Universidade do Minho
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Victor Javier Jiménez Carabalí

The Dynamics of Cost Management Practices in Portuguese Hospitals

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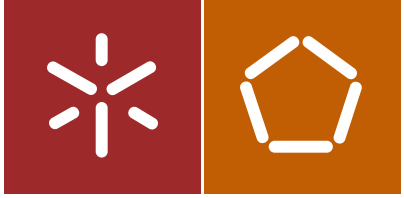

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Escola de Engenharia

Victor Javier Jiménez Carabalí

The Dynamics of Cost Management Practices in Portuguese Hospitals

PhD Thesis
Doctoral Program in Industrial and Systems Engineering (PDEIS)

Work Done Under the Guidance of
Doctor Paulo Sérgio Lima Pereira Afonso

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DECLARAÇÃO

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STATEMENT OF INTEGRITY

I hereby declare having conducted my thesis with integrity. I confirm that I have not used plagiarism or any form of falsification of results in the process of the thesis elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

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I thank Jehovah God for giving me everything I need to get here, and I dedicate this document to my wife, my parents, my nephews, my family and all those who have contributed to my growth, thank you for the time you gave me and apologize For the time that many times I did not have to give them. I thank Professor Paulo for his excellent work as a guide and for his great human quality.

I am grateful to the University of Valle, to the University of Minho and to all the hospitals and people who participated in this research. Thank you very much.

DEDICATION

Esta tese é dedicada com muito amor a minha esposa, Sandra y a mis padres, Maria Ines y Dario.

RESUMO

A saúde é um bem essencial em qualquer sociedade, e com o aumento da população, o aumento da expectativa de vida, novas doenças e tratamentos inovadores, conseguir um equilíbrio entre eficiência financeira e qualidade dos serviços de saúde é um desafio permanente e crescente.

Com o objetivo e tornar o processo de gestão mais eficiente, o Ministério da Saúde em Portugal contratualiza a produção dos serviços que devem ser providenciados à população e os custos associados a dita produção, sendo que a maioria dos recursos são destinados aos hospitais que pertencem ao sistema nacional de saúde. Aqui emergem vários elementos fundamentais desta tese, os quais estão relacionados com o processo de contratualização, gestão dos custos e autonomia ao nível dos hospitais. Sendo o contrato programa o elemento central e mais importante no processo de financiamento dos hospitais, esta tese centra a sua atenção na relação entre a gestão de custos e os processos ex-ante e ex-post da contratualização interna nos hospitais utilizando para o efeito conceitos da teoria dos custos de transação e a da teoria da agência. A complexidade em estimar os custos de transação é maior nos hospitais com respeito a outras organizações devido à existência de processos de contratualização interna e à existência de custos intangíveis. Por outro lado, a existência de diversos agentes com objetivos diferentes acrescenta complexidade à relação contratual e aumenta os custos de agência. Estes aspetos podem influenciar o cumprimento do contrato programa e reforçam a importância da gestão de custos neste contexto. Destas análises emerge a importância da gestão de custos para garantir o cumprimento do contrato programa, tendo em conta as particularidades e complexidades dos hospitais e os antecedentes de insucesso na implementação de sistemas de custeio em hospitais portugueses. Neste sentido, propõe-se e discute-se uma metodologia baseada na gestão de projetos e nas metodologias ágeis de desenvolvimento de software para a implementação dum sistema de custeio em ambiente hospitalar. A aplicação destas metodologias evidencia que os sistemas de custeio devem ser adaptados ao contexto das organizações durante processo de conceção e implementação.

Por outro lado, uma das variáveis que se destacou ao longo deste projeto de investigação foi a variabilidade a qual afeta decisivamente o cumprimento dos contratos. Deste modo, nesta tese também se propõe um modelo de gestão de custos para hospitais tendo em conta a variabilidade dos processos e da procura. Este modelo permite calcular o risco no processo orçamental e também identificar necessidades e oportunidades para a gestão desse risco.

Pretende-se que os diferentes aspetos tratados nesta tese sejam um contributo para a sustentabilidade financeira dos hospitais sem sacrificar a qualidade dos serviços prestados aos utentes.

PALAVRAS-CHAVE: GESTÃO DE CUSTOS, AUTONOMIA HOSPITALAR, TEORIA DOS CUSTOS DE TRANSAÇÃO, TEORIA DA AGÊNCIA, INCERTEZA, CUSTO EM RISCO, CUSTEIO BASEADO EM ATIVIDADES.

ABSTRACT

Health is an essential asset in any society, and with increasing population, increased life expectancy, new diseases and innovative treatments, achieving a balance between financial efficiency and quality of health services is a permanent and growing challenge.

With the objective and to make the management process more efficient, the Ministry of Health in Portugal contracts the production of the services that must be provided to the population and the costs associated with that production, and the majority of resources are destined to the hospitals belonging to the health system. Here, several fundamental elements of this thesis emerge, which are related to the contracting process, cost management and autonomy at the hospital level.

Since the contract is the central and most important element in the hospital financing process, this thesis focuses its attention on the relationship between cost management and the ex-ante and ex-post processes of internal contracting within hospitals using concepts from the theory of transaction cost economics and agency theory.

The complexity in estimating transaction costs is greater in hospitals with respect to other organizations due to the existence of internal contractual processes and the existence of intangible costs. On the other hand, the existence of several agents with different objectives adds complexity to the contractual relationship and increases agency costs. These aspects can influence the fulfillment of the contract and reinforce the importance of cost management in this context.

From these analyzes emerges the importance of cost management to ensure compliance with the contract, taking into account the particularities and complexities of hospitals and the precedents of failure to implement costing systems in Portuguese hospitals. In this sense, this thesis proposes and discusses a methodology based on project management and agile methodologies of software development for the implementation of a costing system in a hospital environment. The application of these methodologies shows that costing systems must be adapted to the context of organizations during the design and implementation process.

On the other hand, one of the variables that stood out during this research project was the variability which decisively affects the fulfillment of the contracts. In this thesis, a cost management model for hospitals is also proposed, taking into account the variability of the processes and demand. This model allows to calculate the risk in the budget process and also to identify needs and opportunities to manage such risk. All this in order to contribute to the financial sustainability of hospitals without sacrificing the quality of services provided to users.

KEYWORDS: COST MANAGEMENT, HOSPITAL AUTONOMY, TRANSACTION COST ECONOMICS, AGENCY THEORY, UNCERTAINTY, COSTING AT RISK, ACTIVITY BASED COSTING.

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List of Abbreviations

ABC	- Activity Based Costing
AD	- Anderson-Darling
AHP	- Analytic Hierarchy Process
BI	- Business Intelligence
BUGC	-Bottom Up Gross Costing
BUMC	- Bottom Up Microcosting
CaR	- Costing at Risk
CAQDAS	- Computer-Assisted Qualitative Data Analysis Software
DAM	- Decision-Analytical Modelling
DRG	- Diagnosis-Related Group
EBITDA	- Earnings before Interests, Taxes, Depreciations and Amortizations
FABC	- Fuzzy Activity Based Costing
FPFABC	- Fuzzy Performance Focused Activity Based Costing
GDP	- Gross Domestic Product
IPMA	- International Project Management Association
K-S	- Kolmogorov-Smirnov
MCS	- Monte Carlo Simulation
NHS	- National Health Service
PDF	- Probability Density Function
PMLC	- Project Management Life Cycle
PMI	- Project Management Institute
RHAs	- Regional Health Authority
RSI	- Relationship-Specific Investment (RSI)
TCE	- Transaction Cost Economics
TDABC	- Time-Driven Activity-Based Costing
TDGC	- Top Down Gross Costing
TDMC	- Top Down Microcosting
TLC	- Trough-Life Cost
VaR	- Value at Risk

1. Problem Identification and General Explanation of the Study

1.1 Introduction and Motivation

A health system can be defined as the set of all organizations, and resources whose sole purpose is to improve the health of individuals and communities. For proper operation, a health system requires resources such as human, technical and financial resources, information and appropriate management systems. It is demanded a proper use of the resources involved but without reducing the quality of service and treatment of worthy users.

Nowadays, problems with health systems are not confined to poor countries. Some rich countries have large populations without access to care because of inequitable arrangements for social protection. Others are struggling with escalating costs because of inefficient use of resources (WHO, 2005).

Within health systems, hospitals are particularly important for several reasons. Namely, they account for a substantial proportion of the health care budget in the system, about 50 per cent in many western European countries and 70 per cent or more in socialist countries (McKee & Healy, 2002).

Hospitals play an important role in the health care system. They are health care institutions that have an organized medical and other professional staff, and inpatient facilities, and deliver medical, nursing and related services 24 hours per day, 7 days per week. Hospitals offer a varying range of acute, convalescent and terminal care using diagnostic and curative services in response to acute and chronic conditions arising from diseases as well as injuries and genetic anomalies. In doing so, they generate essential information for research, education and management. Traditionally oriented on individual care, hospitals are increasingly forging closer links with other elements of the health sector and communities in an effort to optimize the use of resources for the promotion and protection of individual and collective health status (WHO, n.d.).

One of the key challenges to ensure the sustainability of hospitals is the development of relevant and accurate cost information on which to base strategic, pricing, and management decisions (Capettini, Chow, & McNamee, 1998).

Determining the (average) cost of services offered in a hospital given the large number of different activities is difficult and problematic (Llewellyn & Northcott, 2005). But if not measured it cannot be controlled nor managed.

Organizations in the health sector have a number of features that become challenges for the design and implementation of management accounting and control systems. Among these, we may highlight the following: the complexity of the processes, the dominant control by service providers or producers of essential business processes, the existence of multiple (and some conflicting) objectives, the rules imposed by internal and external entities that are sometimes contradictory, the atmosphere highly politicized because most hospitals are publicly funded or rely on any philanthropic or religious entity, among others. Furthermore, organizing rules tend to prevent the use of monetary incentives as mechanisms to achieve goal congruence. While other industries may experiencing the effects of some of these factors they do not face the confluence of all such as hospitals. Attempting to understand how this complexity influences accounting and control system design and use is important given the prevalence of underdeveloped management control systems in this sector and the size and significance of the health care sector in the economy (Abernethy, Chua, Grafton, & Mahama, 2006, p. 805).

Health care services characterized by a strikingly diverse range of organizational forms which can be grouped in several interlinked industries. Such industries are populated with substantial numbers of firms exhibiting each of three fundamentally different ownership types: for-profit, private nonprofit, and public (Hansmann, 1996). Hospitals are no exception, there are public, for-profit and private hospitals each with different characteristics.

In the Portuguese health system, nonprofit hospitals occupy an important place. Most hospitals belonging to the National Health Service (NHS), and about half of the hospitals outside the NHS can be considered as being non-profit. The NHS is relatively recent and several hospitals have been built during the past twenty years but face today obstacles to improve their performance (Barros, 2013, pp. 248–249).

The European health systems face complex and different challenges independently of whether they are funded by insurance or taxes. Some of these changes include using resources effectively and efficiently including rational use of costs and systems to measure the effectiveness of cost management, securing funding for both public health and health care services (Kickbusch & Gleicher, 2012, p. 2)

The Portuguese health system problems are specifically identified with asymmetric geographical distribution of health facilities and human resources, poor sanitation, population coverage not being universal (although there is no precise estimate of coverage), no coordination among existing facilities and providers and little evaluation, multiple sources of financing and a disparity in benefits among

different population groups, centralized decision-making, discrepancy between legislation and policy, and the low actual provision of health services and the low remuneration of health professionals (Barros, Machado, & Simões, 2011a).

A study by Deloitte (2011, pp. 40–41) identified additional problems associated with the Portuguese health system. It is an interesting study because different points of view were collected, from legislators, regulators, payers, public and private providers, among others. Among these problems we may highlight the financial unsustainability of the system, inappropriate organizational model and management, lack of strategic planning, planning and management of human resources result inadequate, the system is not centered on the citizen, lack of quality information, model of funding / allocation of resources misfit, lack of clarity on the role of private entities, not transparent system, bureaucracy, legislative instability and little leadership and a culture of resistant to change.

Thus, a significant number of problems are identified for the health system, many of them related to centralized decision making and the difference between the law and what is done in practice, these two will be studied in this research focusing primarily on the impact they have in the management of hospital costs.

Furthermore, the debate between (more) centralization or decentralization is an important issue in the stakeholders agenda. Some authors show that the decentralization is a ubiquitous feature of health sector reform throughout the world (C. Collins, Araujo, & Barbosa, 2000). Nevertheless, decentralization is important to the Portuguese health system. For example, the National Parliament which produces the law and defines the general rules of the NHS, repeatedly considers one of the qualities that the system should have is to be more regionalized and decentralized and characterized by a participative management (Assembleia da República, 1990; Barros, Machado, & Simões, 2011b; Simões, Fronteira, Augusto, & Hernández-quevedo, 2017).

The organization of the Portuguese health system is based on the division of the country by regionals health administrations (RHA), where each region is provided with means of action to autonomously meet the health needs of its inhabitants, being able when necessary to establish inter-regionals agreements to share certain resources (Assembleia da República, 1990) .

Although the spirit of the law points to a decentralized system and RHA autonomy over budgeting and spending, it is not entirely autonomous and budgets are still set by the central authority. In addition to the same central authority, the Ministry of Health is who appoints the boards of hospitals (Barros et al., 2011a, p. 33).

Furthermore, a hospital level delegation of responsibility to lower level managers in order to make more efficient the use of resources was attempted, so responsibility centers were created. The purpose of these was to better coordinate medical specialties, cost management, and strengthen competitive advantages. Nevertheless, there are currently very few responsibility centers because its creation was never effectively driven. Few centers were created, many failed to exist and some have been removed (Barros et al., 2011a, p. 33).

In recent years, governments around the world have adopted initiatives for the autonomy or decentralization of hospitals including those which were designed in health reforms. Some potential benefits of such empowerment include improved efficiency, the acknowledgment of physician responsibilities, accountability and recipient decision making in the provisioning of service. Some potential risks include reduced efficiency, the marginalization of the public interest and harmful to public health outcomes. In fact, there is no consensus as to the advantages or disadvantages of autonomy, although it is a growing issue in research. Nor is it likely that such consensus will be achieved. Empowering hospitals is complex and its effects are difficult to measure. Indeed, there are many pros and cons to its effects making it difficult the generalization of this measure (London, 2013; Méndez & Torres A, 2010).

This is in regard to system structure, in terms of costs, accounting and management costs in Portuguese hospitals.

> *"A contabilidade analítica não tem sido utilizada pela ACSS - Administração Central do sistema de Saúde - como ferramenta para melhorar a eficiência na gestão dos recursos, e os dados, desfasados no tempo e não auditados, não são comparáveis com os preços definidos para as rubricas do Contrato-Programa e não têm sido utilizados para acompanhar e monitorizar as diversas administrações hospitalares quanto à boa gestão dos recursos ao seu dispor. Ao nível de cada unidade hospitalar, a contabilidade analítica não é utilizada como instrumento de gestão, quer no planeamento, quer com vista a melhorar índices de eficiência, de produtividade, ou, ainda a avaliação do desempenho e os seus controlos, sendo elaborada mais por um imperativo legal do que por um imperativo da gestão, em resultado de uma cultura empresarial. A grande maioria das unidades hospitalares do SNS não desenvolveram estudos que lhes permitissem conhecer os custos associados à sua produção em GDH . -Grupos de Diagnósticos Homogéneos-, consequentemente, compará-los com os respetivos proveito."* (Tribunal_de_contas, 2011, p. 44)

These problems persist years after this evaluation was presented (Silva & Cyganska, 2016).

In summary, the above paragraph in Portuguese, shows that most of the Portuguese NHS hospitals have not developed properly studies that allow them to know their level of production costs, and therefore are

not using the information derived from costing system as a tool to improve efficiency in the management of their resources.

This goes against the idea of the regulator because cutting spending without effective management tools that simultaneously reduce multiple causes of inefficiency in the overall health system may result in a reduction on people's access to health care and, simultaneously, an increase in the regressively of financing health and the creation of (new) inefficiencies (Escoval, Lopes, & Ferreira, 2011, p. 58).

Despite showing improvements with the new budgeting system at the aggregate level, after a few years it was observed a hidden debt, which in 2011 amounted 3,000 million euros, mostly generated by debt arrears of NHS hospitals to the pharmaceutical industry (Barros, 2013, p. 250).

There is evidence that the health system has some problems both in structure and in the inner workings of the hospitals that ultimately affect the cost management of them. Again, we should emphasize that what you do not measure you cannot control.

1.2 Objectives and Research Questions

After presenting the motivation and demonstrate various problems present in the Portuguese NHS, this section presents and explains the main objective of this work which is devoted to identify and analyze the dynamics of cost management in Portuguese hospitals. In this context, case studies can be used to help to understand not only the behavior but also generate plans of intervention in terms of internal cost management practices in hospitals and in the national health system.

Namely, this research project focuses on the impact of centralization and decentralization of hospitals' management in terms of decision making and, particularly, in terms of the relation between hospital's autonomy and efficient cost management practices considering the context of growing uncertainty and risk of such activities. Also, it is important to understand if there is a difference between what the law says and what is practiced in hospitals, with the aim of suggesting improvements to help decision making.

In the first phase of the research project, an exploratory approach was used looking to understand how cost management is implemented and has been evolving in Portuguese hospitals of the current health care system. In this context, it will be important to know which the most common practices of cost management are, why these practices are prevalent and as well as the contrast among theory, law and practice. Practitioners' and academics' claims are a clear evidence that there are gaps and potential for improvement within health systems cost management. Thus, this research will focus on internal and external aspects related with cost management in hospitals namely, hospital autonomy. In this first step,

the dynamics of cost management within hospitals, were seen particularly from the perspective of microeconomics. After understanding the dynamics of cost management, we offer an analysis of how the autonomy of hospitals or not supports cost management and how cost management supports, facilitates or is an obstacle for an effective autonomy of hospitals. This contributes to achieve a deep understanding of the dynamics and system performance measures that allow the development of cost management systems and cost control measures which contribute to improve the performance and efficiency of hospitals.

To meet this general goal, three research topics were intended to be answered, these topics are related to:

1. The dynamics of cost management practices in Portuguese hospitals,
2. Interdependencies between cost management and hospital autonomy,
3. The design of advanced and innovative costing systems for modern cost management in hospitals.

The first research question is more exploratory in nature and has a broader perspective. It was expected that issues related with internal and external hospital autonomy will arise from the results of the initial field work resulting in important explanatory factors of the dynamics of cost management. Thus, research question number was focused on the relationship between both. Finally, effective cost management practices for hospitals may be more dependent of *what should be* and more distant from *what is*, i.e. more resources should be invested in the design of advanced and innovative costing systems for hospitals instead of the use of mature cost management practices with proven results in other industries. Thus, it was intended to develop a deep study of a paradigmatic case of such design of new cost management practices in the hospital context. This case may represent the next or more evolved step of cost management dynamics in hospitals.

1.2.1 The Dynamics of Cost Management Practices in Portuguese Hospitals

More recent analysis shows that there is no best health system. Health sector reform continues to be a key responsibility of health ministries. (Kickbusch & Gleicher, 2012). Indeed, there are many criticisms that the public sector has had in the last two decades to be insufficiently effective and efficient. New management accounting techniques have been developed in response to this criticism (van Helden, Aardema, ter Bogt, & Groot, 2010).

Cost containment (cost control or cost conscious) has been central to discussions of reform and regulation of health care in almost all countries for over more than two decades. In traditional cost-of-service regulation, organizations have no incentive to decrease costs and, if costs increase, the firm can normally secure a higher price from the agent regulator that in most cases it is the government. This is similar to the process of negotiating budgets for hospitals sometimes observed in countries with single payer systems. In this context, health programs and hospitals are shaped by the decisions made in terms of the budgeting process (Dawson, Goddard, & Street, 2001; White, 2013)

Cost system improvement in hospitals is fundamentally determined by health care specific factors such as the dissatisfaction with the legal system that may be caused by an economic discordance or the laws established by the governments that prevent full performance of medical staff, the way internal financial agreements between hospitals and their physicians are institutionalized, the support of the medical staff towards cost system usage, etc. This suggests that health care management should focus on hospital specific elements in order to facilitate the costing system adoption (Cardinaels, Roodhooft, & van Herck, 2004).

As was shown above, Portuguese hospitals lack of efficient costing to improve decision-making. A question that arises is why this happens? This asks for an understanding of the dynamics of cost management in Portuguese hospitals, i.e. issues related with the adoption and use of cost management practices in such cases, the changes involved, implementation and resistance to change, and impact in terms of hospital's overall efficiency. Although there is evidence on the analysis of hospitals and health care costs, these analyzes are generally made from a macroeconomic point of view and not from the hospital's perspective, as it is intended in this research project. Furthermore, cost management in hospitals will be seen from an economic perspective and in this regard, the Agency Theory and the Transaction Cost Economics theory (TCE) are theories that fit this type of situation. According with TCE, companies are hierarchically organized with the aim of reducing transaction costs. Unlike other theories of the firm, TCE also tries to explain why and how governance mechanisms occur inside of the company and its extension to other forms of organization, such as vertical integration and diversification (OE Williamson, 1979). It is highlighted in this theory the importance of knowing the internal relationships and the importance of cost minimization and the transactions performed.

Other theory that can explain the dynamics of the cost management practices is the Agency Theory. This theory can be used to explain the influence of external variables (namely, government's decisions) on internal decisions related with costs in hospitals. An example that relates budgets, agency theory and health systems can be found in (Yan, Yang, & Fang, 2014) where it is shown that it is possible that Agency

Theory may explain the behavior and the relationship between the agents - hospital administrators - and the principal - government.

Thus these questions arise in this regard:

- ✓ Which are the most relevant cost management practices in Portuguese hospitals?
- ✓ Which have been the dynamics of cost management in Portuguese hospitals considering the structure of the health care system and past and current regulations?
- ✓ How economic theories can contribute to explain the dynamics of cost management in Portuguese hospitals?

The expected results of the field work are important to understand why and how the health system settings and existing internal relations in Portuguese hospitals have an influence on the dynamics of cost management in Portuguese hospitals.

1.2.2 Interdependencies between Cost Management and Hospital Autonomy

Governance and leadership are generally considered to be the most difficult but also the most important function of governments in relation to the health system (Smith et al., 2012).

Through the process of health decentralization, countries have sought to improve their efficiency and constrain costs. In fact, the share of gross domestic product (GDP) accounted for health spending has been considerably high and reforms of health care systems have dominated the political agenda of industrialized countries as never before (Barros et al., 2011a; Magnussen, Hagen, & Kaarboe, 2007; Mosca, 2006; Tediosi, Gabriele, & Longo, 2009).

The degree of (internal and external) autonomy or decentralization in making decisions related to cost management in Portuguese hospitals and its relation to the law that regulates the NHS is an important aspect that needs to be analyzed.

- ✓ Which are the interdependencies between cost management and hospital autonomy in Portuguese hospitals?
- ✓ What is the impact of such interdependencies in relation to the practices and the dynamics of the cost management in hospitals?
- ✓ What are the advantages and disadvantages of having or not having such a relationship of interdependency?

Among the expected results is to see if there exist whether positive or negative relationships between autonomy and hospital cost management practices, why and how; and, how this relationship can affect the efficiency of hospitals.

1.2.3 The Design of Advanced and Innovative Costing Systems for Modern Cost Management in Hospitals

One of the key challenges to the continued viability and improvement of the efficiency of healthcare organizations, i.e. for its sustainability, is the development and use of relevant reliable, understandable and accurate cost information on which it will be possible to base strategic, pricing and management decisions not only to state regulators but also for the internal management of the hospital authorities (Demeere, Stouthuysen, & Roodhooft, 2009). Cost information should be the result of proper management of data in response to factors such as the organizational structure of the company, the production process of goods and services and the type of information required by the organization and stakeholders in it. The process of how data is treated depends on the cost system implemented in the organization. (Charlita, 2009) and this one should fits the characteristics of the organization and take into consideration its idiosyncrasies. In this context, an important and disquieting question may arise: the success and the effectiveness of cost management depends (more) on a good implementation and use or on a proper design of cost management systems and practices. Do we need new wines in new bottles or just good bottles (good implementation) are enough?(Davidson, 1963). Have been academics and practitioners focused on adapt mature and generally (poor or insufficient) accepted practices instead of design more tailored and effective solutions? A deeper and more critical understanding of the design process of cost management practices, particularly which can be viewed as advanced and innovative, may be needed. This aspect closes the loop of this research project and may contribute for new research avenues in cost management in particular and management accounting in general.

Indeed, new costing models should reflect the real situation of production processes and cost structure as accurate as possible. However, the circumstances are changing rapidly (Alnestig & Segerstedt, 1996). With work requirements becoming more complex, uncertain, and changing, control systems cannot be static and formal. Rather, control may come in the form of social control systems that allow directed autonomy and rely on the judgment of employees informed by clarity about vision and objectives of the business. Existing research has looked at the intersection between control systems and innovation and entrepreneurship mostly from a functionalist and economics perspective. However, alternative perspectives have been used such as psychology (such as how do control systems affect organizational

creativity), sociology (what is the influence of the designer's network), strategy (dynamic capabilities) or organizational theory (evolutionary theory). Furthermore, some authors consider that current findings have not looked at the design and use of particular systems such as performance measurement or compensation (Davila, Foster, & Oyon, 2009). Thus, the following research questions may be considered:

- ✓ Are current costing systems and cost models not appropriate for the context of cost management in hospitals?
- ✓ Should hospitals design new solutions (e.g. costing systems and cost models) to understand better the behavior of costs in hospitals?
- ✓ How such design process occur or must be in order to be effective?

The expected results are a better understanding of the need and the role of new or advanced cost management practices in hospitals. Particularly, the understanding of the design process of such kind of new or innovative solutions for more effective costing systems in hospitals.

1.3 The Methodology Used

The methodology used for the development of this project is described below. It is noteworthy that the development of this project focused on the study of cost management in hospital settings, and the reality of some hospitals in Portugal was studied.

1.3.1 Research Methodology and Methods

This project began with the desire and need to carry out an investigation that will consider a problem with a considerable social impact in an environment where there is room for improvement in relation to cost management. After analyzing several sectors, the health sector was chosen, mainly due to the complexity of the system, the strategic importance for society and also given the existence of opportunities to develop research within hospital units in Portugal.

With this in mind, an exploratory study of several documents and investigations that identified problems in the management of costs in hospitals from a macroeconomic perspective was carried out, and it was there where a job opportunity was identified that would be to analyze those problems from a microeconomic perspective or internal perspective of hospitals and that was where the objectives and the research questions that this work tackled emerged.

Here the focus of the research work is focused on analyzing the dynamics of cost management and costing methods within hospitals analyzed and then, proposing some improvement measures aimed at providing tools for decision making.

At the same time, it began with a review of the literature, which consisted in the search, reading and analysis of scientific journals of reference journals in each of the areas. This process was carried out throughout the development of a series of documents. The importance of cost management in organizations, the autonomy of hospitals, and transaction costs economics theory were studied with the aim of understanding how transactions within hospitals affect decisions to perform services internally or subcontract.

Once the topics for work were defined, we proceeded to design the process with which the research would be approached and we would try to answer the research questions. In the first instance, the philosophy of the study was defined. The philosophy for this study is an interpretive philosophy, which is an approach to inductive studies. The case study strategy was particularly relevant in this research project because the questions which must be answered are of the type "why" and "how", the investigator have little or no control over events, and the focus is on a contemporary phenomenon within a real-life (Yin, 2009, p. 2); with respect to the time horizon it was a cross sectional study.

In this project, a multi-method research approach was used, in this sense interviews, case study, action research and decision-analytical modelling were used, as well as different methods of data collection - semi-structured interviews, direct observation, documents, information extracted from information systems- and different approaches for information processing (Saunders, Lewis, & Thornhill, 2009).In the research design, an exploratory study was carried out in several hospitals in the country with the objective of knowing the dynamics of cost management in different hospitals. For this, semi-structured interviews were carried out with people from top management in public and semi-public hospitals, among which were some of the most important hospitals in the country. The interview is a qualitative technique that occupies a prominent place in the techniques used for data collection as it is one of the most used in research. It was used a script in order to find answers to the relationship of cost systems with economic theories and additional questions were made to broaden the spectrum of responses. There are a number of advantages to using the semi-structured interview as a method for data collection: 1. to overcome the (possible) poor response rates of a questionnaire survey, 2. It is well suited for the exploration of attitudes, values, beliefs and motives, 3. It provides the opportunity to evaluate the validity of the answers by observing non-verbal indicators, which is particularly useful when discussing sensitive issues, 4. It facilitates comparability by ensuring that all questions are answered by each respondent. 5. it ensures

that the respondent is unable to receive assistance from others while formulating a response (Barriball & While, 1994).

For a case study (K. M. Eisenhardt, 1989b; Yin, 2009) identify some important steps that must be taken into account in the development of a case study, which are: the designing of case studies where the logic of the case studies is established, then preparing to collect case study evidence where the necessary elements are identified before starting to collect case study data. After collecting of case study evidences (Documentation, Archival records, Interviews, Direct observation, Participant-Observation, Physical artifacts) it is necessary to define the tools for data analysis. For the latter, the literature raises 5 possibilities, which can be used according to the data obtained from these methodologies: Pattern Matching, Explanation Building, Time series analysis, Logic models and Cross-case syntheses-. Finally, the report case study must be made accord with the norms established for it. This is one of the most important steps because it will permit the consolidation of the research analysis and the understanding of the findings that allow build or enhance knowledge to existing theories giving conclusions on the subject in question and leave the door open for future research.

Due to the willingness of decision-makers within the hospital to share information. The information associated with the case comes from primary and secondary data. According to (Yin, 2009), interviews are one of the most important methods to collect information in case study, so a protocol was developed and was followed to collect information using semi-structured interviews. The interviews were carried out to the top management, middle management, the administrator and medical staff, these interviews were recorded and analyzed using ATLAS.ti 8.0 software. ATLAS.ti 8.0 is a computer program that assists those who perform a qualitative analysis, providing a tool that facilitates the organization, management and interpretation of large amounts of textual data (which can be written texts, images, sounds, maps and / or videos). For the data analysis the software uses the concept of Hermeneutic Unit (HU) which is an archive of ATLAS.ti where it will be stored and where all the material necessary to work on a qualitative analysis project will be handled. This file stores the information of the primary documents, citations, codes, code families, annotations, networks and the links that interrelate them (Friese, 2014). Other sources of information were direct observation, internal and external documents which were publicly available and offered by government entities.

In addition to the case study, an action research was developed with the objective of contributing to the design and implementation of a new costing system for hospitals. In this case, it was develop and applied in the imaging service of the studied hospital which is a transversal and strategic area within hospitals.

An action research can be expressed in four or five phases according to some authors and can be sketched as shown in

Figure 1.1. The first (*Diagnosis)* phase usually includes a situation diagnosis and an analysis of the problem to be studied. After this, a specific course of action is selected within a set of alternatives (Planning). The implementation (*Take action*) and evaluation (*Evaluating*) is done continuously and dynamically and the results observed throughout the project can be used to improve the initial solution. In this sense, an initial diagnosis was made of what were the initial conditions of the costing system within the imaging service, the number of services to be financed, the resources involved (human, materials, information systems) and with this it was possible to determine the complexity of the system to be studied and the possible ways of action were defined. These steps were used iteratively in the design and implementation of a costing system, which was built incrementally. In other words, to pass to a next phase the previous phase had to be previously validated.

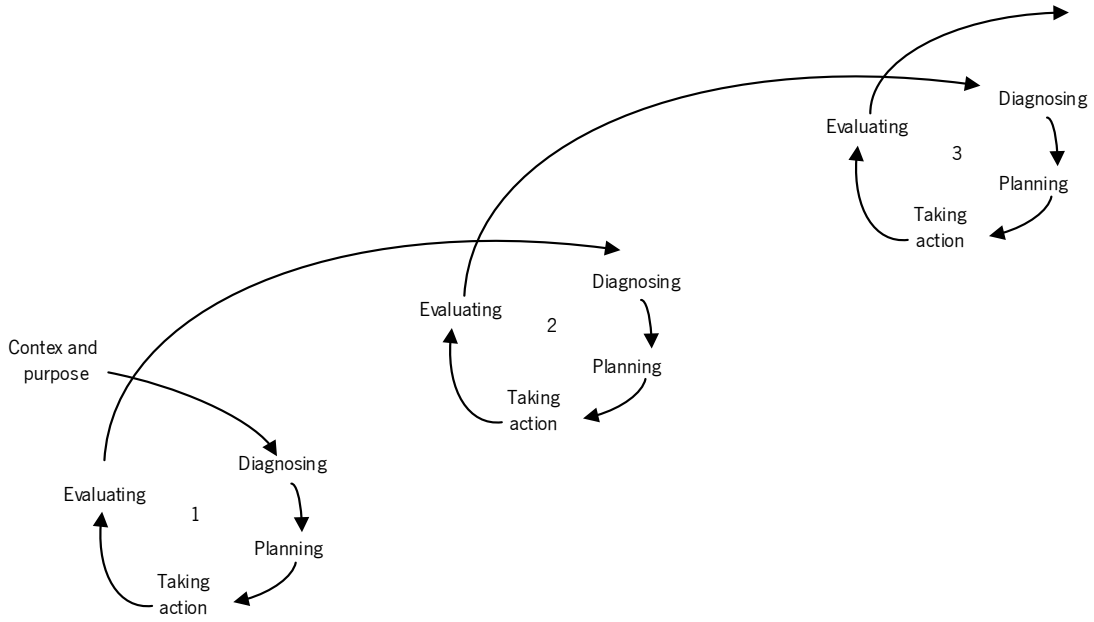

Figure 1.1. The Action Research Process
Source: Saunders et al. (2009)

The negotiation phase can be divided into several stages. One of them was with the entity that would offer information and where would be the case study and action research, where after a mutual agreement were established the limits of the project as well as the treatment and the confidentiality of information. For the interviews, the protocol mentioned in Appendix I was followed. Before each interview, interviewees

were sent the interview guide shown in appendix IV and the confidentiality term shown in appendix V. The confidentiality term was signed before each interview.

Once the negotiation was established and the information was collected, the process of information analysis and results writing was carried out. In order to validate the results found, validation meetings were held with personnel involved in the case study, in the interviews, and with the action research, to discuss and analyze the outputs of the work performed.

conducting the interviews began with the search of contact information of the interviewees, and obtained a database with the email and position of the interviewees and hospital to which they belonged, the objective to interview top management personnel, or hospital administrators Or personnel related to the management of clinical services. Once the information was obtained, contact information was sent to 41 hospitals throughout the country, of which they responded positively. 4. Although few hospitals have characteristics that give great representation to the other hospitals in the country, two of them Are hospital centers i.e. several hospitals are grouped. These two hospitals belong to the E group according to the classification of the ACSS (2016c), Shown in Appendix VI, which brings together the largest hospital centers in the country. The other hospital interviewed belongs to group C, and in this hospital in addition to interviewing top management people, we can also interview a middle management person to a person in charge of the executive, and a person in charge of a clinical center. And the other hospital is a public-private hospital, which gives another perspective since the previous three were purely public. The interviews were conducted between June and August 2016.

