 | ,000 | ,000 |
| 11) Personal Experience | ,089 | ,000 | ,026 | ,170 | ,000 | ,000 | ,006 | ,002 | ,021 | ,003 | | ,010 | ,002 | ,322 |
| 12) Cost effectiveness | ,000 | ,000 | ,002 | ,000 | ,001 | ,000 | ,000 | ,000 | ,000 | ,000 | ,010 | | ,000 | ,000 |
| 13) Macrocyclic | ,030 | ,000 | ,006 | ,003 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,002 | ,000 | | ,000 |
| 14) Low NSF | ,000 | ,000 | ,001 | ,003 | ,000 | ,000 | ,030 | ,000 | ,038 | ,000 | ,322 | ,000 | ,000 | |

Source: Made by the author

After analyzing the previous figure, it is easy to see that several "Buying Criteria" variables are correlated. In this case, it is possible to link the "Everything is important" opinion from the radiologists in the moment of answering the survey. If the analyze is focused only in the "Operational" set of variables, is easy to realize that all the "Operational" variables are correlated in a bigger or smaller grade between each other. Similarly, mostly of all "Buying Criteria" variables are also correlated. Mostly of them are correlated in a positive direction. As it was mentioned before, this can be a result of the "everything is important" perception.

All these variables represent different information that need to be analyses separately. For this study, will be important to identify how all these variables affect the cluster analysis results. On the other hand, it will be easier to the Managerial Team to understand the results of the analysis of all the variables are independently represented. For this reason, all the variables will be stay in the analysis and no Factor Analysis will be performed.

# APPENDIX N°4: U.S. Nested Approach, Segmentation with "Operational" variables

**Figure: Dendogram operational variables**



Source: IBM SPSS v19

The dendongram suggested a two, three and four cluster configuration. The problem of the three clusters configuration is that one of its clusters has only four cases (2,2% of the sample). On the other hand, the four clusters configuration is formed by well distributed clusters.

**Table: Number of cases per cluster results**

| CLUSTER CONFIGURATION | 2 CLUSTERS | 3 CLUSTERS | 4 CLUSTER |
|---|---|---|---|
| CLUSTER 1 | 142 | 142 | 81 |
| CLUSTER 2 | 37 | 33 | 46 |
| CLUSTER 3 | _ | 4 | 37 |
| CLUTER 4 | _ | _ | 15 |

Source: Made by the author

**Table: Analysis of means of the all cluster configuration for "Operational" variables**

| Clusters | S5 MRI scans / week | | | S6 MRI Enhanced Scans / week | | |
|---|---|---|---|---|---|---|
| | 2 Cluster | 3 Cluster | 4 Cluster | 2 Cluster | 3 Cluster | 4 Cluster |
| 1 | 102,12 | 102,12 | 164,32 | 47,00 | 47,00 | 77,84 |
| 2 | 391,22 | 336,21 | 151,65 | 169,73 | 138,79 | 76,15 |
| 3 | | 845,00 | 157,43 | | 425,00 | 58,41 |
| 4 | | | 191,00 | | | 65,67 |

Source: Made by the author

The ANOVA test show that the both "Operational" variables make differences between clusters in the two and three clusters configurations, but they do not in the four clusters configurations. In the other two cluster configurations, both variables make differences, but the three clusters configuration had a group with only four cases.

**Table: test result for two, three and four Clusters configurations with "Operational" variables**

| Variable | Two cluster configuration | Three cluster configuration | Four cluster configuration |
|---|---|---|---|
| | SIGNIFICANCE LEVEL | | |
| S5: MRI scans per week | .000 | .000 | .851 |
| S6: Enhanced MRI scans per week | .000 | .000 | .606 |

Source: Made by the author

Looking at the huge mean difference between the cluster 3 and the others clusters from the three clusters configuration, is easy to see that this one is composed only by four extreme cases. These cases were left out of the analysis (cases 49, 103, 137, 139) to look for new cluster configurations.

Dendrogram using Ward Linkage
Rescaled Distance Cluster Combine

Dendrogram using Ward Linkage
Rescaled Distance Cluster Combine
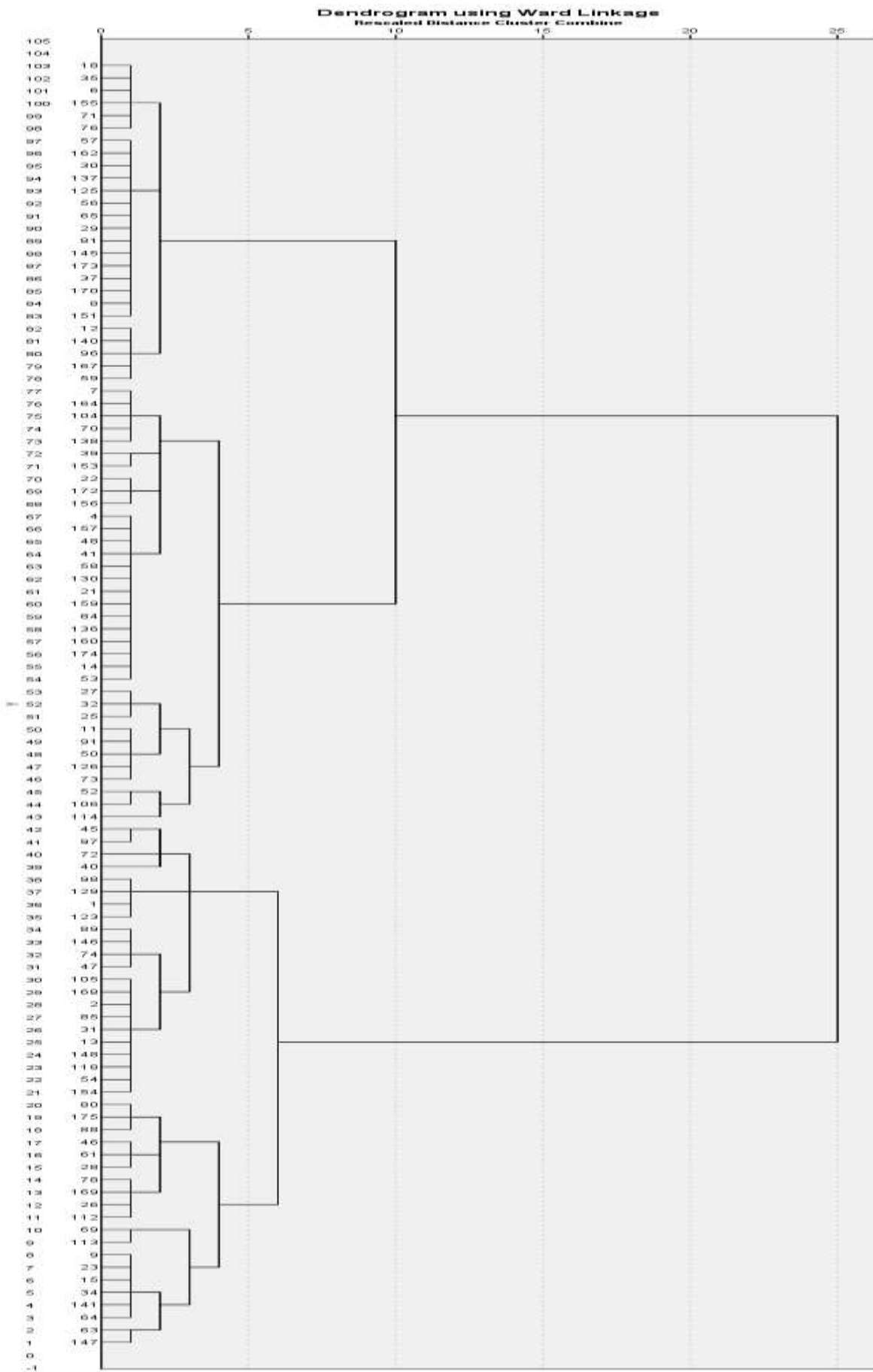
# APPENDIX N°7: U.S. Nested Approach, first cluster analysis for Medium Hospital

**Figure: Dendogram for "Medium Hospitals"**
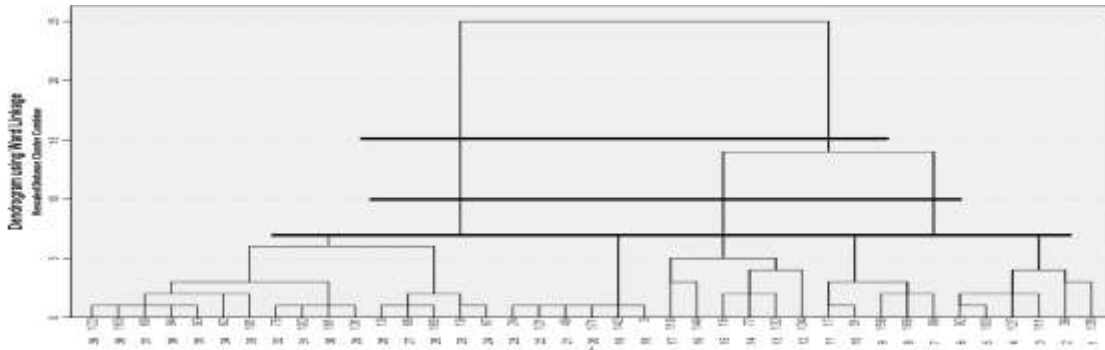


Source: IBM SPSS v19

**Figure: Number of cases per cluster**

| CLUSTER CONFIGURATION | 2 CLUSTERS | 3 CLUSTERS | 5 CLUSTER |
|---|---|---|---|
| CLUSTER 1 | 22 | 22 | 6 |
| CLUSTER 2 | 17 | 6 | 16 |
| CLUSTER 3 | _ | 11 | 6 |
| CLUSTER 4 | _ | _ | 5 |
| CLUSTER 5 | _ | _ | 6 |

Source: Made by the author

**Figure: ANOVA test result for Operational segmentation for "Medium Hospitals"**

| VARIABLE | SIGNIFICANCE | | | VARIABLE | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|
| Cluster configuration | 2 | 3 | 5 | Cluster configuration | 2 | 3 | 5 |
| Excellent contrast | .001 | .000 | .000 | Good tolerability | .005 | .000 | .000 |
| Whole Body | .000 | .000 | .000 | Bottle Sizes | .000 | .000 | .000 |
| MRA | .014 | .008 | .014 | Good availability | .032 | .000 | .001 |
| Children | .157 | .001 | .000 | Personal Experience | .001 | .001 | .004 |
| HighCon/HalfVOL | .016 | .009 | .002 | Cost effectiveness | .013 | .003 | .002 |
| Low GD | .000 | .000 | .000 | Macrocyclic | .000 | .000 | .000 |
| High relaxivity | .081 | .180 | .000 | Low NSF | .068 | .000 | .000 |

Source: Made by the author

According to the ANOVA test, all variables make difference between groups in the five clusters configuration, but this configuration will be left out of the analysis, because all clusters were relatively small and this make very difficult a good analysis of the clusters.

On the other hand, not all variables make differences between groups in the two (Children, High Relaxivity and Low NSF) and three cluster configuration (High Relaxivity) . The three cluster configuration was chosen for the segmentation process, because it follows the same pattern as the previous U.S cluster analysis and only one variable will be left out of the analysis (High Relaxivity).

# APPENDIX N°8: U.S. Nested Approach, final dendogram for Medium Hospital



Dendrogram using Ward Linkage
Rescaled Distance Cluster Combine
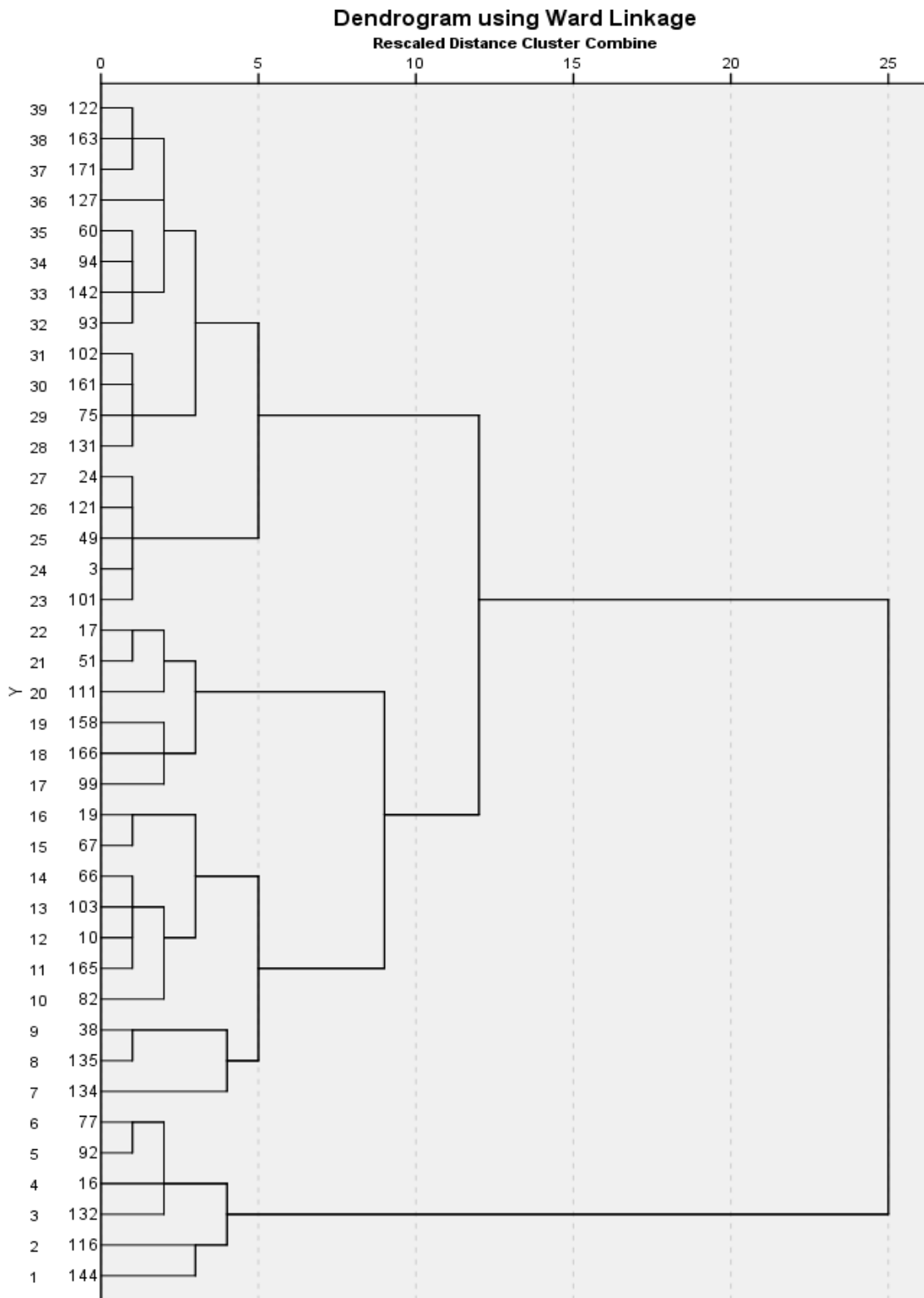
# APPENDIX N°9: U.S. Nested Approach, cluster analysis for Big Hospitals