In addition, throughout the writing of the document, several papers were presented and presented in conferences, forums, book chapters that are already published and several scientific articles submitted to top academic journals which are currently under evaluation

The development of the research can be illustrated through Figure 1.2.

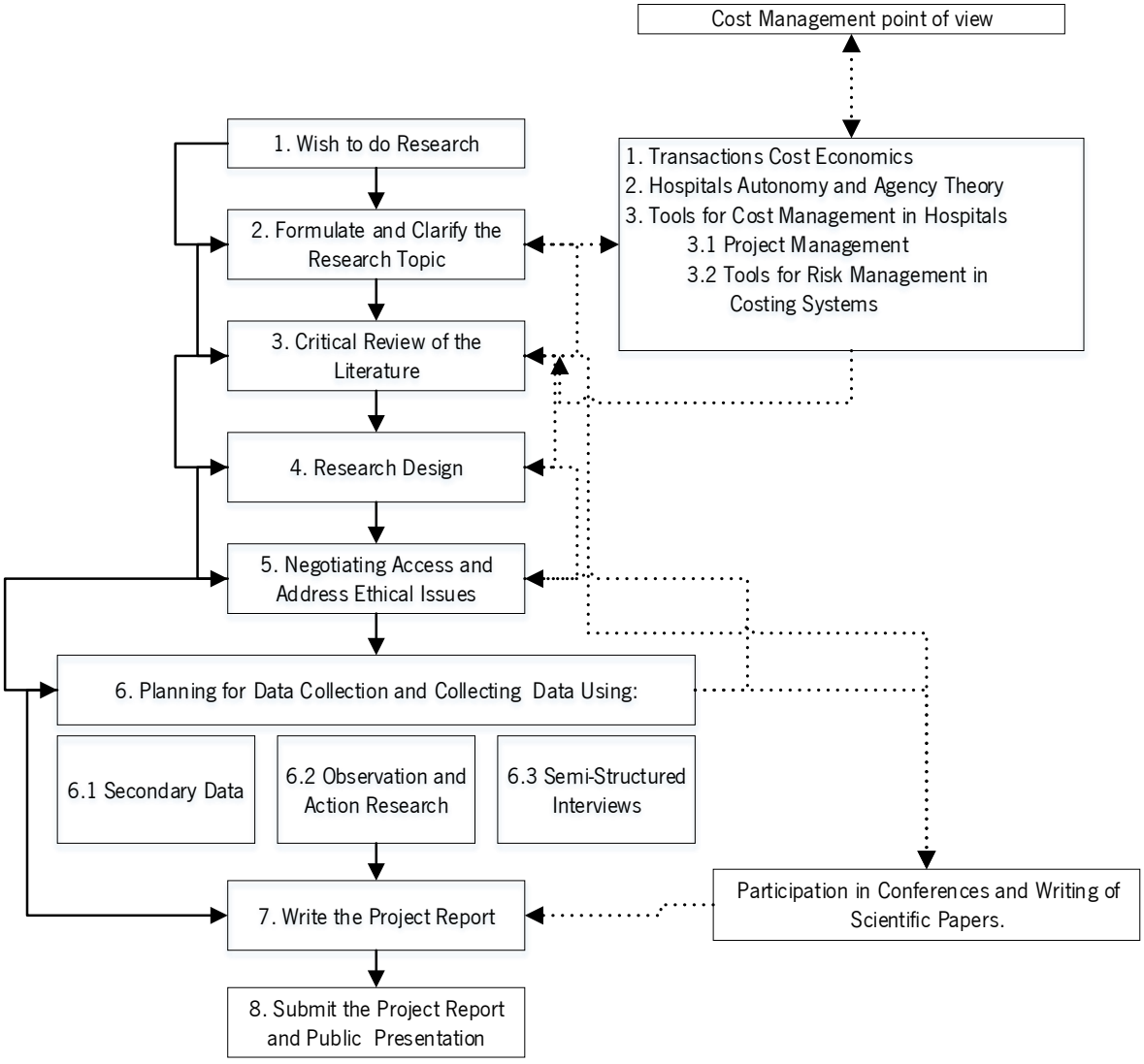

Figure 1.2. Diagram of the Methodology and Methods used in this Research

This Project uses different methodologies to address the challenges encountered throughout its implementation. Using different methodologies has the advantage that allows to adapt and find solutions more appropriate to each research question. However difficulties in handling several methodologies has to do with the dimension of work in the temporal space that the research should be done. In addition to the great amount of work to be developed and information to be analyzed.

Among the limitations of the study are the financial resources to conduct the interviews, since each interview involved researcher resources and the limitations on the part of the interviewees did not respond in a positive way to the participation of the project and the limitation derived from the study period. Finish the project which will be surpassed with the future works and contacts resulting from this research.

1.4 Organization of the Document

This document is organized in 7 chapters, ranging from an overview to a particular vision. Chapter 1 shows a framework for the project, the problems encountered, the motivation and the research questions to be answered.

Chapter 2 presents several theories and concepts that are transversal to the content of the document and serve as a basis for theoretical and practical discussions throughout the project. Chapter 2 also shows some empirical relationships between the concepts and theories that were derived from interviews conducted at various hospitals in the country and literature review. These empirical relationships serve as input for each of the chapters to follow.

Chapter 3 explores one of these empirical relationships for various hospitals. Chapter 4 discusses another of these empirical relationships already specifically for one of the hospitals discussed in Chapter 1. Chapters 5 and 6 respectively will focus on the design of management tools within a hospital department discussed in Chapter 4, and which contribute to practical answers to some of the problems identified in previous chapters. Chapter 7 presents the conclusions and opportunities for further research.

Table 1.1 shows in a schematic way how each chapter is presented, shows the general theme and also the methodology, method or source of information used.

Table 1.1. Structure of the Document

Chapter	Topic	Research Method
1	Introduction	
2	Framework for Cost Management Dynamics in Hospitals	
3	Transaction Cost Economics	Semi-structured Interviewing
4	Agency Theory and Hospital Autonomy	Case Study
5	Project Management	Action Research
6	Risk and Uncertainty in Costing Systems	Decision-Analytical Modelling
7	Conclusions	

Chapter 1 presents the problems identified, the introduction, the motivation and the research questions related to this work, as well as the methodology that was followed for the achievement of the proposed objectives.

In Chapter 2, a framework for cost management dynamic in hospitals is presented, in framework themes are explored that will be used transversally in the successive chapters. This chapter focuses on three fundamental aspects that are related to research questions. These aspects are: the importance of cost management in organizations, the importance and application of hospital autonomy and the fundamentals of Transaction cost economics and its applicability in the hospital field, it should be noted

that in this and the following chapters it is presented in addition to the content a brief introduction that highlights the logic of the chapter and a final conclusion that summarizes some important aspects found and related to the chapter.

Chapter 3 focuses on the analysis of cost management in Portuguese hospitals seen from a microeconomic perspective, for this analysis it was used the theory of transaction cost economics, and as the method of empirical data collection they were used semi-structured interviews made with top management responsible of several hospitals of the country.

Chapter 4 presents the case study that allow us to look at the relationship of hospital autonomy and cost management. The autonomy status of the studied hospital is analyzed and contrasted with the established in the law and the current reality. To analyze this relationship is used as a reference agency theory.

Since it is a theory used when there are found objectives and asymmetric information which are characteristics found in the institutions studied in this project.

So far, an evaluation of the current state of the system has been presented and possible paths of action have been derived, with the aim of contributing to the improvement of the system, hence the following two chapters emerge.

From the previous chapters, the importance of creating costing systems for hospitals was highlighted, and some important concepts emerged: uncertainty in hospitals, the quantity and variety of the information system, the lack of costing systems and resistance to change within such organizations, among others. This raised two concerns addressed in chapters five and six respectively, the first concern is related to the little importance that has been given to the planning and implementation phase of costing systems. The second concern has to do with the suitability of the costing system itself for decision making.

Chapter 5 presents a methodology for the implementation of a costing system aimed at increasing the probability of its effectiveness i.e. its success. Following the case study of Chapter 4, Chapter 5 shows an application of this methodology in one of the departments of the hospital under study.

Chapter 5 focuses on the importance of including project management in the design and implementation of costing systems, in order to increase the probability of success of this type of project, taking into account the history of the application of this type of Projects in Portuguese hospitals that failed, interview results and a practical application, this chapter focuses on two important phases of the implementation of a costing system such as design and implementation.

One of the variables identified throughout the research was the uncertainty derived from the demand for services and the patients' own needs, in order to analyze these variables and their impact on costs, the Chapter 6 presents a costing methodology that adapts to the needs of decision-makers in hospitals and

focuses on a critical variable such as the uncertainty present in the delivery of their services. Here we present a costing model that includes uncertainty, and shows a –Decision-Analytical Modelling of a costing system including the uncertainty that can be used for decision making.

Finally, Chapter 7 presents the main findings, contributions and conclusions of this research project, as well as it discusses the difficulties for its realization and the possibilities for further research.

Some appendices ae presented at the end, among them was the process of gathering information using semi-structured interviews, the process of creating the script of the interviews, the organization chart of the Portuguese national health system and how the different hospitals are grouped in relation to the financing process with the government.

2. FRAMEWORK FOR COST MANAGEMENT DYNAMICS IN HOSPITALS

2.1 Introduction

There are different perspectives to analyze an organization, perspectives ranging from the quality of its products or services offered, type of production systems, level of financial efficiency, cost management system used and others. Within a hospital organization, cost management is very important for a number of reasons. As populations age, health costs increase and in many countries hospitals are funded by the state and operate on the principle of universality "health for all People". In this context, where it is not very easy to define the market, budgets are fixed and are related to expected production volumes, i.e. the cost of treatments performed by hospitals cannot exceed the value received by the state because this would create a deficit, the other hand, considering also limiting compensation schemes based on diagnostic-related groups (DRGs), aggregate difficulty and increasing costs, hospitals face a new challenge of becoming more cost efficient to survive in this changing environment (Cardinaels et al., 2004). One of the strategic tasks for the continued viability of hospitals organizations is the development of relevant and accurate cost information on which to base strategic, pricing and management decision (Demeere et al., 2009)

In addition to this, the complexity within hospital cost management is increased because one of the fundamental aspects in these organizations is the uncertainty in their services offered, particularly, the number and condition of patients who arrive at the hospital at a given moment is variable and in some cases unpredictable (Gaynor & Anderson, 1995).

From the above description, some of the central axes of this thesis are derived, which are related to cost management, uncertainty due to the complexity of the system itself, the importance of efficiency in hospitals from a microeconomic perspective otherwise from within hospital organizations.

Cost efficiency is important not only for good hospital management, but is also a strategic important measure for health funders, which in many cases is heavily supported by government resources (OECD, 2016). In this sense, the government should ensure that resources are used in the best possible way, and one of the mechanisms used for this purpose is the establishment of contracts where not only the volume of production is contracted, but also the maximum cost that the state would be willing to assume for the realization of such production.

In the specific case of the legislation where this study is framed as it is in the Portuguese reality, the state contracts with the hospitals through contracts denominated "the contract" and, in turn, hospitals' top management has to contract with the different departments the volume of production and the expected cost of such production, which implicitly suggests efficiency measures. Is because this that is important to study cost management in hospitals from a contractual perspective, and it is here that the Transactions Cost Economics theory -TCE- takes relevance.

TCE has been applied to analyze the costs associated with changing contractual activities in various health care situations (Ashton, 1998; Ashton, Cumming, & Mclean, 2004; Castaño & Mills, 2013; Marini & Street, 2007; Robinson, 2001), in general terms, this theoretical approach presents a vision of how the organizational structure should be in terms of contractual relations, and defines the transaction costs associated with that structure.

Contract compliance is translated into hospital efficiency, and in recent years the efficiency of hospitals primarily funded by the government has been linked to the autonomy given to hospitals (Castaño & Mills, 2013; London, 2013; Méndez & Torres A, 2010), i.e. autonomy from government to top management and autonomy from top management to the different departments. In this sense, another important variable to analyze is the degree of autonomy and the relationship with cost management and decision making, for that it shows the importance, advantages and disadvantages of this approach in hospital organizations, and how this has been applied in hospitals belonging to the Portuguese national health system. This chapter will also focus on the relationship between hospital autonomy and cost management and how this can affect the degree of contract compliance and organizational structure, in other words this chapter studies the relationships between cost management, TCE and hospital autonomy and agency theory. In spite of studying these relationships in this chapter, chapter 3 explores in more detail the use of TCE to understand cost management in hospitals. In chapter 4 the relationship between hospital autonomy and agency theory is discussed. Both chapters are presented from the perspective of cost management.

This chapter is structured as follows, after this introduction, some important concepts are presented and explained; namely, related to cost management in organizations to then focus on cost management in hospitals, concepts related to the theory of transaction cost economics and also aspects related to hospital autonomy. Then, an exploratory analysis is presented through interviews in several Portuguese hospitals, public and semi-public, and secondary documents. Then, a framework is presented, highlighting the relationship between cost management, TCE and hospital autonomy in the context studied, and finally some conclusions are derived suggesting further research in these topics.

2.2 Conceptual and Theoretical Assumptions

2.2.1 Strategic Cost Management

The globalization of markets and operations has given a fresh impetus to the managers of twenty first century firms for developing new perspectives of various managerial functions that include marketing, design, engineering, production, finance, human resources and accounting (Angappa Gunasekaran & Kobu, 2007). All these perspectives have been developed for meet organizations' goals particularly increasing the value they offer to a wider range of relevant stakeholders. The ability of a company to increase its value added and compete effectively on the increasingly competitive global market is influenced to a large extent by the cost as well as the quality of its products and the ability to bring products into the market in a timely manner (Asiedu & Gu, 1998).

For Stenzel & Stenzel (2003), the cost is an outflow of resources for to the production of goods or services that are expected to have a future benefit to an organization.

Good cost estimation has a direct bearing on the performance and effectiveness of a firm because overestimation can result in loss of business and goodwill in the market, whereas underestimation may lead toward financial losses to the enterprise. Because of this sensitive and crucial role in an organization, cost estimation has been a focal point for the design of operational and strategic plans and a key agenda for managerial policies and business decisions (Niazi, Dai, Balabani, & Seneviratne, 2006).

For organizations be able to optimize their costs, it is first important to quantify them in an accurate manner. The accounting information system is a tool used for this end. The accounting information system within an organization has two major subsystems: a financial accounting system and a (cost) management accounting system.

The main difference between these two systems is the target user. Financial accounting is intended to provide information to both internal and external users, including investors, creditors and government agents. Because that, this type of information must be highly reliable and they have been defined clearly international accepted rules specifying formats and principles of accounting standards for all organizations. On the other hand, traditionally, cost management systems provide information to internal users. Nevertheless, open-book strategies and inter-organizational cost management practices have been changing this paradigm. Specifically, cost management practices include identifying costs, collect and record them, measure, classify and report from different perspectives and considering different assumptions turning such information useful for managers. Cost information is fundamental to determine the cost of products but also serve as a precious tool for decision making. Thus, nowadays, cost

management has a much broader approach than that found in traditional costing systems (D. R. Hansen & Mowen, 2006).

For example, there is a need for satisfactory cost estimation and cost control during the planning phases of the product development cycle. Market demands have changed towards higher quality, shorter delivery times and lower product costs. To be competitive, it is necessary to keep the production costs as low as possible, in order to keep the selling price low. This can lead to an increasing amount of products sold. Anecdotal examples and empirical perception suggest that between 70% and 75% of the product costs is committed during the product design process. Consequently, after the design process has been completed, most opportunities of cost reduction have passed (Asiedu & Gu, 1998; Weustink, ten Brinke, Streppel, & Kals, 2000).

The causes of these costs should be carefully studied. But, the costs of activities and processes do not appear on the financial statements. Yet, knowing these costs and their underlying causes is critical for companies engaging in such tasks as continuous improvement, total quality management, environmental cost management, productivity enhancement, and strategic cost management. Cost management encompasses both the cost accounting and the management accounting information systems.

Cost accounting attempts to satisfy costing objectives for both financial and management accounting. When cost accounting is used to comply with a financial accounting objective, it measures and assigns costs in accordance with the Generally Accepted Accounting Principles (GAAP), cost accounting provides data necessary to measure the true cost of products and to aid in the determination of selling prices (Fleischman & Tyson, 1993; D. R. Hansen & Mowen, 2006).

When used for internal purposes, cost accounting provides cost information about products, customers, services, projects, activities, processes, and other. The cost information provided plays an important support role for planning, controlling, and decision making. This information need not, and often should not, follow the GAAP.

Management accounting is concerned specifically with how cost information and other financial and nonfinancial information should be used for planning, controlling, continuous improvement, and decision making. Management accounting has an overall objective of making sure that organizations make effective use of resources so that value is maximized for shareholders and customers and other interested shareholders.

It should be emphasized that both the cost management information system and the financial accounting information system are part of the total accounting information system (D. R. Hansen & Mowen, 2006).

Indeed, the definition of costing systems implies the recognition that there are generally three types of accounting within organizations namely, administrative, financial and cost accounting (D. R. Hansen, Mowen, & Guan, 2009). For Hansen et al. (2009) and Horgren, Datar, & Rajan (2012a), management accounting measures, analyzes and presents financial and nonfinancial information that helps managers make decisions to achieve the organization's goals, i.e. it is responsible for producing information for internal users; financial accounting is oriented to external users, including investors, government agencies, banks, etc. by measuring and recording business transactions and providing financial statements based on generally accepted accounting principles. Cost accounting provides information to management accounting and financial accounting. Cost accounting measures, analyzes and presents financial and non-financial information associated with the acquisition or use of resources in an organization. Unfortunately, the content of the cost management accounting system is all too often driven by the needs of the financial accounting system. The reports of both cost management and financial accounting are frequently derived from the same database, which was originally established to support the reporting requirements of financial accounting. Many organizations need to expand this database, or create additional databases, in order to fully satisfy the needs of internal users. For example, the overall firm's profitability is of interest of investors, but managers need to know the profitability of individual products. Thus, the accounting system should be designed to provide both total profits and profits for individual products (D. R. Hansen & Mowen, 2006).

Whether an organization sells a product or provides a service, managers must understand how revenue and costs behave, or risk losing control. Indeed, the cost accounting information system is indispensable to make decisions with a strategic formulation, for research and development, budgeting, production planning and pricing, among others (Horngren et al., 2012a).

Nevertheless, like the value of economic goods, the value of a management accounting system depends on its costs and benefits for an organization. The benefit of its management accounting system rests on the system's ability to the transmission of information which will help reach wise economic decisions and the motivation of users to aim and strive for organizational objectives or goals (Horngren, 2004). The cost management system, as part of a management accounting system, is no exception.

For Ehrlenspiel, Kiewert, & Lindemann (2007) there exists various classifications or points of view about costs in an organization. For example, direct cost and indirect costs or overhead; fixed costs versus variable costs; among others.

For this motive, various approaches and methods have been developed for the estimation of costs in organizations. For example, as shown in

Figure 2.1, Niazi et al. (2006) present quantitative and qualitative methods which were developed in order to estimate the cost of producing a good or providing a service.

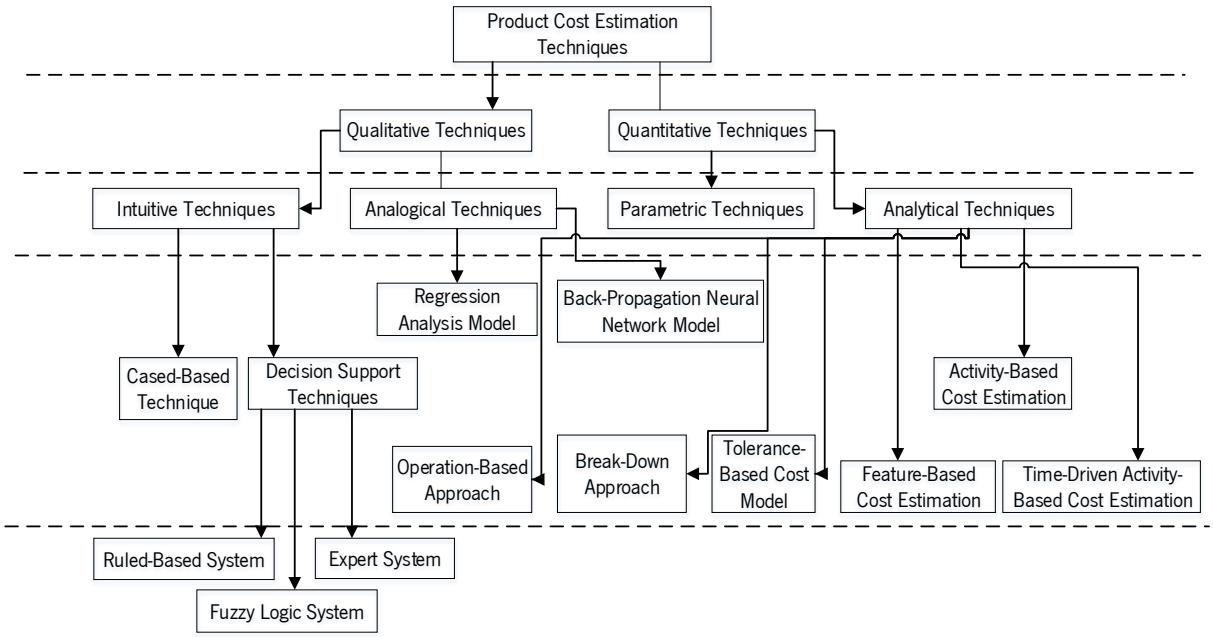

Figure 2.1. Classification of Product Cost Estimation Techniques.
Source: Adapted from Niazi et al. (2006)

As shown in Figure 2.1 there are several methods for estimating costs in an organization, methods ranging from intuitive techniques, where there is little or no information available, to quantitative techniques where are required a lot of information to estimate the cost.

Qualitative cost estimation techniques are primarily based on a comparison between a new product and products that have been manufactured previously in order to identify the similarities with the new one. The identified similarities help to incorporate the past data into the new product so that the need to obtain the cost estimation from scratch is greatly reduced. In that sense, the past design and manufacturing data or previous experience of an estimator can provide useful help to generate reliable cost estimations for a new product that is similar to a past design case. Sometimes, this can be achieved by making use of the past design and manufacturing knowledge encapsulated in a system based on rules, decision trees, etc. Historical design and manufacturing data for products with known costs may also be used systematically to obtain cost estimates for new products.

Quantitative techniques, on the other hand, are based on a detailed analysis of a product design, its features, and corresponding manufacturing processes instead of simply relying on the past data or knowledge of an estimator (Niazi et al., 2006).

The aim of a company's activities is to increase and ensure its profits. Since profits equal the earnings less the costs, there are basically three approaches to maximizing profit (Ehrlenspiel et al., 2007): increasing earnings, the rationalization of processing costs and the development of cost-effective products focusing on reducing the cost from the product design stage.

Cost management is targeted and systematic steered to cost optimization. The aim is to influence the costs of products, processes and resources by using concrete measures, such that an appropriate company success is achieved, and its competitive strengths are improved for a long time to come (Ehrlenspiel et al., 2007).

It is not only concerned with how much something costs but also with the factors that drive costs, such as cycle time, quality and process productivity. Thus, cost management requires a deep understanding of a firm's cost structure as well as its business and product processes.

Implementing cost management successfully requires utilizing appropriate standards, concentrating efforts for maximum effectiveness, and being consistent (Isola, 2002). Managers must be able to determine the long and short-run costs of activities and processes as well as the costs of goods, services, customers, suppliers, and other relevant cost objects.

In this context, various tools have been developed for cost management including standard costing, target costing, activity based costing and management, etc. But, the use of appropriate techniques are not enough. Cost management effectiveness result from fitting characteristics of the organization and contingencies that reflect the situation of the organization; such as the organizational structure, external environment, size, strategy, etc.(Donaldson, 2001).

For this, there is not a unique set of techniques or a combination of methodologies for an organization to manage effectively its cost. Different firms should use different methods for cost controlling and management and for taking strategic decisions.

Furthermore, since the principal aim of private firms is to obtain profit, they seek to keep costs under control but also maximize value. Thus, there is a need to apply a strategic cost management (SCM) approach which relies on the fact that the principal aim of the cost management system is to help enterprises maximize their profit (Apak, Erol, Elagöz, & Atmaca, 2012). SCM is the process of using cost management methods and practices to help companies reach their strategic goals and objectives (Sawyers, 2009).

In this context, one of the important roles of internal accounting information systems within a business is to facilitate the development and implementation of business strategies. Under this view, business management is a continuously cycle of four stages process: 1. formulating strategies, 2. communicating those strategies throughout the organization, 3. developing and carrying out tactics to implement the strategies, 4. developing and implementing controls to monitor the success of the implementation steps and hence the success in meeting the strategic objectives. Cost information play a role at each of these stages. From this perspective, Strategic Cost Management can be defined as the managerial use of cost information explicitly directed at one or more of the four stages of the strategic management cycle. It is such explicit attention to the strategic managerial context that distinguishes SCM from managerial accounting. SCM result from a blending of three underlying themes that are each taken from the strategic management literature. The three elements of SCM are: 1. Value Chain Analysis, 2. Strategic Positioning Analysis and 3. Cost Driver Analysis (J. K. Shank, 1989).

Regarding Cost Driver Analysis proposed by Shank (1989) it is important to point out that Shank's definition is different from the one normally used in costing systems such as ABC. Shank divides the drivers into two categories, a first one called structural cost drivers, related to strategic decisions that will affect the long-term cost structure which are related to: scale, scope, experience, technology and complexity of the organization. The second type of drivers is called executional drivers and are related to: work flow investment, total quality management, capacity utilization, plant layout efficiency, and product configuration and exploiting linkages with costumer or costumer. One of the differences in addition to the length of time they affect (structural is related to long term and executional is related to short and medium term) in the structural drivers more is not always better and in the executional drivers more is always better.

In summary, the accounting and financial management systems and strategic cost management can be represented as it is shown in Figure 2.2.

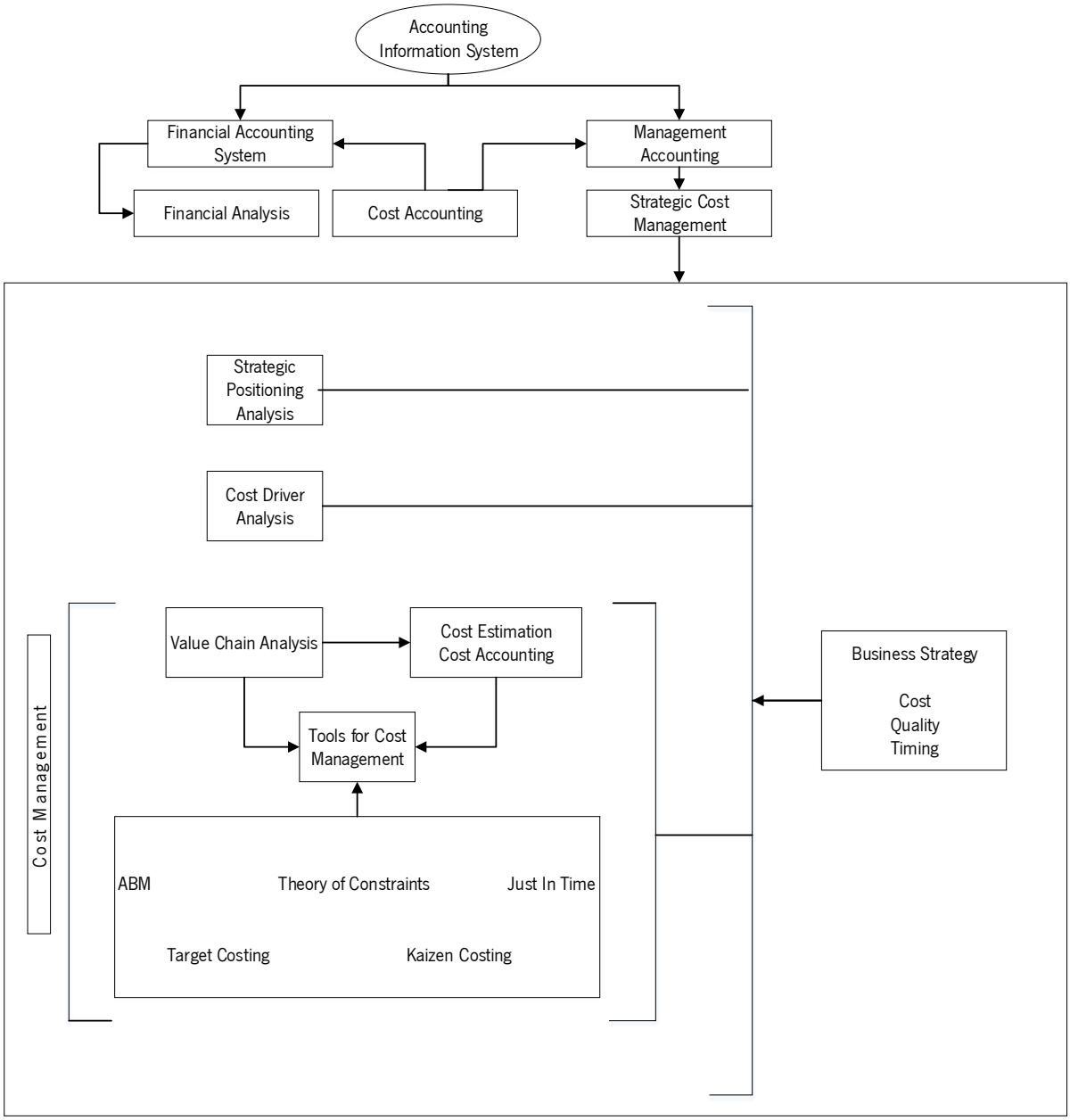

Figure 2.2. Accounting Information System and Strategic Cost Management

Today, researchers and practitioners go beyond the concept of cost accounting and prefer to talk about cost management. This change in terminology is not just in terms of appearance. A cost management approach requires a depth definition of the firm's cost structure and a proper understanding of the business processes. Managers should be able to determine the costs for long periods of core activities and processes, as well as the costs of goods and services. The costs of activities and processes do not appear in the financial statements, but are used for planning, control and decision making. Cost

management is a broad approach and should not be interpreted only as a continuous cost reduction effort. Planning and cost control are usually inextricably linked with the planning of costs, revenues and profits.

Various strategies have been adopted in order to contain costs and different approaches are appropriate in different health care systems. In England, where cost containment has been relatively successful, the emphasis has been on finding ways to increase the productivity of resources in the health care sector. Other countries are likely to follow suit as cost containment strategies take hold (Dawson et al., 2001).

Cost management relies on the principle that costs should be known to use such information for decision making. From the conception of functional organization of a hospital, costing systems presents several alternatives in terms of cost objects. For example, they can be calculated the cost of a service, an order of various services, a department, a responsibility center, a cost center or a profit center. In hospitals, Activity-Based Costing (ABC) can be used to calculate more accurately and allocate better indirect costs which are an increasingly important component of the total cost. By focusing its interest in activities, ABC offers, among others, the following advantages: it identifies the activities that do not add value, identifies expensive or inefficient processes, facilitates continuous improvement, and reduces costs. Indeed, this is one of the methodologies used today by greater acceptance and credibility in terms of costing (Gosselin, 2006).

The data used to develop costing systems are uncertain due to a heavy reliance on parameter estimation. This primarily exists because gathering the necessary information to generate product costs is an expensive process and also because in some cases the processes are varied and difficult to standardize. Since data are typically historically based and often estimated, the true values of such data are uncertain, and the input data are likely to be inaccurate. The need to take into account the uncertainty in planning decisions dating back to the models of functional planning, where resources for the future are allocated based on current data and future projections. Given that the true value of each data parameter may never be known, it is important to acknowledge and handle the uncertainty within the costing system. This will allow the system user to have a better understanding of the behavior of the system and its inherent risk (Nachtmann and Needy 2003a; Gupta and Maranas 2003).

Yet, in health care there is a progressive need to refresh cost accounting techniques in order to allow managers and clinicians to obtain more accurate information so that it may be possible to analyze the profitability of each department, service and other relevant cost objects, supporting future investments. Considering that work requirements are now more complex, more uncertain and changing, control systems cannot be static and formal (Davila, Foster, & Oyon, 2009). Even ABC data are often estimated

due to cost and time constraints, which leads to inherent imprecisions and uncertainty (Nachtmann & Needy, 2003).

2.2.2 Cost Management in Hospitals

The twentieth century was characterized by the predominance of social and political thought which held that public health was the responsibility of the state and that it is more able to deliver health services to all people and particularly to those who could not pay private services (Bernal, 2007).

Health systems are predominantly public, and in most cases, governments are the main providers of health services being also responsible for the legislation governing the health system. The amount of resources invested in health care represents a significant amount within the economies of the countries, for example, Figure 2.3 shows the health expenditure as a percentage of the GDP of different countries mainly in Europe. In 2015, the European Union –EU– dedicated 9.9% of its GDP to health care.

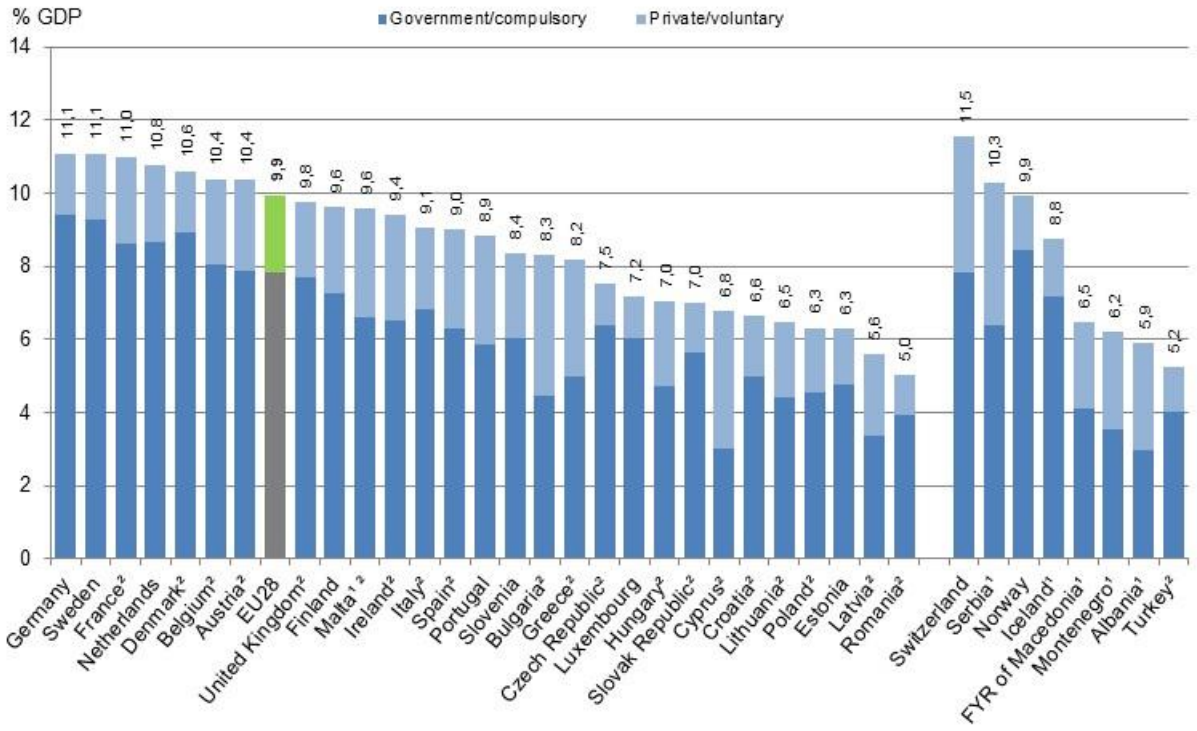

Figure 2.3. Health Expenditure as a Share of GDP, 2015 (or Nearest Year)
Source: OECD Health Statistics 2016 (OECD, 2016)

Clearly, the role of the private sector in the health system is determined by the dominant role of the public administration and its policies in terms of health.

The Figure 2.4 shows the historical expenditure on health services as a percentage of the GDP of several countries between the period 2005 and 2015, in this Figure the behavior of Portugal is highlighted and that as shown in Figure 2.4 it has closely followed the average of the Countries of the EU. From these resources, around 70% are dedicated to hospitals. Given the large number of resources dedicated to health care and its importance to society as an essential good, it is necessary to develop tools that allow them to be applied efficiently, to improve their application, to be controlled, among others.

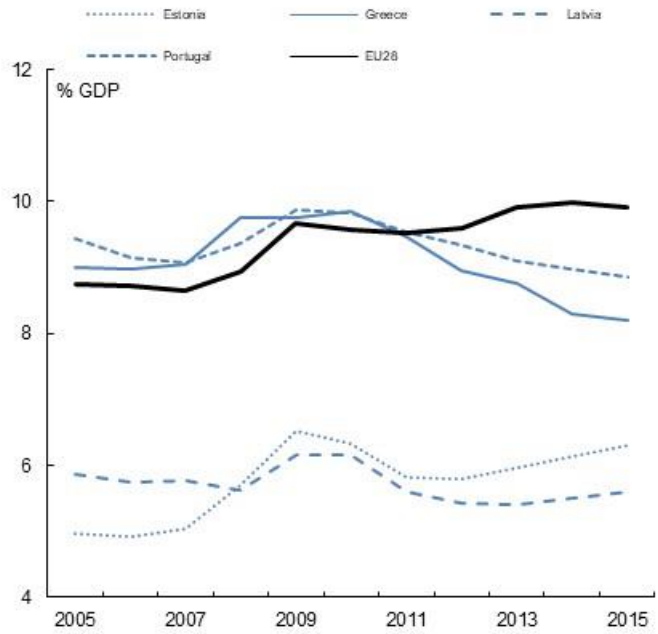

Figure 2.4. Health Expenditure as a Share of GDP, Selected European Countries, 2005-15
Source: Health Statistics 2016, OECD (2016)

To give a good health care service, organizations should strive to make a good use of resources namely, labor costs and financial resources. One way to achieve such objective is through effective cost management practices; for it must understand how costs are really configured as these should be taken into account to not only to reduce the need of financial resources but also to maintain or even improve the quality of the service through a higher economic efficiency of the use of the available resources.

A health system is the sum total of all the organizations, institutions and resources whose primary purpose is to supply or support health services. A health system needs staff, funds, information, supplies, transport, communications and overall guidance and direction. And it needs to provide services that are responsive and financially fair, while treating people decently. Within health care systems the organizations that generally consume the most resources are the hospitals, which makes it essential for them to have an efficient cost management.

For Nackel, Fenaroli, & Kis (1987), an efficient cost management system in a hospital must fulfill at least five basic functions which are: cost determination, activity forecasting, functional cost center budgeting, performance reporting on a product level and performance reporting on a functional level. Of these aspects, the determination of the cost will be an aspect to emphasize throughout this thesis.

Several methodologies have been used to estimate costs in hospitals, among which Diagnosis Related Groups –DRG- (Hauck, Zhao, & Jackson, 2012; Lehtonen, 2007), Activity-Based Costing –ABC– (Krug, Van Zanten, Pirson, Crott, & Borght, 2009) and in recent years, Time-driven activity-based costing –TDABC– (Keel, Savage, Rafiq, & Mazzocato, 2017). The DRG was firstly developed by (Fetter & Freeman, 1986) of university of Yale and since 1983 has been used as an approaching financing system in the United States. DRG is a system of classification of patients admitted to acute hospitals that groups patients into clinically coherent and similar groups from the point of view of resource consumption –no necessarily is considered a costing method–. It allows to define operationally the products of a hospital, which are not more than the set of goods and services that each patient receives according to its needs and the pathology that led to the hospitalization and as part of the defined treatment process. A relative weight, i.e. a weighting coefficients reflecting the expected cost to the treatment of a typical patient grouped in that DRG, expressed in relative terms against the typical average patient cost at the national level, is associated with each group. The case-mix index (CMI) of a hospital thus results from the ratio between the number of equivalent patients weighted by the relative weights of the respective DRGs and the total number of equivalent patients. The DRGs have been used normally for reimbursement purposes (Voss, Limpens, Brans-Brabant, & van Ooij, 1997).

In 1984, a project was started in the Ministry of Health to study the feasibility of implementing this system in Portugal. The project resulted from a contract between the Portuguese Ministry of Health and the U.S. Agency for International Development for the studies of adaptation of the American model to the Portuguese reality.

In 1989, the first tests of the use of DRG were made as a basis for financing hospitalization. The classification of patients in DRG was generalized and became mandatory. It was precisely in 1990 that

the concept of case-mix obtained through the DRG was used for the first time to calculate the financing of hospital admission of the Portuguese NHS.

With regard to the *"Contrato programa"* (The contract) , the inpatient production lines, outpatient surgical and part of the medical outpatient services are financed in full on the basis of that patient classification system accounting for around 51% of total funding in 2009 of the NHS sources . The financing of these production lines results from the product between the base price, the case-mix index and the number of equivalent patients.

The Table 2.1 shows the development of several DRG systems in Europe - including Portugal - and the purpose for which they are used.

Table 2.1. Introduction and Purpose of DRG System Over Time

Country	**Year of DRG introduction**	**Original purpose(s)**	**Principal purpose(s) in 2016**	**The share of hospital cost reimbursed through DRG payment**
Portugal	1984	Hospital output measurement	Payment, budgetary allocation, performance measurement	80%
France	1991	Description of hospital activity	Payment	80%
England	1992	Patient Classification	Payment	60%
Ireland	1992	Budgetary allocation	Budgetary allocation planning	<80%
Finland	1995	Description of hospital activity, benchmarking	Planning and management, benchmarking, hospital billing	Varies by Hospital
Sweden	1995	Payment	Benchmarking, performance measurement	Varies by Hospital
Spain(Catalonia)	1996	Payment	Payment, benchmarking	15%-20%
Austria	1997	Budgetary allocation	Budgetary allocation planning	96%
Estonia	2003	Payment	Payment	39%
Germany	2003	Payment	Payment	80%
Netherlands	2005	Payment	Payment	84%
Poland	2008	Payment	Payment	>60%

Source: Adapted from Busse, Geissler, Quentin (2011), and Miriam and Siok Swan Tan et al. (2014)

It is noteworthy that the application of the model in Portuguese hospitals is one of the oldest in Europe. The implementation of DRGs in Portugal was a fundamental step to introduce new concepts and a new attitude in the management of hospitals and its financing model focused on the concept of inpatient product (ACSS, 2011a).

Generally, DRG systems are fed by outputs from hospitals themselves. The data provided by cost accounting plays an important role in calculating the weights of DRGs but if the data given by accounting systems is inaccurate at the end estimated DRGs will also be inaccurate. In addition, DRG systems do not allow to identify activities or processes where the production and the management of the resources can be improved and thus contribute effectively to the overall efficiency of hospitals.

In this sense, hospitals must decide on a costing system that suits their needs. Costing methodologies can be grouped depending on the level of detail and desired accuracy as shown in Figure 2.5 where the level of precision is determined by the identification of cost components -gross costing versus micro-costing- and valuation of cost components -top-down versus bottom-up costing-, the combination of the bottom-up and micro-costing methodologies is generally believed to be the better methodologies because allows to calculate the cost of the products or services with more accuracy and also offer information for the improvement of the efficiency of the processes.

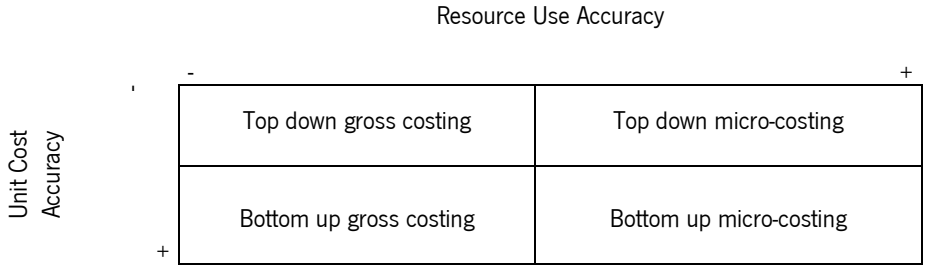

Figure 2.5. The Level of Accuracy at the Identification and Valuation of Cost Components
Source: S. S. Tan, Rutten, Van Ineveld, Redekop, & Hakkaart-Van Roijen (2009)

A methodology bottom-up micro-costing that has been used and is of great acceptance in the organizations is the Activity-Based Costing (ABC) - (Lawson, 2005). Table 2.2 shows some examples of research on of ABC costing in hospitals and their main results.

Table 2.2. Application of ABC in Health Care

Author(s) and Year	Application or Findings
(Udpa, 1996)	This research shows the application of an ABC to a hospital's outpatient care service, this article highlights the difficulties for cost estimation when the cost information is poor, or, there is more is distributed in different information systems.
(Baker & Boyd, 1997)	For a surgery room, they analyze how the cost system reports are presented and how this information can be used to improve efficiency and quality.
(Lievens, Van Den Bogaert, & Kesteloot, 2003)	One of the aspects to be highlighted in theses researches is that the ABC allows to identify key costs, or critical costs that must be analyzed and controlled for the improvement of cost efficiency
(Grandlich, 2004)	He shows the advantages of using an ABC costing system in surgery. These advantages include the identification of critical activities -those activities that contribute greatly to cost-, improvement in financial forecasts and the possibility offered to identify opportunities for savings.
(Cardinaels et al., 2004; Eldenburg, Soderstrom, Willis, & Wu, 2010)	They find that one of the factors to ensure the success of a costing system is related to involving physicians in the design process of the costing system and in the information systems that support the costing system.
(Larsen & Skjoldborg, 2004)	They compare the ABC costing system with the DRG system and shows the implications of sub or over estimating the cost mainly when the information is used in the repayment process.
(Lawson, 2005)	He performs a longitudinal study in health care organizations and finds that they give up on the implementation of a costing system due to its complexity and lack of commitment of the top management.
(Shander et al., 2010)	They apply the ABC costing system in 4 different hospitals for the blood transfusion process during surgery. An aspect to be highlighted is that the information resulting from the ABC helped to discover the existence of overestimation of the costs and of internal variability derived from the geographical position of the patients.
(Pandey, 2012)	This research identifies the advantages of the ABC method in comparison to traditional costing methodologies in healthcare, noting that although it has advantages, the adoption of ABC as a method for estimating costs requires a substantial commitment and could challenge the beliefs, Habits, and long-standing priorities. However, the marginal benefits obtained from a better understanding of actual costs may be greater than the marginal costs derived from the estimate.
(Cannavacciuolo, Illario, Ippolito, & Ponsiglione, 2015)	In their research they highlight how ABC can help identify inefficiencies in therapeutic pathways established in healthcare organizations. Despite the advantages offered by this method, they also show that migrating from a cost center-based accounting system to an activity-based system is a complex process, and can be a barrier to using this method.

In recent years some research in health care have used the TDABC developed by (R. S. Kaplan & Anderson, 2004) which uses the logic of ABC however for some processes simplifies the calculation of cost given the simplification in the use of drivers, TDABC demands fewer resources by demanding only two important parameters: the capacity cost rate, and the time required to accomplish activities in service

delivery – thus the name "time-driven". Table 2.3 shows some of these research and some aspects that stand out in them.

Table 2.3. Application of TDABC in Health Care

Author(s) and Year	Application or Findings
(Demeere et al., 2009)	This research focuses on the impact on management decisions with the implementation of a TDABC in outpatient clinic environment, and highlights some advantages of TDABC on ABC, among them the rapid adaptability of the model to the changes and the decrease of complexity as compared to the ABC model.
(R. S. Kaplan et al., 2014)	They study how different hospitals in Europe and the United States have applied the TDABC with the aim of improving the quality of services provided to patients. They find that TDABC is widely accepted among physicians in hospitals where it is applied and can be a tool for continuous improvement of services.
(Yu et al., 2016)	They find that one of the difficulties in the application of TDABC in surgery has to do with the degree of resource utilization during surgery, to solve this problem they recommend involving the medical staff in the process of design and implementation of TDABC.
(Keel et al., 2017)	Despite the advantages with respect to ABC, the authors point out that it is a recent methodology and some potential of the model such as being able to be applied in reimbursement processes is still in an incipient stage, so they recommend to evaluate very well the move to this new methodology, since it can be costly and the marginal gain of migrating to the TDABC may not exceed the marginal cost when compared with the cost systems already existing in hospitals.
(Haas & Kaplan, 2017)	They used TDABC to compare the variance in cost of a medical procedure in 29 hospitals in the United States, highlighting the reduction of complexity derived from the decrease of drivers compared to ABC.
(Yu et al., 2017)	They highlight the detailed process maps with the application of TDABC and their adaptability to process changes and therefore to the change in costs.

Regardless of the costing methodology used, it is always appropriate that the management of the hospitals well as the regulating authorities should consider if the benefits of having a costing system that calculates the costs in a more detailed way are greater than the additional costs and the complexity incurred in the improvement of such costing system (Siok Swan Tan et al., 2014).

With respect to the second function described by Nackel et al.(1987), the activity forecasting**,** this function takes place in two levels - product and procedure - in the first step the demand for each product must be estimated At the first level, it is necessary to estimate the demand for each product. Given the variety of services that are normally offered in a hospital, the analysis for each service may be unmanageable, so it may be necessary to group services by production lines or families with the objective of reducing information and making it more manageable for decision makers. The product lines or families allow a

more reasonable analysis of the factors that are going to affect the expected demand, this includes: the absolute and the relative demands.

The absolute demand, which depends on the characteristics of the population, mortality rates, morbidity, and treatment options, and, the relative demand, which is the participation of the hospital in absolute demand based on competitive factors, case mix index, composition of medical personnel, number of beds, installed capacity, geographical position, among other factors.

The process of estimating product demand is generally the responsibility of the hospital's top management, along with production managers and service managers who are generally doctors. Once product demand has been predicted, the volume and type of product that such demand requires will also be predicted, in terms of quantity, resource consumption and processes.

Once this process is completed, the hospital is ready for the functional cost center budgeting. In this stage, the hospital must translate the demand for predicted workload into each cost center into a forecast of the financial, labor, material, and overhead requirements necessary to meet anticipated demand or contracted demand for a given period, a work in which statistical information is needed and where possible occurrence of future diseases should be considered and their possible impact on workload and costs. Then, for performance reporting on a product level, once the activity is executed, it is necessary to compare the actual production, with the estimated production, in order to determine deviations, possible causes and what will be the course of action for the next period. And, finally in the performance reporting on a functional level the cost information will only be useful if it can be used to make decisions, in the sense of comparing the actual cost information incurred with the information estimated for example in the annual budget in order to identify future intervention measures aimed at improvements of efficiency and improvements in the provision of services.

2.2.3 Hospital Autonomy

According to (Makinen et al., 1993), hospital autonomy is related to that hospitals are partly self-governed, self-directed or generate their own financing with income related to system user payments. Autonomy can be seen in several ways, at one end can be hospitals funded and directed directly by the government, and at another end are private hospital institutions and whose direction is independent of the state, and between these two extremes are some entities with more or less level of autonomy.

Hospital autonomy involves public hospitals that are part of the NHS of a country and become institutions based on greater freedom for its governance and management thus eliminating bureaucratic constraints in order to maximize efficiency. The hospital autonomy should not be understood as a dichotomy hospitals

versus governments, but as a removal of barriers to governance and leadership, improving the management of resources and to fulfill the objectives expressed through the laws of the regulator, which is in most cases the State (D. Collins, Njeru, Meme, & Newbrander, 1999; Méndez & Torres A, 2010). Hospital autonomy has a number of different meanings. In general, the term is used for describing public hospitals that have moved away from being part of the public sector health system, with all the bureaucratic constraints this system imposes on their management, to having more latitude in their government and management.

Three basic elements are defined to measure the degree of hospitals' autonomy: governance, operations and management, and finance. Governance is associated with the ownership of the assets of the hospital, who owns the assets and has the ability to set policies? Management and operations are related with the administrative functions necessary to provide hospital services and the management of medical and nursing staff. Finance is related to who finances and pay hospital operations, including recurrent costs and the cost of capital (D. Collins et al., 1999). Table 2.4 shows the range of states for hospital autonomy considering Collins et al. (1999).

Table 2.4. Range of States of Hospital Autonomy

Level Element of Hospital Organization	- - - No autonomy	- - + Intermediate states of autonomy	- ++ Intermediate states of autonomy	+++ Full autonomy
Governance				
Hospital Board	MOH hospital with MOH hospital administrator, no hospital board	Non-profit corporation; government officials and community board of directors	For profit corporation; Private board	Privately owned and managed
Long-range Planning				
Operations and Management				
Clinical Management Administrative management Human resource management Supplies and logistics	MOH personnel	Blend of MOH and private sector	Hospital corporation personnel	Private sector Personnel and owned
Financing				
Financial Management Source of funding	100% government allotment	Modest income from users fee and insurance; Most income from government allotment	Most income from user fees and insurance; Some government subsidy	100% income from user fees and insurance
Generating revenues				

Source: Adapted from Collins et al.(1999)

Consequently, autonomy regularly relates to the decentralization of decision-making from the central national administration. In the last years, many countries have practiced some changes in the organization of their health care systems. Decentralization of financial and political power has been perceived as useful to improve outcomes; namely, leadership, governance and competition have come to the fore in health care systems of different economies. In particular, decentralization has been perceived as a means to revamp the performance of health care systems and as a way to provide services that correspond to local needs and demands, what is an obvious problem in many health care systems worldwide and is an evidenced by the imbalance in the distribution of hospital resources. In this context, funding and/or management responsibilities have been transferred to sub-layers of government - e.g. there are regions in Italy which confirm the complexity of such processes of decentralization and re-centralization that sometimes can paradoxically reinforce each other - or to specifically created health agencies -i.e. District Health Authorities in Britain or Regional Health Administrations – (RHA) in Portugal. It is not always easy to show improvements in a health system after the adoption of a more autonomous system. For example, hospital autonomy in Vietnam is generating complex and varied effects. In municipal and provincial hospitals, giving autonomy to hospitals has created opportunities to reorganize services, increase investments and revenues, and improve staff pay. But, the effects of autonomy on service quality are unclear (London, 2013).

Various are the objectives to be attained by giving more autonomy to hospitals; the following are four of them. First it seeks to reduce the responsibilities of government as the sole provider of funds for hospitals; this is because public resources are increasingly scarce and limited. The second objective has to do with the general trend towards privatization, which has been linked to the pursuit of improving the efficiency of organizations. A third objective is related to increased community involvement with decentralized systems. As a fourth objective is the increased responsibility for decisions made in hospitals. These objectives are not exclusive and additional can be considered as a combination of these (D. Collins et al., 1999).

Several aspects are considered in the implementation of hospital autonomous, being the legal structure a critical element for the success. The success of decentralization depends on the organizational culture of the hospital and the degree of commitment of top management for its implementation. The implementation of hospital autonomy is usually performed gradually (D. Collins et al., 1999).

2.2.4 Transaction Cost Economics

The notion of the company as a "black box" was questioned by (Coase, 1937), for him, the fact that the economic system was thought to be coordinated by the price system was only a partial description.. That there are at least two economic coordination mechanisms: the markets and the company. In the market mechanism, the price system is the one that guides -in decentralized manner- the needs and opportunities of resource allocation; in the company, the principle of organization is different because through the hierarchy, the inherent authority system makes the reallocation of resources. Throughout many decades, several authors studied Coase's approaches, and it was Willamson (1985) that synthesizes some ideas of his ancestors and poses the TCE, with which he tries to answer the question “why organizations exist?” For Williamson, the firm is a particular type of organization - it is a management hierarchy - that allows to manage the exchanges or transactions and, in this way, to minimize costs, unlike other types of organization, especially the markets. This theory explores the boundaries of the firm: which transactions are developed within, which are bought, which are outsourced, which are carried out jointly between two or more firms. Thus, unlike other theories of the firm, for which it was simply a black box, the TCE also tries to explain the mechanisms of government within it and its extension to other forms, such as vertical integration and diversification.

TCE is focused on two concepts, the transaction costs and the governance structures. One of the central ideas is related to the premise that aligning transactions with the organizational structure contributes to the reduction of transaction costs. Initially, this topic was approached from the economics’ perspective, but in the last decades it has also been important in other areas namely in business administration., where it is applied as a normative idea to improve decision making of administrators (Ghoshal & Moran, 1996; Schneider, Bremen, Schonsleben, & Alard, 2013).

One of the central elements of TCE is that enterprise boundaries and how different levels of vertical integration can be explained by the cost of governance. The costs of governance are those costs that are related, with the search, negotiation, contracting, problem solving and administration of the contracts. These can be internal because the firm can do what it needs, or external because the firm can buy what it needs. According to the TCE, the company must carry out the activities internally when its cost of external governance exceeds the cost of internal governance. The TCE focuses on the transaction and indicates that its cost is related to the characteristics of the transaction (Gulbrandsen, Sandvik, & Haugland, 2009; Williamson, 1985).

For approximately fifteen years, between 1975 and 1991, TCE focused on the classical dichotomy "make or buy". However, since 1991 different models have been presented that try to include these decisions

as well as other variables and decisions that appear more and more in the competitive environment of the business (Dahlstrom & Nygaard, 2010).

For (O. E. Williamson, 1988) the application of TCE involves three fundamental concepts: (1) the behavioral assumptions, (2) the attributes of the transactions, and (3) the fundamental transformations. These concepts are presented below, highlighting the main elements to take into account in the theory of transaction costs, and the implications from the theoretical and organizational point of view.

2.2.4.1 Behavioral Assumptions of the TCE

The TCE considers two critical behavioral assumptions. The first is a cognitive assumption: human agents are assumed to be "intendedly rational, but only limitedly so", the second behavioral supposition is that human agents are given to opportunism, which is a deep condition of self-interest seeking that contemplates guile.

Under the assumption of bounded rationality, the limits of competition are recognized cognitive behavior of the human being and it is assumed that individuals are "intentionally rational, only in a limited way", as they face restrictions neurophysiological and language disorders. For (Williamson, 1985), the economy of limited rationality studies two approaches, on the one hand the decision processes, and on the other hand the structures of government, in both the express costs of planning, adaptation and monitoring of the transactions must be considered explicitly.

With regard to opportunism is meant the pursuit of self-interest with deception, this includes but does not limit ways such as lying, stealing and deceiving. This factor includes both active and passive forms, and both ex ante and ex post types. Ex ante and ex post opportunism are known in the insurance literature under the names of adverse selection and moral hazard, respectively. The first describes those situations prior to the signing of a contract, in which one of the contracting parties, which is less informed, is not able to distinguish good or bad quality of what is offered by the other part. The process that will follow this asymmetry of the parties is a phenomenon of adverse selection that only the worst qualities will be offered.

Moral hazard describes situations in which an individual has private information about the consequences of their own actions and yet other people bear the consequences of the risks assumed. Moral hazard tells us how individuals take greater risk in their decisions when the possible negative consequences of their actions are not fully assumed by them, but by a third party. Failure to fulfill the parties in an appropriate and fully responsible manner, and risk mitigation measures, lead to problems of ex-post execution, both of which are related to opportunism.

The assumptions related to opportunism are important because they allow in first one to distinguish and consider ex ante and ex post opportunism, and second one, allows to identifying the reason for the actual or apparent conditions of the information asymmetry in the contracting processes, which generate problems of economic organization.

Because of human nature, transactions involving ex post opportunism can be presented, and contracting parties should be alerted to the consideration of contingencies. Economic organizations will benefit if appropriate ex ante safeguards can be developed.

In addition to these considerations, it should be taken into account that the information can be revealed in a strategic, non-frank or true form when requested. This is why the disparities in the initial information between the parties will not be overcome by the proposals of the whole meeting information. On the other hand, the asymmetries of the initial information will persist. In fact, additional asymmetries will arise because of the combined presence of bounded rationality and opportunism.

To show how these two assumptions, limited rationality and opportunism can affect or generate the contracting process between the parties (Williamson, 1985), related them as it is presented in Table 2.5. As it can be seen in Table 2.5 a state where there is no limited rationality or opportunism is described as a utopia, where the parts of the contract perfectly match what they have committed, this state does not represent the reality of the processes of contracting in the extreme case where the two elements are present the contracting process is more complex and mechanisms must be created to try to minimize the risk either in the ex-ante stage or in the ex-post stage.

Table 2.5. Relationship between Opportunism and Bounded Rationality

		Bounded Rationality	
		Absent	Admitted
Opportunism	Absent	Bliss (condition of contractual utopia)	"General Clause" Contracting The parties to the contract will share relevant information that may affect the relationship or scope of the contract.)
	Admitted	Comprehensive Contracting (A complete contract is drawn up which includes all possible contingencies that may occur and how to resolve them.)	Serious contractual difficulties (Approach according to reality)

Source: Willamson (1985).

In the study of organizations, Williamson 1998 shows that both limited rationality and opportunism must be studied together, and in addition these behavioral assumptions have implications in contractual theory and organizational economics, as shown in Table 2.6.

Table 2.6. Organization Implications of Behavioral Assumptions

	Behavioral Assumptions	
Implications	Bounded rationality	Opportunism
For the contractual theory	Comprehensive contracting is infeasible	Contract as promise is naive
For economic organization	Exchange will be facilitated by modes that support adaptive, sequential decision making	Trading requires the support of spontaneous or crafted safeguards

Source: Williamson (1988).

To understand the characteristics of transaction costs, it is necessary, in addition to the assumptions of limited rationality and opportunism, to analyze the characteristics of transactions.

2.2.4.2 Attributes of the Transactions

According to (O. E. Williamson, 2010) several units of analysis have been proposed to understand organizations, however efforts to name the attributes of those units of analysis are rare. In TCE, transactions are the basic unit of analysis, in the words of Willamson (1988; 1985) "*A transaction occurs when a good or service is transferred across a technologically separable interface. One stage of activity terminates and another begins. With a well-working interface, as with a well-working machine, these transfers occur smoothly…the economic counterpart of friction is a transaction cost*". In TCE the attributes of a transaction can be grouped according to: (1) the condition of asset specificity, (2) the degree and type of uncertainty to which it is subject and (3) the frequency with which the transaction occur. An explanation of each of these dimensions is given below.

1) Asset Specificity

Asset specificity refers to durable investments that are not amortized in support of particular transactions, whose opportunity cost is much lower in the best alternative uses or by alternative users if the original transaction is terminated prematurely. For Willamson (1985) There are at least four types of specific assets, these are: site specificity, physical specificity, human asset specificity and, dedicated asset. The following describes each of them.

a. Site Specificity: In this this type of specificity, the buyer and seller are in a proximity relationship, which is derived from ex ante decisions to minimize transport costs and inventories. Once installed, the assets are immovable to a high degree.
b. Physical Specificity: In this type of relationship, all or some of the related parties in the transactions invest in equipment and machinery with transaction-specific design features, so that the investments have lower values when used for alternative purposes.
c. Human Assets Specificity: These are investments in human capital that are specific to the relationship and that arise from the learning process of the company. In this case one or both parts of the relationship develop skills or knowledge whose value depends exclusively on the relationship established with the other part. In other words, this specificity is related to investments specialized in human talent adapted to one or more specific transactions within a relationship (Gulbrandsen et al., 2009).
d. Dedicated Asset: This type of specificity is related to general purpose investments made by a provider due to the existence of a customer willing to buy large quantities. In this type of relationship if the consumer early terminates the contract creates a problem of great surplus capacity for the provider.

The specificity of the assets is one of the fundamental axes of the transaction cost economics theory of the, however to have relevance within the theory, it must be linked to the limited rationality, the opportunism and the presence of uncertainty. The specificity of the assets is so important that in the absence of this condition, the world of the contract would be greatly simplified.

2) Uncertainty

An important dimension in a transaction is related to the degree of uncertainty, which depends on the opportunist behavior and the limited rationality of the agents involved. Uncertainty is related to the degree of asymmetric information among economic agents and is also linked to the likelihood that they will not meet the contracted commitments (Banterle & Stranieri, 2008). The importance of uncertainty depends on the level of specificity of the assets, i.e. an increase in uncertainty matters little for non-specific transactions, since new business relationships can be easily found and the continuity of the relationship has little value. On the other hand, when assets are specific to a given degree, increasing uncertainty makes it more necessary for the parties to develop a system for resolving things, as contractual gaps are

expected to increase, and the chances of sequential adaptations will increase in number and importance as the degree of uncertainty rises.

3) The Frequency

The frequency describes the rate of reoccurrence of a transaction. Either they are carried out more frequently or not, it has implications in terms of the costs involved in their governance structure, since the creation of specific contracts and follow-up can be very costly for an organization. . In this way, if the transaction involves specific assets and a high frequency, governance costs can be recovered more easily.

Table 2.7 illustrates the relationship between the specificity of assets and the frequency of transactions, assuming that they operate in an environment of uncertainty.

Table 2.7. Illustrative Transactions

		Investment Characteristics		
		Nonspecific	Mixed	Idiosyncratic
Frequency	Occasional	Purchasing standard equipment	Purchasing customized equipment	Constructing a plant
	Recurrent	Purchasing standard material	Purchasing customized material	Site-specific transfer of intermediate product across successive stages

Source: Willamson (1985).

In practical terms, the asset specificity and uncertainty have received a great scrutiny that other important TCE variables, such as frequency and fundamental transformations (David & Han, 2004).

2.2.4.3 The Fundamental Transformations

The concept of fundamental transformation is important because it helps to clarify how organizations or people take distinctive identities and why this is relevant, within a contractual relationship. Identity is usually explained by some form of asset specificity and is the cause of the exchange relationships with small numbers (Few suppliers after bidding process) and the influence of information (Few winners of the tender will have insider information regarding their competitors for future contracts.). The identity of the parties occurs because in a bidding process, winning bidders will enjoy advantages over losers to the extent that they will not have made to compete, the same substantial investments as these. Consequently, what was originally a condition of a large number of bidders, was effectively transformed -ex post- into a condition of exchange with a small number and, in the end, a bilateral relationship. Likewise, and because of uncertainty, opportunism and limited rationality, the winning bidders are in a condition of influence the information with respect to the other bidders. Such a condition exists when the actual underlying circumstances of the transaction are known to one or more parties but cannot be discerned by others without making some kind of investment or incurring in some kind of cost or cannot be disclosed (Tadelis & Williamson, 2012; Williamson, 1985).

The transformation motivates the adoption of specialized government structures. The transformation gives importance to the identity of the parties due to the bilateral dependence on supplier-user relationship; for example, in some cases there are large investments made by the supplier just to satisfy disproportionate contractual obligations imposed by user's, and also because the user or buyer may not have the ability to draw on other sources of supply under more favorable conditions. Under such conditions, a contract and form of governance will be required to respond to such events. Without safeguards against the risk of misappropriation, the parties will refuse to invest in specific assets in their relationship, in spite of the gains they might obtain, for fear that they will disappear in subsequent disputes over their distribution. One way to safeguard is to establish from the beginning the terms of trade in a long-term contract. However, the conclusion of contracts increases the demands that weigh on limited rationality and suffers from imperfections in the limitation of opportunism. Under uncertainty, participants in a contract must anticipate and invent the response to a large number of contingencies or prescribe a process for the implementation of the adaptations. Both facts must be made in terms supposedly understandable and applicable at a reasonable cost for the transaction to make sense(O. E. Williamson, 1988).

Given these characteristics, it is difficult to anticipate and define contractual obligations that annul the fact of having to go to expensive legal struggles. In this case, there are two extremes of inflexible contracts, or very flexible contracts that give the opportunity to opportunism. Therefore, the greater the complexity

of the transaction and the greater the uncertainty, the limitations of the contract to safeguard against opportunism favor the creation of institutions, that is to say internally, one of the main dilemmas that the TCE tries to answer between make or buy a product or service.

In addition to the fundamental transformation is important to consider intertemporal considerations, this because some conditions of asset specificity are evident from the outset, others evolve during contract implementation, for example the specificity of human assets can be increased because of the learning of doing (O. E. Williamson, 2010).

2.2.5 Agency Theory

The agency theory is based on the concept of agency relationship introduced in the literature in the early 1970s (M Jensen & Meckling, 1976; S. A. Ross, 1973; Spence & Zeckhauser, 1971), the agency relationship was defined as one of the oldest codified modes of social interaction. The agency theory, allows to rigorously address some of the most pressing problems that arise in modern companies, especially large ones. The separation between ownership and control, with the consequent discussion on the most suitable incentives for the executives to take the decisions that most agree to the shareholders is one of them.

The starting behavioral assumptions of agency theory are the same as in of TCE, it is based on the fact of bounded rationality of individuals and opportunistic behavior, in addition to recognizing the uncertainty in the organizational context (K. Eisenhardt, 1988; K. M. Eisenhardt, 1989a).

An agency relationship is a contract between two parties, one of them (the agent) undertakes to carry out an activity on behalf of the other party (the principal), the relationship or the accomplishment of this task assumes that the principal delegates a certain authority on the agent so that the latter act and make decisions on his behalf, in exchange, agent will receive a certain kind of compensation. For example, a central government can give autonomy to top management of a hospital to perform the management of resources (M Jensen & Meckling, 1976; Thompson & Mckee, 2011).

The problem arises when the principal and the agent have different objectives, that is, each has different interests and there is asymmetry in the information, in this case the principal cannot determine if the agent has had an appropriate behavior (K. M. Eisenhardt, 1989a). When these two problems occur, different objectives and information asymmetry, it can give rise to opportunistic behaviors on the part of some of the individuals. In formal literature, two aspects of the agency problem, moral-hazard and the adverse selection, are cited.

The opportunistic behavior is presented before the signing of a contract and generates problems of adverse selection. For example, the agent can claim to have certain skills when hired. Adverse selection arises because the principal cannot fully verify these skills at the time of hiring or while the agent is working. Agency theory states that because contracts cannot be written and executed without cost, managers will take advantage of and act for their own interests by sacrificing efficiency in the organization(H. Chang, Cheng, & Das, 2004).