**Figure: Dendogram cluster "Big Hospitals"**
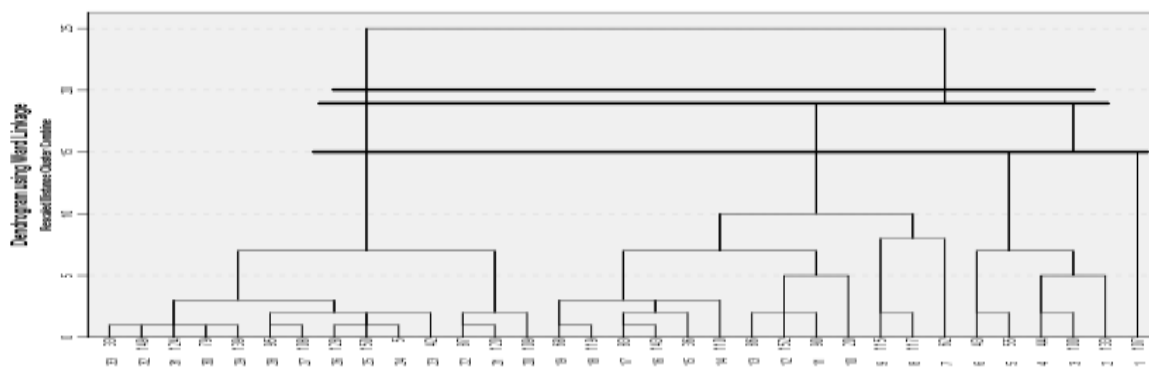


Source: IBM SPSS v19

**Table: Number of cases per cluster**

| CLUSTER CONFIGURATION | 2 CLUSTERS | 3 CLUSTERS | 4 CLUSTER |
|---|---|---|---|
| CLUSTER 1 | 14 | 14 | 14 |
| CLUSTER 2 | 19 | 13 | 13 |
| CLUSTER 3 | _ | 6 | 5 |
| CLUSTER 4 | _ | _ | 1 |

Source: Made by the author

The dendogram suggested a two, three and four cluster configurations. The two and three clusters configuration are well distributed, but the four cluster configuration has cluster with one case. This cluster is composed by one radiologist, who has the lower scores from the whole sample in different variables. This radiologist comes from the cluster 3 belonging to the three cluster configuration, the cluster with lower score in mostly all variables.

**Table: ANOVA test result for Operational segmentation for "Big Hospital" cluster**

| VARIABLE | SIGNIFICANCE | | | VARIABLE | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|
| Cluster configuration | 2 | 3 | 4 | Cluster configuration | 2 | 3 | 4 |
| Excellent contrast | .349 | .061 | .000 | Good tolerability | .063 | .175 | .001 |
| Whole Body | .015 | .022 | .000 | Bottle Sizes | .003 | .013 | .008 |
| MRA | .001 | .001 | .002 | Good availability | .148 | .326 | .006 |
| Children | .023 | .000 | .000 | Personal Experience | .050 | .000 | .001 |
| HighCon/HalfVOL | .000 | .000 | .000 | Cost effectiveness | .034 | .050 | .083 |
| Low GD | .000 | .001 | .000 | Macrocyclic | .027 | .086 | .032 |
| High relaxivity | .142 | .314 | .013 | Low NSF | .086 | .196 | .283 |

Source: Made by the author

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The ANOVA test shows that five variables make no differences between groups in the two clusters configuration, six in the three clusters configuration and three in the four clusters configuration. Moreover, the four clusters configuration has a one cluster member. For the next hierarchical cluster, five variables, which made no differences between all the groups, are going to be taken out of the analysis: Contrast Detection, Low Risk NSF, Good Tolerability, Good Availability and High Relaxivity. This way, the researcher will have the opportunity to analyze the effects of these variables in the previous cluster analysis.

**Figure: Dendogram cluster "Big Hospitals" without five variables**
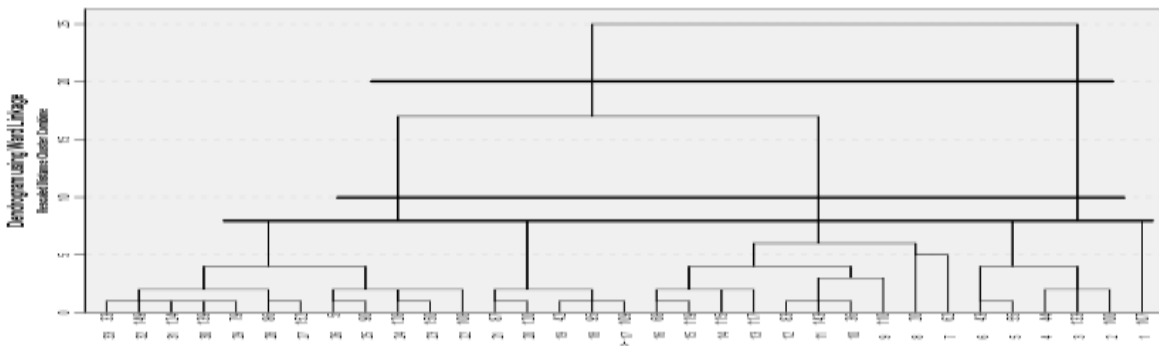


Source: IBM SPSS v19

**Figure: Number of cases per cluster**

| CLUSTER CONFIGURATION | 2 CLUSTERS | 3 CLUSTERS | 4 CLUSTER |
|---|---|---|---|
| CLUSTER 1 | 27 | 17 | 17 |
| CLUSTER 2 | 6 | 10 | 10 |
| CLUSTER 3 | _ | 6 | 5 |
| CLUSTER 4 | _ | _ | 1 |

Source: Made by the author

The only cluster configuration that really change in comparison with the previous cluster analysis; is the two clusters configuration. In the two clusters configuration of this analysis has almost all cases concentrated in the Cluster 1. In the other hand, the three and four clusters configuration did not showed significant changes.

**Figure: ANOVA test result for Operational segmentation for "Big hospitals" without five variables**

| VARIABLE | SIGNIFICANCE | | | VARIABLE | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|
| Cluster configuration | 2 | 3 | 4 | Cluster configuration | 2 | 3 | 4 |
| Whole Body | .880 | .107 | .002 | Bottle Sizes | .215 | .005 | .003 |
| MRA | .014 | .004 | .007 | Personal Experience | .032 | .043 | .097 |
| Children | .000 | .000 | .000 | Cost effectiveness | .051 | .022 | .040 |
| HighCon/HalfVOL | .098 | .002 | .002 | Macrocyclic | .244 | .003 | .001 |
| Low GD | .073 | .004 | .001 | | | | |

Source: Made by the author

The ANOVA test shows that six variables make no differences between groups in the two clusters configuration and one in the three, and four cluster configurations. As the three cluster configuration has distributed the cases more evenly through the clusters, the author proceeds to take out the "Whole Body" variable to see if the rest of the variables still make differences between groups in this configuration. For the next hierarchical cluster, one variable was left out of the analysis: Whole Body.

**Figure: Dendogram cluster "Big Hospitals" without six variables**
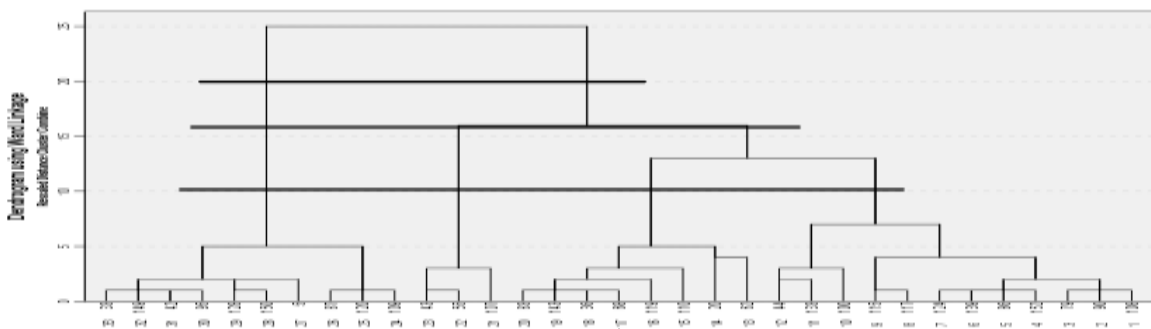


Source: IBM SPSS v19

**Figure: Number of cases per cluster**

| CLUSTER CONFIGURATION | 2 CLUSTERS | 3 CLUSTERS | 4 CLUSTER |
|---|---|---|---|
| CLUSTER 1 | 10 | 10 | 13 |
| CLUSTER 2 | 23 | 20 | 8 |
| CLUSTER 3 | _ | 3 | 3 |
| CLUSTER 4 | _ | _ | 9 |

Source: Made by the author.

The dendogram suggested a two, three and four cluster configurations. The cluster 3 in the three and four cluster configuration has only three cases, which represent the 9% of the sample. All configurations are fine to be chosen for market segmentation.

**Figure: ANOVA test result for Operational segmentation for Big hospitals without six variables**

| VARIABLE | SIGNIFICANCE | | | VARIABLE | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|
| Cluster configuration | 2 | 3 | 4 | Cluster configuration | 2 | 3 | 4 |
| MRA | .000 | .001 | .004 | Bottle Sizes | .010 | .012 | .006 |
| Children | .023 | .000 | .000 | Personal Experience | .168 | .020 | .04 |
| HighCon/HalfVOL | .000 | .000 | .002 | Cost effectiveness | .041 | .001 | .000 |
| Low GD | .000 | .000 | .000 | Macrocyclic | .087 | .006 | .000 |

Source: Made by the author

The ANOVA test showed that all the variables make differences between groups in the three and four clusters configurations, while the two clusters configuration has two variables that did not make differences between groups. The author decided that was not useful or valuable to keep taking out variables as the most important variables for the U.S. market were already left out of the analysis. The three clusters configuration is also unsatisfactory as it has a cluster with only three cases.

**Figure: "Buying Criteria" means per attribute in the "Big Hospitals" – three cluster configuration without six variables**
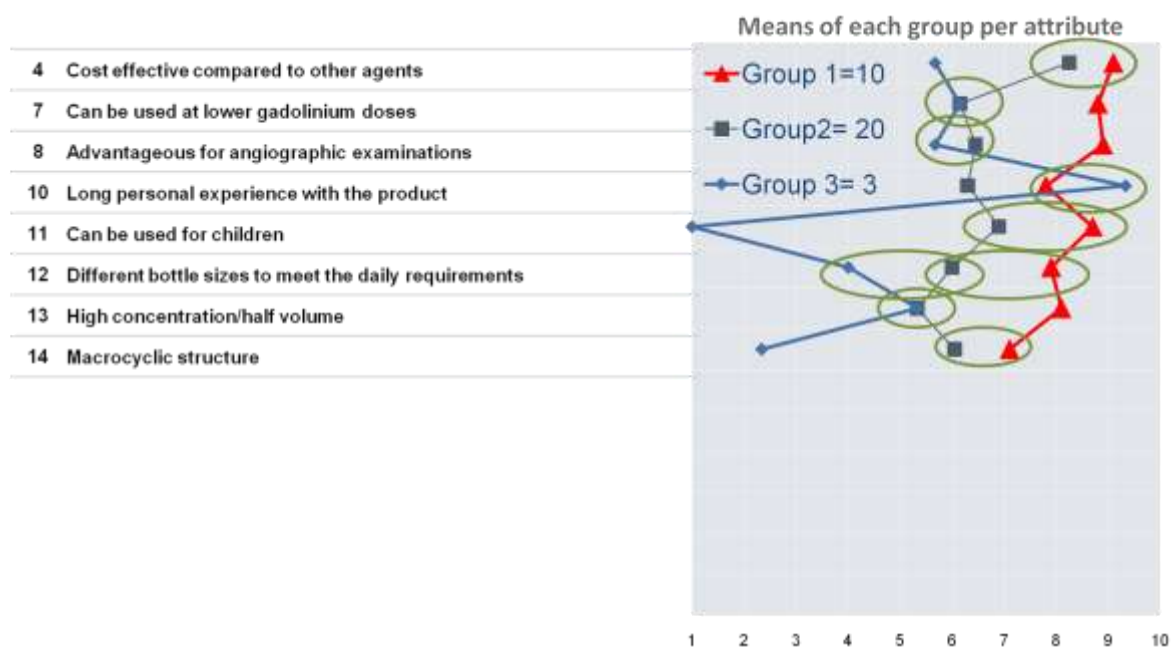


Source: Made by the author

In the previous graph, it is possible to analyze the three clusters configuration. The Cluster 1 and 2 have different opinion regarding the attributes for MRI products. According to the Scheffé test, they seem to share almost the same opinion for the "Cost Effectiveness", "Long Experience", "Children", "Sizes" and "Macrocyclic" variables. The cluster 3 is only interested in "Long Experience" and showed no interest for "Cost Effectiveness". As the other cluster analysis, the Cluster 1 could be considered a "Demanding Group", the Cluster 2 an "Average" group, but the Cluster 3 is most complicated to explain. For the big and only interest they showed in "Long Experience" they seem to be a cluster only interested in MRI products, which they have a long experience using them.