On the other hand, opportunist behavior may present itself and generates what is called moral hazard. The moral hazard refers to the lack of effort on the part of the agent, it is the risk of contracting individuals who withhold effort or misappropriate the organizations resources. The argument here is that the agent may simply not present the agreed effort. Moral hazard occurs when agents take actions that affect the likelihood that some event will occur and these actions are unverifiable. There is moral hazard when an individual has more information about his own actions than the rest of the individuals, this situation generates that, if it is another individual who bears the costs associated with the lack of effort or responsibility, the incentives to strive or being responsible are distorted (Cohen & Baruch, 2010; K. M. Eisenhardt, 1989a).

In order to mitigate the negative effects of opportunistic behavior, a series of safeguard mechanisms can be articulated that can try to counteract them. These mechanisms can be control, guarantee or safeguard and they generate agency costs. Agency costs may be control costs incurred by the principal to try to eliminate the agent's opportunistic behavior; the bonding expenditures by agent, are those incurred by the agent to mitigate the principal's lack of confidence; and, finally, the costs related to the residual loss. The residual loss is the inevitable difference between the decisions made by the agent and the one that would have actually taken by the principal, the greater the divergence between agent and principal, the greater the residual loss (M Jensen & Meckling, 1976).

Other costs that are not very explored in the literature and sometimes even confused with the agency cost, but present some differences are the influence cost. An organization can incur influence costs even when the central authority is both incorruptible and smart enough not to interfere in operations without a good reason. This is mainly because an executive in a central office commonly relies extensively on others for information gathering, suggestion, statistics and analysis to make a good decision.

Employees affected by a decision are often the same on which the executive must rely to make a good decision; so, the employee's efforts to influence the decision will generate a cost of influence. Employees may be tempted to distort information reports, to withhold information from central office and other employees, and to spend valuable time to improve their skills for their own benefit, to spend time and

resources designing strategies to be promoted, or even to think about how a decision could influence the principal.

On the other hand managers worried about how the higher authorities will evaluate their performance, can avoid the risky investments that the company must carry out. These distortions in the way employees spend their time, report their information and make their decisions can cause a loss of productivity, which is called influence cost. They are a cost of discretionary authority because they only arise when there is an authority whose decision can be influenced (Agoglia, Hatfield, & Lambert, 2015; Milgrom & Roberts, 1990).

2.3 Methodology and Research Methods

Once the key concepts for this research were identified, an exploratory analysis was performed to corroborate the existence of an empirical relationship between these concepts, framed within the hospital activities belonging to the Portuguese health system.

Exploratory studies serve to prepare the ground and usually precede investigations with descriptive, correlational or explanatory scope (Hernández Sampieri, Fernández Collado, & Baptista Lucio, 2010; Saunders et al., 2009). An exploratory study is an esteemed resource for finding out what is happening; to seek new understandings; to ask questions and to assess phenomena in a new light (Robson 2002). The time spent on exploratory research is useful since this approach can show whether it is worth continuing the research or whether the course of action should be changed. According to Saunders, Lewis, & Thornhil(2009) there are three principal ways of conducting exploratory research:

- ✓ A search of the literature;
- ✓ Interviewing 'experts' in the subject;
- ✓ Conducting focus group interview.

For this research, we used the first two elements, the literature review related to cost management, hospital autonomy and TCE in the Portuguese hospitals, as well as semi-structured interviews as mentioned in Chapter 1, and taking into account the protocol of the Appendix 1 and the interview script shown in Appendix 2.

Appendix 1 shows the steps for interviewing from the point of view of the protocol that was followed for its elaboration. This appendix shows how the contact with the interviewees was established until the analysis of each one of the interviews, through the recording of each of them, their transcription and subsequent analysis.

Appendix 2 shows the process of constructing the interview script which started with research design and literature analysis, as well as periodic meetings with the advisor and with a person in charge of the production of one of the hospitals interviewed during the period from September 2015 to December 2015, a period in which an iterative analysis was used to define topics and questions to be used during the interview process, and a pilot test was conducted with the person in charge of production in a hospital for refining the questions, and to verify aspects such as the time that would be dedicated to the interview that should be close to one hour for each of them.

The interviews were conducted between June 2016 and August 2016, the summary of interview profiles is shown in Appendix VII.

Computer-assisted qualitative data analysis software (CAQDAS) or qualitative data analysis software (QDAS) was used to organize the summary of the interviews (Tummons, 2014). QDAS provides tools to assist qualitative research such as transcription analysis, coding and text interpretation, recursive and discourse analysis. There are several software packages available for qualitative data analysis such as Qualrus, Tams analyser, QDA Miner, HyperResearch, Maxqda, QSR N4, Transana, Ethnograph, Kwalitan, Nud*ist, N6, CATMA,Tosmana, FreeQDA, Cassandre,Aquad,RQDA Nvivo and ATLAS.ti. In this research it was used ATLAS.ti. 8.0.

ATLAS.ti is a computer program that assists those who perform a qualitative analysis, providing a tool that facilitates the organization, handling and interpretation of large amounts of textual data (which can be written texts, images, sounds, maps and / or videos), despite being a computational tool that reduces the work in terms of organization, all analyzes must be performed by the researcher, i.e. ATLAS.Ti does not perform the analysis and does not replace the researcher.

ATLAS.ti works with the concept of hermeneutical unity (HU). The hermeneutic unit is the archive of ATLAS.ti where it will store and handle all the material necessary to work on a qualitative analysis project. This file stores the information of the primary documents, citations, codes, code families, annotations, networks and the links that interrelate them.

The primary documents are the files that contain the text, image, audio, maps and / or video to be analyzed. In the case of the interviews 6 primary documents were generated, since two of the interviews were carried out together, that is to say 8 interviewees were interviewed in 6 interviews.

Citations are the text segments marked in the primary documents for further analysis. They are the fragments of text or content that are marked as important or significant for the study problem. They can came from a few words, a line, a complete sentence, a paragraph or several paragraphs.

In qualitative analysis, codes are ways of classifying the material analyzed at an abstract level and represent the basic unit of analysis. The codes in ATLAS.ti are keywords that are assigned to this basic unit and that help us to mark and classify appointments. In terms of coding, a strategy was used after transcribing the interviews, a reading of each was made and a code structure was created on paper that was refined as codes were identified that captured the same information. Something that helped in this process was also the interview script itself, being semi-structured and there was a previous structure that helped the structuring of the codes.

In ATLAS.ti families can group codes, primary documents and annotations, which helps to make different classifications and carry out the analysis at a more abstract level.

In the process of encoding interviews, a large number of codes emerged, which after being debugged were grouped into five categories or families, which are:

- ✓ Organizational Structure: This category took into account not only the organization of hospitals, but also the decision-making process and autonomy related to decision-making, in this category 5 codes were used.
    - Organizational Structure,
    - Hierarchical Structure,
    - Responsibility Centers,
    - Autonomy in Resource Management, and
    - Autonomy in Decision Making
- ✓ Cost Management: This category addresses aspects related to the cost management process, costing systems, the advantages and disadvantages of the current costing system, the background and the importance and usefulness of cost management for decision making; 9 codes were used.
    - Cost Management,
    - Cost Accounting
    - Costing Systems
    - Costing Systems Implementation
    - Problems with Costing Systems
    - Using of Cost Information
    - Cost Control
    - Incentive Policy
    - Level of Satisfaction with the Costing System

- ✓ Variability and Uncertainty: The existence and importance of internal and external variability within hospitals was also identified - internal variability understood as the variability that in the treatment and therefore in the cost that a certain disease has, and external variability that is associated with the level of demand - an aspect that also came to the light during the interview; in this case the codes used are related to the internal and external variability and the management of said variability; for this were used 3 codes.
    - o Internal Variability
    - o External Variability
    - o Risk and Uncertainty Management
- ✓ TCE and agency theory: This category was identified aspects related to the process of outsourcing and mainly internal and its relation with the cost management, in this category are, the difficulty to measure the production, the specificity of the assets, and problems with the information for this 11 codes were used.
    - o TCE
    - o Asymmetry of the information
    - o Production Indicators
    - o Complexity in the production definition
    - o Contractual relationship
    - o Specificity of resources
    - o Specificity of Assets
    - o Outsourcing
    - o Insourcing
    - o Contract
    - o Controlling
- ✓ Other: Other aspects related to external variables influencing internal cost management such as the importance of cost management in the context of this framework, some innovations within hospitals, and resistance to change, among others were aspects considered here; for this 11 codes were used.
    - o Hospital Autonomy
    - o Importance of Project Management
    - o Innovation
    - o Intangible Costs

- Lack of Autonomy
- Lack of Information Systems
- Organizational Culture
- Private Hospitals
- Qualifications
- Resistance to change
- Project Management

The profile of the interviewees is shown in Appendix VI, the variety of backgrounds and functions interviewed is highlighted. The interviews were carried out at different levels namely, clinical level, intermediate management, top management and production managers, besides the fact that both public and private-public hospitals were studied. One point to note is that among the interviewees are two of the six most important hospitals in the country.

In order to perform the analysis of the collected data through the interviews and to highlight the most important findings, two tools of the ATLAS.ti were particularly important: the CooC Table and the Code-Document-Table, which allows to identify the existing relations between citations and codes, allowing to establish empirical relationships between the code and the first analyzes, which were contrasted with other findings from other interviewees, in addition to the theory and financial reports and other reports of the units interviewed.

After the analysis of the information what was discussed from a theoretical point of view and also in the process of preparing a new interview, some results of previous interviews were included in order to see if there were divergences or different points of view on a particular situation.

The analysis of the interviews allowed to know some realities related to cost management in the Portuguese hospitals, to understand some relations and to make some propositions of which some are answered along the other chapters and others remain for future works.

2.4 Framework Development

This section presents the framework developed considering the purpose of the research, the literature and the exploratory study supported in a set of semi-structured interviews. The analysis of the findings supported the development of 4 main propositions which were used to design the framework presented at the end of this section. These propositions are embedded in the framework and were explored further in the other stages of the research project and can be found in the other chapters of this thesis.

With the increase in the cost of health due to a scenario of technological and therapeutic innovation, associated with a progressive aging of the population and an increase in life expectancy achieved with clinical innovation and the greater consumption of clinical resources, there is an increase in citizens' expectations regarding the health care they wish to receive.

Such situation makes evident the need for a detailed knowledge of the costs incurred in hospital activity. In this sense, in 2007, the Portuguese Ministry of Health, launched a pilot project to implement an activity-based costing system in hospitals, with the objective of implementing an ABC costing system for the costing of hospital activity. This project involved, in a first phase, 5 hospitals of different ARS, and in a second phase in 2008, it was lengthened trying to calculate the costs of certain pathologies - mainly oncological and mental - and was extended to 5 more hospitals. Among the advantages found in the implementation, they can be highlighted the improvement in the quality of cost information, the adjustment of prices and costs for budgeting exercises and the possibility of benchmarking costs between institutions. Although this model has an international recognition, the high implementation costs, did not allow the continuity of the project (Borges et al., 2010).

More recently, the Ministry of Health attempted to create a unique costing system transversal to hospitals, however:

> *"About two years ago, the Ministry of Health, thought to implement a system of costing that would be transversal to all hospitals, given the complexity and given the delay and the different teams that exist in the various hospitals, they abandoned the project, it was also an extremely expensive project, (...) they decided to abandon (...) we have a cost accounting system that I consider inefficient." (HOSPITAL 4/ INTERVIEWEE 8)*

As on other occasions the project of implementing a costing system failed, this happened partly because it wants to implement a model costing system for all hospitals without recognizing their particularities. It would be important to take steps to contribute to future projects related to the implementation of hospital costing can be successful and useful tools for internal decision making and support the contracting processes.

In the year 2017, the scenario is not very different with respect to the implementation of ABC costing systems. Indeed, none of the hospitals interviewed in this research had an ABC costing system. All of them use a certain type of cost accounting for cost management however, some hospitals made different efforts to perform better cost management practices. One of the reasons why an ABC costing system was not implemented was explained as follows:

> *"There are no appropriate information systems for this costing method [i.e. activity based costing], each hospital should develop its own; in addition to feeding [manually] the costing system with information becomes unsustainable for a hospital because of the great human [resources] effort that is required for this purpose." (HOSPITAL 3/INTERVIEWEE 7)*

In this sense, computer information systems or information and communications technology (ICT) were mentioned as key factors for the success of such cost management system. Indeed, ICT are, nowadays, essential tools for a complete, timely and accurate computation of costs and to support decision making. However, we could observe that the degree of computer information systems is quite heterogeneous from hospital to hospital. Indeed, some hospitals already have business intelligence and do not buy computer applications that are not integrated into their information systems, and other hospitals have a number of very different systems that communicate with each other and that make the obtaining of information an expensive task, and where in some cases the marginal gain of obtaining this information is less than its marginal cost. This difference in information systems was explained by an administrator as follows:

> *"Although public hospitals have a structure that is practically the same, before the crisis began in 2008, each hospital had full purchasing autonomy [and] bought applications or computer tools that it wanted to manage its processes, and therefore some hospitals are more developed than others in this regard." (HOSPITAL 4/INTERVIEWEE 8)*

Thus, a national project for the implementation of a certain kind of costing system and cost management practices in hospitals is very complicated to have success considering the different types and maturity levels of ICT in the Portuguese hospitals.

Another situation regarding the information systems that allows to determine costs in a more detailed way has to do with the participation or involvement of the medical personnel. This has been highlighted by some administrators.

> *"[There is a] ... difficulty in which the Doctors use information systems, since in essence they are concerned with the care of patients, and not with issues that have to do with the management of the services where they are inserted." (HOSPITAL 1/INTERVIEWEE 1)*

Indeed, ICT will be effective if the users are motivated, conscientized and trained not only to integrate their daily tasks with the information systems but also to have notions of how to manage their departments

contributes to the continuous improvement of the hospital. In this context, the user is very important in the success equation and the binomial relationship technology or technical aspects and users can be effective through very different configurations.

However, it should be noted that despite the fact that there are no costing systems properly implemented in the hospitals interviewed, these ones are on the front line of Portuguese hospitals and we will not find more sophisticated or effective solutions in other cases. Besides, in this context, effectiveness is not only correlated to the complexity and the sophistication of used systems. Some hospitals, which have a good information and communication system, are able to perform very well even with a poor or undeveloped costing system from an orthodox point of view of what we consider to be a costing system and cost control. Indeed, a cost conscious philosophy can exist and be very successful using other methods and strategies.

These facts deserve our attention and reduces the role and relevance of costing in this context which is not only dependent on the sophistication of the information system.

> *"Good communication systems [...] are not only related to the computer system but also to the organizational culture and the appropriation of cost management by all hospital staff." (HOSPITAL 3/INTERVIEWEE 6)*

As can be seen, the success of a cost management system depends not only on ICT, but also on the attitude of individuals interacting with the system and an organizational culture that promotes the importance of a good cost management and efficiency within the hospital.

Thus, from the analysis of the interviews, in this sense we lead to the following proposition:

Proposition 1: Effective and efficient costing systems in hospitals need to be supported by good information and communication systems but also depend on individual engagement and organizational cost consciousness.

In fact, there is some satisfaction with the way cost management is carried out in Hospital 3 and, in this case, it was emphasized the importance of having not only good systems to estimate costs but also a cost management culture at all levels of the organization.

> *"The degree of satisfaction with the costing system, (...) one can assume that it is reasonable, of course that varying the opinion of the various stakeholders here from the hospital, but I think we have a good costing system that is generally accepted by all organs least one of the services."(HOSPITAL 3/ INTERVIEWEE 6)*

The level of satisfaction with cost estimation and cost management systems varies between hospitals but it was observed that those who had a positive position in favor of their costing system had walked in several directions in common, first having integrated information systems, staff with awareness of the importance of cost management in organizations as well as including medical and administrative staff in discussions about cost management.

Mainly in those hospital whose cost management culture was more permeated in the organization or had more efficient information and communication management tools it was found a moderate satisfaction with their cost estimation.

> *"We have a global costing system, so I can say how much it costs me a DRG, I can say that [a DRG] last year had revenues." (HOSPITAL 2/INTERVIEWEE 5)*

Hospital 2 had information systems that made it possible to calculate the cost of services rendered in a useful time for decision making. In the other hospitals dissatisfaction with the cost management system was evident. For example, in Hospital 1.

> *"We cannot [determine the cost], the financial information is not disclosed, so we do not have access to the computer system at all, only if it was all done manually." (HOSPITAL 1/INTERVIEWEE 1)*

In general terms Hospital 1 staff is not satisfied with their cost information system compared to hospital 2 which has a reasonable degree of satisfaction of their system, which makes it clear that cost management systems will be more successful in the extent to which efficient information and communication systems exist and the widespread perception that cost efficiency is a strategic variable for the good performance of a hospital.

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Another field that was addressed in the interviews has to do with the level of autonomy of hospitals particularly, autonomy for decision making. One of the ideas of the government has been to decentralize

decision-making, first externally, decentralizing decisions from the ministry, and others has to do with internal decentralization through responsibility centers. The government wished to provide autonomy to medical personnel not only in the development of their care functions but also administrative autonomy within hospitals (since the service directors must be health personnel) for which responsibility centers played an important role.

In many hospitals across Portugal the responsibility centers were never implemented and in cases where they were implemented later they were discontinued because they did not fit the organizational model of some hospitals, or there was not enough organizational structure to support them.

In this sense, at the internal level, the general feeling shared by the interviewees can be expressed through the words of the manager of Hospital 4.

> *"Every time public entities [i.e. hospitals] are little endowed with autonomy, the directors of service (which are clinicians) have little autonomy to make decisions related to the contracting of resources [...] all the direct expenses have to have the approval of the board of administration." (HOSPITAL 4/INTERVIEWEE 8)*

Supposedly, the directors would have the autonomy to be able to operationalize the responsibility centers. By definition, the existence of responsibility centers implies the existence of autonomy. However, in practice, the government suggests and regulates the responsibility centers, but later does not grant the necessary autonomy to hospitals and their administrative councils, which, in turn, cannot grant the necessary internal autonomy so that the application of the responsibility centers result effective.

The general idea is that with the responsibility centers the management of resources will be entrusted to the service directors, however at the moment the decisions of them were described as:

> *"[The service directors] have the power to make the basic decisions, now hiring and other things [i.e. making investments, acquiring new medicines, and outsourcing services] that they do not, do not have... that is a competence of the board of directors... [they] only [have autonomy to make schedules, even [about] overtime they do not have [autonomy to decide], so this has to go through the top management." (HOSPITAL 1 /INTERVIEWEE 1)*

This shows and corroborates the idea that despite the existence of legislation that promotes the internal decentralization of hospitals, the degree of autonomy within the hospital is reduced and even the management processes are centralized in top management and in some cases even at the regional administration level.

Furthermore, one of the problems with cost management and costing is information asymmetry, i.e. financial information is not shared with all service managers, which also discourages the computation of costs, and this is also related to the little autonomy for decision making.

> *"(...) If I wanted to know right now how much it costs me to do a CT scan for a patient, [such information] it does not exist. I get to know how much is spent [on labor, materials and overhead in the department] if I specifically wanted to know [a particular product], I have to pick up that patient and do the math, there is not yet [information on] the cost of [specific] procedures, there is still no such information." (HOSPITAL 1/INTERVIEWEE 2)*

Ironically or paradoxally, autonomy and cost transparency may result in additional problems. A basic premise is that responsibility centers are cost-efficient, know where resources are spent and where costs can be controlled, with respect to knowing the cost of products or services, a general feeling was expressed as follows:

> *"(.....) I think the ministry does not have much interest in knowing the specific cost, because on the day we know the specific cost of patient treated, in theory, the ministry will be obliged to reimburse all costs (...) and I speak for [my hospital], but I can speak in a way for the group of hospitals, [the costing system] is very deficient, practically nonexistent." (HOSPITAL 4 /INTERVIEWEE 8)*

From this point of view, a relation between cost management and autonomy through of the responsibility centers is evidenced. This finding indicates that for a responsibility center to be managed effectively, the cost of the provision of services must be computed adequately. However, knowing the cost of providing services could evidence undervaluation or overvaluation of the cost by the state in the contracting processes.

In the case of undervaluation, of the use of responsibility centers may force to increase the expenditure of the NHS with the objective of meeting the real needs of the population. On the other hand, in case of overvaluation this would oblige hospitals to be more efficient since the state could reduce the budget for the next period. In other words, autonomy and good cost management will implicitly affect the external and internal contracting processes in hospitals. Despite being an obvious premise, it is interesting that in practical terms it seems that they are not taken into account since on the one hand the government has reduced the autonomy for the decision making to the top management and these in turn fail to give enough autonomy to their service managers or production managers, and on the other hand the

government insists on the creation of responsibility centers, which given the current structure of autonomy is practically impossible.

From these comments and from the general analysis of the interviews, one proposition can be derived.

Proposition 2: Within hospitals, the implementation of responsibility centers will only be successful to extent that they are supported by cost information systems and the intermediate managers are given autonomy to make decisions related to the management of resources.

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One of the aspects that stands out in the interviews is the importance of the contract in the decisions that have to be taken in the hospital. The contract is a fundamental element as it lay the foundation on the financing of the hospital. The Ministry of Health 2017 reported that hospitals that meet the contract will be hospitals that will be given greater autonomy for decision making, here arises a natural link between the contractual process and the autonomy in hospitals and by extension with the responsibility centers.

Furthermore, within each of the hospitals, there is an internal contracting process, taking into account the capacity of each service, its requirements which are duly planned and what top management has contracted with the government.

One of the variables to measure the efficiency of the contract is the cost associated with the services offered by hospitals, a priori to measure improvements in efficiency or possible inefficiencies that affect the cost, the actual cost should be calculated, analyzed and managed. Cost management tools can contribute to improving or at least give another look at the processes of contracting health services with the government.

With respect to the fulfillment of the contract some difficulties were found. One of the interesting factors of the interviews is related to the way hospitals are financed, basically, the government buys production from hospitals according to what is agreed in a contract. In turn, top management contracts production with each of the services. This process is not standardized in all hospitals, since it depends on the communication systems used by each one and the role of clinical directors in this process. According to one of the administrators of a hospital:

> *"Compliance with the contract within the services also depends on the leadership capacity of clinical directors, which in some cases is not [satisfactory]." (HOSPITAL 1/INTERVIEWEE 1)*

This shows that compliance with internal contract depends not only on variables related to service delivery (such as the type of patient, or the type of treatment administered), but also depends on the management skills of service directors and the degree of alignment of their objectives and the objectives of top management.

In addition, the homogenization of the measures of comparison of one hospital to another are not so clear, this occurs because the contracts are established in terms of treated patients, and for most hospitals to know the costs for each patient treated is not easy, because patients consume several services within the hospital and the such cost is not calculated due to the lack of information and communication systems.

In a way, when considering everything in average and general terms, the contracting process with the (external) government has to be complemented or responded with great internal flexibility (saving on one side to compensate for situations that are already known are more expensive than what the state pays). It means that there are patients who are probably too cheap (because the hospital spends less on them than it receives from the state) to compensate for very expensive ones (where it gets less than the actual cost of the patient).

In the case of having a symmetrical distribution of patients the average would correspond to the value that hospitals receive from the government, the problem is that with the aging of the population and complexity in diseases and their treatments and the specificities of demand faced by each hospital it is possible to count a greater proportion of patients with more costs than the real value, which would generate breaches in the contract. To deal with the rigidity of the external contracting, the internal contracting must be flexible.

With regard to complementary medicine and diagnostic services there are objectives found among the management or reduction of the cost, quality of service and overall compliance with the contract, this derives from that:

> *"(...) The hospital is not funded by examination, the hospital is funded by the patient, so the more examinations the patient makes, the more costs the hospital has. Therefore, contrary to most services, we have [a] difficulty here in the service [which is related to] that the increase in production is not an increase in revenues, at the same time we also have to have an efficient response and meet response times." (HOSPITAL 1 /INTERVIEWEE 2)*

In other words, there are objectives found between making a better diagnosis (which increases the cost) and the income received for treating the treated patient, which generates difficulties in fulfilling the contract. In this context, it is shown that the cost of production is not the only cost that seems to affect the contract, but also costs associated with the quality of service delivery which can be considered hidden costs and deserve attention in the hospital context.

Other difficulties encountered to comply with the contract has to do with the variability and complexity of the pathologies and the influence that this has on the cost; in this sense it was observed that:

> *"(... ..) Just to get an idea, I have the contract that I have with the state... for example, I [contract] 15,000 surgeries that I have to do in a year, at a price they pay me for surgical, which currently it is a surgical internment, or a medical internment, they pay me based on a price, but later it is weighed by the case-mix index, which is the coefficient of hospital complexity, they pay me imagine 2,800 euros (...) if material costs are currently 18,000 euros, imagine that the patient later took more antibiotics, this gentleman costs more than 20,000 euros, but the state only pays me 2,800; and currently a two major health problems, because increasingly, we have highly differentiated patients." (HOSPITAL 4/INTERVIEWEE 8)*

This suggests that the contract may not be met by inefficiencies of the system and also by the implicit variability of the production process, which is usually not corroborated because there are no tools to measure such variability and its impact on cost.

One aspect that stands out is that there is variability not only in the treatments performed, but also induced by the patients' own characteristics, such variability will end up having an impact on the performance of the contract. To the extent that such impact ("risk") can be measured (i.e. using risk measurement models), it will be possible to generate measures for prevention, mitigation or acceptance, or simply explain why the non-compliance with the contract is via the volume of production or by an extra cost of the services performed.

All the interviewees talked about the variable internal and external variability and how it is managed, in most cases the external variability was controlled because the people who arrived at the hospital had already passed through prior consultations in other centers and internal variability, although there is a generalized notion of its existence, its quantification has not been studied because according to an administrator.

> *"... this would be a step forward, first would be to have a cost determination system, appropriate."(HOSPITAL 1/INTERVIEWEE 3)*

This comment highlights the idea of maturity of the costing systems to the extent of first recognizing the importance of having a costing system that works, and then moving forward for risk measurement models associated with these costs, which would generate valuable information for the decision makers.

Another aspect is that, in order for the contract to be complied with, it is necessary to have committed and dedicated personnel in the management of resources, waste reduction and efficiency improvement. One of the problems that we can found in hospitals (mainly public) has to do with the lack of incentives for medical personnel which may result in adverse selection problems by top management and also opportunism in the performance of medical work itself. In this sense it was observed that:

> *"We have a problem too large with medical staff, medical staff is a rather scarce resource, they are few, and actually the recruitment policy of medical staff is not very flexible, so they have many more incentives outside, as they are scarce, and private [organizations] pay them more than we pay here, it is not very attractive to work in the public. There are not many incentives, so we also have few resources, because hiring policies are very restrictive in monetary terms, so that people do not come or leave easily." (HOSPITAL 1 /INTERVIEWEE 2)*

This shows that one of the problems associated with the fulfillment of the contract is also related to the lack of incentives which does not contribute to the improvement of the efficiency of the processes or the existence of an increasingly growing private market. And even if the staff is committed to the hospital, the contract may not be fulfilled also because the hiring was undervalued with respect to the actual amount of demand for the services offered.

All these elements, besides the opportunistic behavior that we can found from the part of the doctors, or of the own patients, the limited rationality, the internal and external variability, the specificity of the human, physical and locational assets, and the very complexity of the system creates transaction costs which, while true, are not necessarily useful in deciding between market or internalizing activities, are useful in determining the transaction costs necessary to maintain competitive advantages over other public hospitals and private hospitals.

Indeed, the inherent uncertainty and risk associated to demand variability is an important issue in this context.

> *"The hospital can and should attend to all the [patients] that appear (...) the capacity [is] limited by the number of [existing] beds, [however] we sometimes have patients in the corridors. (...) in surgeries if there is no capacity [they are placed] on the waiting list. Therefore [lack of capacity], it is the only condition for not being able to attend patients in a timely manner." (HOSPITAL 1/INTERVIEWEE 1)*

> *"We are, at a production level, already almost full capacity, that is in total capacity. I can say that we are in an occupation rate of 97%, which is serious because in a hospital the occupancy rate could never be above 90% [in case] there is a fire [or a tragedy], we are usually in the 95, or 97%, we are already in the limit." (HOSPITAL 3/INTERVIEWEE 7)*

This is an important element that can influence the performance of the contract: the variability and the growth of demand which can lead to the contracted capacity being exceeded in many cases and therefore generating non-compliance. Nevertheless, it is a non-compliance not derived from inefficiencies but from the very basic and fundamental conception of the service, since health is considered a public and universal good.

This shows that cost overruns may be due to overcapacity, and that a strategy to comply with the contract may be to sacrifice quality of service by increasing patients on waiting lists. Thus, is why the contract fulfillment analysis program must be accompanied by the analysis of the quality of the service. Nevertheless, at the same time (necessary) a focus on the quality of the service will put additional pressure on the contract design and execution. This is in line with the words of the interviewee three who pointed out that:

> *"[with respect to the volume of production] there is no limit (.....) obviously we have our accounts always monitored, and we try to do not make the situation unsustainable in terms of management, ... we are an underfunded institution [and] already we have repeatedly pointed out this situation [to the government], [we] have shown with numbers why this... [this situation] is proven, but resources are scarce... and what I am saying is also the feeling of other [hospitals]." (HOSPITAL 1/INTERVIEWEE 3)*

Sub-financing may be one of the causes of non-compliance of contracts. Such situation can be understood through a good estimate of costs. However, it is a difficult task since hospitals are complex organizations demanding for sophisticated information and costing systems. Furthermore, the general perception that there is a problem of lack of capacity and internal and external variability about patients can demotivate changes. It is here that cost management is important because it can permit to understand the real cost of the services and eventually renegotiate contracts when underfinancing. In other cases hospital institutions can be pushed to decrease the quality of service in order to comply with contracting, whether internal or external.

All these variables make compliance with the contract contingent upon a number of variables that must be analyzed internally (in contractual processes with departments or services) and then see their impact externally.

As it is noteworthy the hospitals are concerned about the fulfillment of the contract and the analysis of the variables related to it. From the foregoing, the following proposition arose.

Proposition 3. The fulfillment of the contract depends on a good management of the internal contracting process and of the internal and external variability.

Furthermore, in this context, a cost management system can be useful in several ways. First to see how efficient resource management is in a hospital compared to others. Second, to understand the causes of compliance or non-compliance of the contract. Third, through the use of responsibility centers, can be created conditions for greater autonomy in the decision-making process, since the fulfillment of the contract is indexed to the level of autonomy. Failure to comply with the contracts would not only limit the internal autonomy of hospitals, but would impair the quality of the service, which would give some competitive advantage to private entities that increasingly have more specialized resources and in the words of one of the managers of hospitals,

> *"[private hospitals] are taking the best resources due to the economic incentives they offer and the flexibility of the timetable in the provision of the services [... they] have been gaining ground in the last years, not only in terms of quantity [provided services/patients served]but also at the level of specialization and complexity." (HOSPITAL 4/INTERVIEWEE 8)*

Indeed, lack of autonomy is a great disadvantage for public hospitals. First, due to the existing and growing pressure and competition from the private sector in which the level of autonomy and flexibility to make decisions is greater compared to the public sector. Secondly, because the health ministry has indexed the release of autonomy for public hospitals to comply with the contract. From here emerges the last proposition:

Proposition 4. As the relationship between compliance with the contract and autonomy can generate virtuous circles for those who generate strategies to comply which will allow them to improve their management systems and, inversely, vicious circles for those that do not

comply due to lack of autonomy to make decisions and deteriorate their administrative processes.

— * —

The above considerations suggest that the contract (internal or external), and the variables that affect it must be analyzed before, during and after the execution process with the objective of generating measures that allow to understand the dynamics of the behavior of the costs and their respective management.

Thus, effective cost management systems should allow to understand the cost structure and also identify the (hidden) costs inherent to the contracting process. Nevertheless, such costs, i.e. related to the contracting process, typically are not estimated by hospitals' management accounting. These costs include those related to the design process, implementation and control of the contract, costs associated with quality, among others. Furthermore, this perspective will permit to understand how variability plays an important role in compliance or breach of contract.

Accordingly, a framework based on the concepts and theories explained before and also the empirical relationships that have emerged from the field study is shown in Figure 2.6.

Figure 2.6 is based on the principle that in order to have good cost management practices in hospitals, tools must be available to quantify and identify the cost associated with the services provided.

A good cost management system will not only quantify the cost but also generate intervention measures to reduce or eliminate inefficiencies that do not add value if they generate costs for hospitals.

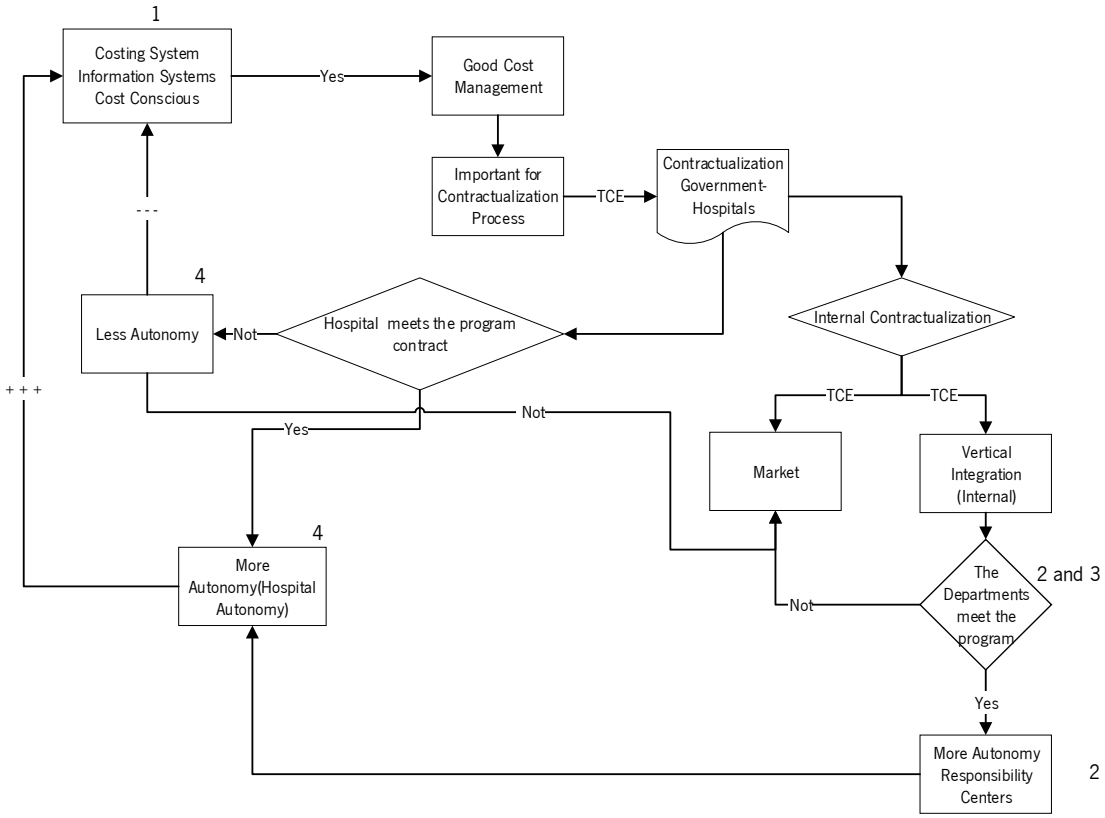

Figure 2.6. Cost Management Dynamics in Hospitals

In this context, a series of elements and relationships emerged as important. Such elements and the relationships among them were previously presented and discussed through the four propositions.