**Figure: "Buying Criteria" means per attribute in the "Big Hospitals" – four configuration cluster without six variables**
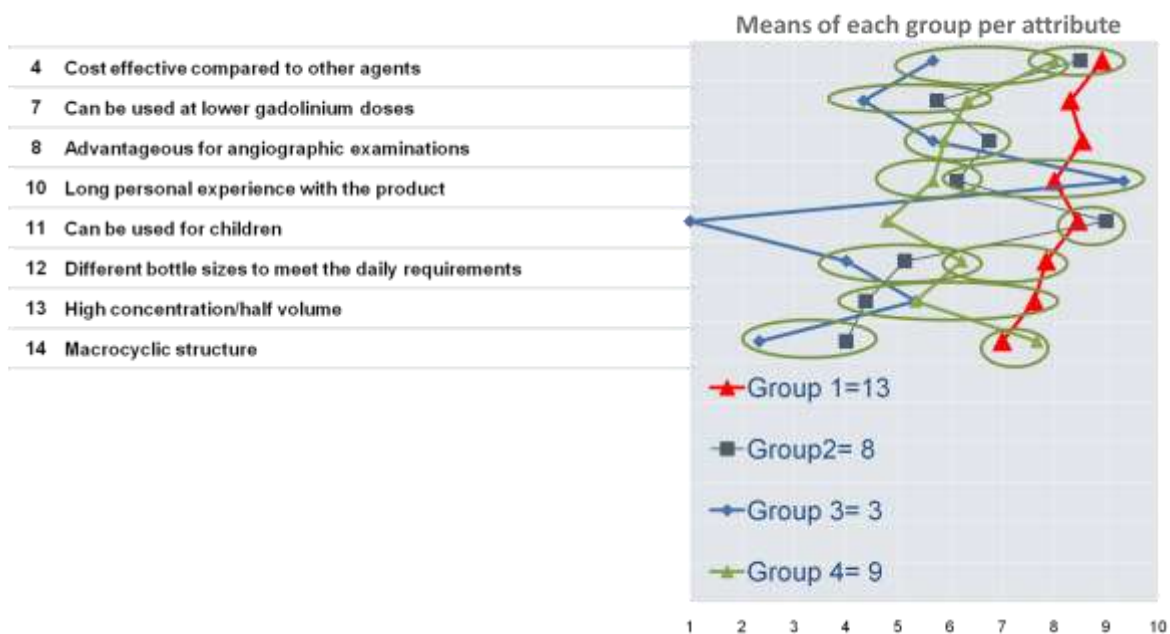


Source: Made by the author

On the other hand, the four cluster configuration is more complicated to explain. Several variables showed no differences between groups. At the same time, the Cluster 3 and the new Cluster 4 are mixed between the two other clusters. There is no business use for this segmentation results.

The author took the decision that the operational cluster "Big Hospitals" is not a good candidate for a hierarchical cluster analysis. The previous graph can give a certain idea of what can be found in this cluster using those eight variables. There is no use to take out more variables for more cluster analysis, as mostly all important variables have been already left out of the analysis. For the same reason, this operational cluster will by analyze as a whole segment.

**Figure: "Buying Criteria" means per attribute in the "Big Hospitals" cluster**
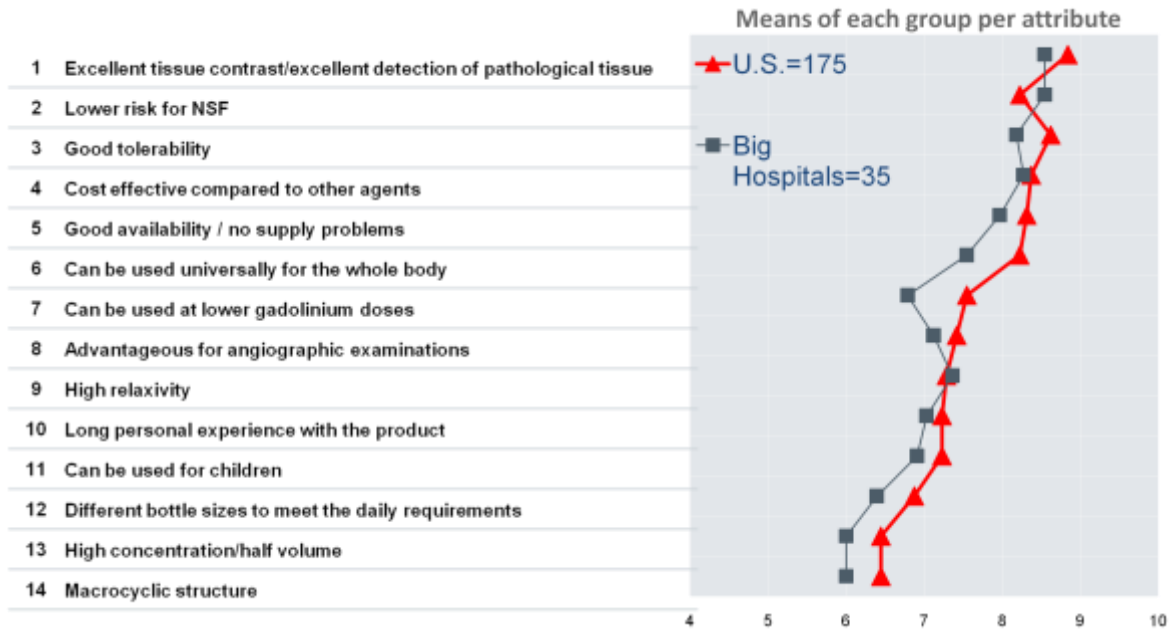
Means of each group per attribute

| | | |
|---|---|---|
| 1 | Excellent tissue contrast/excellent detection of pathological tissue | |
| 2 | Lower risk for NSF | |
| 3 | Good tolerability | |
| 4 | Cost effective compared to other agents | |
| 5 | Good availability / no supply problems | |
| 6 | Can be used universally for the whole body | |
| 7 | Can be used at lower gadolinium doses | |
| 8 | Advantageous for angiographic examinations | |
| 9 | High relaxivity | |
| 10 | Long personal experience with the product | |
| 11 | Can be used for children | |
| 12 | Different bottle sizes to meet the daily requirements | |
| 13 | High concentration/half volume | |
| 14 | Macrocyclic structure | |

U.S.=175
Big Hospitals=35

In the previous graph is possible to see that this "Big Hospital" cluster has lower means in all attributes; with the exception of "Lower Risk for NSF" while "Cost Effectiveness" and "High Relaxivity" behave as the U.S. mean. Taking this into account, it is possible to state that this group has a "normal" concern for efficacy and prices, and a "High" concern for safety attributes.

# APPENDIX N°10: U.S. Cluster analysis for the company

It was decided to segment the U.S. market using the "Operational" and "Buying Criteria" variables, but the "Personal enhanced MRI scans / week" "Breast Scans / week" and "Liver scans / week" variables were left out from the analysis. The sample has 43 radiologists who do not perform normally MRI scans. They all belong to the public sector and did not answer the 3 questions related to these variables. Instead of taking out the 43 radiologists of the sample, measure that could have a great impact in the sample representativeness of the sample, the only "Operational" variables to be used were "MRI Scans / week" and "Enhanced MRI scans / week". These "Operational" variables should be helpful to identify groups that belong to hospitals that have a very big patient load per week.

As the analysis has to deal with different measuring units, the variables were standardized directly through the cluster analysis. The same criteria as the European Analysis will be use for the selection of segments; the segment should be no more than four or five, they should be simple to identify and understandable for the managerial team.

**Figure: Dendogram U.S. with operational and characteristic variables**
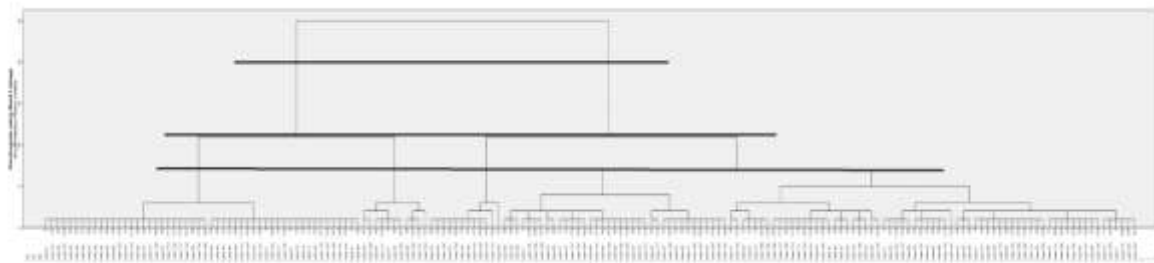


Source: IBM SPSS

The dendogram shows clearly three different configurations: two, four and five clusters configurations. The two clusters configuration will be left out for its simplicity. On the other hand, the four and five clusters configuration was also not satisfactory, because of the merging of small clusters. Looking for a better clustering results, another test was made with three clusters configuration, just to get the same problem.

**Table: Number of cases per cluster**

| CLUSTER CONFIGURATION | 3 CLUSTERS | 4 CLUSTERS | 5 CLUSTERS |
|---|---|---|---|
| CLUSTER 1 | 116 | 104 | 37 |
| CLUSTER 2 | 52 | 52 | 67 |
| CLUSTER 3 | 11 | 11 | 52 |
| CLUSTER 4 | _ | 12 | 11 |
| CLUSTER 5 | _ | _ | 12 |

Source: Made by the author

**Table: Analysis of means of all cluster configurations for "Operational" variables**

| Clusters | S5 MRI scans / week | | | S6 MRI Enhanced Scans / week | | |
|---|---|---|---|---|---|---|
| | *3 Cluster* | *4 Cluster* | *5 Cluster* | *3 Cluster* | *4 Cluster* | *5 Cluster* |
| 1 | 143,84 | 132,12 | 166,62 | 58,38 | 55,88 | 71,22 |
| 2 | 113,29 | 113,29 | 113,06 | 55,42 | 55,42 | 47,42 |
| 3 | 581,82 | 581,82 | 113,29 | 300,00 | 300,00 | 55,42 |
| 4 | | 245,42 | 581,82 | | 80,00 | 300,00 |
| 5 | | | 245,42 | | | 80,00 |

Source: Made by the author

In the three and four cluster configuration, the third cluster represent the higher number of MRI scans in both variables. In the four clusters configuration is possible to see that the fourth cluster comes from the first cluster of the other analysis, representing the second higher representation of MRI scans in both variables. In the five clusters configuration, the new cluster is the second one. This cluster comes also from the first cluster and represent the lower number of MRI scans from the old first cluster. The smaller clusters (four and fifth clusters in the five cluster configuration) represent the higher number of MRI scans per week. Both cases represent the 6, 2% and 6, 7% respectively. As these clusters are very small, the third cluster configurations seem to be the better one. For comparison, the author took out five outliers coming from the "Operational" variables (cases 141, 139, 104 and 50) if it was possible to find new and better clusters configurations.

**Figure: Dendogram U.S. with "Operational" and "Buying Criteria" variables without four extreme cases**



Source: Made by the author.

Without the four extreme cases, the dendogram suggested three new configurations: two, three and four clusters configurations. Is possible to see another one with six clusters, but they are too several clusters according with the criteria exposed in the "Methodology" chapter.