It is interesting to see how the first proposition is the starting point and end up of the other propositions influencing either positively or negatively. The first proposition shows that efficient cost management will be successful inasmuch as hospitals have a system to estimate costs, but also that they have information and communication systems that allow their proper functioning, without forget one of the most important aspects which is related to the existence of an organizational culture and individual behavior related to the awareness that cost management is important for the hospital. These elements are important for a good contracting process, whether external or internal.

With regard to the internal contracting process, top management must contract production with its own departments or consider the possibility of buying production outside the hospital, the latter being the last resort when the capacity or quality of its services is compromised.

With respect to the way of managing the resources in hospitals, the idea of the government is that it be carried out autonomously by each service or department, being supported on the responsibility centers. As it is evident these centers are nonexistent, nonexistent and to the extent that the centers are created,

there must be tools that allow management and control to be carried out efficiently. One of this tool is cost management since it will allow not only the managers of the center to understand the behavior of their costs, but also the top management and the government to identify causes of compliance or breach of the contract. It is here that the second proposition arises in the evaluation of the fulfillment of the contract.

This compliance will depend on the internal management of the department and on the management of the variability and capacity of the hospital, which is related to the third proposition.

One of the aspects discussed is related to the relationship between autonomy and contract performance. Although it is a seemingly simple relationship, it introduces some complexities that must be emphasized. In Figure 2.6, it is shown that the compliance of the contract internally will generate more autonomy that will allow to have more resources or manage the resources for improvements than in the future will contribute not only to the improvement of hospital's management but also to the costing system itself, which contributes to have more and more tools to fulfill the contract. Failure to comply with the contract will not only strengthen the market (private institutions) but also create less autonomy to make decisions, where improvements will be more restricted and the likelihood of future non-compliance increases. Failure to comply with the contract may generate the opposite effect i.e. having less autonomy and less ability to improve, this argument is related to the fourth proposition. Although noncompliance may be associated with process inefficiencies, it may also be related to endogenous variables such as the capacity of the system that was contracted, and the variability (internal or external) of patients, among other factors. This non-compliance may force external services to be contracted in order not to sacrifice the quality of the NHS. However, they can be contracted at prices that are not known if they are appropriate due to the inexistence of a costing system within hospitals, i.e. before thinking about compliance or non-compliance of the contract should have metrics to identify the causes of these non-compliances and one of the tools for that could be a costing system, these aspects are related to propositions two and three. In general terms, Figure 2.6 also highlights that there is a relationship between cost accounting, the contract (and all the decisions involved) and the level of autonomy, some of these relationships will be object of study in the next chapters.

2.5 Discussion and Conclusions

The study of cost management within hospitals is fundamental not only for the financial sustainability of hospitals but also to guarantee a greater coverage of the service, this because, when quantifying costs,

inefficiencies and activities that do not generate value can be identified and eliminating them will allow to serve more people without deteriorating the quality of service.

> *"We have a set of costs that is basically fixed, and therefore taking for granted that we will bear those costs, [we] have to maximize the production that we can achieve with that volume of costs (...) if we do not produce, what happens is that we keep those costs fixed, and the next year we lose some funding, which is not desirable, so our scope is to maximize installed capacity." (HOSPITAL 1/INTERVIEWEE 3)*

Cost efficiency is a strategic variable for hospital business control since it guarantees the achievement of funding sources, which is why strategic cost management in hospitals should be an inherent practice in the provision of other services (Hsu & Qu, 2012; J. K. J. Shank, 1989).

Despite all the advantages that strategic cost management can present it is not an easy task and needs great planning with the aim that at the end, after investing a large amount of resources its usefulness can last in time to ensure the appropriate return on investment.

The implementation of cost management systems in hospitals by the government has failed (Borges et al., 2010) and this can be explained from several perspectives, one of them is related to the fact of wanting to implement a standard methodology (e.g. ABC) without foreseeing in the first instance whether this methodology will be appropriate for hospitals. Or, from another perspective, if hospitals are prepared to assume this new innovation from the point of view of organizational structure and the day-to-day praxis as well as from the point of view of organizational culture. This is in harmony with what is mentioned in (Gosselin, 2006) where it is shown the importance of taking into account in the design, implementation and routinization of a costing system factors related to the external environment (i.e. heterogeneity of demands, competition, environmental uncertainty), the individual characteristics (i.e. disposition toward change, process knowledge, role involvement), organizational factors (i.e. centralization, functional specialization, internal communications, training) and technological factors (i.e. complexity for users, compatibility with existing systems, relative improvements over existing system, relevance to managers' decisions and compatibility with firm strategy). These factors, coupled with the type of services and processes that are performed in a hospital, which vary not only because of the complexity of the service but also because of the variability between patients and the performance measures used, make cost management even more complex, however necessary for decision-making (Hsu & Qu, 2012).

In spite of this, the hospitals themselves have decided to establish their own cost determination systems that allow them to carry out a certain type of cost management, although not perfect at least that allows to determine to a good extent the behavior of their resources and generate an organizational culture

around cost, training the medical and administrative personnel on these issues and raising awareness of the importance of cost management, not only from the strategic vision of the organization but also from the operational management of the organization.

On the other hand, those hospitals who have failed to develop cost measurement systems complain about the lack of cooperation of their staff and the few integrated computer tools to perform an analysis of information in a reasonably useful time for decision makers. It is an issue that remains to be explored in order to determine functional solutions for medical staff and decision makers. In addition to these aspects already mentioned, proposition 1 highlighted the importance of information and communication systems for the success of the cost determination system. In this sense, Cuellar & Gertler (2006) points out that for hospitals the existence of information systems that can collect data related to costs, quality, quantity and performance, allow identifying areas or processes in which there is room for improvement, which in the case of hospitals would be vital to understand why compliance or breach of contracts and if it is internal or external. In harmony with propositions 1 and 2 , one interesting finding of this study is related to the importance of the cost management culture in relation to the costing techniques themselves, i.e. it is possible that in complex environments such as hospitals the solution is not the exact estimate of costs, more if having a culture of inefficiency reduction and cost intention have to go through the quantification of cost, not meaning the costing is not important, but rather including the idea of cost management should be a useful tool for decision making to the extent that its marginal cost is less than its marginal benefit. In another sense, the government has given laws and guidelines to provide the hospitals and their care units with internal autonomy through the use of responsibility centers, which has also failed. Normally the autonomy hospital is given in several fields, governance, financial issues, human resources management and use of management information data (Geyndt, 2017), as evidenced in this study, although the idea of the responsibility centers tries to give autonomy in these fields, the organizational structures do not allow their implementation, partly derived from the very complexity of the hospitals and the made in most cases not having developed a culture of cost management

It is not possible to implement a responsibility center without having prepared the personnel of that center in management tasks or at least be aware of the importance of such management, nor can it be implemented if the elements are not sufficient for the for the computation costs and efficiency measures to control them, in addition cannot implement this type of measures when all decisions are centralized in the board of directors and worse even when the hospital board does not have sufficient autonomy to act in benefit of the efficiency, being subject to a set of bureaucratic rules that although they watch for

the compliance with the legal provisions for the national health system may go against the overall efficiency of the system.

Proposition 3 raised a very interesting issue related to the importance of having good internal management practices for contract fulfillment (internal or external) and the management of the variability or uncertainty. It happens that the system can be efficient but there are non-compliances derived from not expected variability. Variability can come from several sides, for example Arrow (1963) identifies several sources of variability or uncertainty namely, external variability (the nature of demand), variability derived from the expected behavior of the physician, internal variability (variability in patients with the same pathology) and variability due to the supply conditions. These sources of variability must be studied since they can directly or indirectly impact the fulfillment of the contracts, and in turn affect the level of autonomy of the hospitals because both are interrelated as explained.

Another element related to autonomy which was reflected in Proposition 4 has to do with the fact that the government wants to link the level of autonomy to those who comply with the contract, although it is an interesting measure should be taken into account that this could create harmful behaviors for users to the extent that this is not also linked to quality indicators. In addition to being able to create virtuous circles for those who comply with contracts, to be more autonomous and to improve more for the next period, and vicious circles for those who do not comply and are subject to lower levels of autonomy for successive periods, thus limiting their capacity to improve to guarantee better levels of autonomy. Viewed from this perspective, we could say that the autonomy linked to efficiency indicators could bring a problem of heterogeneity in the health sector entities, this is in line with Mosca (2006) which indicates that when hospitals are autonomous they can place first place their specific interests by placing barriers to the implementation of measures related to regional or national priorities.

Additionally, related to autonomy and cost management has to do with the internal contracting of production, which in turn is related to the outsourcing of hospitals to the government. It is a complex process where first the homogenization between hospital processes in the measurement of the output is not easy due to the own characteristics of the processes. There is also information asymmetry at different levels, from government to top-management and from top management to different departments (Thompson & Mckee, 2011). In addition, the system is complex and multiple principal-agent relationships are presented throughout the service delivery, top management-administrators, administrator-physicians, physicians-patients, making the system complex and difficult to quantify in terms of production results, efficiency and costs (Forgione, Vermeer, Surysekar , Krishnamurthy Wrieden, & Plante, 2005). This complexity makes interesting the study of the contracting process, the variables that are involved and the

practical and theoretical implications that this topic may imply, and even though hospitals strive to comply with what they have contracted, the creation of cost management tools will allow in the near future to have a better monitor of their contracts and to have a different position in the processes of negotiation with the government.

This complexity in contracting processes should be addressed in its ex ante and ex post stages for that can be used economics or organization theory. With respect to such analyzes, Kim & Mahoney (2005) emphasize that for the ex-ante analysis, a recommended theory is agency theory and for the ex-post perspective, the TCE. This approach is in harmony with Dahlstrom & Nygaard (2010) which recognize that although TCE has also been used for ex-ante analysis, the current trend recognizes a broader application in the ex-post contractual relationships. In this research, one of the limitations of the study has to do with the number of hospitals interviewed, although an effort was made to contact all public hospitals in the country, the positive response was only a few. However, one of the advantages has been to have in the study, two of the five main hospitals in the country, which allowed to have information of hospitals of the first line in the NHS. With the results of this study, propositions and model proposed, it is possible to develop further research namely, a survey or an in-depth case study that allow to validate some of the propositions and findings realized in this study. This will be found in the next chapters of this thesis.

3. COST MANAGEMENT FOR HOSPITALS: A VIEW FROM THE TRANSACTION COST ECONOMIC THEORY

3.1 Introduction

Contracting has been an instrument used in the health sector to allocate financial resources to providers, constituting a milestone in the substitution of passive modalities of affectation by proactive or strategic modalities. It emerges as an important resource for increasing health gains, involvement and efficiency of providers (Valente, 2010). Health care contracts are often incorporated into the legislation of the countries and are properly regulated. A perfect contract would define all future obligations and contingencies ex ante so that it would never be necessary to renegotiate a contract. However, the cost of making such a contract would be too high and the buyer will never be able to foresee all possible future changes, for example he could not determine with certainty the internal variability of patients - grade severity for the same type of disease - and factors related to the morbidity of the population and all the implications that this would have in terms of planning and medical care. That is why in health, contracts are usually reviewed, and negotiated all the time in order to ensure compliance. Given the complexity of healthcare services, contracts will therefore certainly have to remain incomplete (Figueras, Robinson, & Jakubowski, 2005; Herberholz & Supakankunti, 2015).

In recent years, the models for financing and contracting hospitals in EU countries have undergone significant changes, with a clear shift from retrospective financing systems to the establishment of prospective budgets. There has been a transition from models based on historical cost reimbursement to models based on prospective values, some of them accompanied by a more or less explicit contracting process, as in Portugal, whose formally prospective component is defined by DRGs.

In spite of the developments, with the use of prospective methods, several constraints persist in Portugal, including underfinancing and consequent chronic deficits, management limitations, lack of integrated planning, communication problems, inefficient use of human resources and a lack of confidence in the system. In Portugal, at hospital level, the allocation of financial resources imposes the existence of a costing system. The application of this is fundamental to use in complementarity with the contractual mechanism, since it allows to determine with more precision the real costs and possible deviations, to carry out studies of efficiency – cost vs quality - and a sustained internal contracting (Escoval, Fernandes, Matos, & Santos, 2010).

Thus, so far, two fundamental elements in hospital management arise, on the one hand, the difficulty in contracting processes, and on the other hand, the cost management related to these contracts. Cost management is important because the measures of efficiency and cost represent the generally accepted financial indicators derived from the healthcare financial management literature (Coyne, Richards, Short, Shultz, & Singh, 2009) and despite the fact that there is a great deal of work related to efficiency and cost to measure health outcomes in cost- effectiveness analysis, there is still no clear agreement as to how or what quantify or how reveal outcomes in a consistent way (Linna, Häkkinen, & Magnussen, 2006). Strategic cost management offers important management knowledge, both strategically, tactically and operationally. In a world where competitive advantages are difficult to maintain, costs must be managed strategically, aggressively and intelligently. A company that fails to reduce its costs just like its competitors will see its profits shrink and may be threatened, as competition increases, cost efficiency becomes more imperative (Kulmala, Paranko, & Uusi-rauva, 2002).

For example, in Portugal, contracting in health is defined as the relationship that is established between the financing, purchasing and healthcare providers. In this process must be detailed the desired health outcomes for each level of funding availability, this under the assumption of a level of autonomy and responsibility of all involved in the process.

With regard to contracting processes in hospitals in Portugal, these can be divided into two parts, an external contracting, which is the one performed by the government with the top management of each of the hospitals, and the other internal contracting, which is made by the top management with each department, or service within the hospital and which contributes greatly for the fulfillment of external contracting.

In the process of external contracting are closely involved the Central Administration of the Health System (ACSS), the Regional Administrations (ARS), the Ministry of Health (MH), and Service Entities (Hospitals) (see NHS organization chart in Appendix 4) which through several iterations try to reconcile the needs of the population with the existing financial resources in the NHS. The outsourcing process is supported by the computer application SICA (Information System for Contract and Follow-up).

The external contracting begins with the planning of health needs and the definition of investment priorities, followed by the collection of information from the institutions that will be contracted and ends with the evaluation of the hospital's performance and the fulfillment of the contracted objectives.

In the contracting phase, the *contrato programa* (the contract) is foreseen, in which the objective is to adjust production proposals to the health needs of the population, agreeing production levels and associated costs that ensure the principles of equity, effectiveness and efficiency of the system with

respect to the provision of the service and also contributing to the economic and financial sustainability of the hospitals and in general of the NHS.

The contract between hospital's top management and its services or departments (internal contracting) is integrated with the external contract; in order to this integration be effective, each department or service must meet cost and production levels established for them. This contracting process can be seen as a purchaser-provider relationship. Among the premises of internal contracting is the fact that this process must be integrated into a modern, responsible and rigorous management culture, and it allows promoting the responsibility and autonomy of professionals and teams, contributing to increase motivation and commitment, levels of productivity and efficiency of services and thus reducing the inefficiencies of the system. In addition, in this process, management must create mechanisms to ensure that commitments and objectives are internally assumed by the organization, mechanisms to measure compliance, and reward mechanisms for compliance (ACSS, 2011b, 2016c).

In the process of internal contracting, a fundamental variable is costs. Among the existing costs in an organization we have production and administrative costs, however there are other costs that although not easily quantifiable are present in this type of organizations mainly when there are contracting processes between parties. These costs are called transaction costs, which depend on variables such as complexity, specificity of the assets involved, limited or bounded rationality and opportunism.

Opportunism may be related to conflicting objectives between purchaser (the top management) and providers (departments, services, responsibility centers among other form of organizations within the hospital) which contributes to reduce the consumer responsiveness, the quality for the same cost, and the efficiency (Harris, Mosedale, Garner, & Perkins, 2014).

On the other hand, bounded rationality means that those involved in contracting are unable to accurately predict future events, such as how demand behavior and patient status will be, such as patient behavior and healthcare professionals behavior (Marini & Street, 2007).

Both opportunism and bounded rationality in a contractual relationship generate additional costs to the production and administrative costs that deserve to be explored. In this context, this chapter focuses on the relationship between internal contracting and cost management. Particularly, the costs derived from the contractual relationship which may influence decision-making related to the services provided in order to comply with the agreements established in the contract.

To study this relationship, the transaction costs economics (TCE) theory was used by the fact that the dominant perspective informing the use of contracts is TCE (Bigelow & Argyres, 2008; Le Bon & Hughes, 2009; Schepker, Oh, Martynov, & Poppo, 2014), In addition, it is a theory where one of the underlying

pillars has to do with the estimation of the costs that for the hospital sector is still representing a great challenge. This is important to the extent that in the case of the hospital sector, it is properly regulated and depends largely on the government and not on the market, this is why some studies have focused on cost efficiency rather than prices. Although the previous point gives the idea of non-existence of the market, with the appearance of private services in health systems, an increasingly important decision will be to provide health services using government entities, or subcontracting private entities. These elements make hospital complex systems and this chapter explores the relationship between cost management and transaction costs.

In this chapter, we analyze the process of internal contracting and cost management from the point view of the TCE. One of the objectives of this study is to identify if there is a relationship between the contracting process and cost management of the hospitals under study, using for this the lens of TCE, For in order to understand the internal dynamics of cost management in hospitals derived from internal contracting processes and identify the costs inherent to such contracting processes.

This chapter is organized as follows, after this introduction (Section 1). Section 2 presents the literature review, concentrating on the key aspects of TCE.

This section highlights the characteristics of transactions, the type of decisions and costs that are generated in a contractual relationship. In addition to highlighting various TCE applications in the health care environment.

Section 3 shows how the exploratory study was developed in order to find relationships between TCE and cost management practices in the hospitals that participated in the study. Section 4 shows the main results obtained, first identifying the transaction costs inherent to the internal contracting process and increasing the cost of production or service delivery, and then highlighting some contributions to TCE models and literature, mainly because the inclusion of internal transaction costs and intangible costs (related to the quality of health services). Section 5 the discussion, conclusion and possibilities for future studies are developed.

3.2 Literature Review

In this section we present the basic foundations of TCE and its application in Healthcare. In the first instance, a brief description of various theories is made and then a focus on the TCE is made. The transaction and the contractual process are presented as a central axis of the theory of TCE in organizations, in addition to the importance of opportunism, limited rationality and uncertainty. After

presenting the theoretical framework of TCE, some applications in healthcare are discussed, highlighting their main contributions, limitations and opportunities for improvement.

3.2.1 Transaction Cost Economics Theory

In the study of organizations in recent decades, two basic premises have been considered, in the first instance, that institutions matter and secondly that the determinants of institutions are susceptible of analysis using the tools of economic theory (Macher & Richman, 2008; Matthews, 1986). In this context, various theoretical approaches have been developed around these premises. For example, the contingency theory considers that everything is relative. The effectiveness of organizations, and at the end, profitability, depends on the fit of organizational structure and contextual variables. Contingencies explain that there is a functional relationship between environmental conditions and appropriate management techniques for the effective achievement of the objectives of the organization. Environmental variables are independent variables, while administrative techniques are dependent variables within a functional relationship (Donaldson, 2001; Fiesher, 1998; Luthans & Stewart, 1977).

An interesting application of the theory of contingency in healthcare services investigated the determinants and outcomes of management accounting practices used by public health-care managers. More specifically, it proposed and empirically tested a comprehensive, contingency-based research model which addresses three related issues which are related to: fist the use of management accounting the design of the management accounting system, second the satisfaction of top management with management accounting is an indicator of the good or bad design of a management accounting system, and finally with that financial performance is influenced by the use of management accounting. this demonstrated that the relationship between management accounting and its influence on decision-making within these organizations (Macinati & Anessi-Pessina, 2014).

Furthermore, institutional theory in management accounting research can be presented in three main streams: New Institutional Theory -NIT-, Old Institutional Economics –OIE- and New Institutional Economics -NIE-. New institutional economics is preoccupied with the origins, incidence, and ramifications of transaction costs. Indeed, if transaction costs are negligible, the organization of economic activity is irrelevant, since any advantages of one mode of organization appears to hold over another will simply be eliminated by costless contracting (OE Williamson, 1979). NIE or Transaction Cost Economics –TCE- provides a useful analytical framework to explore the functioning of contractual relationships after the purchaser–provider split. Transactions costs are the costs associated with making an economic exchange under alternative structures that govern the transaction. A shift from one governance structure

to another can be seen as essentially a search for a governance structure that reduces the problems that emerge ex-post in a relationship between two parties, i.e. their transaction cost (Castaño & Mills, 2013). The TCE sheds most light on firm limits and the circumstances under which it is best to arrange activities within a hierarchy versus interrelating in a market with providers or other contractors (Caniëls & Roeleveld, 2009; Harding & Preker, 2000). TCE is one of the most important perspectives in management and organizational studies, however the debate continues on the empirical studies that support it (David & Han, 2004).

In recent decades, TCE has emerged as a dominant theory for the analysis of contractual structures and governance associated with economic exchanges, and TCE has been an established concept for analyzing economic organizations (Schneider et al., 2013). TCE recognizes in such exchange processes frictions are generated which in turn generate transaction costs. The objective is then to minimize such transaction costs either by carrying out activities within the company or acquiring them in the market, which will depend on the costs generated by the exchanges (Donato, 2010).

With respect to the various ways in which an organization can be understood Williamson (1985) presents the scheme shown in Figure 3.1. The theories shown in Figure 3.1 are mainly concerned with the economic theory of the firm and market organizations and not with sociological approaches which normally focus on power, embeddedness, network theories (Smelser & Swedberg, 2010).

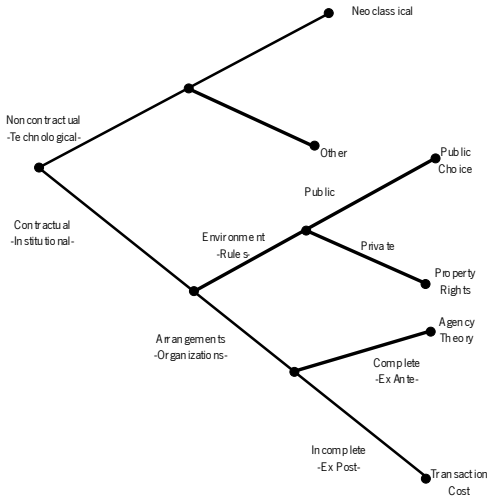

Figure 3.1. Economic Theories of Organization
Source: Williamson (1990)

The first differentiation made in Figure 3.1 is related to whether an organization theory views the organization from the contractual or non-contractual point of view. In the 1960s, the dominant approach

was to see the company as a technological function - mainly from the point of view of production - rather than in contractual terms.

In the technological approach, contractual issues were little taken into account, mainly because both the boundary of the company and property rights were assumed to be clearly established and well defined and in the case of disputes are also assumed that these did not generate costs and are easy to solve. It was assumed that all contracts were efficient, the inefficiencies and their implications for the organizational structure were not examined.

In Figure 3.1 the first node of the contractual branch reflects this distinction between environment and arrangements. The branch of the institutional environment is concerned with establishing the rules of the game in both the public and private sectors. Public choice literature has been developed in response to the first, while the property rights economy deals with the second one.

The public choice theory tries to link the economy with politics through government, understood as the sum of individual wills, to know what are the factors that determine the policies that government chooses from among the different options presented to it (Blumm, 1994). In general, this theory studies the inefficiency caused by the action of the government caused by an attempt to solve the market failures. Thus, this theory postulates that scientific evidence would point to the government, not the market, as the entity that should be limited or reduced in a welfare society. The branch of institutional arrangements is more interested in the details of the organization. Both the alignment of ex ante incentives -the agency theory node- and ex post governance -the transaction cost nod- are relevant. The first of them maintains that the contracts are complete, from where all the relevant contractual action is concentrated in the ex-ante agreement. Incompleteness in contracts is characteristic of TCE which include ex post and ex ante governance (J. Kim & Mahoney, 2005)

TCE has been widely discussed in areas such as economics (North, 2016), marketing (Oliver Williamson & Ghani, 2012), supply chain management (Grover & Malhotra, 2003; Hennart, 2010; Wacker, Yang, & Sheu, 2016), finance (Li, Wang, Hoi, & Huang, 2017; Thapa & Poshakwale, 2010), organizational theory, strategy (Sinnewe, Charles, & Keast, 2016), law and public policy (Coggan, Whitten, & Bennett, 2010; Dagdeviren & Robertson, 2016; Garrick, Whitten, & Coggan, 2013; Prasad & Shivarajan, 2015), health economics (Hajli, Shanmugam, Hajli, Khani, & Wang, 2015) and agricultural economics (DeBoe & Stephenson, 2016; Macher & Richman, 2008).

The key conceptual move to TCE is to describe firms not in neoclassical terms -as production functions- but in organizational terms -as governance structures-. The basic insight of TCE is to recognize that in a world of positive transaction costs, exchange agreements must be governed, and that, contingent on the

transactions to be organized, some forms of governance are better than others (Macher & Richman, 2008).

A contract is understood as an agreement between two or more persons - natural or legal - in order to create a legal system that regulates a business, or some economic relationship. The contracts constitute an agreement that defines the terms that allow each of the parties involved, protect and assert their rights and also know their responsibilities (R. Hall, 1992). There is evidence that as a contract is drawn up, it may affect the coordination of the parties and the results that can be obtained in the contractual relationship (Schepker et al., 2014).

Williamson (1985) relates three fundamental elements of the transaction costs theory and the processes of negotiation between the parties, these elements are: the bounded rationality, the opportunism and the specificity asset; this under the supposition that in all cases, there is a level of reasonable uncertainty. These elements are shown in Table 3.1.

Table 3.1. Attributes of the Contracting Process

Behavioral Assumption			
Bounded Rationality	Opportunism	Asset Specificity	Implicit Contracting Process
0	+	+	Planning
+	0	+	Promise
+	+	0	Competition
+	+	+	Governance

Source: Williamson (1985)

In the absence of bounded rationality, i.e. when all conditions are known, before and future conditions can be predicted with absolute certainty, a global negotiation is initiated from the beginning, taking into account the existence of opportunism in one of them parties, the contract must be written, however the contingency or future problems are resolved in advance. In this scenario, there are no problems in executing the contract. In the context of the absence of bounded rationality, the implicit contracting process is summarized in a planning process for all future events.

Another possible scenario is the situation where the parties contracting or involved in the relationship are subject to bounded rationality, there is a specificity of assets, however the opportunism is absent, in this case the word of each of the parties is sufficient to establish the relationship, to put it in another way, the relationship is established by means of “promises”.

In this case in the ex-ante process, each party undertakes from the outset to execute the contract efficiently in order to maximize the benefit of the relationship. The contract defines and includes the greatest number of future contingencies without being able to foresee them in full, and during the execution phase the parties comply with what has been promised.

Another consideration present in Table 3.1 is given when the agents are subject to bounded rationality, and there is opportunism, but it is presumed that the specificity of the assets is absent, these characteristics reduce the contracting process to the world of competition where the identity of competitors is not more relevant.

A more complex scenario in the contractual relationship occurs when the three elements are present in a relationship, the specificity of assets, bounded rationality and opportunism.

In this scenario, only planning is not enough because they are not known or it is very difficult to predict all future eventualities, suggesting that they arise and the relationship must be modified over time. On the other hand, even if all details are known (absence of bounded rationality) the promises are not fully fulfilled due to the opportunism of those involved. And because assets are so specific, it is important to know the identity of the parties involved. This is the world of governance, this is the world where transaction costs gain strength, with the aim of organizing transactions to economize on problems arising from contingent activities derived from bounded rationality, while protecting against the dangers of opportunism of the agents. This logic of TCE shows a broader view of the economic problem of organizations whose objective has been focused only on profit maximization.

According to (Williamson, 1985) there are at least three forms of contracting, in each of them a form of governance is induced, they are classical, neoclassical, and relational contracting as shown in Table 3.2.

Table 3.2. Efficient Governance

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">Investment Characteristics</td></tr>
<tr><td>Nonspecific</td><td>Mixed</td><td>Idiosyncratic</td></tr>
<tr><td rowspan="2">Frequency</td><td>Occasional</td><td rowspan="2">Market Governance (Classical contracting)</td><td>Trilateral Governance (neoclassical contracting)</td><td rowspan="2">Unified Governance</td></tr>
<tr><td>Recurrent</td><td>Bilateral Governance (relational contracting)</td></tr>
</table>

Source: Williamson (1985)

In classical contracting the identity of the parties is irrelevant for the transactions and there are a large number of buyers and sellers on each side of the transaction. The agreement is carefully delineated, solutions are prescribed and third party participation is discouraged. Emphasis is placed on rules, formal documents and automatic settlement transactions. In this context, long-term contracts executed in conditions of uncertainty are very expensive. Classical contracting is applied in environments where transactions are standardized no matter how often they occur. This form of contracting approximates market governance in which the identity of the parties is of no importance, substantive content is determined by reference to the formal terms of the contract, legal rules are applied and each party is protected against opportunistic behavior of the other parts.

Furthermore, in the neoclassical contracting scheme, long-term contracts executed under conditions of uncertainty are developed and applied to occasional and non-standardized transactions. In this case, different types of problems can be faced as not all future contingencies can be anticipated from the beginning and because appropriate adaptations will not be evident for many contingencies. This form of contracting approaches trilateral governance, that is, when a problem arises instead of appealing immediately to judicial litigation, assistance is used (arbitration by a third party for the resolution of disputes and evaluation of execution), so it is called trilateral.

Finally, relational contracting arises from the progressive increase in the "duration and complexity" of the transaction that makes the neoclassical contract insufficient. This type of contract has its origin in the "relationship as it has developed over time" (unlike the neoclassical in which the reference for making adaptations is the original agreement). It is applied for recurrent and non-standardized transactions and is organized into structures of bilateral or unified governance.

Relational contracting can be divided into two dimensions, bilateral governance and unified governance. In the relational contracting, the fundamental transformation is applied due to the non-standardized nature of the transactions, thus valuing the continuity of commercial relations. In this type of relationship the high frequency of transactions contributes to the recovery of the investments needed to support the existence of the relationship.

In both bilateral governance and unified governance, there are two parties (buyer and seller), but in bilateral governance the two parties are autonomous (for example two different organizations). In unilateral governance, the two parties belong to the same organization (for example two departments, where one sells or produces to the other), and although in the past the activities of one of the departments have been carried out abroad, due to their level of specificity it is possible that the organization has decided to carry it out internally with a process of vertical integration (Williamson, 1985).

The main difference between the market and the internal organization can be framed in the following principles: markets promote great incentives and restrict the bureaucratic distortions that are present internally in the organizations, markets have the capacity to add demand and generate economies of scale but, on the other hand, organization can have access to different forms of internal governance and efficiency management.

Market governance and other forms of governance raise the boundaries of organizations from the perspective of TCE and make clear the dichotomous decision between make or buy. To analyze these decisions, Williamson (1985) proposes the following assumptions.

Let $\beta(k)$ be the bureaucratic costs of internal governance and $M(k)$ the corresponding cost of market governance, where k is an index related to the specificity of the assets ($k = 0$ means absence of specificity), it is also assumed that, $\beta(0) > M(0)$ and $M' > \beta'$ evaluated for each k, this is due to comparative incapacity of adaptation that markets have as transactions become more specific.

Letting $\Delta G = \beta(k) - M(k)$. This indicates the potential gains or losses derived from governance costs when given a specific specificity of the assets an organization decides to make instead of buy in the market a product or service.

Under these assumptions, the decision to buy rather than to make is preferred when the specifics of the assets are low, this is due to the avoidance of bureaucratic costs and control of domestic production. On the other hand, internal organization is favored by the existence of a great specificity of assets, because there is a high degree of bilateral dependence, and bureaucratic costs can be diluted as adjustments are made between the parties.

These assumptions are shown in Figure 3.2. As Figure 3.2 shows, there is a level of specificity of assets $(\bar{k})$ when the decision to make or buy would provide the same results, which means that $\Delta G = 0$.

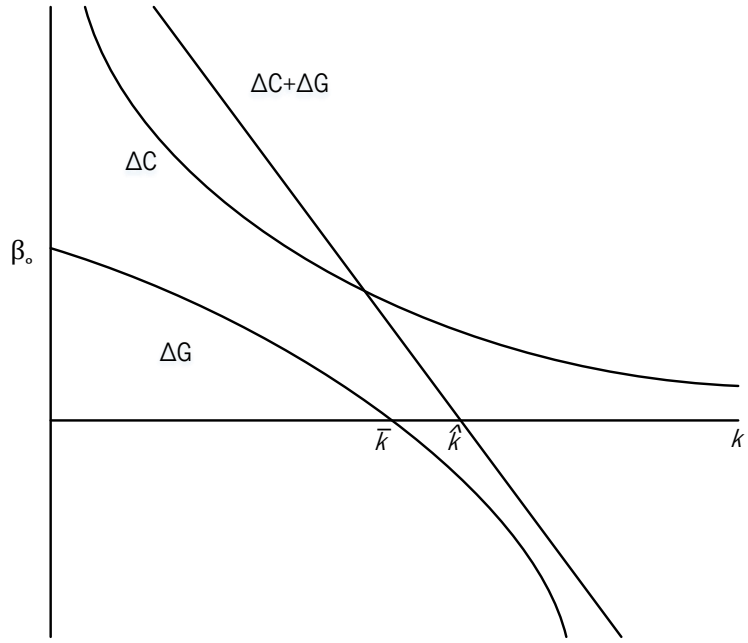

Figure 3.2. Comparative Production and Governance Costs
Source: Williamson (1985)

On the other hand, let ΔC be the steady state production cost difference between producing to one's own requirements and the steady state cost of obtaining the same item in the market.

Letting, $\Delta C = IC(k) - EC(k)$, where $IC(k)$ is the internal production cost and $EC(k)$ is the external cost or cost of acquisition in the market, taking into account a certain specificity of the assets in the relationship. ΔC recognizes the existence of economies of scale that favor the market with respect to internal organization.

Expressing ΔC as a function of asset specificity, it is reasonable to assume that ΔC will be positive and will be decreasing in function of k. When internal resources of the organization are used the cost of production is penalized with respect to the cost of the product in the market, when one has standardized transactions, with available economies of aggregation, the market can take advantage of the existence of economies of scale, from where ΔC is considerable when there is low specificity of the assets. The cost disadvantage decreases but remains positive for the intermediate grades of specified assets. Therefore, although differences between orders begin to appear, external suppliers can add the various demands of many buyers and produce at a lower cost than the company that produces its own needs. As services come and services become very close to unique goods for each organization (k is high), aggregation economies of external supply can no longer be realized, where ΔC approaches zero. Contracting production externally does not offer economies of scale which encourages internal production.

In this sense, given an optimal or specified level of the assets, the objective would be to minimize the sum of ΔC and ΔG. Economies of scale favor the organization of the market, in a wide range of specific assets while the specificity of assets favors the vertical integration of activities.

More generally, if k^* is the optimal or suggested degree of the level of asset specificity, Figure 3.2 shows that:

1. Market acquisition has advantages both in economies of scale and in governance when the optimal or potential specificity of assets is small ($k^* \ll \hat{k}$).
2. The internal organization enjoys advantages when the specificity of the optimal assets is considerable ($k^* \gg \hat{k}$). Not only because the market cannot take advantage of economies of aggregation or economies of scale, but also because the lock-in problems when assets are specific are often greater.
3. If only production costs are analyzed, in most cases, the company would be at a disadvantage with the market the organization will never be integrated if only production costs are considered as a measure of the make or buy decision. Only when contracting difficulties intrude between the firm and the market compared to vertical integration and the values of k^* exceed $\hat{k}$.

All of these elements presented above show how transaction costs theory is adapted to problems where there are contracting processes, whether there is a competitive market or not, or where the specificity of the assets is important.

Authors such as Holmström & Roberts (1998) recognize the importance of TCE in modern economic theory, but criticize the fact that in TCE when speaking of specific assets no reference is made to direct upfront costs in ex ante investments. For example, it does not differentiate between a specific asset that costs ten millions and other one that costs one hundred millions, inside and outside the contractual relationship. In addition, using the aggregate level of quasi-rents (what is left to be won if an alternative one is given to the asset that was foreseen due to the existence of the contractual relationship) which is the value of an asset over its salvage value (Alchian & Woodward, 1988; Carney & Gedajlovic, 1991). Created by the investment as an approximate unit of asset specificity does not consider the importance of information asymmetry. Williamson´s approach assumes that an asymmetric relationship with one of the parties in a dominant position, does not differ from a symmetric one at the same aggregate level of asset specificity. That is, it does not consider the importance of information asymmetry and uses the specificity of assets as the basis for decision-making.

Another problem identified by Holmström & Roberts (1998) is related to the determination of the transaction cost. This is due to the fact that within an organization the same resource can perform several transactions, therefore to know the cost of each transaction we would need a costing system.

From its beginnings, the TCE has been defended as well as criticized, nevertheless immense works have been developed throughout the last decades aiming practical contributions of this theory. The TCE presents interesting elements related to cost management as is the cost determination itself to make decisions about whether it is better for an organization to make or buy. This discussion will be addressed in next section, below is presented as the theory of transaction costs has been used specifically when addressing issues related to health care.

3.2.2 Transaction Cost Economics in Health Care

Several studies have been conducted using TCE in the health care sector (Marini & Street, 2007). For example, (Robinson & Casalino, 1996) used the logic of TCE in California hospitals, and focused on two types of health care decisions, vertical integration, based on unified ownership and virtual integration, based on contractual networks. Among the findings, this research highlights the potential advantages of large physician organizations in terms of economies of scale, enhanced risk bearing ability, reduced transaction costs related to negotiation, monitoring and execution of what is agreed in the contract, the capacity for innovation in methods of managing care services and the reduction of the holdup problems. Because the market is imperfect (Acemoglu, Johnson, & Mitton, 2009), on the other hand, the virtual integration has as advantages, the easy adaptation to the change in the environment, and the maximization of the efficiency.

When most TCE studies focused on the make or buy decision and specific assets, Coles & Hesterly (1998) stressed the importance of including uncertainties in addition to assets. They argue that in the hospital industry there are pressures to make or buy in public and private organizations, in the case of public institutions these decisions may be more pressured by political and non-economic decisions than by strictly economic decisions, which is not the case in private entities where the decision to make or buy is guided by principles related to the maximization of efficiency and profit.

Although the decision to buy or buy is an important decision in most organizations, (Ludwig, Groot, & Van Merode (2009) point out after analyzing some Dutch hospitals that the level of subcontracting of their services is low and normally outsourcing does not affect the efficiency of hospitals , so they question whether much importance should be attached to make or buy decisions. In contrast (Cuellar & Gertler, 2006) discuss the negative effect of vertical integration (with the objective of reducing transaction costs)

on hospital efficiency, due to the absence of a competitive market, which generates inefficiencies that can be translated into high costs in the provision of services.

Donato (2010) highlights the potential of TCE in health, but questions the fact that its conceptualization is static i.e. it does not consider the variations that can occur in a contractual relationship and the fact that trust and changes occur over time and do not necessarily compel to vertical integration. He suggests to apply TCE jointly with the resource-based view -RBC- to cover these deficiencies. Other authors analyzed the contractual process between providers and clients of the New Zealand health system under the TCE's eyes highlighting some benefits such as the improvement in the commercial relationship and the quality of accountability by service providers (Ashton, 1998; Ashton et al., 2004)

One of the areas where there is no consensus is the relation between the autonomy of health systems and the effect on transaction costs in the provision of services. For example Mendoza (2010) conduct a study in the Philippines of how the high transaction costs within a system, make a buyer decide to go to secondary markets, in this research stands out as the high transaction costs associated with a kidney transplant in the frame legal established in the Philippines, contribute to the existence of illegal traffic of these organs, from this perspective the high internal transaction (in the legal system), leads the "buyers" to the external market (illegal market). In this study the high costs transaction costs are induced by the amount of rules established by the government. On the other Jarman & Greer (2010) mention that the liberalization of health services can also generate high transaction costs in the system. Here an interesting aspect to study is the relation of the levels of autonomy and transaction costs that this generates for a health system.

In the research of Cruz, Haugan, & Rincon (2014) they used the TCE to analyze how the asset specificity influences the financial performance of external and internal governance structures for medical device maintenance in public and private hospitals. This study is relevant because of the number of maintenance transactions analyzed, which were more than 1,400, a significantly larger amount than that found in similar studies.

Using the TCE (Chao, Yu, Cheng, & Chuang, 2013) analyzes the relationship that 128 hospitals in Taiwan have with their medical device providers, finding that the specificity of the assets has a positive effect on the trust and confidence in turn a positive effect on the level of commitments of the relationship. On the other hand, the uncertainty damages the confidence and therefore also the level of commitment in the relations buyer-seller. In this same line of reasoning, Xu & van de Ven (2009) establishes that the existence of fewer suppliers (in many cases having a single supplier) contributes to a decrease in transaction costs since it is easier to align them with the policies of the organization.

Dutch Duijmelinck, Mosca, & Ven (2015) make an interesting study of transaction costs from the perspective of the relationship between consumers and health insurers. Two important aspects of this study are the fact that it is argued that health insurance markets will only be more competitive, efficient and of quality as long as consumers have the possibility to change easily and freely from insurer, i.e. the system would be forced to be efficient in an environment of free choice of health care provider.

The second aspect is related to the fact that transaction costs associated with an insurer change are the main factors that make a person not change insurer and that contributes to the inefficiency of the system in general, i.e. in this case, high transaction costs (costs of change) force ineffective or harmful relations to one of the parties.

Castano & Mills (2013) developed a study within twenty two Colombian hospitals to understand the role of relationship-specific investments and contract incompleteness as sources of transaction costs, through a largely qualitative study.

This study presents a useful framework for exploring contractual relationships between purchased-provider hospital environments. It is taken into account that the costs of these relationships are associated with the realization of an economic exchange under defined governance structures.

Changes in the internal governance structure can be viewed essentially as a search for reduction of ex-post problems that arise in a bilateral relationship; in other words, a search in the reduction of transaction costs. Based on this study, there is evidence of transaction costs when the variables shown in Figure 3.3 are presented.

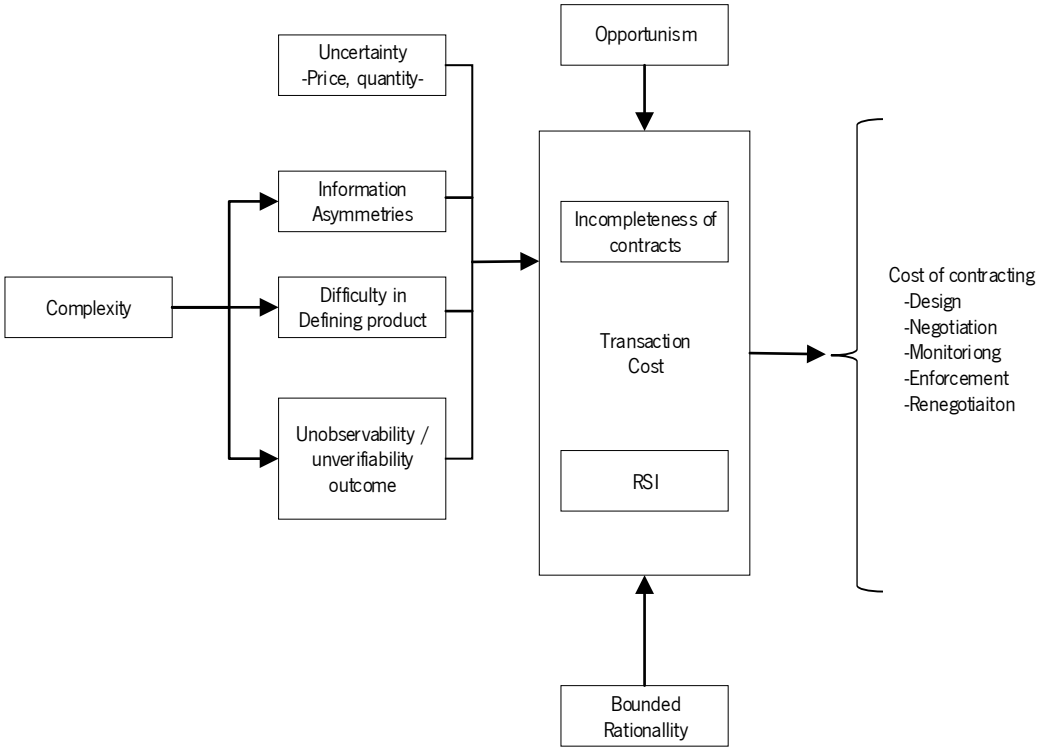

Figure 3.3. Transaction Costs of Market-Based Relationships. Within a Context of Bounded Rationality and Opportunism, Contract Incompleteness and Relationship-Specific Investment (RSI)
Source: Adapted from Castaño & Mills (2013) and Miranda & Kim (2006)

Figure 3 highlights important elements that contribute to incomplete contracts, such as uncertainty in costs and quantity, the complexity in defining, observing and verifying service that has been performed and asymmetric information, which generates incomplete contracts, given the presence of opportunism, limited rationality and specificity of those who in turn generate transaction costs. This research will serve as a starting point to visualize the process of internal contracting in some Portuguese hospitals, identifying variables that generate incomplete contracts, the relationship of the specificity of the assets with the generation of transaction costs and all this from the point of view of cost management.

3.3 Methodology and Research Methods

The methodology used in this research was semi-structured interviewing. The following is a description of some particularities of this methodology, as well as the process that was followed for its application in this research, highlighting elements related to the before, during and after the interviews taking into account the good methodological practices for this type of approach.

An interview is an exchange between the researcher and the participants, the participant shares information and the researcher a sense of presence or accompaniment in the story (Corbin & Morse, 2003). An elementary feature of the qualitative research interview method has to do with the relationship that is established between the interviewee and the interviewer (Cassell & Symon, 2004b).

With respect to classification, interviews can be classified as structured, semi-structured, or unstructured interviews. In structured interviews, the interviewer performs his work based on a guide to specific questions and is exclusively subject to it, in this case the script indicates which questions should be asked and the order in which they should be done. The structured interviewing has the advantage of systematization, which facilitates classification and analysis, and also presents a high objectivity and reliability. Its disadvantage is the lack of flexibility that entails the lack of adaptation to the subject being interviewed and a smaller depth in the analysis.

In semi-structured interviews, the interviewer uses a question or question guide and is free to introduce additional questions to clarify concepts or obtain more information on desired topics. The semi-structured interviews present a greater degree of flexibility than structured ones, because they are based on planned questions that can be adjusted to the interviewees. Its advantage is the possibility of adapting to the subjects with enormous possibilities to motivate the interlocutor, to clarify terms, to identify ambiguities and to reduce formalisms. Semi-structured interviews are considered to offer an acceptable degree of flexibility, while maintaining sufficient uniformity to achieve interpretations consistent with the purposes of an investigation (Díaz-Bravo, Torruco-García, Martínez-Hernández, & Varela-Ruiz, 2013).

In the unstructured interviews there is no predetermined list of questions to ask, there is only one theme or idea of what you want to explore and in this case the interviewer is asking questions as some elements of interest arise (Sampieri, Collado, Lucio, & Pérez, 1998; Saunders et al., 2009).

The unstructured interviews are more informal, more flexible and are planned in such a way that they can be adapted to subjects and conditions. In this type of interview participants have the freedom to go beyond the questions and may deviate from the original plan, the disadvantage of this type of interviews is that they may present gaps in the information needed in the research (Doody & Noonan, 2013).

For Cassell &

Symon (2004b) design and using qualitative research interviews can be grouped into 4 steps which are:

- ✓ defining the research question,
- ✓ creating the interview guide;
- ✓ recruiting participants;
- ✓ carrying out the interviews.

For the definition of the research question, the elements of Chapter 1 and Chapter 2 and those presented in this introduction were taken into account with the objective of knowing and if there are establish relationships between TCE and cost management in the hospital environment. With respect to the following steps: creating the interview guide, recruiting participants and carrying out the interviews they were taken into account the protocol presented in the Appendix 1 and the interview script shown in Appendix 2.

Appendix 1 shows the steps for interviewing from the point of view of the protocol that was followed for its elaboration. This appendix shows how the contact with the interviewees was established until the analysis of each one of the interviews, through the recording of each of them, their transcription and subsequent analysis.

Appendix 2 shows the process of constructing the interview script which started with research design and literature analysis, as well as periodic meetings with the advisor and with a person in charge of the production of one of the hospitals interviewed, this happened during the period from September 2015 to December 2015, a period in which through an iterative analysis topics and questions were defined to be used during the interview process, and a pilot test was conducted with the purpose of validating and refining the questions, as well as to verify aspects such as the time that would be dedicated to the interview that should be close to one hour for each.

There are different ways of conducting the interviews, being the interview usually face to face the dominant technique when interviewing (Hollway & Jefferson, 2000), however due to the increase in mass media recent studies have explored the interview via telephone (Pieper, 2011) or Internet and intranet-mediated (electronic) interviews (Zhang, Kuchinke, Woud, Velten, & Margraf, 2017) which have the advantages of being less expensive and have a greater geographical extent, but do not allow the reactions of respondents to be perceived, which can be a valuable element in qualitative research (Novick, 2008) In this research all interviews were conducted face to face.

The interviews were conducted between June 2016 and August 2016, the summary of interview profiles is shown in Appendix VII. All the interviews were recorded, a confidentiality term was given, so that the names of the institutions and the interviewees did not appear, these were replaced by an interviewee code.

One interesting aspect to mention has to do with the variety of hospitals that were interviewed. Four organizations were interviewed, two of which are hospital centers (which together comprise six hospitals) a public-private partnership, and a hospital of medium size. The semi-structured interviews were carry

out with the top management of several Portuguese hospitals, with elements of middle management and clinical staff in charge of clinical services

Computer-assisted qualitative data analysis software (CAQDAS) or qualitative data analysis software (QDAS) was used to organize and make the analysis of the interviews (Tummons, 2014). QDAS provides tools to assist qualitative research such as transcription analysis, coding and text interpretation, recursive and discourse analysis. There are many software packages available for qualitative data analysis such as Qualrus, Tams analyser, QDA Miner, HyperResearch, Maxqda, QSR N4, Transana, Ethnograph, Kwalitan, Nud*ist, N6, CATMA,Tosmana, FreeQDA, Cassandre, Aquad, RQDA, Nvivo and ATLAS.ti. In this research it as used ATLAS.ti. 8.0

ATLAS.ti is a computer program that assists those who perform a qualitative analysis, providing a tool that facilitates the organization, handling and interpretation of large amounts of textual data (which can be written texts, images, sounds, maps and / or videos), despite being a computational tool that reduces the work in terms of organization, all analyzes must be performed by the researcher, i.e. ATLAS.Ti does not perform the analysis and does not replace the researcher.

Thus, once the interviews were recorded, they were transcribed, and analyzed through Atlas.ti 8.0 software.

For this part of the research, they were used mainly the questions in sections 2, 3 and 4 of the interviews script as shown in Appendix 2. These sections are related to elements such as cost management, uncertainty treatment, contracting process, incentives, asset specificity, among others.

In the process of analysis they were used codes and quotations that allowed to realize later the analysis. The interviews were coded, taking into account the definition of code an coding presented by Saldaña (2015). This author defines a code as *"a word or short phrase that symbolically assign a cumulative, significant, essence-capturing, and/or evocative attribute for a portion of language based or visual data*". The resulting codes from these sections were:

- ✓ Cost Management: This category addresses aspects related to the cost management process, costing systems, the advantages and disadvantages of the current costing system, the background and the importance and usefulness of cost management for decision making; 9 codes were used.
    - Cost Management,
    - Cost Accounting
    - Costing Systems
    - Costing Systems Implementation

- Problem with Costing Systems
- Using of Cost Information
- Cost Control
- Incentive Policy
- Level of Satisfaction with Costing System

✓ Variability and Uncertainty: The existence and importance of internal and external variability within hospitals was also identified - internal variability understood as the variability that in the treatment and therefore in the cost that a certain disease has, and external variability that is associated with the level of demand - an aspect that also came to the light during the interview; in this case the codes used are related to the internal and external variability and the management of said variability; for this were used 3 codes.

- Internal Variability
- External Variability
- Risk and Uncertainty Management

✓ TCE and agency theory: This category was identified aspects related to the process of outsourcing and mainly internal and its relation with the cost management, in this category are, the difficulty to measure the production, the specificity of the assets, and problems with the information for this 11 codes were used.

- TCE
- Asymmetry of the information
- Production Indicators
- Complexity in the production definition
- Contractual relationship
- Specificity of resources
- Specificity of Assets
- Outsourcing
- Insourcing
- Contract
- Controlling

Once the coding process was carried out, the analyzes were performed taking into account the reviewed literature in order to answer the research questions and discover interesting elements of the TCEin the hospital environment. The analysis performed is shown below.

3.4 The Empirical Study

The basis of TCE are the concepts of transactions, contracting processes and governance established between two or more parties. In this sense the following sub-section shows how the payment system works in the NHS in Portugal, which gives rise to the contract between hospitals and the RHAs. Next step is shown how has been the financial compliance of said contract of the different RHAs and hospitals from the financial point of view, i.e. considering the Earnings Before Interests, Taxes, Depreciations and Amortizations (EBITDA.)

It then presents an analysis of the internal contracting process (hospital with departments, or with services) and governance from the point of view of TCE and cost management. In order to identify the contracting elements that result in transaction costs and their impact on cost management, these elements are condensed in a figure where one of the important components is the complexity and uncertainty in the internal relationships in hospitals.

Then, taking into account the complexity of the hospital, a critical analysis of the costs associated with the make or buy decision represented in Figure 3.1 is presented.

3.4.1 Contracting Process in Portuguese Hospitals: The Payment System

The health system Portugal is an integrated health system from the financing units - mainly the government - to the units that provide the services to the community. This integration is possible thanks to the contractual process between the regional administration, central administration and hospital institutions. The contractual process is based on a methodology of relationship among financiers, buyers and suppliers. The tool used for this purpose is called the contract-, which defines the level and composition of the contracted production, the objectives to be achieved, as well as the indicators that allow to verify the performance of the institutions in the perspective of guaranteeing the principles of access, service quality and financial economic performance. Once the contract has been drawn up, the service providers must coordinate their internal efforts in order to comply with the contract, which is achieved following a strategy defined at the macro level by the board of directors. In this sense, the means and internal communication strategies are relevant to the extent that clear, defined and well-known objectives must be established by all those involved in the process. The articulation between the three levels of management, government, boards of directors and levels of intermediate management - departments, management centers, responsibility centers - is necessary to define clear objectives and policies that allow not only to comply with the contract but also to ensure the sustainability of the system

and the quality of services in the short, medium and long term (Matos, Ferreira, Lourenço, & Escoval, 2010). The contracting process aims to contribute to strengthening the diagnosis of the population's health needs and to reinforcing the implementation of good care and organizational practices that ensure high levels of access, quality and efficiency in the NHS, placing citizens and their families at the center of interventions of all care providers, reinforcing the articulation and coordination among these, valuing the performance of professionals and encouraging clinical and health Governance (ACSS, 2016c). The contracting process takes place externally – between Hospitals and government entities – and internally – between Management, Departments, accountability centers. According to (ACSS, 2016c), In 2017 internal contracting processes should be integrated into a modern, responsible and rigorous management culture , promoting the responsibility and autonomy of professionals and teams thus, contributing to increase motivation and commitment, levels of productivity and effectiveness of services, and to reduce inefficiencies and waste in NHS institutions.

The contracting process starts with the planning of health needs and the definition of investment priorities, followed by the collection of information from the institutions to be contracted and ends with the evaluation of the performance of the contracted goals. They are three distinct phases, which differ essentially in terms of the objectives to which they are intended and which determine different interlocutors and responsibilities and, for the time horizon.

The planning and colleting phases provides the basis for the negotiation and of the contract, in which the objective is to adjust production proposals to the health needs of the population, agreeing production levels that ensure the principles of equity, effectiveness and efficiency of the system - implying an effective knowledge of the population's health needs - as well as their economic and financial sustainability.

In the monitoring phase of the implementation of the contract by the institutions, the objective is to systematically collect information that enables the comparative analysis of the institutions' real performances against the contracted one, in order to promote corrective measures or to promote good results. This phase reveals critical aspects to the fulfillment of the intended objective, namely the context of externalities and the quality of the data reported.

The contracting process takes place within a time horizon that normally starts at the second quarter of the year prior to the year for which it is intended to be the contracting, and the monitoring phase, due to the nature of the exercise itself that takes place during the contracted year. The process ends with the evaluation of the degree of compliance with the contracted goals and performance objectives achieved, allowing to determine the inherent consequences and apply the rules defined in the contract. This phase

occurs after the closure of the year for which the contracting process was carried out, accompanied by the process of accounting of the billing process of the contract (ACSS, 2011b).

At the internal level of hospitals, contracting takes place at the micro level and promotes the alignment of the objectives. However, it is always framed by external contracting that drives or limits it.

After a SWOT analysis regarding internal contracting in Portuguese hospitals Matos et al. (2010) emphasize as strengths the fact that the internal contracting based on the history of several years has been improved in these hospitals; in some hospitals there are already plans of intermediate management training and in some hospitals there is already an effective involvement of intermediate management levels in the contracting process.

Among the weaknesses and threats that they stand out are: excessive focus on operational management over strategic management, lack of accountability culture and quality in some organizations -effectiveness vs. efficiency-, poor involvement of middle management in hospital management, lack of leadership ability, lack of management training at the intermediate level of management, lack of autonomy in the management of human resources, legal difficulties to implement performance evaluation policies and incentive systems, lack of credible and integrated information systems to monitor qualitative and real-time results, lack of information systems that allow service and medical act, lack of real costing methodologies at national level, lack of definition of criteria and common language, explicit timetable, unique interlocutor and documentary simplicity in external contracting. In addition to analyzing the needs of the population, one of the bases of the contract also focuses on the own capacity of the hospitals which in turn is related to the capacity of each service, department or responsibility center.

This generates that top management of the hospital must "contract" the production with each service, department or responsibility center to fulfill its objectives proposed in the contract that is to carry out an internal contracting process

The internal contracting process is important to the extent that it will contribute to meeting the financial objectives set out in the outsourcing process. One of these objectives mentioned in ACSS 2017 for the external contracting process in 2017 is that each hospital must plan and manage in order to achieve a positive EBITDA in 2017, eliminating the accumulation of new arrears and implementing the measures of containment and rationalization of costs to achieve this objective. This objective is important because, as shown in

Figure 3.4, in the last years -2014 to 2016- the EBITDA sum of the hospitals grouped in the 5 Regional Health Administrations shown in Appendix 3, are mostly negative. Since prices are fixed according to the

established DRGs the improvement of this indicator will be achieved by being more cost efficient, indicating that cost management is a key strategic factor in hospitals.

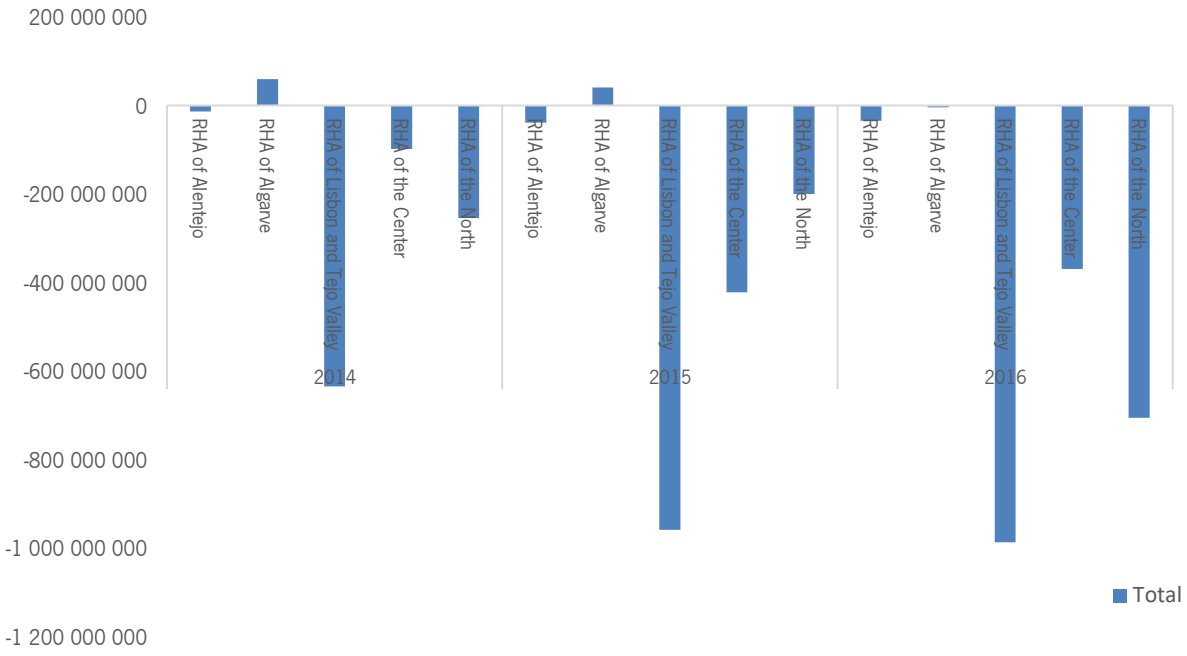

Figure 3.4. Sum of EBITDAs for RHAs between 2014 and 2016
Source: Based on ACSS (2017a)

Due to the EBITDA is a good approximation of the capacity of a company to generate profits considering only its productive capacity, the accumulation of negative EBITDA over the years for most RHAs indicates a systematic non-compliance of the contracts, since the cost exceeds in most cases the revenues received by the RHAs (which come mainly of state resources). This difficulty can be explained by several factors, the first one may be due to inefficiencies in the provision of health services, or it may be that the projected value for DRGs is lower than the actual value of the treatments. Although there are many factors to explain these results, there is an evidence of a problem that, if maintained over time, could sacrifice the financial efficiency of the system or affect the provision of the services and their quality.

The picture is nothing different at the hospital level. In percentage terms with regard to the number of hospitals per region, the level of non-compliance with EBITDA is also high and in general has deteriorated over the years, it is noteworthy that in almost all regions the level of non-compliance exceeds the majority of cases in 50%. This may be due to problems that may affect the RHAs and which were mentioned earlier.

Table 3.3 shows the percentage of hospitals or hospital centers with negative EBITDA in the years 2014, 2015 and 2016 grouped by each of the RHAs.

Table 3.3. Analysis of the Negative EBITDA between 2014 and 2016 of Portuguese Hospitals Organized by RHAs

Year\RHA		Alentejo	Algarve	Lisbon and Tejo Valley	Center	North
2014	Number of Hospitals	4	1	13	12	16
	% Hospitals with Negative EBITDA	75,0%	0,0%	76,9%	41,7%	68,8%
2015	Number of Hospitals	4	1	13	12	16
	% Hospitals with Negative EBITDA	75,0%	0,0%	69,2%	58,3%	50,0%
2016	Number of Hospitals	4	1	13	12	15
	% Hospitals with Negative EBITDA	75,0%	100,0%	69,2%	58,3%	93,3%

Source: Based on ACSS (2017a)

Crossing the information in Table 3.3 with the one presented in Figure 3.4 it is possible to predict that part of the breaches of the RHAs is due to breaches in the contract with the hospitals, and the contract with the hospital in turn can be defined as a sum of internal contracts. Therefore, it is fundamental to analyze the internal contracting to determine the source of the non-compliances that will allow to determine intervention measures either via efficiency improvement or by the way of more injection of resources by the state. The process of internal contracting, its complexity and implications will be analyzed in the following section.

3.4.2 Cost Management in the Internal Contract Process from the Perspective of TCE

Following Castaño & Mills (2013) approach, these are related to the first with limited rationality and opportunism, that is, not having knowledge of the possible actions, in this case, the actions of the doctors, administrative and patients, the latter are not the subject of this research in terms of behavior however they are an important element that can be considered in a future study.

With respect to the limited rationality in the contracting process, different opinions were found in the hospitals interviewed. When asked if it is easy for an administrator to know everything that a director does, one of the administrators responded:

"If it is a quantitative level, yes, at the technical level no, nor do they have to know, so sometimes they argue some things for this technical justification, for example, seeing fewer patients in the consultation, if we ask why this month had fewer patients In the consultation, one answer may be that the patients are more complicated, they have more problems, the pathologies are more differentiated, and this we cannot counter-argument." (HOSPITAL 1/INTERVIEWEE 2)

Related as this subject is also the asymmetry of information between the board of directors and the different units within the hospital. Although it is present within the units interviewed, the asymmetry of information is linked to the organizational culture and is not perceived in the same way within the hospitals organizations.

"The board of directors has inside information" "It is financial services, it is they who have the information. And if there is any control activity is on the part of financial services." (HOSPITAL 1/INTERVIEWEE 1)

"The business intelligence that we have is not only for administration, it is for the doctors, and for the directors of service, therefore they daily monitor whether they are above their activity or below their activity, not only in quantity but also in Quality indicators." (HOSPITAL 3/INTERVIEWEE 6)

"There is a link here, quite large, that is, the information provided is not the same, it is the same and have the same degree of detail for all actors, according to their scale and hierarchy, what the agent has to Know we know, now in the board of directors, we share an anti-terrorist maxim, that is, we share the information, and we are convinced that the more there is a novel award of economy for a few years that won with something that was the theory of conditioned knowledge , Or the theory of the Action of conditioned knowledge, that is that people have their actions the better the more knowledge they have, their actions will be conditioned to the degree of knowledge, we are of the opinion that the agents have to have the maximum knowledge To condition their actions, plus a positive packaging and not a negative packaging." (HOSPITAL 3/INTERVIEWEE 6)

These comments show opposite ideologies, with different implications, in the case of the organization where the culture of information sharing is more open was observed a better fulfillment of the contract and the quality of the management systems than in which the information was considered Privileged Another important factor from the point of view of TCE has to do with the ability to define the product and to be able to measure the outcomes of the process, in the case of hospitals the relationship of the contract with the provision of services can make this measurement difficult, In the first instance because:

"...The hospital is financed by the patient, so the more tests the patient does, the more costs the hospital has." (HOSPITAL 1/INTERVIEWEE 2)

"It is very difficult to determine production." (HOSPITAL 1/INTERVIEWEE 1)

"We have to treat everyone, we cannot say [that] this patient does not interest us." (HOSPITAL 3/INTERVIEWEE 7)

"When you have a factory, you can decide not to make this product and make another, either because the market pays more or because the market pays less, it is not, therefore you can choose your production mix, we cannot choose the mix of And therefore if a doctor wastes a lot of time on that patient, the only thing I could do was try to make the doctor more efficient, and waste less time, and then there would be quality problems because the doctor has to do his job. And when you contract production, they will want to reach that level. Difficulties to measure production always exist, now we make an effort every day to minimize these difficulties." (HOSPITAL 3/INTERVIEWEE 6)

As can be seen, there are also great difficulties in measuring hospital production. In addition to this, each patient is a patient and the consumption of resources is different, this creates another characteristic related to the internal, and external variability, in this case external variability is what Mils calls uncertainty in quantity i.e. not knowing how many patients are going to arrive, and internal variability a concept that we introduce since it is in this context is important since it is related Variability in the amount of resources consumed by patients with similar pathologies. In this sense, we find that in terms of resources and therefore in costs the hospitals show this problem, different approaches for their treatment, from doing nothing to trying to monitor possible deviations was found when analyzing the interviews.

"We try to estimate the game and then follow up to see if there are no deviations, and if there is a considerable deviation we have to understand why. The variability of costs, this variability may be more or less visible, when it becomes visible, when this variability has an impact on the analysis of global deviations that we make to the hospital, and therefore it is not visible at that level, in an episode I will not watch episode by episode."(HOSPITAL 2/INTERVIEWEE 5)

In this hospital variability is important at the macro level, and they have information systems to be able to analyze deviations in a reasonable time for decision making.

> *"I can take that patient and do the math and know how much it cost me, now every patient is a sick person and it's all very complex, we'll always know this on average because things are not always in detail or the same , Even the same procedure for patient A and patient B, the costs may be different, because the patient is also different, even in the same time at the time of the examinations, the same examination to a different patient, may have a time completely different." (HOSPITAL 1/INTERVIEWEE 2)*

In this same hospital another interviewee said that despite knowing the existence of internal variability in terms of trying to quantify it.

> *"No, this has been very little. Here there is only one thing they did recently that was a computer system an application that they created recently that includes risks are more risks of falls and these things all more to calculate costs, consumptions, not have(....)." (HOSPITAL 1/INTERVIEWEE 1)*

> *"We do not have any model to quantify variability, we know that it can exist, I do not know the extent of its importance." (HOSPITAL 4/INTERVIEWEE 8)*

This leaves in evidence that although the internal variability exists the way to treat it is different from hospital to hospital. As far as external variability is concerned, it was controlled or stabilized by consultations in local health units, however in the emergency area it was not possible to foresee and in these cases only capacity management was carried out.

One of the most important variables in the TCE has to do with the specificity of the assets, in this sense it was verified specificity by human resources, this is obvious since for being a vital service and very specific knowledge, it is necessary to count with qualified personnel and all personnel providing services must have minimum levels of qualification.

> *"We currently have between 30 and 40 doctors doing the doctoral process, because we do a lot of clinical trials, we do a lot of clinical research, from the management point of view the hospital is not only doctors, although its core business is the area Clinic from the management point of view also worries us always being in the front line." (HOSPITAL 3/INTERVIEWEE 6)*

Location specificity, because the services must be provided within the specific facilities of the hospital, and specificity of equipment since outside the relationship the equipment would have little commercial value or could not be used in alternative activities.