**Table: Number of cases per cluster results**

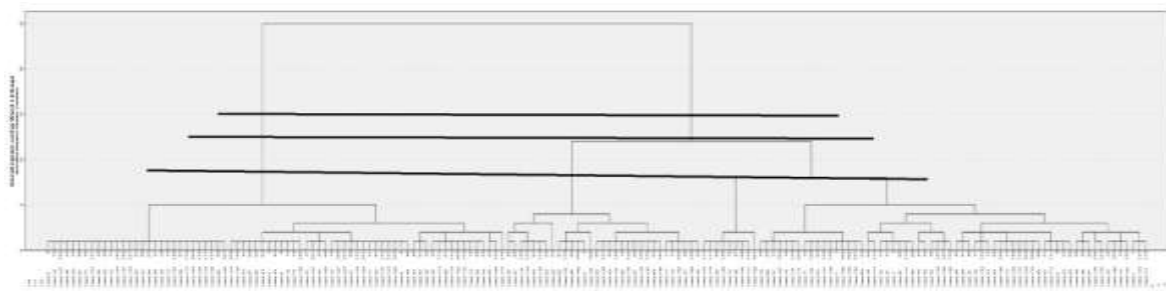| CLUSTER CONFIGURATION | 3 CLUSTERS | 4 CLUSTERS | 5 CLUSTERS |
|---|---|---|---|
| CLUSTER 1 | 71 | 62 | 62 |
| CLUSTER 2 | 73 | 73 | 44 |
| CLUSTER 3 | 31 | 31 | 31 |
| CLUSTER 4 | – | 9 | 29 |
| CLUSTER 5 | – | – | 9 |

Source: Made by the author

**Table: Analysis of means of all cluster configurations for "Operational" variables**

| Clusters | S5 MRI scans / week | | | S6 MRI Enhanced Scans / week | | |
|---|---|---|---|---|---|---|
| | 3 Cluster | 4 Cluster | 5 Cluster | 3 Cluster | 4 Cluster | 5 Cluster |
| 1 | 120,70 | 110,40 | 110,40 | 47,39 | 46,21 | 46,21 |
| 2 | 103,51 | 103,51 | 118,75 | 47,38 | 47,38 | 52,30 |
| 3 | 305,48 | 305,48 | 305,48 | 142,90 | 142,90 | 142,90 |
| 4 | | 191,67 | 80,38 | | 55,56 | 39,93 |
| 5 | | | 191,67 | | | 55,56 |

Source: Made by the author

The four and five clusters configurations have small groups (Nine cases represent the 5% of the sample). In both scenarios, the nine cases cluster is the same. The new cluster in the five cluster configuration is the Cluster 4 with twenty nine cases that comes from the Cluster 2 and has the lower mean for MRI scans from all the clusters. While the third cluster has in all configurations the highest MRI scans per week, the nine cases clusters in both four and five clusters configurations, have the second highest number of MRi scans per week.

The five cluster configuration is complicated to understand and do not seems to be a good result for a market segmentation and three groups share also similar means. On the other hand, for both four and five clusters configurations, the nine cases cluster represents the 5% of the sample. These nine cases are three private, five communities and one academic hospital. On the other hand, this cluster shows the lower scores for the "Buying Criteria" variables. This group could be a under sampled group of clients.

As it was mentioned in the "Methodology" chapter, the clusters configurations would not been suitable for good market segmentation, if they contained small clusters. For that reason, it is preferable to take both configurations (Four and five clusters configurations) out of the analysis, instead of taking out more extreme cases. Again all the configuration showed that all the variables make differences between groups.

**Table: ANOVA test result for three, four and five Clusters configurations without four extreme cases in the U.S.**

| VARIABLE | SIGNIFICANCE LEVEL | VARIABLE | SIGNIFICANCE LEVEL |
|---|---|---|---|
| MRI Scans / week | .000 | High relaxivity | .000 |
| Enhanced MRI scans / week | .000 | Good tolerability | .000 |
| Excellent contrast | .000 | Bottle Sizes | .000 |
| Whole Body | .000 | Good availability | .000 |
| MRA | .000 | Personal Experience | .000 |
| Children | .000 | Cost effectiveness | .000 |
| HighCon/HalfVOL | .000 | Macrocyclic | .000 |
| Low GD | .000 | Low NSF | .000 |

Source: Made by the author

On the other hand, the configuration with three clusters was more interesting to analyze. It has a good configuration of groups in comparison with the first three cluster configuration (with the outliers included), where there was a cluster with only eleven cases. Doing a more carefully analysis, this configuration demonstrated to have the following characteristics.

**Table: Scheffe´s test for "Operational" variables**

| VARIABLE | (I) CLUSTER | (J) CLUSTER | MEAN DIFFERENCE (I-J) | SIG. |
|---|---|---|---|---|
| S5 MRI scans / week | 1 | 2 | 17,197 | ,461 |
| | | 3 | -184.780* | ,000 |
| | 2 | 1 | -17,197 | ,461 |
| | | 3 | -201.977* | ,000 |
| | 3 | 1 | 184.780* | ,000 |
| | | 2 | 201.977* | ,000 |
| S6 Enhanced MRI scans / week | 1 | 2 | ,011 | 1,000 |
| | | 3 | -95.509* | ,000 |
| | 2 | 1 | -,011 | 1,000 |
| | | 3 | -95.520* | ,000 |
| | 3 | 1 | 95.509* | ,000 |
| | | 2 | 95.520* | ,000 |

Source: Made by the author

Taking as an example the "Operational" variables, in the descriptive analysis is possible to see that the group three has much more MRI scans per week as the other two groups (For example: 300 against 100 MRI scans per week). This is confirmed by the Scheffé test; the Cluster 1 and 2 are very similar in these variables and the only cluster which differ from the other ones; is the Cluster 3.

Similar pattern is seen in the characteristics variables. In the next graph, the globes indicate Scheffe´s test result between Clusters 3 and 2. Green globes indicate variables that make no differentiation between clusters according to the Scheffe´s test. Yellow globes indicate variable that make differentiation in all the clusters. Variables are sorted from higher importance to lower importance for the U.S. sample.

**Figure: "Buying Criteria" means in each Cluster**
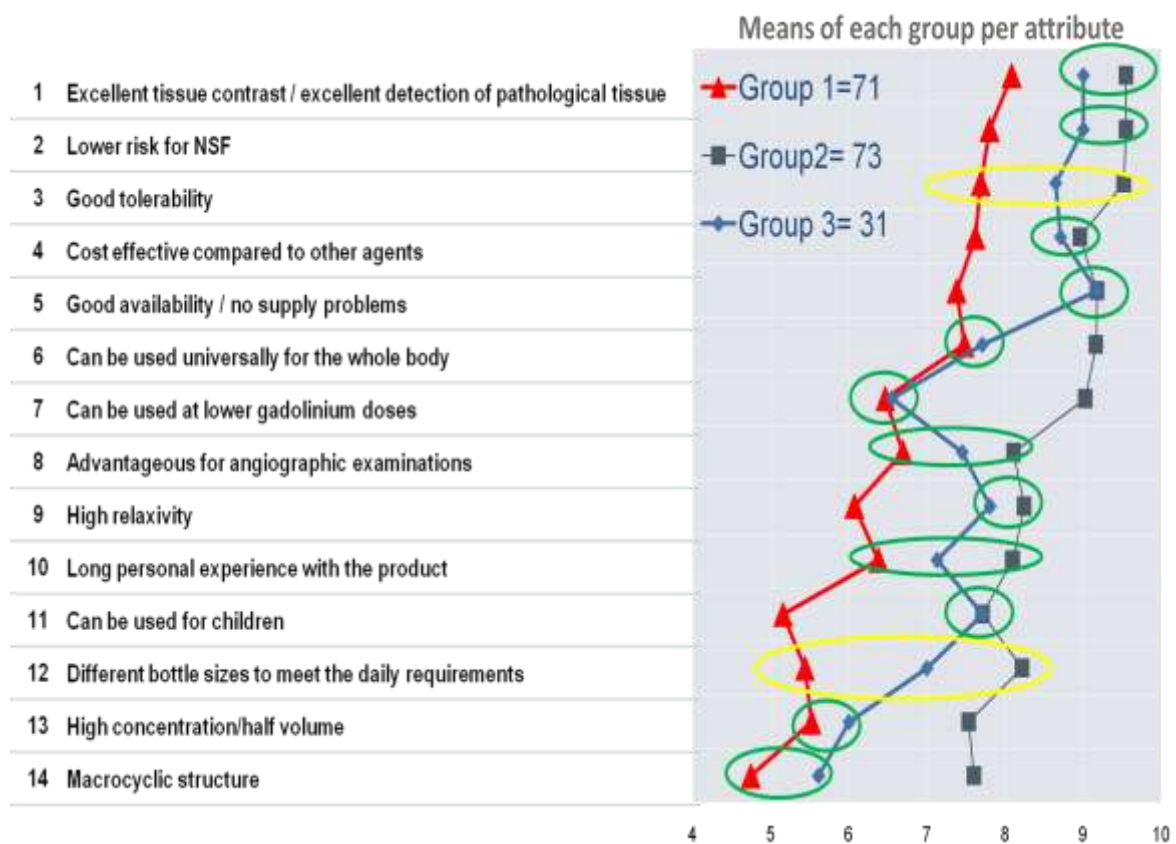


Source: Made by the author.

According to the ANOVA test all variables make differentiation between groups, but the Scheffe´s Post Hoc test indicates that the differences between means of the second and third group do not make any difference. The third group seems to be only different to the second one in the MRI scan. This way, it is possible to say that there are a "Not demanding", a "High Through put" and a "Demanding" group. The problem is that the only thing that characterize the "High Through put" cluster is it higher patient load, but regarding to the characteristics variables, it do not show differences (Scheffé test) in eight of fourth teen variables with the "Demanding" (four of them in the first six most important attributes in the U.S. market) and three with the "Not demanding" group.

This cluster configuration seems to be not so clear and hard to understand. It can be close to reality, but there is not a managerial use for this segmentation. It is not helpful to

determinate three groups, which two of them are really hard to differentiate in some aspect with the other clusters.

Looking for a better understanding of the market and for a clustering configuration useful for the managerial team, the "Operational" variables were taken out of the analysis and another cluster analysis was performed only with the "Buying Criteria" variables. The "Buying Criteria" variables are in the same scale and for that reason, they were not standardized.

Dendrogram using Ward Linkage
Rescaled Distance Cluster Combine
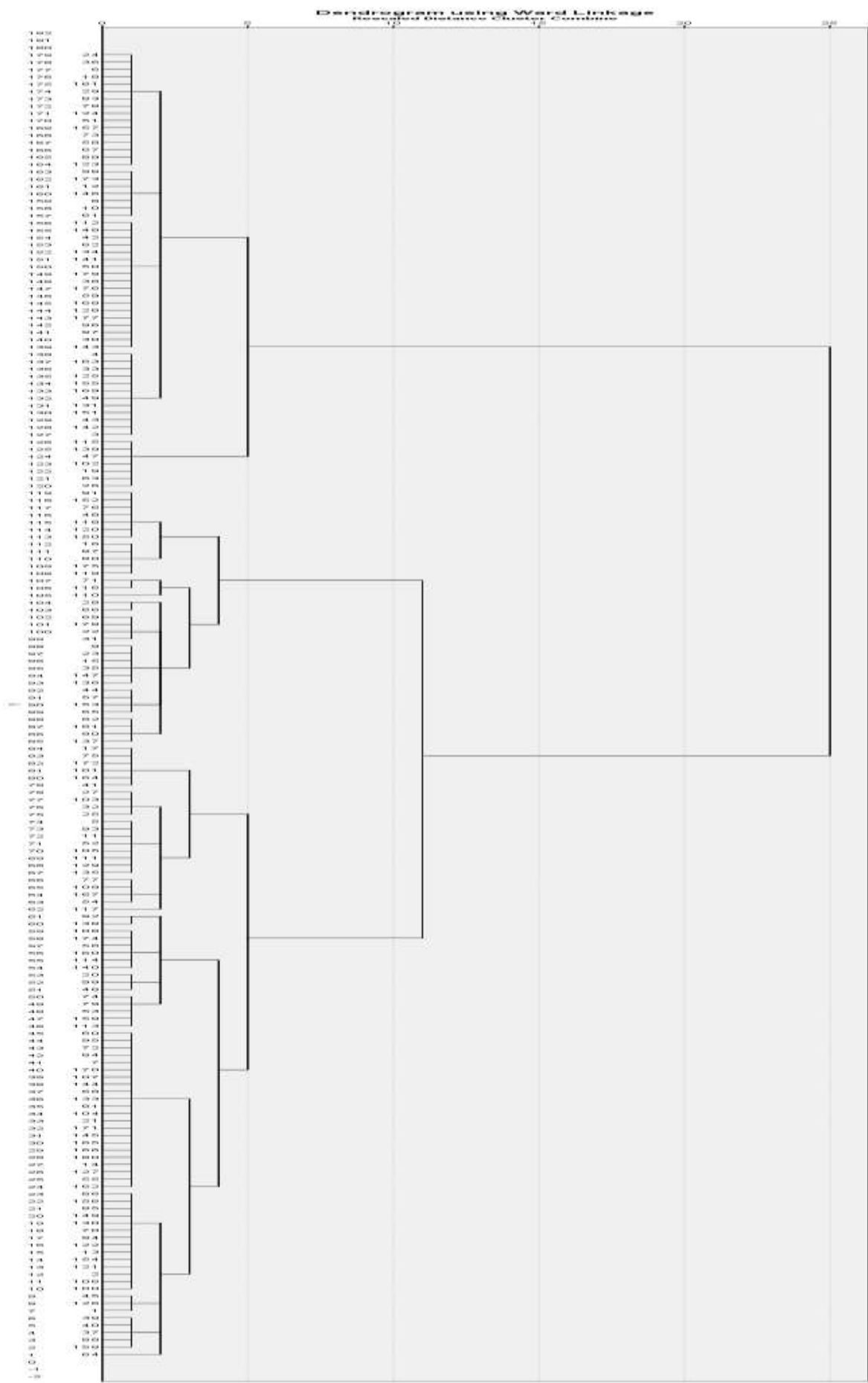
# APPENDIX N°12: Descriptive analysis for "Buying Criteria" in the U.S. five cluster configuration

**Descriptives**

| | | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound | | |
| Q7_CONTRAST_DETECTION | 1 | 61 | 8.77 | .956 | .122 | 8.53 | 9.02 | 7 | 10 |
| | 2 | 53 | 9.43 | .991 | .136 | 9.16 | 9.71 | 5 | 10 |
| | 3 | 23 | 9.57 | .662 | .138 | 9.28 | 9.85 | 8 | 10 |
| | 4 | 35 | 7.46 | 2.160 | .365 | 6.72 | 8.20 | 2 | 10 |
| | 5 | 7 | 9.43 | .976 | .369 | 8.53 | 10.33 | 8 | 10 |
| | Total | 179 | 8.84 | 1.462 | .109 | 8.62 | 9.05 | 2 | 10 |
| Q7_WHOLEBODY | 1 | 61 | 7.52 | 1.709 | .219 | 7.09 | 7.96 | 2 | 10 |
| | 2 | 53 | 9.23 | .912 | .125 | 8.97 | 9.48 | 7 | 10 |
| | 3 | 23 | 8.83 | 1.370 | .286 | 8.23 | 9.42 | 5 | 10 |
| | 4 | 35 | 7.46 | 1.961 | .331 | 6.78 | 8.13 | 2 | 10 |
| | 5 | 7 | 9.00 | 1.155 | .436 | 7.93 | 10.07 | 7 | 10 |
| | Total | 179 | 8.24 | 1.700 | .127 | 7.99 | 8.49 | 2 | 10 |
| Q7_ANGIO_EXAMS | 1 | 61 | 7.26 | 1.601 | .205 | 6.85 | 7.67 | 1 | 10 |
| | 2 | 53 | 8.62 | 1.319 | .181 | 8.26 | 8.99 | 5 | 10 |
| | 3 | 23 | 7.57 | 2.501 | .522 | 6.48 | 8.65 | 1 | 10 |
| | 4 | 35 | 5.77 | 1.896 | .320 | 5.12 | 6.42 | 2 | 10 |
| | 5 | 7 | 7.86 | 1.069 | .404 | 6.87 | 8.85 | 6 | 9 |
| | Total | 179 | 7.44 | 1.963 | .147 | 7.15 | 7.73 | 1 | 10 |
| Q7_CHILDREN | 1 | 61 | 6.90 | 1.877 | .240 | 6.42 | 7.38 | 1 | 10 |
| | 2 | 53 | 8.70 | 1.462 | .201 | 8.30 | 9.10 | 5 | 10 |
| | 3 | 23 | 8.91 | 1.535 | .320 | 8.25 | 9.58 | 5 | 10 |
| | 4 | 35 | 3.09 | 1.853 | .313 | 2.45 | 3.72 | 1 | 7 |
| | 5 | 7 | 1.57 | .787 | .297 | .84 | 2.30 | 1 | 3 |
| | Total | 179 | 6.74 | 2.867 | .214 | 6.31 | 7.16 | 1 | 10 |
| Q7_HIGHCON_HALFVOL | 1 | 61 | 5.70 | 1.792 | .229 | 5.25 | 6.16 | 2 | 9 |
| | 2 | 53 | 8.38 | 1.390 | .191 | 7.99 | 8.76 | 5 | 10 |
| | 3 | 23 | 5.48 | 2.042 | .426 | 4.60 | 6.36 | 1 | 10 |
| | 4 | 35 | 5.54 | 1.788 | .302 | 4.93 | 6.16 | 1 | 9 |
| | 5 | 7 | 7.00 | 2.000 | .756 | 5.15 | 8.85 | 5 | 10 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | 179 | 6.49 | 2.121 | .159 | 6.17 | 6.80 | 1 | 10 |
| Q7_LOW_GD | 1 | 61 | 6.69 | 1.421 | .182 | 6.32 | 7.05 | 3 | 9 |
| | 2 | 53 | 9.28 | .841 | .115 | 9.05 | 9.51 | 8 | 10 |
| | 3 | 23 | 7.35 | 2.740 | .571 | 6.16 | 8.53 | 1 | 10 |
| | 4 | 35 | 6.54 | 2.174 | .367 | 5.80 | 7.29 | 2 | 10 |
| | 5 | 7 | 8.71 | 1.254 | .474 | 7.55 | 9.87 | 7 | 10 |
| | Total | 179 | 7.59 | 2.043 | .153 | 7.29 | 7.89 | 1 | 10 |
| Q7_HIGH_RELAX | 1 | 61 | 6.67 | 1.930 | .247 | 6.18 | 7.17 | 1 | 10 |
| | 2 | 53 | 8.85 | .969 | .133 | 8.58 | 9.12 | 7 | 10 |
| | 3 | 23 | 6.96 | 2.246 | .468 | 5.99 | 7.93 | 2 | 10 |
| | 4 | 35 | 6.23 | 2.059 | .348 | 5.52 | 6.94 | 1 | 10 |
| | 5 | 7 | 8.00 | 1.915 | .724 | 6.23 | 9.77 | 5 | 10 |
| | Total | 179 | 7.32 | 2.048 | .153 | 7.02 | 7.62 | 1 | 10 |
| Q7_GOOD_TOLER | 1 | 61 | 8.28 | 1.240 | .159 | 7.96 | 8.60 | 5 | 10 |
| | 2 | 53 | 9.53 | .846 | .116 | 9.30 | 9.76 | 7 | 10 |
| | 3 | 23 | 9.74 | .541 | .113 | 9.51 | 9.97 | 8 | 10 |
| | 4 | 35 | 7.06 | 1.999 | .338 | 6.37 | 7.74 | 2 | 10 |
| | 5 | 7 | 8.71 | 1.496 | .565 | 7.33 | 10.10 | 6 | 10 |
| | Total | 179 | 8.61 | 1.591 | .119 | 8.38 | 8.85 | 2 | 10 |
| Q7_SIZES | 1 | 61 | 6.02 | 2.053 | .263 | 5.49 | 6.54 | 1 | 10 |
| | 2 | 53 | 8.51 | 1.368 | .188 | 8.13 | 8.89 | 5 | 10 |
| | 3 | 23 | 7.78 | 2.152 | .449 | 6.85 | 8.71 | 1 | 10 |
| | 4 | 35 | 5.20 | 1.891 | .320 | 4.55 | 5.85 | 1 | 9 |
| | 5 | 7 | 8.71 | 1.380 | .522 | 7.44 | 9.99 | 6 | 10 |
| | Total | 179 | 6.93 | 2.264 | .169 | 6.59 | 7.26 | 1 | 10 |
| Q7_AVAILABILITY | 1 | 61 | 8.00 | 1.265 | .162 | 7.68 | 8.32 | 5 | 10 |
| | 2 | 53 | 9.17 | 1.014 | .139 | 8.89 | 9.45 | 6 | 10 |
| | 3 | 23 | 9.52 | .730 | .152 | 9.21 | 9.84 | 8 | 10 |
| | 4 | 35 | 6.63 | 1.972 | .333 | 5.95 | 7.31 | 3 | 10 |
| | 5 | 7 | 9.29 | .951 | .360 | 8.41 | 10.17 | 8 | 10 |
| | Total | 179 | 8.32 | 1.648 | .123 | 8.08 | 8.57 | 3 | 10 |
| Q7_PERSONAL_EXP | 1 | 61 | 5.89 | 2.169 | .278 | 5.33 | 6.44 | 1 | 10 |
| | 2 | 53 | 8.36 | 1.388 | .191 | 7.98 | 8.74 | 5 | 10 |
| | 3 | 23 | 8.43 | 1.590 | .332 | 7.75 | 9.12 | 5 | 10 |
| | 4 | 35 | 6.97 | 1.740 | .294 | 6.37 | 7.57 | 4 | 10 |
| | 5 | 7 | 8.00 | 1.414 | .535 | 6.69 | 9.31 | 6 | 10 |

| | | N | Mean | Std. Deviation | Std. Error | Lower Bound | Upper Bound | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|---|
| | Total | 179 | 7.24 | 2.081 | .156 | 6.93 | 7.55 | 1 | 10 |
| Q7_COST_EFFECTIVE | 1 | 61 | 7.98 | 1.597 | .204 | 7.57 | 8.39 | 3 | 10 |
| | 2 | 53 | 9.28 | .907 | .125 | 9.03 | 9.53 | 6 | 10 |
| | 3 | 23 | 9.04 | 1.397 | .291 | 8.44 | 9.65 | 5 | 10 |
| | 4 | 35 | 7.29 | 1.856 | .314 | 6.65 | 7.92 | 3 | 10 |
| | 5 | 7 | 8.29 | 1.254 | .474 | 7.13 | 9.45 | 6 | 10 |
| | Total | 179 | 8.38 | 1.625 | .121 | 8.14 | 8.62 | 3 | 10 |
| Q7_MACROCYCLIC | 1 | 61 | 5.51 | 2.248 | .288 | 4.93 | 6.08 | 1 | 10 |
| | 2 | 53 | 8.38 | 1.164 | .160 | 8.06 | 8.70 | 6 | 10 |
| | 3 | 23 | 4.70 | 2.010 | .419 | 3.83 | 5.56 | 1 | 8 |
| | 4 | 35 | 4.31 | 2.259 | .382 | 3.54 | 5.09 | 1 | 9 |
| | 5 | 7 | 8.29 | 1.254 | .474 | 7.13 | 9.45 | 6 | 10 |
| | Total | 179 | 6.13 | 2.522 | .188 | 5.76 | 6.50 | 1 | 10 |
| Q7_LOWRISK_NSF | 1 | 61 | 8.44 | 1.737 | .222 | 8.00 | 8.89 | 2 | 10 |
| | 2 | 53 | 9.62 | .657 | .090 | 9.44 | 9.80 | 8 | 10 |
| | 3 | 23 | 9.22 | 1.204 | .251 | 8.70 | 9.74 | 5 | 10 |
| | 4 | 35 | 7.51 | 2.306 | .390 | 6.72 | 8.31 | 2 | 10 |
| | 5 | 7 | 9.57 | .787 | .297 | 8.84 | 10.30 | 8 | 10 |
| | Total | 179 | 8.75 | 1.724 | .129 | 8.50 | 9.01 | 2 | 10 |

# APPENDIX N°13: U.S K-means cluster

During the K-Means analysis, the researcher was able to confirm that all variables make differences between groups according to the ANOVA test.

**Table: ANOVA test result from the K-Means cluster analysis with the "Buying Criteria" in a three cluster configuration in the U.S.**

| VARIABLE | SIGNIFICANCE LEVEL | VARIABLE | SIGNIFICANCE LEVEL |
|---|---|---|---|
| Excellent contrast | .000 | Good tolerability | .000 |
| Whole Body | .000 | Bottle Sizes | .000 |
| MRA | .000 | Good availability | .000 |
| Children | .000 | Personal Experience | .000 |
| HighCon/HalfVOL | .000 | Cost effectiveness | .000 |
| Low GD | .000 | Macrocyclic | .000 |
| High relaxivity | .000 | Low NSF | .000 |

Source: Made by the author

The K-Mean classified all the cases in three groups. They are not equal to the results of the hierarchical cluster analysis, but the three groups show some similarities with the other results. The three clusters are sorted by the level of importance that the radiologists give to the products attributes. In this specific case, the biggest group is more "Demanding" (N°3), the smaller one is the "Indifferent" (N°2) and the "Average" (N°1) is just two cases smaller than the "Demanding".

**Table: Number of Cases in each Cluster from the K-Means Cluster**

| CLUSTER | NUMBER OF CASES |
|---|---|
| 1 | 67.000 |
| 2 | 43.000 |
| 3 | 69.000 |
| Valid | 179.000 |
| Missing | 2.000 |

Source: Made by the author.

This does not mean that the first cluster analysis useful for managerial decision or for market segmentation. But, the K-Mean was able to confirm the results of the previous cluster analysis could be optimal.

# APPENDIX N°14: European Data Analysis

In this section the author will describe some analysis made to the data recollected by the MRI Tracking Study like a basic descriptive analysis, outlier's detection, Multicollinearity effect and the possibility of a factor analysis will be evaluated.

### A. Descriptive analysis and outlier's detection

It is important to perform a small descriptive analysis of the variables, because it will give the researcher a general overview about the behavior of the information collected in those variables. Just by doing this simple analysis, the author could determine some information that will be helpful for the next analysis.

**Table: Descriptive Statistics of the 14 variables in the European sample**

|  | S5:MRI scans / week | S6: Enhanced MRI scans / week | S7: Personally Enhanced MRI scans / week | S9: LIVER scans per week | S10: BREAST scans per week |
|---|---|---|---|---|---|
| Valid Cases | 294 | 294 | 294 | 294 | 294 |
| Missing Cases | 0 | 0 | 0 | 0 | 0 |
| Mean | 174.38 | 82.04 | 38.53 | 10.49 | 7.10 |
| Std. Error of Mean | 10.780 | 5.062 | 1.895 | .651 | .733 |
| Median | 150.00 | 60.00 | 30.00 | 8.00 | 3.00 |
| Mode | 150 | 100 | 20 | 5 | 0 |
| Std. Deviation | 184.841 | 86.791 | 32.500 | 11.159 | 12.565 |
| Variance | 34166.120 | 7532.708 | 1056.264 | 124.517 | 157.874 |
| Skewness | 7.516 | 5.542 | 2.410 | 3.185 | 3.868 |
| Std. Error of Skewness | .142 | .142 | .142 | .142 | .142 |
| Kurtosis | 86.632 | 47.293 | 8.594 | 17.301 | 19.694 |
| Std. Error of Kurtosis | .283 | .283 | .283 | .283 | .283 |
| Range | 2488 | 990 | 240 | 100 | 100 |
| Minimum | 12 | 10 | 10 | 0 | 0 |
| Maximum | 2500 | 1000 | 250 | 100 | 100 |
| Sum | 51267 | 24120 | 11328 | 3083 | 2088 |

Source: Made by the author

It is useful to analyze the distribution of the data. Distribution measurements allow the researcher to identify how the data is separated or agglomerated according to its graphical representation. For this analysis is important to analyze the Skewness (data is distributed evenly around the arithmetic mean) and Kurtosis (the degree of concentration values presented in the central region of the distribution) values[38]. Its usefulness lies in

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[38] When the data distribution has a skewness (g1 = ± 0.5) and a coefficient of kurtosis (g2 = ± 0.5), is called the Normal Curve.

the ability to identify the characteristics of the distribution without having to generate the graph.