All these elements are important to the extent that they generate contracting difficulties, since the contracts are incomplete and the hospital must incur costs to control the relationship. In this sense, the costs related to the monitoring of the activities to control the compliance with the contracted are highlighted and a cost that is not very considered and that in this environment is important the cost of retention of the doctors, because:

> *"What happens to our hospital center, once again I think it is transverse to large hospitals, I believe in the same problems, the private health sector is robbing us of all professionals, we are becoming more and more specialized and Because it is the purpose of the state to take away from these large hospitals what the minister is calling the aircraft carriers, which are supposed to treat highly differentiated diseases, normal pathologies being in second-line hospitals, and still in a first stage of care Priors, nor should they come here, and therefore we are supposed to have highly specialized and differentiated resources and we fail to maintain them, to captivate them, to form them professionals are trained here, and end the specialization and are immediately asked for or seduced More by the private hospitals, because in particular we by law have to read contracts for 40 hours, plus there are 25 hours, here by law are required To do urgency, and with shifts of 12 or 24 hours, there, they can offer contracts without having to make urgencies, here the salary of a specialized doctor are two thousand and anything they offer three thousand and such, the result we cannot To have professionals here, the new ones, the good ones to half a dozen who stay because they like and know that there is great differentiation here, a lot of people the younger, they are more concerned about what it is that comes at the end of the month, because they have family , Need to pay the house, and in the financial part, ends up being more important than the professional part, and they end up leaving, the same goes with nursing, we have highly differentiated nurses, the block for example they are leaving us because each More and more private hospitals are opening new units, specializing also and therefore coming to our professionals because they are highly differentiated." (HOSPITAL 4/INTERVIEWEE 8)*

This is an important fact to consider, since in order to be competitive in the provision of the service, we must have qualified and highly differentiated personnel. In order to retain them, retention policies and incentives must be developed, although it is true that due to the crisis economic benefits are stagnant, incentives through personal recognition, research or training are highly valued by people in the health sector And incentive policies in this direction would guarantee qualified, motivated personnel that allow the fulfillment of the contract not only in cost but also in the quality of service provision.

One of the results of the interviews regarding the contracting process between the top management of hospitals and their departments or production centers has to do with the fact that hospitals are at different levels not only of contracting culture but also of compliance with contracts.

However, they all recognize that the estimation of production costs and service quality indicators, such as patient readmissions rate, are important insofar as they allow identification of problems in outsourcing, identifying inefficiencies, or identifying opportunities to improve services and thus reduce costs without affecting quality.

In cases where costs cannot be reduced, an additional concern is related to increasing the volume of production, which could indicate an increase in income since in the contract revenues are received by the number of patients treated, taking into account minimum and maximum limits.

However, attending more patients does not mean increased income for all departments or internal areas of the hospital, for example this problem was evidenced in the imaging service of a hospital. The department coordinator's comment regarding complying with it which is contracted with the top management of the hospitals highlights this aspect.

> *"There is always a goal that is never fulfilled which is to reduce demand. Because the hospital is not funded by examination [...] no, the hospital is funded by the sick, so the more tests the patient does, the more costs the hospital has. Therefore, contrary to most services, we have this difficulty here, because the increase in production is not an increase in revenue, at the same time we also have to have an efficient response and meet the response times. Response times are also a quality factor. But the fact that we have too much demand will not increase revenue. And the goals are to decrease the number of exams. And this for us is complicated. And we have not succeeded because it really needed to have a medical team, to do an effective screening of the requests, and to get peer acceptance, to have regular meetings with the other services as well, [...] this then involves a lot of people [...] We have requests coming from the urgency, we have requests coming from the internment, requests coming from the consultation, and this is a long time work. The work is neither short nor medium... this is a long-term job. Medicine is becoming more and more defensive, and a defensive medicine always involves a greater number of requests for examinations, there are many, many exams."(HOSPITAL 1/INTERVIEWEE 2)*

From this emerges an interesting paradox: it is necessary to reduce costs in a paradigm of more assistance / patients and more complex and expensive exams. This could be solved in several ways, it could be accepted that the cost will simply increase by increasing the complexity of the product and try to stabilize or maximize if possible the relationship between quality and cost, or simply maintain or reduce costs by sacrificing the quality of the services provided, which would not be expected from a system that wants to guarantee the quality of its citizens. The solution would be more to increase the resources given to health, maintaining or improving quality levels at the same time as processes are optimized in a continuous improvement effort in order to mitigate such increasing in expenses.

In the case mentioned above a greater number of tests performed means a greater increase in costs, but not a greater increase in revenues, which may affect EBITDA. In this sense, some hospitals are already doing work to try to standardize some processes and homogenize at least the medical prescription for certain types of diseases in order to provide quality treatment without to harm the finances of the hospital. This comment made clear that the contracting process with the different departments is more complex because:

> *"To know the cost of a patient it is necessary that the departments are interconnected since the measure with which they are financed is by" inpatient "or treated patient and not by number of exams, or number of times the patient consumes a certain resource within the hospital, which may vary not only from patient to patient but also from doctor to doctor."(HOSPITAL 4/INTERVIEWEE 8).*

This reveals asymmetries in information and in some cases lack of information that not only makes it difficult to calculate production costs, but also makes it difficult to understand the internal transactions and the cost related to them.

This added to a simple reduction in the number of treatments or the number of medical prescriptions is also not the most obvious solution, because it may be that more resources are spent on diagnosis and less on treatment, or less resources spent on diagnoses.

Re-admissions exist where the health status has deteriorated further and the cost of the patient re-entered may be higher than in the initial state. This highlights one of the key variables in the contracting process identified by Castaño & Mills (2013), the difficulty of measuring output and the difficulty of measuring results, one of the variables that generate incomplete contracts.

After analyzing all these elements, one of the first conclusions is that the internal contracting process in hospitals is a complex task. Due to the nature of hospitals'services and processes, the computation of production costs is complex, coupled with the existence of limited rationality, opportunism, and specificity of human and physical assets, it also generates internal transaction costs related to the design of the contracts, their execution and the monitoring itself, as well as learning costs (when new staff are needed) and costs that can be hidden due to inefficiency. These elements are represented in Figure 3.5.

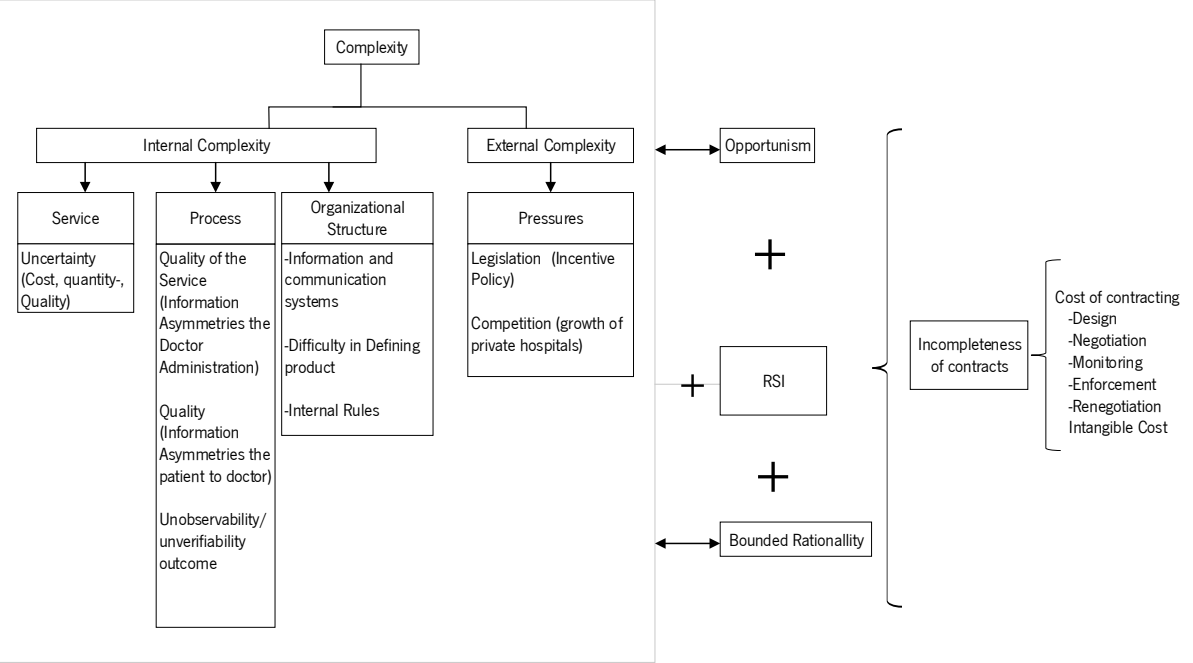

Figure 3.5. The Transaction Cost of Internal Contracting in Hospitals

Figure 5 highlights some elements that generate complexity in the hospital system, which make it difficult to estimate costs, contract compliance (whether internal or external) and finally generate transaction costs. In the figure, these elements were grouped according to whether they are internal or external to the hospital.

With respect to the external complexity, it involves two elements. The first one derived from the policies of the government, which do not consider attractive incentive policies to promote productivity. This can have a negative effect on the costs of providing the service due to the high number of inefficiencies, which will directly or indirectly influence the fulfillment of the contract.

Another element that generates internal complexity is related to the pressure exerted by the competition (mainly from the private sector), which by having better conditions and flexibility is being taken the best professionals, which forces public hospitals to invest continuously in order to get professionals (which is a specific and scarce asset), which often have to be trained, incurring in costs related to such training and learning process. This is a cost that is not normally considered in the costing exercises but which generates a negative impact on the compliance of the contract.

With respect to internal complexity, the elements were grouped as follows, considering product-derived complexity (the service offered to patients), the complexity derived from the processes developed for the provision of the service and the complexity itself derived from the organizational structure.

With respect to the complexity derived by the services, the fact that there is internal variability (derived from the own pathologies) and the external variability (derived from the type of patients that arrive at the hospital) should be highlighted. This, added to the fact that pathologies are increasingly complex and increasingly more sophisticated diagnostics are required, which are more costly, turn the estimation of the production cost and the analysis of the efficiency or inefficiency that will impact the contract more difficult.

On the other hand, the complexity derived from the processes is significant because most of the processes occur as result of the interaction between doctors and patients, and the variables associated to the efficiency, outputs and quality of the service depend on the behavior of the doctor, of the patient, of the treatment and of the evolution of the pathology. All this generates asymmetry in the information, difficulty in estimating the cost and increase in the cost control, which also has a negative impact on compliance with the contract.

Finally, the complexity derived from the organizational structure contains elements such as the difficulty associated with the existence of multiple information systems which are not interconnected, which makes it difficult to control transactions and estimate the cost of service delivery.

The difficulty to define or parameterize cost objects since the contract assumes a value per DRG per patient and the treatment or resources related to each patient may be different depending on the evolution of the different pathologies. In this group, another element is related to the internal rules that result in a lack of autonomy for decision making by the intermediate level personnel, which can make it difficult to control costs and transactions because decisions are centralized in top management.

Analyzing the aspects of TCE and cost management in hospitals we realize that hospitals are complex institutions where their internal contracting process is difficult to monitor due to internal and external elements. Such complexity coupled with the specificity of the assets and the opportunism of the agents involved generates costs that are mostly difficult to quantify or are normally not taken into account in traditional cost accounting (such as design, control and learning costs).

This complexity turns difficult the estimation of the cost of the services. Nevertheless, it is a fundamental variable to understand breaches in the internal or external contracting processes.

If the cost of the services can be estimated internally, comparing said cost with the market could help to identify inefficiencies or opportunities for improvement, or simply allow deciding whether the hospital's production is done internally or can be subcontracted.

However due to the complexity for the hospital sector the make or buy decision must take into account some considerations that are studied in the next section.

3.4.3 Comparative Production and Governance Cost in the Hospital from the Perspective of TCE

To Buy or Make decisions were presented by Willamson (1985) comparing internal production costs (costs of production and administration) versus the costs of acquiring in the market, taking into account the costs of buying and transaction costs associated to such relation.

This relationship was presented in Figure 3.2 where $\beta(k)$ is the bureaucratic costs of internal governance and $M(k)$ the corresponding cost of market governance, $\Delta G = \beta(k) - M(k)$ indicates the potential gains or losses derived from governance costs when given a specific specificity of the assets an organization decides to make or buy in the market a product or a service.

On the other hand, Willamson (1985) compares the cost of internal production with the cost of purchase outside the organization, taking into account the economies of scale; being $\Delta C = IC(k) - EC(k)$, where $IC(k)$ is the internal production cost and $EC(k)$ is the external cost or cost of acquisition in the market, taking into account a certain specificity of the assets in the relationship.

Considering these elements, the make or buy decision is related to:

$$\Delta G = \beta(k) - M(k) \text{ and } \Delta C = IC(k) - EC(k).$$

With all these elements and in the presence of specificity of the assets, therefore the decision curve (DC) is given by:

$$DC = \Delta G + \Delta C = \big(\beta(k) - M(k)\big) + (IC(k) - EC(k))$$

This expression considers, on the one hand, the importance of the costs associated with governance, and on the other, the importance of the difference between the cost of a service performed internally and carried out in the market.

Regrouping the above expression it can be expressed as:$DC = (\beta(k) + IC(k)) - (EC(k) + M(k))$

In spite of yielding the same result from the previous expression, this expression shows the problem from a different and more intuitive perspective, since the first grouping of terms focuses on the internal production and the second expression focuses on the costs related to the acquisition of the good or service in the market. From a simplistic logic, when DC takes positive values would be giving the idea of buy and when negative the option should be make or do internally.

In the approach proposed by Willamson (1985) both $IC(k)$ and $\beta(k)$ are known variables and rarely their origin or estimation is discussed, but in the case of hospitals, $IC(k)$ is not a known parameter and as already evidenced it is not an easily estimated parameter.

> *"The costing system once again in the NHS, and I speak for my hospital but I can speak in a way by the group of hospitals, (...) cost accounting, is very deficient, practically nonexistent, about two years in this The ministry of health, thought of implementing a system that would be transversal to all hospitals, given the complexity and given the delay and difference of teams that exist among the various hospitals, abandoned the project." (HOSPITAL 4/INTERVIEWEE 8).*

On the other hand the beta cost or the cost of bureaucracy in Williamson's words, for the case of hospitals is also a more complex cost this because not only involves the actual administration but also involves internal transaction costs that must ensure The fulfillment of the objectives but also maintain the relationship with the medical staff which is a specific asset of the relationship plus it also has a wide variety of offers from other institutions, which may compromise the provision of services within hospitals.. We could say then that the bureaucratic cost would be given by:

$$\beta^*(k) = \beta(k) + ITC(k)$$

Where:

$ITC(k)$ = Internal Transaction Cost

Here the specificity of the assets is a critical variable to explain the existence of some of the transaction costs that are generated (David & Han, 2004). These internal transaction costs are related in the relationship of the top management with each of the directors or coordinators of the services, depending on how the hospital is organized, and will be influenced by the limited rationality, the opportunism, the specificity of the assets and the difficulty of defining measurement indicators.

On the other hand, in the decision curve, the relationship $EC(k) + M(k))$ is given by market values, in these factors probably the most difficult to quantify will be what is the cost of the relationship or transaction costs captured by the variable $M(k)$, Under the assumption that this sum takes a low value compared to domestic production, i.e. the market is attractive under the logic of the TCE the decision would be to buy or what otherwise said to acquire in the market. For the study in analysis it is important to consider that the decision is not so linear, inasmuch as because it is considered a public good, the process of "buying services is not so easy", in addition hospitals must have an installed capacity Should

be used and should strive to comply with what has been established in the contract, being a service mostly public the decision would be more for the improvement of internal efficiency than for making the decision to carry out the activities and services externally. Another factor has to do with the specificity of place specificity of place that in this case by service logistics some patients must be treated within the same hospital to guarantee the quality of service.

> *"When we cannot do an examination inside the hospital, we have to do it, and of course these tools are useful in that sense because it is to prove that if we take the examination out, and introduce all the associated costs in carrying out an examination, it will not Being only the cost of the examination, will be the cost of the patient going, transportation, and other costs that are not even measurable, more that are clinical costs, are not measurable in monetary terms more than in terms of quality service, then in terms Of even hospitalization times can increase because also the fact that the patient leaves and the instability that sometimes creates this to the patient. If all this was measured it was easier to prove, everyone already knows that it is more expensive to do out there, roughly with the things that we know, maybe it was easier to make realize that the money that is spent every year To do exams abroad if it was used to remodel the services and acquire new equipment was much better used." (HOSPITAL 1/INTERVIEWEE 2)*

Hence the idea of having to consider the intangible costs, or the costs associated with the quality of the service, which in some cases are so high that even if a procedure outside the hospital is financially cheaper, the most appropriate and rational decision is performed within of the hospital. In the healthcare literature the intangible cost are related to: the psychological pain to the family and loved one (Kirigia, Sambo, Sambo, & Barry, 2009), the pain, the anxiety and the depression (Haines & McPhail, 2011), the reduction of the desire to consume food or medicines (Akazili, Aikins, & Binka, 2008). All the intangibles are related to the decrease of the quality of life of the patient or the worsening of his/her health condition. Seen from another point of view, that is, there are services that, despite being cheaper, should be provided in the hospital to reduce the risk of virus, deterioration of the patient's quality, which in the end would not only affect quality, Health, but also the total cost due to the increase in the number of days in hospitalization, or due to possible future readmissions with more complications than the initial ones.

It is important then, besides considering the cost of the market and controlling the transaction, to consider the intangible costs.

Let $IC(k)$ the measurement of intangible costs.

Then the market relation (MR) would be given by:

$$MR = EC(k) + M(k) + IC(k)$$

From all of the above it would be necessary that the adjusted decision curve related to make or buy would be given by:

$$ADC = (\beta^*(k) + IPC(k)) - MR$$

With this in mind, Figure 3.6 shows that the DC ratio may have upward or downward displacements depending on the size of the ITC and IC.

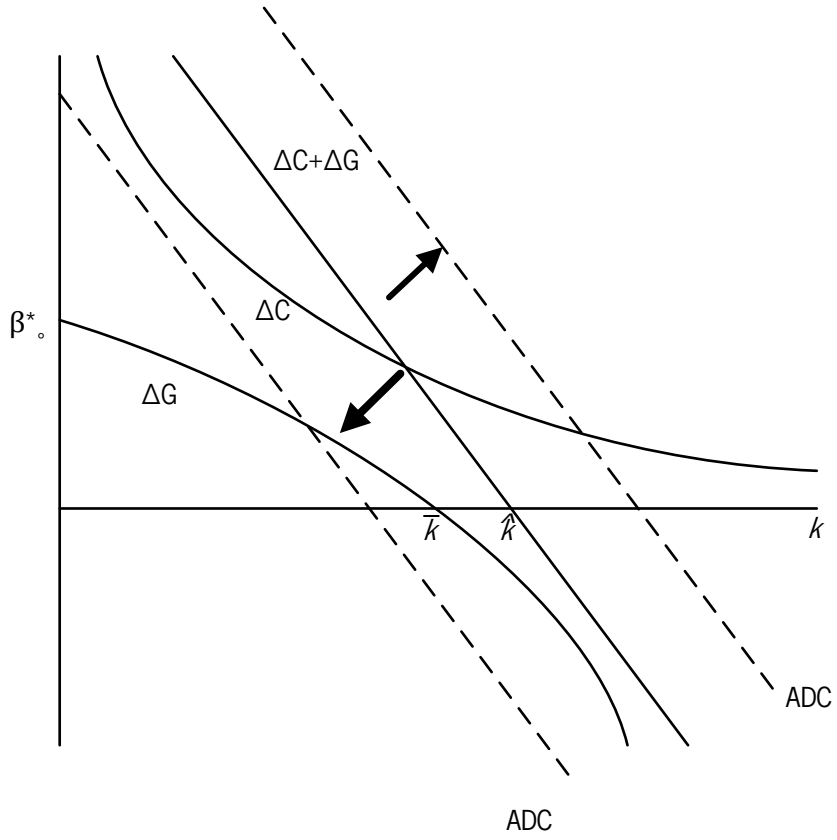

Figure 3.6. Comparative Production and Governance Costs Including ITC and IC

Although it is true that as the system is structured decisions usually go through internalize rather than buy, given the installed capacity, the fact of being a market mainly financed by the state that must guarantee the coverage of all citizens and non-existence given that there is no market logic in the health sector. The logic of the market makes sense to the extent that in 2016 was approved the law of free circulation of users. The system Free Access and Circulation of Users in the NHS (LAC) approved by

Order No. 5911-B / 2016, of May 3, allows the user, together with the family doctor responsible for the referral, to opt for any of the hospitals where there is the specialty consultation you need. The hospital unit can be located anywhere in the country, if you have the specialty. The presentation of alternatives to the user is made according to criteria of geographical proximity and information on the average response times in each specialty, per hospital unit (ACSS, 2016a). This could lead to users who were once a guaranteed demand, can go to other providers of the health service, thus reducing the income of the hospital to which it would be directed before the implementation of the law of free access and circulation, as it is a new law and is in the implementation phase will be the subject of future work.

3.5 Discussion and Conclusions

The cost management in hospitals is a complex task, not only for the provision of services but also for the large number of variables that influence the consumption of resources and, therefore, the final cost of providing services. This chapter discussed cost management from a look at transaction costs and their relationship to the contractual process.

Given the structure of the NHS, and the payment system in Portugal, the contract is a fundamental tool for the provision of quality services that guarantee coverage of the population.

Because a DRG-based system is used, the payment received per patient served is generally fixed, so improvements in financial results must be in two ways, either by maximizing capacity utilization or by being more Efficient in the management of the resources, which will be reflected in income greater than the costs and generates financial sustainability of this type of institutions without sacrificing the quality in the provision of the service.

The complexity of the system increases because in addition to the external contractual process must be carried out an internal contracting process that must be integrated to be able to meet the requirements of this funder, which in most cases is the state. In this sense it is important to use tools and theories that help to understand the dynamics related to the contractual processes and the execution of them, one of these theories is the TCE.

One of the postulates of the theory of transaction costs is that organizations exist to replace the market when the cost of controlling relationships exceeds the fact of performing transactions internally. However, it could be noted that organizations such as hospitals do not necessarily comply with this postulate, since while internal costs may be higher, the nature of the service, installed capacity and legal conditions may

make the Outsourcing of services, this is in line with what is mentioned by Ghoshal & Moran(1996) and Balakrishnan, Eldenburg, Krishnan, & Soderstrom (2010).

They underscore that the organizations are not mere substitutes for structuring effficient transactions when markets fail; The organizations possess unique advantages for governing certain kinds of economic activities through a logic that is very different from that of a market. TCE is "bad for practice" because it fails to recognize this difference. That is to say the decision of the organizations to carry out their activities inside or outside the same must be analyzed not only from the point of view of costs but also of variables such as the quality of the service or the typology itself.

Another of the important elements in the decision process in the theory of transaction costs are the costs themselves, in the postulates, the process of obtaining the costs is given by known or easy to calculate with the exception of the costs of however, for hospitals an interesting factor has to do with the complexity that exists in the estimation of costs of providing services, which are influenced by variables such as the number of medical prescriptions, the characteristics of the patients themselves Have the same pathology plus different physiological conditions or with the same main pathology plus different secondary pathologies, the type of resources with which the institution counts, among others.

Something to emphasize in hospitals has to do with variables that can induce costs in addition to the cost of production and are related to the contractual process and there the TCE stands out in trying not only to recognize those costs but also to some way to quantify them.

In addition to these factors, factors such as the support of information and communication systems, receptivity to change, existence of cost management policies, make it difficult to estimate the cost that in TCE are not widely discussed in this context quite relevant. For decision making between buy or make.

In this sense, more attention should be paid to methodologies for estimation of production costs and not only to develop tools or analysis for the determination of transaction costs in order to determine the structure of governance that best suits a given context.

One of the main contributions of this research was that in including two important variables in make or buy decision making, the first one has to do with the internal transaction costs derived from the hospital's own internal contracting process different from the costs of administration. Internal transaction costs in turn generate transaction costs such as retention costs of medical personnel and costs of control of the internal contract itself.

The second has to do with the costs of intangibles, which are related to all those hidden or additional costs incurred if the decision were to carry out a process that could deteriorate the patient's health or worsen their critical situation, resulting in not only affecting the patient but also making the total cost,

including treatment and possible re-hospitalizations, higher than the cost of having treated the patient internally since the initial cost was greater than treating the patient outside hospital facilities.

The consideration of these variables in the make or buy decision is in line with the study of Madhok (1996), where they show the importance of including variables associated with the organizational context and the benefits obtained by performing activities within the organization. Our study shows specifically these two variables which were adapted to the hospital context.

Although the distinction between public and private was not made within the interview analysis process, the interviewees had semi-private hospitals and the majority of the public and the interviewer's perception was that internal transaction costs were lower in public private partnership hospitals , this to count on systems of information and communication more efficient, which is in harmony with Ashton et al (2004) ,They mention that lack of good information-especially on costs, volumes and quality-increased the costs of contracting and made monitoring and accountability difficult.

In addition to this, semi-private hospitals have incentive policies to reduce transaction costs. This is in harmony with the study conducted by Coggan, Whitten, & Bennett (2010) they shows that transaction costs related to: information search, enactment, establishment, implementation, including contracting, support administration, monitoring and enforcement, are assimilated and treated differently depending on whether the organization is public or private, and describe a way to include ex ante safeguards that minimize transaction costs in the drafting of new contracts or in the renegotiation of contracts.

4. INTERDEPENDENCIES BETWEEN COST MANAGEMENT AND HOSPITAL AUTONOMY

4.1 Introduction

In recent years, health care systems of developed and developing countries have faced great changes due to population growth and also the increase in the costs associated with the provision of medical services. In this context, several countries have wanted to introduce in their National health systems - most of which are funded by the state and where hospitals consume a large part of the resources - business management philosophers used in private organizations, with the aim of making better use of existing resources, increasing efficiency of the system. One of these philosophies is related to the autonomy given to hospitals (London, 2013).

One of the fundamental elements of management in hospital units is the fulfillment of the contract between the top management and the state. For this, the top management performs an internal contracting with each one of its different departments which are in charge of the production of the services portrayed in the contract. In order to increase the efficiency of the services or department since the year 1998 the Portuguese NHS has wanted to include the idea of responsibility centers within the hospitals which has not been implemented successfully but the idea still persists.

In this sense, ACSS (2016c) mentions that the negotiation process in hospital care for 2017 has as one of its objectives to deepen the internal contracting process, constituting several responsibility centers, reinforcing the autonomy and responsibility of services and stimulating commitment and participation teams and professionals. This idea has several components namely, efficiency (which must be measured or have a set of indicators) and the contract as a central element and the autonomy (hospital autonomy, as is commonly known in the literature).

Potential benefits of Hospital Autonomy include the increase of the efficiency, better reaction to local needs, better health results. Potential disadvantages include reduced efficiency, the relegation of public interests, for example (Homedes & Ugalde, 2005) indicate that this reforms gives benefits to multinational companies and consultancy firms-, and deterioration of health results. Currently, there is no consensus among the advantages and disadvantages of the hospital autonomy, regardless of an increasing in the volume of research in this area.

Hospital autonomy is complex and its effects are difficult to amount, while evidence organized for or against it is typically too mixed to permit generalization. Furthermore, the hospital autonomy topic is highly politicized, and is clouded by normative assumptions about state and market policies. That is why it is important that research in this area be directed at measuring impacts in a specific and not generalizable context (London, 2013).

The level of autonomy could be on two levels, autonomy given by the government to the hospital board of directors, and internal autonomy, i.e. autonomy given by the board of administration to its different departments or departments, the latter is the research object of this chapter.

In this sense, there are two extremes within hospitals, hospitals without autonomy, or where all decisions are centralized, or hospitals with the highest level of autonomy where activities are decentralized and decision power is delegated to intermediate or lower level elements of management. Between both, there is a continuum of arrangements and configurations.

The delegation of freedom to make decisions in hospitals is called decentralization or some measure of autonomy.

Among the benefits that stand out from the autonomy is that the managers or administrators of lower or intermediate levels have better information of the production of the services and the working conditions in relation to top management. In addition, this encourages the development of competence and helps the development of leadership, and giving independence can help employees to be happier with their jobs and feel motivated to comply with what they have been entrusted with.

On the other hand, the decentralization of the activities also generates costs, these are related to the fact that the autonomous managers can make decisions that are not the best ones according to the interests of the organization, in addition it is possible to duplicate activities which increases the cost in compared to having centralized activities, and usually the cost of creating, accumulating, and processing information is generally increased.

When an organization decides in favor of autonomy, delegating power to the segments of the organization is important, autonomy should be real, not just "lip service". Top managers must abdicate to make decisions made by segment managers in most circumstances.

Insofar as it is given autonomy, it is important to design, implement and use good management control systems, which must consider two dimensions: the level of responsibility and the degree of autonomy. These dimensions can be framed in what are known as responsibility centers, where on the one hand there are cost centers - defined responsibilities and low level of autonomy - and on the other hand profit centers - defined responsibilities and high level of autonomy. It is important that in the design of

accounting control systems, top managers must consider the system's impact on the individual behavior and organizational culture desired by the organization.

The management control system must be designed in such a way as to achieve the best possible alignment between local manager decisions and the actions top managers.

For this, it is important to create management control metrics. These performance measures should be coupled with incentives to align the objectives of the autonomous decision-makers with the general management. Incentives are the rewards, both implicit and explicit, for managerial effort and actions.

One of the economic theories that includes costs, the contracting process, the delegation of power (autonomy), and the level of the incentives and the alignment with the objectives of the organization is the agency theory (J. Kim & Mahoney, 2005).

The agency theory illustrates how the failure to align the objectives among the principal and the agents of a company reduces the value of the organization - lower economic benefit - through higher information costs (control or linkage), in addition to operational inefficiencies and other manifestations of moral hazard that can that compromise the financial stability of an organization.

Managers depend on various performance measures and financial incentives to increase goal congruence and reduce moral hazard and adverse selection, but the resulting management controls are economically effective only when the cost of control - i.e., incentives and costs - is less than the cost of divergent behaviors between the principal and the agent (Bouillon, Ferrier, Stuebs, & West, 2006). In addition, the agency theory will be used to ensure that the focus of the study is related to cost management and costing systems and in the hospital background, the cost system as a whole can potentially to help understand agency problems (Pizzini, 2006).

In this sense, in this chapter we used the agency theory from a positive logic to analyze the dynamics of responsibility centers within a hospital, which by law are defined however have had problems with its implementation not only in the studied hospital but also in all hospitals in the country.

This chapter begins by analyzing the autonomy from a macro level to a micro level, through the analysis of agency theory and the normativity for responsibility centers and then analyze important aspects of this theory and its relationship with the levels of autonomy, all based on the contract, and with the objective of identifying elements that emerge from the internal contracting process.

In order to understand autonomy at the level of hospitals, this chapter focuses on the figure of the centers of responsibility, its characteristics are studied from the legal point of view i.e. considering what is regulated through the law. Through a case study in a hospital, the level of compliance with said law and also the relationship of the responsibility centers with the agency theory are discussed.

This chapter is organized as follows, after this introduction the literature review is presented where fundamental aspects of the hospital autonomy and the theory of the agency and its applications in healthcare are addressed, then the methodology is explained, before the presentation of the case study and the discussion of the findings. The chapter ends with the main conclusions derived from the case study analysis.

4.2 Literature Review

4.2.1 Strategies for the Regulation of the Health Sector

Throughout the last decades several strategies and tools have been developed for the regulation of health systems. Policy makers have established norms and strategies to structure and configure health related regulation. The scope of all these options has increased over the past two decades, reflecting the inclusion of approaches adapted from other sectors of the economy - for example, the idea of independent regulatory agencies for public services. These potential strategies now encompass a considerable territory, and although the underlying idea of each is to achieve the same basic social and economic goals, among them are different internal logics, secondary consequences and different implementation mechanisms (Saltman, Busse, & Mossialos, 2002).

According to (Colton, Frisof, & King, 1997), regulation in health care has at least 3 purposes, which are to guarantee the universal access, to allow public accountability and to promote the quality of services.

There is a fairly broad range of strategies that is closely linked to how the state exercises authority over actors within a national health system. Table 4.1 shows that these can vary from military-style command-and-control systems model of authority, where the whole process is centralized in the government and the non-compliance of the rules implies application of penalties, instead of being a strategy based on negotiation.

These strategies are strategies of extreme obedience, where using the law the intention is to prohibit reprehensible behavior. The line that bound the styles of authority is between the entities owned by the government and without autonomy for decision making and the entities that are owned by the government, however they have autonomy for decision making.

Other strategies indicated by Saltman et al. (2002) are the strategies called steer-and-channel regulation, where health policies reflect a greater degree of autonomy for agents participating in the national health system. In this type of strategies there is separation of lender-financier-regulatory functions, which may

be public-private alliances, and different contracting processes. The existence of these activities allows the creation of a more comprehensive health system, with systems and regulatory strategies more complex than those of a military-style command-and-control model of authority system.

Table 4.1. Continuum of State Authority in the Health Sector

Degree of state authority and supervision	
Stronger	
Command-and-Control	- Public entities, managed directly by the government
Steer-and channel-regulation	-Public entities, managed indirectly by the government -there are hierarchies in the health sector -Private non-profit organizations, with statutory responsibility -sickness funds, associations of physicians affiliated with social health insurance -Non-profit private entities, without statutory responsibility -private non-profit hospitals- -Private for-profit entities as a complement to the national health system -private hospitals with contracting regime with the government -Private Entities -private Hospitals, Pharmaceutical Companies, For profit private Insurance Companies-
Weaker	

Source: Adapted from Saltman et al. (2013; 2002)

There are different regulatory strategies in health, an option is the military-style command-and-control on the other hand (Saltman et al., 2002) define that the steer-and-channel strategies can be divided in five different options, which are: decentralization -four alternatives-, enforced self-regulation, accreditation, independent regulatory agencies and intersectoral cooperation. As a public policy, each of these strategies have advantages and disadvantages that must be evaluated and a government may decide to apply a strategy or the combination of several strategies to define the structure of the health system.

The four alternatives of decentralization are usually applied with other regulatory policies, they show changes in the organizational structure, as well as different levels of authority for decision making, these four alternatives are: deconcentration, devolution, delegation and privatization (Rondinelli, Nellis, & Cheema, 1983). The deconcentration consists in transferring some administrative and / or technical functions to lower levels of administration (regional, provincial or local), but maintaining the power of

decision at central level. The delegation of functions implies transferring some functions and competences to lower levels of decision making at local levels, but maintaining the central level of control, even if indirectly. The devolution is the most advanced state in the decentralization process, involves the transfer of functions and resources to the lower levels of decision and the privatization involves a fundamental shift from predominantly public-sector to predominantly private-sector authority.

In a health system these strategies are combined with the goal of having more efficient, and better quality systems. The logic of steer-and-channel regulation creates increasingly autonomous organizations. Among the entities that are expected to be given and which are more autonomous in the health systems are the hospitals, in what is called of the hospital autonomization.

Hospital autonomization is related to the increase of administrative autonomy within public hospitals. It implies a change in the centralized management of resources and the formation of organizations that depend less on the state in the provision of services and in the decision-making process. One of the great arguments for autonomization has to do with the desire and the possibility of eliminating perceived inefficiencies in centrally managed hospital systems. Hospital autonomization is different from privatization, because hospitals continue to be financed largely by the government, but with changes in the way of making internal decisions and management processes (London, 2013).