Looking at the Skewness and Kurtosis values of the five "Operational" variables, it is possible to see that the distribution of the data is not normal. Both values are very high in all the variables. The high positive Skewness values mean that the data is left-skewed and the high positive Kurtosis values mean that the data is mostly distributed around the arithmetic mean, but not evenly. These distribution characteristics can be seen in the following example regarding to the "MRI scans / week" variable.

**Figure: MRI examinations / week histogram**



Source: IBM SPSS v19

The number of "MRI scans / week" are distributed in a wide range of data (from 12 to 2000 MRI exams x week) with a very high standard deviation and a very small mean in comparison with the minimum and maximum values. The same can be seen in all the others "Operational" variables. These could indicate that is very possible to find some hospitals or radiologists that perform a very high numbers MRI scans per week compare with what the sample try to represent. It is possible that these cases do not represent the population according to their extremes values and could be considered outliers.

**Table: Z-scores greater than +3 for European "Operational" variables**

| | S5:MRI scans / week | S6: Enhanced MRI scans / week | S7: Personally Enhanced MRI scans / week | S9: LIVER examinations per week | S10: BREAST examinations per week |
|---|---|---|---|---|---|
| Cases > +3 | 2 | 4 | 6 | 3 | 7 |
| % | 0,6% | 1,2% | 1,9% | 0,9% | 2% |
| Cases | 46, 211 | 191, 211, 192, 46 | 212, 250, 133, 191, 192, 30 | 174, 133, 30 | 53, 61, 51, 54, 133, 50, 30 |

Source: Made by the author

In the previous figure, it is possible to see the amounts of cases (in Z-scores) greater than +3. No Z-score was under -3. This information gives a first glance regarding the possible presence of outliers in the sample. There are some cases in each variable than can be considered outliers according to the Z-scores analysis. In the following graph it is possible to confirm the cases than can be considered outliers.

**Figure: Analysis of extreme cases for "Operational" variables**
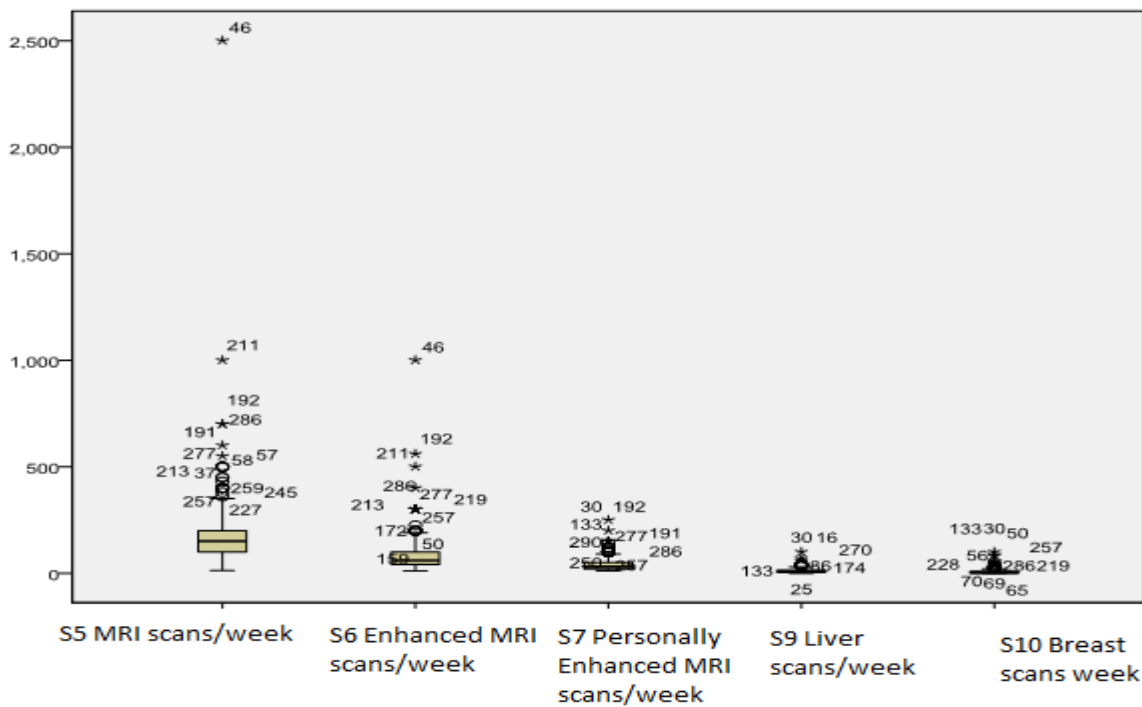


Source: IBM SPSS v19

With the previous graphical representation is easy to identify the possible outliers related to the five operational variables. It is possible to confirm several of the outliers founded in the Z-scores analysis. The case 46 and 211 work in a hospital where more than 1000 MRI

and enhanced MRI[39] scans are performed every week. Case 46 is a Spanish radiologist who worked in a not classified hospital, where 2500 MRI and 1000 enhanced MRI scans are performed per week. The case 211 is a German radiologist who worked in a private hospital where more than 1000 MRI and 500 enhanced MRI scans are performed per week. Both cases surpass by far the 174 and 82 MRI and enhanced MRI scans mean per week. This review gives a good example of how are behaving the outliers in the "Operational" variables.

**Figure: Analysis of extreme cases for "Operational" variables without cases 46 and 211**
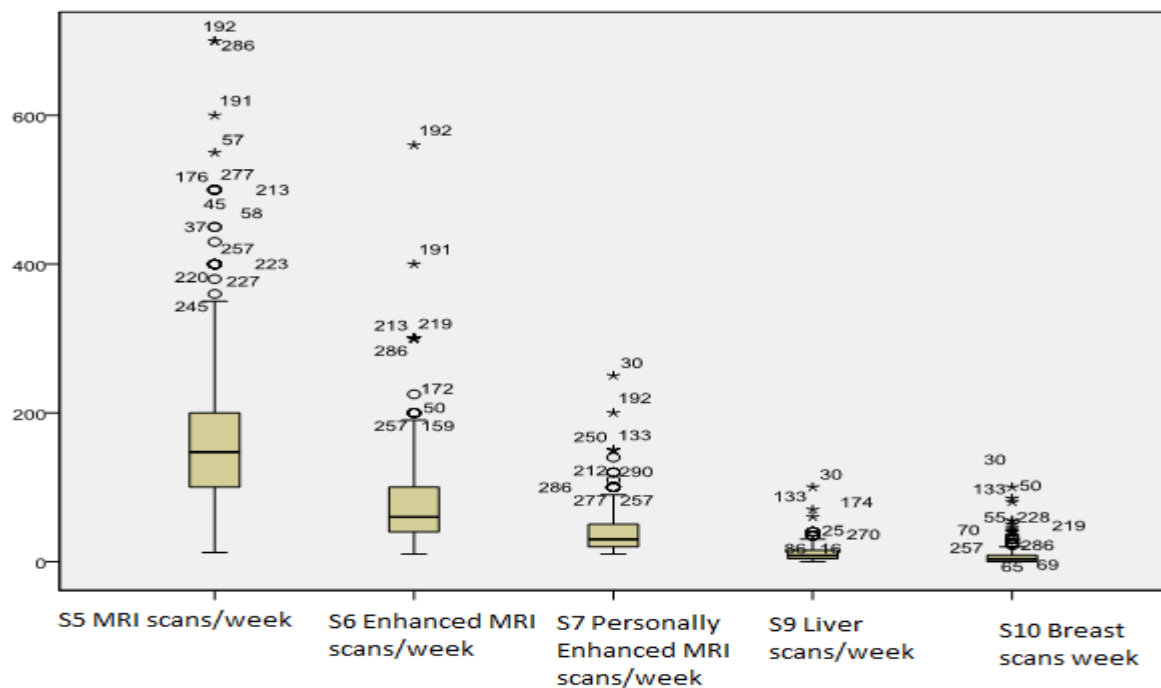


Source: IBM SPSS v19

Taking out the cases 46 and 211, is possible to identify other extreme cases like cases 30, 50, 54 (Spain), 133 (Italy), 171, 174, 191, 192, 213, 219 (Germany), 277 and 286 (France). Several of them were also founded in the Z-scores analysis. These 14 outliers cases represent the 4,8 % of the whole European sample. At the same time, the boxplot can give a first approach to know which kind of results can be expected after segmenting the market only with the operational variables. The boxplot shows that there is a group of cases that represent a high amount of MRI and enhanced MRI procedures per week while there are other groups of cases closest to the mean with fewer MRI and enhanced MRI procedures per week.

On the other hand, is also important to identify how the data is represented in each country. As the analysis of Europe is done including four different countries, to identify

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[39] [39] MRI exams performed with MRI contrast agents.

certain pattern in each country will be helpful to afterwards compare this results with the cluster´s results to see the effect of each country´s data in each cluster.

**Figure: "Operational" variables analysis per country**
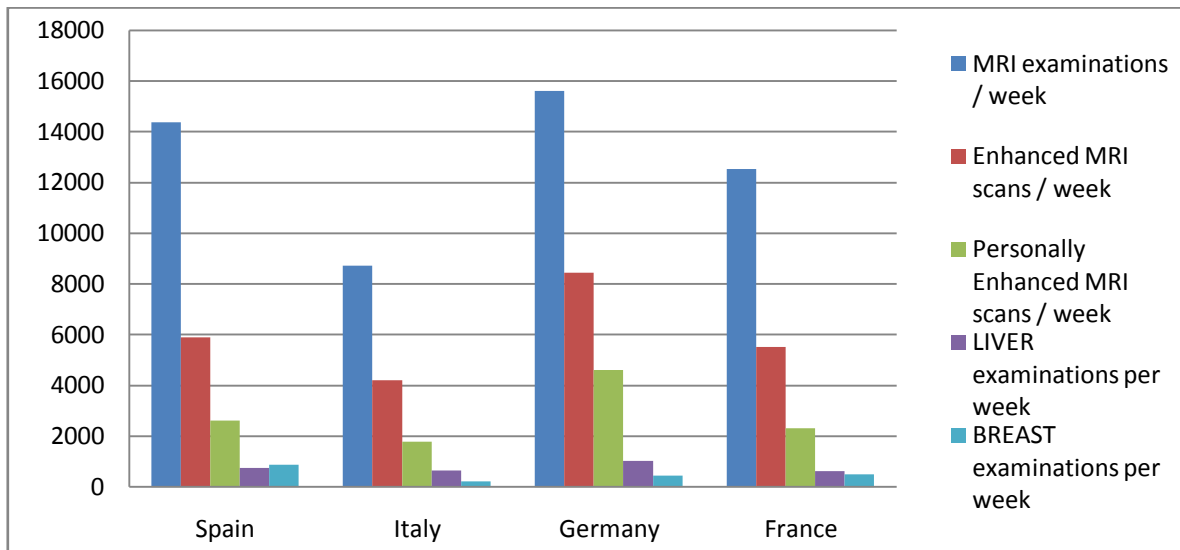
Certain patterns can be identified in each country. For example, is clear that Germany has the higher amount of procedures of the region followed by Spain. In the other hand, Italy has a very small numbers of procedures in comparison with each country.

**Table: Descriptive analysis of the 14 "Buying Criteria" variables in Europe**

| | N | Minimum | Maximum | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|
| **Excellent contrast** | 294 | 3 | 10 | 8.83 | 1.489 | 2.217 |
| **Whole Body** | 294 | 1 | 10 | 7.93 | 1.892 | 3.579 |
| **MRA** | 294 | 1 | 10 | 7.62 | 1.885 | 3.553 |
| **Children** | 294 | 1 | 10 | 7.34 | 2.315 | 5.359 |
| **HighCon/HalfVOL** | 294 | 1 | 10 | 6.47 | 2.116 | 4.475 |
| **Low GD** | 294 | 1 | 10 | 7.07 | 2.074 | 4.302 |
| **High relaxivity** | 294 | 1 | 10 | 7.36 | 1.772 | 3.139 |
| **Good tolerability** | 294 | 1 | 10 | 8.92 | 1.369 | 1.874 |
| **Bottle Sizes** | 294 | 1 | 10 | 7.11 | 2.246 | 5.046 |
| **Good availability** | 294 | 1 | 10 | 7.83 | 1.890 | 3.570 |
| **Personal Experience** | 294 | 1 | 10 | 7.65 | 1.966 | 3.867 |
| **Cost effectiveness** | 294 | 1 | 10 | 7.51 | 2.086 | 4.353 |
| **Macrocyclic** | 294 | 1 | 10 | 6.75 | 2.292 | 5.252 |
| **Low NSF** | 294 | 1 | 10 | 8.37 | 1.894 | 3.586 |

Regarding to the personal characteristic variables is easy to see that the means of all variables are over 7 points, except for High Concentration/Half Volume and Macrocyclic. It is important to mention, according to the Market Research Team, that in the Healthcare

industry, including the radiology or diagnostic imaging business, is very reasonable that all the radiologist or medics answered under the assumption or perception that every attribute is important. This effect is related to the risks that exist in the medical profession, where product´s secondary effects or misscare of patients can result in sickness or death.

**Table: Skewness and Kurtosis analysis of the 14 "Buying Criteria" variables**

|  | Skewness | | Kurtosis | |
| --- | --- | --- | --- | --- |
|  | Statistic | Std. Error | Statistic | Std. Error |
| Excellent contrast | -1.636 | .142 | 2.697 | .283 |
| Whole Body | -1.098 | .142 | 1.163 | .283 |
| MRA | -.900 | .142 | .909 | .283 |
| Children | -.894 | .142 | .205 | .283 |
| HighCon/HalfVOL | -.335 | .142 | -.246 | .283 |
| Low GD | -.597 | .142 | -.123 | .283 |
| High relaxivity | -.450 | .142 | -.188 | .283 |
| Good tolerability | -1.834 | .142 | 5.256 | .283 |
| Sizes | -.795 | .142 | .249 | .283 |
| Good availability | -.961 | .142 | .793 | .283 |
| Personal Experience | -.897 | .142 | .453 | .283 |
| Cost effectiveness | -.904 | .142 | .372 | .283 |
| Macrocyclic | -.408 | .142 | -.582 | .283 |
| Low NSF | -1.358 | .142 | 1.761 | .283 |

Source: Made by the author

The Skewness and Kurtosis analysis give an interesting overview of the distribution of the data. Only three variables (HihCon/HalfVol, High Relaxivity and Macrocyclic) seem to be symmetrically distributed. All the other variables tend to be negative and asymmetrically distributed (Curve to the right side of the mean). Regarding to the Kurtosis analysis, seven variables are mesokurtic (evenly distributes around the mean). These variables are Children, HighCon/HalfVol, Low Gd, High Relaxivity, Sizes, Personal Experience and Cost effectiveness. For the same reason, it is possible to conclude that HihCon/HalfVol, High Relaxivity are the only variables of the whole set that are normally distributed. The other variables tend to be leptokurtic distributed (mostly distributed around the arithmetic mean, but not evenly). This analysis gives a clear overview regarding the behavior of these fourth teen variables.

**Table: Z-scores smaller than -3 (No cases found greater than +3)**

|  | CASES < -3 | % | CASES |
|---|---|---|---|
| Excellent contrast | 6 | 2% | 107, 241, 274, 278, 27, 225 |
| Whole Body | 4 | 1,4% | 77, 111, 130, 123 |
| MRA | 3 | 1% | 130, 226, 242 |
| Children | 0 | 0% | - |
| HighCon/HalfVOL | 0 | 0% | - |
| Low GD | 0 | 0% | - |
| High relaxivity | 2 | 0,7& | 242, 252 |
| Good tolerability | 3 | 1% | 265, 40, 107 |
| Bottle Sizes | 0 | 0% | - |
| Good availability | 4 | 1,4% | 164, 283, 109, 154 |
| Personal Experience | 2 | 0,7% | 249, 265 |
| Cost effectiveness | 3 | 1% | 203, 226, 265 |
| Macrocyclic | 0 | 0% | - |
| Low NSF | 4 | 1% | 123, 130, 265, 222 |

Source: Made by the author

The Z-score analysis (No cases were found greater than +3) to identify outliers has been helpful to determinate that four variables do not have any extreme cases. On the other hand, the other variables showed between one to three extreme cases except for the "Excellent Contrast" variable, which has four extreme cases.

By the same reason will be easy to understand the formation of the Boxplots in the next figure. Moreover, it is easy to identify the extreme cases, as for most of the variables; any radiologist answering less than four points will be very far away from the mean. To keep the representativeness of the sample, any extreme value found in these variables will be kept in all the analysis.
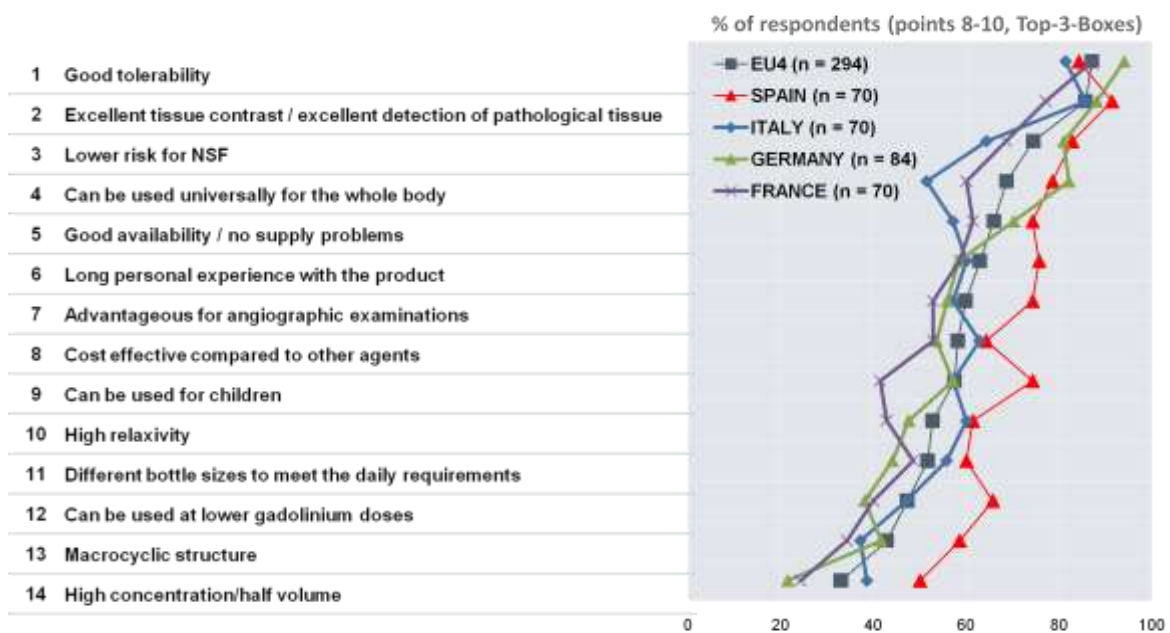
**Figure: Analysis of extreme cases for Breast and Liver "scans per week" variables**
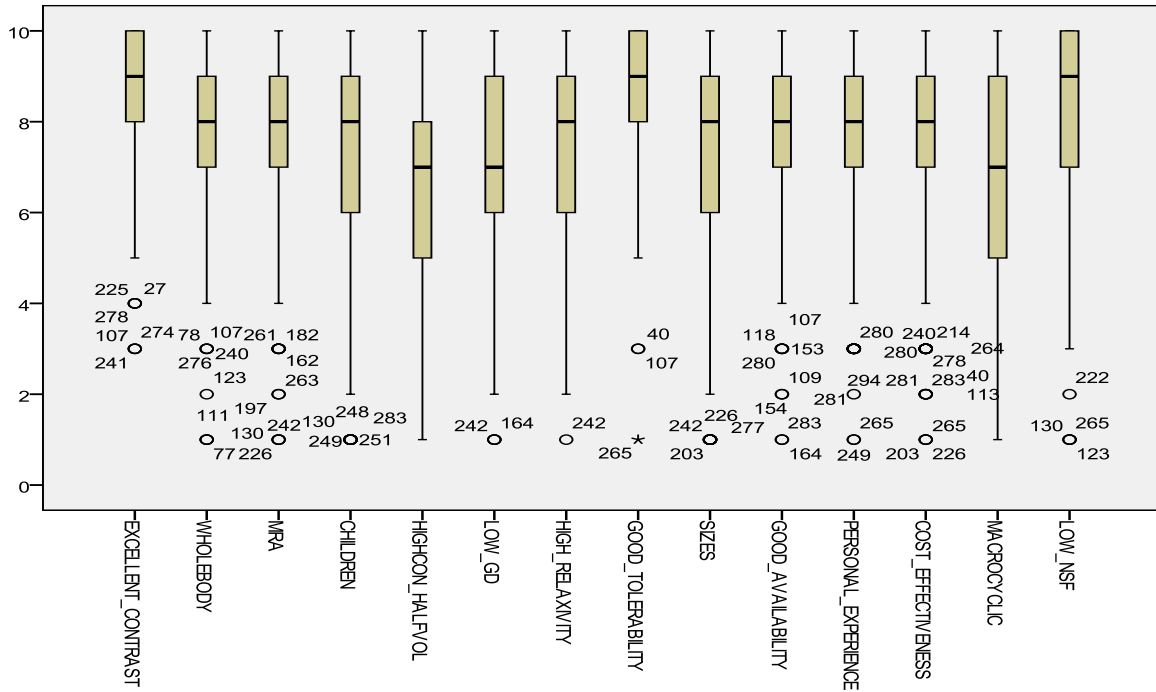
As the market will be analyzed as a region, it is important to review the behavior of each country regarding to the characteristic variables. In the next chart, the attributes are sorted by importance (from most important to less important) according to the European mean in each attribute. According to the European mean and the Box Plot in each attribute (all mean are around 7 and 8 points) all the attributes are very important. For that reason, the next graph will measure the importance of each attribute according to how several radiologist in each country score 8, 9 or 10 points in an attribute (3 Top Boxes).

**Figure: Importance of attributes for MRI agents for EU countries**



| | |
|---|---|
| 1 | Good tolerability |
| 2 | Excellent tissue contrast / excellent detection of pathological tissue |
| 3 | Lower risk for NSF |
| 4 | Can be used universally for the whole body |
| 5 | Good availability / no supply problems |
| 6 | Long personal experience with the product |
| 7 | Advantageous for angiographic examinations |
| 8 | Cost effective compared to other agents |
| 9 | Can be used for children |
| 10 | High relaxivity |
| 11 | Different bottle sizes to meet the daily requirements |
| 12 | Can be used at lower gadolinium doses |
| 13 | Macrocyclic structure |
| 14 | High concentration/half volume |

The previous graph shows different information regarding the behavior of the fourth teen "Buyer Criteria" variables. Each point in the graph represents the mean value of the scores the radiologist gave to each variable in several geographical areas. First of all, the variables are sorted by level of importance according to the opinion of the whole European sample (EU4 line). This ways, it is easy to see which variable are the most and less important for the European radiologist.

It is also easy to distinguish some patterns in each country. The Spanish radiologists seem to give more importance to all the attributes for a MRI product in comparison with the average European radiologist. Moreover, the German radiologists have mixed opinion about the importance they give to the attributes. For the five more important attributes, German radiologists give them equally importance than the Spanish radiologist, but after the fifth attribute (Good availability) the German radiologist give equally or less importance to these attributes in comparison with the European opinion. The Italians radiologists have a special concern for "Cost Effectiveness", "High Relaxivity", "Bottle Sizes" and "Macrocyclic" variables. These variables are under the 8$^{th}$ place, but Italians radiologists give them similar importance as Spanish radiologist, over the European mean. For the most importance attributes, the Italians Radiologists do not show a special concern. Finally, the French radiologists are who less importance to all attributes except for "Good Tolerability" variable.

From this analysis it is possible to infer that the Spanish radiologists have more demanding requirements for MRI products as they give a big importance to all the attributes. In the other hand, German radiologists are equally demanding, but only in the fifth first attributes, all related to efficacy, safety and one indication (Whole Body approval). Italians radiologists give more importance to "operational" attributes such as "Cost Effectiveness", and "Bottle sizes", and to efficacy and safety variables such as "Excellent Contrast", "High Relaxivity" and "Macrocyclic" structure. French radiologists give a high importance to "Good Tolerability", but it is not as important for them as for the Spanish or German radiologist. All the other attributes are equally or less importance in comparison with the general European opinion.

### B. Multicollinearity

It is also important to evaluate the correlation between variables. The multicollinearity can have different effects in a cluster analysis. Correlation has not been significant at the 0.05 significance level (2-tailed) in mostly all "Buyers Criteria" variables. The "Operational" variables are correlated with a few "Buyers Criteria" variables. On the other hand, the "Operational" variables are correlated between each other in different directions and grades.

**Table: Correlation (Sig. levels) between "Operational" and "Buying Criteria" variables**

| | S5:MRI scans / week | S6: Enhanced MRI scans / week | S7: Personally Enhanced MRI scans / week | S9: scans per week | LIVER | S10: BREAST scans per week |
|---|---|---|---|---|---|---|
| S5:MRI examinations / week | | ,000 | ,000 | ,000 | | ,088 |
| S6: Enhanced MRI scans / week | ,000 | | ,000 | ,000 | | ,000 |
| S7: Personally MRI Enhanced scans / week | ,000 | ,000 | | ,000 | | ,000 |
| S9: LIVER scans per week | ,000 | ,000 | ,000 | | | ,000 |
| S10:BREAST scans per week | ,088 | ,000 | ,000 | ,000 | | |
| Excellent contrast | ,592 | ,544 | ,606 | ,331 | | ,801 |
| Whole Body | ,227 | ,255 | ,002 | ,256 | | ,001 |
| MRA | ,720 | ,828 | ,218 | ,201 | | ,147 |
| Children | ,809 | ,973 | ,139 | ,180 | | ,142 |
| HighCon/HalfVOL | ,952 | ,862 | ,833 | ,120 | | ,027 |
| Low GD | ,264 | ,491 | ,947 | ,246 | | ,003 |
| High relaxivity | ,569 | ,310 | ,046 | ,170 | | ,084 |
| Good tolerability | ,435 | ,166 | ,239 | ,060 | | ,679 |
| Sizes | ,242 | ,738 | ,541 | ,648 | | ,429 |
| Good availability | ,465 | ,493 | ,633 | ,302 | | ,755 |
| Personal Experience | ,864 | ,911 | ,215 | ,617 | | ,379 |
| Cost effectiveness | ,234 | ,228 | ,156 | ,644 | | ,520 |
| Macrocyclic | ,373 | ,176 | ,008 | ,249 | | ,001 |
| Low NSF | ,070 | ,078 | ,158 | ,847 | | ,275 |

Source: Made by the author

It is not hard to understand why the "Operational" variables could be correlated. All the "Operational" variables represent MRI scans per week, but in different situation. While "MRI scans / week" and "Enhanced MRI scans / week" represent the MRI scans performed in the hospital where the radiologists work, the other variables represent the MRI scans performed directly by the radiologist. Independently of the statistic correlation of these variables, it is important to analyze them separately for the different relevant information these variables can give to the researcher. On the other hand, it is understandable the

correlation between the variable "Whole Body" with "Personally Enhanced MRI scans / week" and "Breast scans /week" as the Whole Body indication in a MRI product will permit the radiologist to diagnostic different body parts with the products and that can increase the number of MRI scans. At the same time, in mostly all countries (except fot the U.S. region) the breast indication is part of the Whole Body approval. There is not a visible explanation for the other correlations found.

Regarding the "Buying Criteria" variables is possible to see correlations under the significance level of 0.05.

**Table: Correlation (Sign. levels) between "Buying Criteria" variables**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1) Excellent contrast | | ,000 | ,000 | ,067 | ,007 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 |
| 2) Whole Body | ,000 | | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 |
| 3) MRA | ,000 | ,000 | | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 |
| 4) Children | ,067 | ,000 | ,000 | | ,000 | ,000 | ,000 | ,007 | ,000 | ,000 | ,000 | ,000 | ,000 | ,011 |
| 5) HighCon/HalfVOL | ,007 | ,000 | ,000 | ,000 | | ,000 | ,000 | ,023 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 |
| 6) Low GD | ,000 | ,000 | ,000 | ,000 | ,000 | | ,000 | ,003 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 |
| 7) High relaxivity | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 |
| 8) Good tolerability | ,000 | ,000 | ,000 | ,007 | ,023 | ,003 | ,000 | | ,001 | ,000 | ,000 | ,000 | ,000 | ,000 |
| 9) Sizes | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,001 | | ,000 | ,000 | ,000 | ,000 | ,001 |
| 10) Good availability | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | | ,000 | ,000 | ,000 | ,000 |
| 11) Personal Experience | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | | ,000 | ,000 | ,000 |
| 12) Cost effectiveness | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | | ,000 | ,000 |
| 13) Macrocyclic | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | ,000 | | ,000 |
| 14) Low NSF | ,000 | ,000 | ,000 | ,011 | ,000 | ,000 | ,000 | ,000 | ,001 | ,000 | ,000 | ,000 | ,000 | |

Source: Made by the author

After analyzing the previous figure, it is easy to see that all "Buying Criteria" variables are correlated with the exception from "Excellent Contrast" and "Children". In this case, it is possible to link the "Everything is important" opinion from the radiologists in the moment of answering the survey. It was visible before, in the boxplots and in the descriptive analysis, that all the variables have scores over 7 points in all the variables.

Mostly of them are correlated in a positive direction. As it was mentioned before, this can be a result of the "everything is important" perception mentioned in the previous section of this chapter.

All these variables represent different information that need to be analyses separately. For this study, will be important to identify how all these variables affect the cluster analysis results. On the other hand, it will be easier to the Managerial Team to understand the results of the analysis of all the variables are independently represented. For this reason, all the variables will be stay in the analysis and no Factor Analysis will be performed.

## APPENDIX N°15: Europe cluster analysis without fourth teen extreme cases from the "Operational" variables

As it was noted in the first dendogram, the five clusters configuration had a one member cluster. This cluster is a German hospital with more than 2500 MRI procedures per week. To proof the effect of the outliers in these results, fourth teen extreme cases from the "Operational" variables were taken out. A dendogram shows the possibility of four or five cluster analyses. All the variables show differences between groups according to the ANOVA test in both scenarios.

**Figure: EU Dendogram without 14 extreme cases**
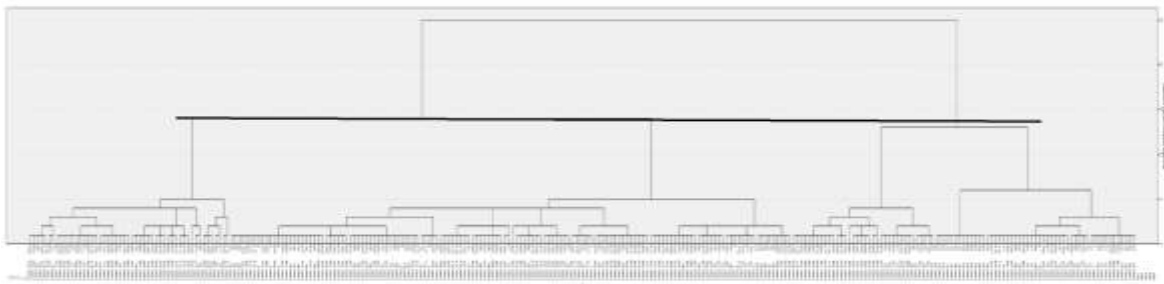


Source: IBM SPSS v19

**Table: Number of cases per cluster**

| CLUSTER CONFIGURATION | 4 CLUSTERS | 5 CLUSTERS |
|---|---|---|
| CLUSTER 1 | 51 | 38 |
| CLUSTER 2 | 142 | 142 |
| CLUSTER 3 | 51 | 51 |
| CLUSTER 4 | 36 | 36 |
| CLUSTER 5 | _ | 13 |

Source: Made by the author

**Figure: ANOVA test result for 4 and 5 Clusters configurations**

| VARIABLE | SIGNIFICANCE LEVEL | VARIABLE | SIGNIFICANCE LEVEL |
|---|---|---|---|
| MRI Scans / week | .000 | Low GD | .000 |
| Enhanced MRI scans / week | .000 | High relaxivity | .000 |
| Personal MRI scans /week | .000 | Good tolerability | .000 |
| Liver MRI scans / week | .000 | Bottle Sizes | .000 |
| Breast MRI scans / week | .000 | Good availability | .000 |
| Excellent contrast | .000 | Personal Experience | .000 |
| Whole Body | .000 | Cost effectiveness | .000 |
| MRA | .000 | Macrocyclic | .000 |
| Children | .000 | Low NSF | .000 |
| HighCon/HalfVOL | .000 | | |

Source: Made by the author

The four cluster configuration without the fourth teen outliers is similar to the four cluster configuration with outliers included (the one chosen as a good segmentation result for the European market), but there are different related to the number of cases in each group, but still is possible to see that the Cluster 4 is a "High through Put" cluster.

## APPENDIX N°16: European cluster analysis, first dendogram with all cases included



Dendrogram using Ward Linkage
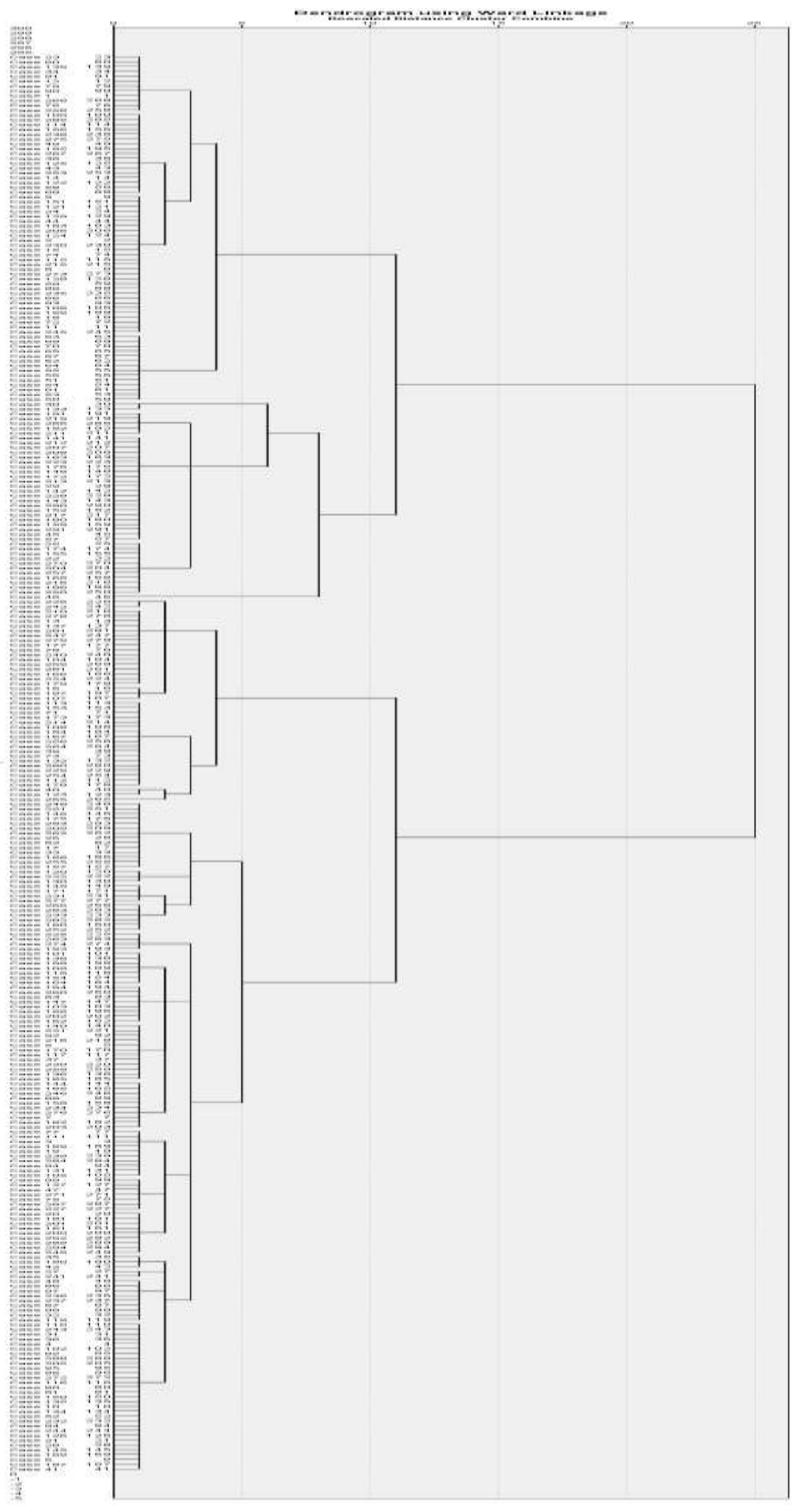
# APPENDIX N°17: European K-Means Cluster

**Figure: ANOVA test in the K-Means clustering method for all fourteen variables in the four cluster configuration in Europe**

| VARIABLE | SIGNIFICANCE LEVEL | VARIABLE | SIGNIFICANCE LEVEL |
|---|---|---|---|
| MRI Scans / week | .000 | Low GD | .000 |
| Enhanced MRI scans / week | .000 | High relaxivity | .000 |
| Personal MRI scans /week | .000 | Good tolerability | .000 |
| Liver MRI scans / week | .000 | Bottle Sizes | .000 |
| Breast MRI scans / week | .000 | Good availability | .000 |
| Excellent contrast | .000 | Personal Experience | .000 |
| Whole Body | .000 | Cost effectiveness | .000 |
| MRA | .000 | Macrocyclic | .000 |
| Children | .000 | Low NSF | .000 |
| HighCon/HalfVOL | .000 | | |

Source: Made by the author

The K-Mean clustering method classified all the cases in four groups, but without satisfactory results. According to the following table, two of the four groups have only two and one cases each. Cluster 2 is formed only by the extreme case N°46 (the case with greater MRI scans / week and the Cluster 1 is formed by extreme cases N° 30 and N°133. As the Hierarchical Cluster analysis did, the K-Means was not able to gather all extreme cases under one cluster. If the fourth teen outliers founded in the "Operational" variables are taken out, the results of the four clusters will improve, as the cases will be better distributed around the four Clusters.

**Figure: Number of Cases in each Cluster from the K-Means Cluster**

| Number of Cases in each Cluster with outliers | | Number of Cases in each Cluster without outliers | |
|---|---|---|---|
| CLUSTER | NUMBER OF CASES | CLUSTER | NUMBER OF CASES |
| 1 | 2.000 | 1 | 128.000 |
| 2 | 1.000 | 2 | 77.000 |
| 3 | 156.000 | 3 | 25.000 |
| 4 | 135.000 | 4 | 50.000 |
| Valid | 294.000 | Valid | 280.000 |
| Missing | .000 | Missing | .000 |

Source: Made by the author

The K-Mean was not able to successfully confirm the results of the previous cluster analysis as several extreme cases were needed to left aside of the analysis to find similar results in the clusters composition. On the other hand, the composition of the groups is very different in comparison with the hierarchical cluster results.