4.2.2 Hospital Autonomy

Public hospitals in Europe have undergone a process of change where, despite being mostly public, they use incentives and follow practices similar to the private sector. An important element in these reforms has been to establish a certain autonomy, necessary to face the challenges and to restrict the influence of political actors in the decision making inside the hospitals (Durán & Saltman, 2013).

The word autonomy transmits a quantity of meanings such as good governance, contractual interactions between public hospitals and the government and market experience (Suriyawongpaisal, 1999). The definitions for hospital autonomy are related to hospitals being self-directing, self-governing, and self-financing. Hospital autonomy can be configured in different ways, at one extreme is the lack of autonomy where hospitals are financed and controlled directly by the government, and at the other end private institutions, and between these configurations are a set of configurations where Hospitals can be located. Although private institutions have their own systems of governance which must be in accordance with governmental regulations, autonomy should not be understood as absolute independence from the government. (Makinen et al., 1993).

An interesting analysis of hospital autonomy is proposed by (Chawla, Govindaraj, Berman, & Needleman, 1996), where autonomy is differentiated if decisions are taken at the macro level, such as in the national domain of a health system, or taken within the domain of the hospital -micro level-, it should be noted that this research focuses on the internal level of the hospital. Table 4.2 shows a conceptual framework for hospital autonomy and its relation with the decision making at the different levels.

Table 4.2. Conceptual Framework for Hospital Autonomy

Policy and Management Functions	Extent of Autonomy		
	Fully Centralized Low Autonomy	Some Autonomy (a / b / c)	Fully Decentralized High Autonomy
A. Health Domain			
Overall Health Goals	All decision making entirely by owner	Decision making jointly by owner and hospital management	
Hospital Specific Goals	All decision making entirely by owner	Decision making jointly by owner and hospital management	Decision Making entirely by hospital management
B. Hospital Domain			
Strategic management	Direct control by owner: Government Parastatal or private	Governance through a Board appointed by owner, and guide by owner, but not subservient to owner	Independently constituted Board, making independent decisions
Administration	Direct management by owner, who also sets the rules for management of the hospital	Limited powers decentralized to hospital management, owner still welds some influence over management decisions	Independent management operation under Board´s directions, with significant independent decision-making capacity
Procurement	Centralized procurement, with owner deciding on quantities and total financial outlay	Combination of centralized and decentralized procurement	Procurement completely under control of hospital management
Financial Management	Full funding by owner; owner has financial control	Owner subsidy plus funds through other sources, come owner influence but finances generally under Board´s control	Self-financing; no owner subsidy, funds entirely under Board control, significant independent decision-making capacity for managers
Human Resource Management	Staff appointed by owner, completely under owner´s regulatory control	Staff employed by Board, and subject to the Board´s regulation, but also subject to owner´s regulation	Staff employed by Board, all condition and regulation set by Board; managers have significant decision-making capacity

Source: Chawla et al. (1996)

In Table 4.2 health domain refers to decisions made at the government level or in the relationship between governments and hospitals, in which hospitals generally have little or no interference, and are decisions over which the hospital has little control to change them. On the other hand, in the hospital domain, it refers to actions, decisions or activities over which the hospital usually exercises greater control.

The two functions of the health domain are: the total formulation - the design and norms of the national health system - health goals - for example, deciding goals of the national health service, distribution of resources for health, prevention programs -, and setting hospital-specific goals - for example defining the top management of hospitals, define criteria and ways of evaluation, etc.

The five functions of the hospital domain are: strategic management, procurement, financial management, human resource management, and administration, the following is a brief description of each one.

- ✓ Strategic management: This function is related to the definition of the hospital and the alignment of the hospital with the strategic objectives of the hospital, as well as the definition, attribution, and regulation of activities for the hospital to function (Chawla et al., 1996; Pettersen, Nyland, & Kaarboe, 2012).
- ✓ Procurement: This function is related to acquisition, purchase of medicines, equipment necessary for the provision of the service and other non-hospital supplies that are necessary for the provision of services. Efficient procurement management is a key variable when it is desired to reduce the health care expenditure (Briggs, 2013; Chawla et al., 1996).
- ✓ Financial management: This function is related to the generation of resources for the achievement of the strategic objectives and the work that must be performed within the hospital, as well as adequate planning, accounting, distribution, control of those resources, contracts, operation maintenance, etc.
- ✓ Human resources management: This function is related to the management and training of hospital staff, this includes administrative, medical and support staff. In this function also includes the processes of contracting and the negotiation of salaries(Chawla et al., 1996; Pettersen et al., 2012).
- ✓ Administration: This function is related to all other activities that are not financial, strategic, procurement or management, but are necessary for the daily operation of the hospital.

For each of these domains, either external or internal, Chawla et al. (1996) defines a set of specific activities that must be performed in each of the functions previously defined in Table 4.2, and are presented in Table 4.3.

In developing countries, policies related to autonomy in hospitals have had little success. For example, (Geyndt, 2017) analyzes the application of hospital autonomy in Iran, Tunisia, Lebanon, Pakistan, the Dominican Republic, Zambia, Uganda, Indonesia, Malaysia, Ecuador and Kenya, concluding that the little success in the application of autonomy is mainly due to the lack of autonomy delegation on decisions related to human and financial resources.

In these countries, central administrations show great resistance to sharing their authority and it is the Ministry of Finance that controls the revenues and expenditures.

The Public Service Commission is reluctant to relinquish its role of hiring, promoting, transferring, and dismissing government employees. The Ministry of Health does not wish to relinquish its authority to designate hospital personnel, to procure medical supplies, equipment, and support. In addition, management information systems collect activity measures that will be aggregated nationally only for statistical purposes and do not provide financial and clinical information that can be used for decision-making by top management of hospitals.

Table 4.3. Activities within Various Policy and Management Functions

Policy and Management Functions	Specific Activities
A. Health domain	National goal-setting, Role definition, Laws and regulations
B. Hospital Domain	
Strategic Management	Mission definition, Strategic planning, Operational guidelines, asset management
Financial Management	Resource mobilization, Resource Planning and allocation, Accounting of income and expenditures
Human Resource Management	Hiring and firing of personnel, Creation of posts, Determination of employee rules, Contracts and salaries
Procurement	Purchase of drug and medical supplies, purchase of non-medical supplies, Purchase of equipment
Administration	All the day-to-day management activities required in implementing hospital mission and running hospital, such as: time schedules, space allocation, information management, consumer relation, etc.

Source: (Chawla et al., 1996)

Several studies have been developed to analyze the impact of hospital autonomy in different parts of the world, for example (Méndez & Torres A, 2010) analyzes how the application of the hospital autonomy in Chile generates some political reforms in the administration of human resources for the health system; this research introduced the political challenges around human resources for health when autonomy hospital is implemented in a country.

Castaño & Mills (2013) analyze hospital autonomy from the perspective of transaction costs economics and analyze the relationships observed between purchasers and the 22 public hospitals in Colombia, in order to understand how the contracting process is more or less efficient when the hospitals have autonomy to decide.

Most of these studies are carried out at the macro level, but the approach given in this research was at a micro level, taking into account the function of financial management, concentrating on resource planning and efficient management thereof.

The delegation of power to the top management of the hospital or to the levels below the top management derived from the hospital processes autonomy can also lead to problems dealt with the agency theory given that the agency relationship arises when a principal delegates authority over an agent to make decisions or actions in favor of him (Yan, Hsu, Yang, & Fang, 2010).

4.2.3 Agency Theory: Concepts and Applications in Healthcare

Following are some studies related to the agency theory in healthcare which allow to identify the potential problems existing in the delegation of hospital autonomy and its relation with the contracting process. A brief description of the agency theory is made, as well as about some propositions that are studied using this theory and some applications in the hospital environment.

The agency theory constitutes one of the most consolidated branches within the economic theory of the organization (Pepper & Gore, 2015). In its beginnings, the agency theory was based on the study of the relations between managers and shareholders (Agrawal & Knoeber, 1996). However, in more recent times, authors in the field of management have begun to explore the implications that this approach may have for disciplines of organizational behavior and strategic direction, such as the implicit and / or explicit contractual relationships that exist between the different participants of a company and the behaviors of the organizations to achieve the business objectives (Hoti, Hughes, & Sunderland, 2011; Tate, Ellram, Bals, Hartmann, & van der Valk, 2010; Zu & Kaynak, 2012).

From the point of view of agency theory, an organization is a nexus of contracts (Fama, 1980) where a number of agency relationships are generated between the parties involved in the contracts. In these

relationships, each of the parties contributes in some way to the organization in order to obtain remuneration (Cardinaels, 2009).

For example, shareholders put capital in the company and expect a profitability, the workers who contribute with their effort, their knowledge and their time, expect to receive remuneration, suppliers that contribute with materials and products, or supplies expect to charge a price for them.

There are many participants in these relationships with the company which may have different objectives and different information and may therefore have conflicting interests, and therefore opportunistic behaviors that would necessarily generate agency costs, since the organization will implement a series of safeguard mechanisms for try to avoid these opportunistic behaviors. Table 4.4 shows one overview of the agency theory and its main characteristics.

Table 4.4. Agency Theory Overview

Characteristic	Concept in Agency Theory
Key idea	Principal-agent relationships should reflect efficient organization of information and risk-bearing costs
Unit of Analysis	Contract between principal and agent
Human Assumptions	Self-interest Bounded rationality Risk aversion
Organization Assumptions	Partial goal conflict among participants Efficiency as the effectiveness criterion Information asymmetry between principal and agent
Information Assumptions	Information as a purchasable commodity
Contracting Problem	Agency (moral hazard and adverse selection) Risk sharing
Problem Domain	Relationships in which the principal and agent have partly differing goals and risk preferences (e.g., compensation, regulation, leadership, impression management, whistle-blowing, vertical integration, transfer pricing)
Cost	Agency Cost Influence Cost

Source: Eisenhardt (1989a) and Milgrom & Roberts (1990)

According to the agency theory one of the main problems in corporate governance is to create norms and incentives, tacit or explicit contracts - written or oral - that contribute to align the behavior of the agents, with the objectives of the principal, by means of an optimal distribution of the risks, under conditions of uncertainty (Fama, 1980).

From its roots in information economics, agency theory has been developed along two lines of research: positivist and principal-agent (Michael Jensen, 1983). The two streams share a common unit of analysis: the contract between the principal and the agent. They also share common assumptions about people, organizations, and information. However, they differ in their mathematical rigor, dependent variable, and style.

Positivist researchers have focused their attention on identifying situations in which the principal and agent are likely to have conflicting goals and then describing the governance mechanisms that limit the agent's self-serving behavior has been an important research topic. Positivist research is less mathematical than principal-agent research. The positive research involve the discovery of some aspect of how the world behaves and are always potentially refutable by contradictory evidence (Michael Jensen, 1983).

Characteristic of formal theory, the principal-agent paradigm involves careful specification of assumptions, which are followed by logical deduction and mathematical proof. Two propositions capture the governance mechanisms which are identified in the positivist stream. One proposition is that outcome-based contracts are effective in curbing agent opportunism. The argument is that such contracts coaling the preferences of agents with those of the principal because the rewards for both depend on the same actions, and, therefore, the conflicts of self-interest between principal and agent are reduced. In formal terms, Proposition 1 states that: when the contract between the principal and the agent is outcome based, the agent is more likely to behave in the interests of the principal. The second proposition is that information systems also curb agent opportunism. The argument here is that, since information systems inform the principal about what the agent is actually doing, they are likely to curb agent opportunism because the agent will realize that he or she cannot deceive the principal. In formal terms, Proposition 2 can presented as follows: when the principal has information to verify agent behavior, the agent is more likely to behave in the interests of the principal.

These two propositions serve as a basis for the later considerations that are made in this study.

In a healthcare system, the agency relationship can be given by the relationship between the government - the principal - and the top management of a hospital - the agent - (Thompson & Mckee, 2011; Yan et al., 2014), or, the relationship between the top management of the hospital - the principal - and the different departments, middle managers - the agents - , or, the relationship between the doctor and the patient (Scott & Vick, 1999). Currently, ethical dilemmas are present in health care organizations, for example the patient is poorly informed and the doctor can influence not only the diagnosis but also the

treatment that will be offered to the patient (Grytten, Skau, & Sorensen, 2011; Rathert, May, & Chung, 2016).

As already mentioned, agency problems are usually related to information asymmetry, it is interesting that Thompson & Mcke (2011) showed that in health systems there will always be agency problems because the information is naturally asymmetric due to the uncertainty that exists in the demand for services and new technologies that can be used in the future.

The principal–agency problem in health care announces that medical services providers will act to maximize their profits at the expenditure of the patients' or State's interests. This problem applies particularly when professional regulations are deficient and incentives exist to straight link providers' actions to their profits, for instance, a fee-for-service payment system. The most often mentioned principal–agency problem in health care is the provider induced demand (Yan et al., 2014). Agency theory focuses on the fact that large financial incentives tied to agency performance will improve the quality of health services (Suelflow, 2016).

Several studies have been used in health care using agency theory, among which is the research conducted by Mendes, Lunkes, Flach, & Kruger (2017) in public and private hospitals in Brazil which stresses that to control the effects of agency, one of the incentives is the remuneration given to employees, which is seen as a mechanism of control or a mechanism that induces learning, this study emphasizes that due to the national legislation in force for the public sector, remuneration exerts less influence on employees than those who work in private entities and are remunerated according to their performance. In addition, this study emphasizes that remuneration is viewed differently by employees in the clinical area and in the administrative area.

4.3 Methodology and Research Methods

4.3.1 Method and Methodology

The research method that was followed in this research consists of a single case study in a hospital of category C of those presented in Appendix VIII.

The case study is a research method of great relevance for the development of the human and social sciences that involves a process of inquiry characterized by the systematic and in-depth examination of one or several social entities. The purpose of the case study is to know how all the parts of the case work

to create hypotheses, daring to reach explanatory levels of supposed causal relations found between them, in a specific natural context and within a given process.

It is necessary to specify that the case study may include both single-case and multiple-case studies (depending on one or more units of analysis) but their fundamental purpose is to understand the particularity of the case. A case can be a person, a student, a family, a program, an educational system, or a nation, usually can be constituted by any circumstance that is unique and worth investigating in depth, a case is a bounded system of which needs to know information.

Among the advantages of a case study is the fact that it can be a way to deepen a research process from the first analyzed data, it is appropriate for small-scale research, within a limited time, space and resources, it is a method open to resume other personal conditions or different institutions and favors cooperative work and the incorporation of different professional optics through interdisciplinary work (Baxter & Jack, 2008).

Yin (2009) distinguishes three different types of objectives: exploratory, descriptive and explanatory. In an exploratory study the results can be used as a basis for formulating research questions. In a descriptive case study, an attempt is made to describe what happens in a particular case, and an explanatory case study transcends interpretation.

We performed a descriptive case study, for the accomplishment of the case study were followed the steps proposed by Cassell & Symon (2004a) and Yin (2009) to conduct a case study which are: development of research design, preparation to collect information and evidence, collection of evidence, analysis of evidence and generation of reports.

The research design is related to the logical sequence of steps that will be taken to link the research question which for this study is related to that despite the fact that the responsibility centers in Portugal have been legislated, in practice they have not been implemented or have been replaced by other governance structures.

Because the research question related to hospitals in Portugal was linked, the question itself already delimited the places where the case study would be applied, after establishing several contacts, a hospital belonging to the Portuguese NHS agreed to work with us in this investigation, established the limits of the investigation and it was also made clear that the information would be handled confidentially.

Regarding the collection of information, this was done in a systematic way, always following a logic from the general to the particular, then proceeded to analyze the national and regulatory composition of contracting in the Portuguese national health system through documents such as the contracting reference term (ACSS, 2016c) and the manual of the contracting process (ACSS, 2011b), this allowed to

understand the context in which the hospitals were inserted and at a later time to determine if external variables could affect the internal results of the hospital.

The hospital was then analyzed as an organization, using documents published on the official website of the hospital, such as the analysis of its mission, vision, internal regulations, and the financial results and contracts made by the hospital in recent years. In addition to regular meetings with staff in the area of production management of the hospital, they were made meetings with staff in charge of a department (head of service) and people in the area of information systems, which helped to have an overview of the problem. The summary of those meetings was registered, becoming a researcher's diary.

In addition to knowing the general reality of the hospital, two areas were studied in more depth, the area of imaging service and the area of reproductive medicine, with this it was possible to identify which would be the way to follow for the development of the investigation.

Before knowing in depth the reality of the hospital it was not known what theory or theories will be used, but after several months of research some perspectives emerged to be part of this research namely, agency theory and concepts related to hospital autonomy and responsibility centers.

In addition to all these elements that allowed identifying characteristics of the hospital, between May and August 2016, 4 semi-structured interviews were conducted with people from different backgrounds and functions within the hospital.

In May 2016 a pilot test was conducted with one of the hospital's production managers. After this pilot the interview was applied to a service chief, a person from the hospital's executive committee and a person from the board of administration. The protocol followed was shown in Chapters 2 and 3 of this thesis.

All interviews were tape-recorder and transcribed. And then, they were analyzed using Atlas.ti 8.0 software. With respect to the validity of the study, we took into account the following elements: contextualization, saturation and triangulation (Gerring, 2004).

With regard to contextualization, the study of the literature, and the primary or secondary collection allowed us to understand and define the hospital as the unit of analysis. The saturation is related to the justification of an affirmation based on multiple tests, for it was taken into account the opinion of several people involved in the process and several sources of evidence. And triangulation was made when the empirical elements were contrasted with theory, in this particular case, the agency theory.

The analysis of the information allowed to identify interesting elements that contrast the legislation related to the responsibility centers, the practical elements and their relation with the hospital autonomy and the agency theory.

4.4 Case Study

4.4.1 Hospital Autonomy and Responsibility Centers in Portugal

The structure of an organization is an arrangement of lines of responsibility within the company. When managerial tasks are delegated, regardless of the level, it can be said that a responsibility center, which is an apart, a department, a segment, a subunit, etc. of an organization, whose leader is responsible for a specific set of activities. The higher the level of the manager or leader, the broader the responsibility center and the greater the number of dependents. When measuring results by areas of responsibility, the actual plans, budgets, actions and results of each accountability center should be measured. Typically, there are at least four types of accountability centers, as shown in Table 4.5, these are cost centers, revenue centers, profit centers and investment centers. In a cost center, the manager is only responsible for the costs. In a revenue center, the manager is only charged for the income. In a profit center, the manager is responsible for the income and costs, and in an investment center, the manager is responsible for the investments, income and costs. A responsibility center can be structured to promote a better alignment of individual goals and the goals of an entire organization. (Horngren, Datar, & Rajan, 2012b)

Table 4.5. Responsibility Center Summary

	Type of responsibility Center			
Factors	Cost Center	Revenue Center	Profit Center	Investment Center
Controlled by center Management	Cost	Revenues	Cost, revenues	Cost, revenues and significant control over investment
Not controlled by center management	Revenues, investment in inventory, and fixed assets	Cost, investment in inventory and fixed assets	Investment in inventory and fixed assets	
Measured by the accounting system	Cost relative to a budget	Revenue relative to a budget	Profit relative to a budget	Return on investment relative to a budget
Not measured by the accounting system	Performance on critical success factors other than cost	Performance on critical success factors other than revenue	Performance on critical success factors other than profit	Performance on critical success factors other than return on investment

Source: Atkinson, Kaplan, & Young (2012).

For ACSS (2010) hospitals are complex social organizations with an important business component. They concentrate high technical and technological resources and large financial resources, and their management should promote greater effectiveness and social efficiency, in order to maximize results. Hospitals are, however, subject to inefficiencies of various kinds: financing that is essentially retrospective and predominantly related to expenditure and unrelated to the activity performed; lack of planning, objectives and effective control system, with regard to production, resources and results; low productivity and poor level of use of equipment; in addition to having payment systems that do not take into account the individual performance. (Alkhamis, 2017).

In the hospital environment, the attribution of management responsibility at levels which are behind to top management makes it possible to manage resources in a more efficient way. This was the reason why in Portugal, according to (Ministério da Saúde, 1988), they were created "Responsibility Centers" within hospitals. The purpose of responsibility centers was to group hospital services under homogeneous criteria, and then give them autonomy in order to better coordinate medical specialties, contain costs, and improve competitiveness. At present there are very few responsibility centers, since their creation never gained momentum. In the last reforms of health in Portugal there has been negligence in the creation and monitoring of this type of responsibility centers, which in most cases are non-existent and the few that were created many were eliminated. (Barros et al., 2011b)

All this, despite the efforts of governments to regulate and implement responsibility centers within hospitals, more than 20 years after the "Decree-Law 19/88 of January 21 (1988)" was written and which raised and legislated the creation of responsibility centers (Ministério da Saúde, 1988), responsibility centers in hospitals had not yet been implemented (Simões et al., 2017). Later, in 1998, the Ministry of Health organized a project team - Dispatch 1278-98 - with the objective of planning and establishing the fundamental principles of the responsibility centers and so it was born the "decree law 374/99" of 18 September 1999 that basically regulates the responsibility centers (Ministério da Saúde, 1999). Among some interesting features of this decree we may highlight the following:

- ✓ Article 2: *"Responsibility centers are intermediate organizational structures, grouping services and / or functional units that are homogeneous and / or similar" and "Responsibility centers may coincide with departments and may exceptionally coincide with services when their size warrants it"*
- ✓ Article 3: *"Responsibility Centers aim to improve the accessibility, quality, productivity, efficiency and effectiveness of health care delivery through better management of the respective resources"*

- ✓ Article 4: "*Participation of management professionals in order to improve their performance and increase their professional satisfaction and integration of management functions with those of technical management and operational management, making the process of making decision"*
- ✓ Article 13: *"Responsibility centers should establish with the management councils of their hospitals annual program contracts setting out the objectives and the means necessary to achieve them and define the mechanisms for periodic evaluation". "The program contracts should translate and include as integral parts the annual responsibility centers' annual activity plan, the investment plan, and the training and research plan". "The responsibility centers program contracts are integrated and should be consistent with the plan of competencies and hospital budget"*
- ✓ Article 25: *"All NHS hospitals and hospitals should be organized in responsibility centers by December 2003, and their respective boards of directors should undertake the necessary preparatory work in accordance with the implementation plan"*

As article 25 shows, hospitals had 3 years to implement responsibility centers, what did not happen. Despite the failures, reforms have been carried out over the years to improve efficiency in hospital management.

After 30 years of failure, the idea of implement responsibility centers in hospitals still remains (ACSS, 2016c; Ministério da Saúde, 1988). . For example, by the year 2017, the health ministry proposed the development of pilot projects for the implementation of responsibility center-in hospitals of the NHS, which will allow the internal organization of hospital institutions to be reformed, adapting them to modernity, making them more competitive in a global market and more effective in creating value for users and society (ACSS, 2016c). The responsibility center should preferably be constituted in hospital institutions with a high degree of differentiation and technical and technological specialization, taking advantage of synergies and complementarity of the specialties and thus allowing an integrated and timely response to the citizen. The constitution of the IRC has the following objectives:

- ✓ To improve the accessibility and response times of the NHS to citizens;
- ✓ To Increase the efficiency and profitability of the installed capacity in the public network of the NHS;
- ✓ To rationalize expenses, through the reduction of charges with activity performed abroad, internalizing the provision of care;
- ✓ To contribute to the complementarity and articulation between the various services in institutions;

- ✓ To increase the levels of productivity and satisfaction of NHS professionals, associating the attribution of institutional and financial incentives to the performance effectively achieved;
- ✓ To promote the autonomy, the involvement and the responsibility of the professionals in the management of the resources, encouraging them to exclusively develop their activity in the NHS;
- ✓ To encourage a healthy competition model between NHS services and institutions.

The responsibility center will have a working model with time dedicated to production, training and research activities. It will also be able to contract production and create payment mechanisms for performance which should contribute to improve productivity and reduce response times in the NHS.
Responsibility centers will provide care with high standards of access, quality, effectiveness and efficiency and the activity carried out here will be remunerated in the same way as the generic principles of incentive to the activity carried out, namely:

- ✓ Increase, at 10% of the price of the consultations (first and subsequent) carried out in the responsibility center;
- ✓ Increase at 5% of the production lines of medical and surgical DRG (inpatient and outpatient) in the responsibility center (ACSS, 2016c).

These incentives aim to align the objectives of the accountability centers with the hospital's objectives and with the objectives of the NHS.

4.4.2 Responsibility Centers in the Hospital

Usually associated with responsibility centers are ideas for increasing efficiency and ideas for using incentive systems as part of the available tools. Although there is a current legislation for responsibility centers, it was verified that in the hospital studied they do not operate taking into account such regulations.
Until 2013, the hospital had responsibility centers for each department, however this model was eliminated, one of the reasons explained by the direction for such change have to do with the fact of adjusting the organic structure in order to guarantee the optimization of processes as well as eliminate redundant activities and also have a structure that allows the reinforcement of the internal contracting process as an instrument to ensure the improved application of available financial resources in order to improve the economic balance and financial sustainability of the hospital (HOSPITAL 1/INTERVIEWEE 3).

Despite being regulated for more than 20 years and being an important element, the hospital object of the case study does not use responsibility centers. This situation does not occur only here but is a generalized characteristic of all what public hospitals in the country.

In the words of Simões et al (2017), this is because the reforms on hospital management led to neglect the importance of responsibility centers, and this explains the fact that no more responsibility centers have been created, or have been removed. In the hospital under study the responsibility centers were then replaced by the directorate for production of clinical area and the production manager of each service. In this new organizational model, the role of the service director was reinforced as a driving force for the whole clinical practice, in order to guarantee a response to the needs of the population, in terms of production. The objective was to create an intermediate level of resource management that would bridge the gap between the service managers and the top management of the hospital, also with the idea of an integrated management of resources.

There are several interesting aspects related to the contract, hospital autonomy, the agency theory and the responsibility centers. While it is true that the hospital does not function exactly with the idea of responsibility centers proposed by the government, it does recognize the importance of the decentralization of resource management within the hospital. It is evident here also the existence of three levels of principal and agent, first the government (main and top management), second (top management and production managers), third (production managers and service managers) (HOSPITAL 1/ INTERVIEWEE 1).

With respect to the fulfillment of the contracted objectives, it should be noted that since the change in 2013, the hospital did not comply with the program contract in two of the three following years, which shows that there are still elements to analyze that allow determining, quantifying or eliminating the causes of such breaches.

Despite being included in the internal regulations of the hospital, the autonomy for the management of resources has been difficult to apply, for example, one of the respondents answered.

> *"All strategic decisions are taken by the board of directors, may and are somewhat conditioned by the general guidelines of the trusteeship, plus the departure yes, the decisions of the general directors of service, be they clinical, be they more from the administrative area are operational decisions." (HOSPITAL 1/INTERVIEWEE 3)*

Operational decisions have to do with processes, the management of available human resources and everything related to the provision of the service. On the other hand, strategic decisions or related to

financial resources have not been authorized neither to the directors of service, nor to the production managers, these are centralized in the top management, which is contrary to what is proposed by Atkinson et al. (2012) and Chawla (1996) for responsibility centers and hospital autonomy.

One of the difficulties for the implementation of responsibility centers is the lack of systems for the measurement of resource consumption, such as cost management systems in the hospital.

Analyzing two departments, reproductive medicine and imaging services we were able to corroborate that there is no costing system or cost management system to analyze the management of resources, which generates asymmetric information. This information asymmetry hinders the control activities of the agents by the principals.

Another element related to responsibility centers is that agents must not only have autonomy to make decisions, but also know or have the capacity for decision making, which for service managers is not always easy according to one of the hospital's production managers.

> *"Sometimes we do not have service directors with enough leadership (...). (The director) should be responsible for structuring, and for the overall vision of the service, but this does not always happen." (HOSPITAL 1/INTERVIEWEE 1)*

This quote shows two important elements of agency theory, moral hazard and adverse selection for responsibility centers, these elements may not be induced by the agents' own desire, but may be induced by having to carry out activities of management that probably are part of their professional skills because they were hired to treat people and not for management tasks. Or, that simply the nature of the service provided generates that the quality objectives can conflict with the financial management of the hospital.

To correct these patterns of behavior, the agency theory proposes the use of two tools of management that generate agency costs, first has to do with control and second with incentives.

Although there are regular meetings to analyze the fulfillment of the contracted objectives, the control process is a complex process due to the lack of systems to estimate costs, the lack of integrated information systems and the lack of organizational culture on cost management.

With respect to incentives, a director of a service indicated that these simply do not exist. Another comment related to the incentives was the following: "No [there are not many incentives], there are only a few doctors who have an incentive system because they have come to a height. Now, for the new [contracted] physicians there are no incentives. They have incentives associated with the goals they have to fulfill for the performance appraisal system and are usually service production goals, as are incentives associated with the service of a department But that also as they are of the service all the doctors that were in that service will have the same note. So it's not even a custom thing. It does not permeate the individual incentive properly if the service meets [the objectives] all the doctors have the same evaluation. And [the incentives] are less and less because incoming doctors no longer have such incentives." (HOSPITAL 1/INTERVIEWEE 1)

The reduced existence of incentives added to the difficulty in control may be one of the causes for breach of contract. However, factors such as variability, capacity and the patient's own behavior must be taken into account as mentioned above.

Seen from another perspective, the problem can be derived from higher-level agency relationships such as the relationship between the government and the top management of hospitals, according to ACSS (2016b) in an interview with 98% of the top management of hospitals in the country where 97% of hospitals considered that for "substantial improvement in performance" it is "important" to restore autonomy. They also recognize the importance of creating accountability centers with the objective of improving efficiency, but they also recognize that it is necessary for the government to improve financing, autonomy of hospitals, human resources, incentives and acquisitions of equipment and essential elements for the functioning of hospitals.

The analysis of these elements reveals some important elements. The first has to do with the fact that for the responsibility centers to work, there must be autonomy on the part of the principals. Second, there are a number of elements such as the objectives found, the lack of incentives and behavior of the human being that can influence the fulfillment of the contract and finally despite the theory of the responsibility centers to be interesting there is still a long way to go its full operation in hospitals, first the necessary structures and conditions must be created, and from the approach of this thesis it is foreseen that without the existence of cost management systems it will be very difficult to apply and extract the advantages of the responsibility centers.

With all the above, Table 4.6 shows the basic concepts of the agency theory in the hospital context.

Table 4.6. Agency Theory for Hospitals

Characteristic	Concept in the Agency Theory
Key idea	Relationship Principal-Agent Government (principal) - Top management (agent) Top management (principal) - Directorate of production(agent) Top management (principal) - Director of services (agent) Director of services (principal) - Physicians (agent) Physicians (principal) - Patients (agent)
Unit of Analysis	Internal and external Contract
Human Assumptions	Self-Interest Bounden Rationality Risk Aversion
Organization Assumptions	Opposite objectives, quality of service and financial management
Agency Cost	Control: Difficulty to control due to the lack of information and communication systems to understand the attitudes of the agent and understand the causes of breach of contract can be internal (due to inefficiencies of the agents) or external (induced by the complexity of the demand and variability in the services provided) Incentives: Difficulty to have incentives due to the legislation in force, which can lead to inefficiencies. In addition, it is difficult to define incentives aligned with the interests of the agents due to the multiplicity of interests and that the objective of the hospital is not only financial efficiency.

Two important elements are highlighted in Table 4.6: the costs associated with control and incentives. Being complex systems, the cost of obtaining information is high, and this may be one of the reasons why the costing and information systems have failed in their implementation. One way to solve the problem is not to measure and not control (thus control costs would not be incurred), however this position could hide inefficiencies.

On the other hand, the cost associated with the incentives is low due to the legislation in force, however the fact of not existing can decrease the overall efficiency and generate breaches greater than the value that should be paid for such incentives.

4.5 Discussion and Conclusions

Next, we discuss these questions related to autonomy and responsibility centers in hospitals from a triangular perspective by taking into consideration related aspects already presented in Chapter 2, in theory (agency theory, hospital autonomy and cost management) and findings extracted from the case study itself. This analysis will be presented out in three parts. First, two classic propositions of the agency

theory will be analyzed, then two propositions derived from the analysis of Chapter 2 and finally some findings from the case study. Hospital autonomy asks for tools such as responsibility centers and these only are effective if delegation of responsibilities occurs thus, both are interconnected. In such cases, agency relationships are established and the typical and additional problems related to the agency theory emerge. These aspects are discussed below.

4.5.1 Fundamental Propositions

Responsibility centers involve some fundamental elements, on the one hand, the delegation of power in an agent for making decisions that should be taken by the principal, and on the other hand, the existence of a contract, which, in a higher level, must be aligned with the contract program.

Because there is an agency relationship, it is very likely that agency situations will arise that in turn will generate agency costs. There are two fundamental propositions when analyzing agency problems according to Eisenhard (1989a).

Proposition 1 is related to the idea that insofar as the objectives of the agent and the principal are aligned and appended to a result variable, the agent will tend to behave according to the interests of the principal. This proposition highlights the importance of aligning the objectives so that the agent works according to the interests of the principal. One of the principal's objectives is to maintain the financial stability of the hospital and comply with the contract program. On the other hand, the objectives of the medical staff are more focused on providing the service with the best possible quality, using innovative methods taking into account the particularity of each patient (HOSPITAL 1/INTERVIEWEE 3).

Although it is a logical proposition in the case of hospitals, it is difficult to implement when, for example, the quality of the patient can be affected by the reduction in costs. This is a common problem in business activities but it is magnified when both, the quality of the service and costs related are not easily recognized and controlled.

On the other hand, the financing system itself makes it difficult in some cases to align the objectives. For example, the idea is to serve more patients with the installed capacity since the hospital is financed by treated patients without considering the diagnostic areas such as the image service.

If a patient needs more than a diagnosis, the diagnostic number will be a driver of the cost but not of the income. The decrease in the number of diagnoses could sacrifice the quality and an increase in the number of diagnoses could affect the compliance with the contract, and this can happen not because of inefficiencies but because of the variability of the patients.

This case study shows that there is more difficulty in aligning the objectives of the principal and the agents in environments characterized by high levels of uncertainty, either in the services provided and in the processes that produce them. This occurs because the quality of care is a major objective for hospitals in addition to efficiency, however due to the restriction of resources top managers must balance this objective with objectives of the financial type (Tiemann, Schreyögg, & Busse, 2012).

In addition to this we can see a possible failure of the agency theory because being focused too much on financial aspects and disregard aspects such as quality, which in the case of health services is a fundamental variable. This approach is in harmony with Fiss & Zajac (2004) and Segrestin & Hatchuel (2011) who mention that the agent is not only motivated by financial returns but also by production objectives. Furthermore, in the case of hospitals, not only the number of services provided is important, but also the quality of service provision (Forgione et al., 2005).

On the other hand, proposition 2 is related to the fact that the less asymmetry of information exists, the more the agent will behave according to the interests of the principal.

In the case of the hospital environment there is a difficulty in this regard that has to do with the agent a priori will have more knowledge than the principal (due to the degree of specialization of doctors), additionally the behavior of the patient that can affect the result final. This implies that due to the difficulty of measuring the outcome it will be difficult to reduce the asymmetry of the information and thus, avoid opportunistic behavior or inefficiencies of the system.

In addition to the quality, variability and difficulty to measure the result, another important element in the contract has to do with the determination of costs (whether production or agency). To the extent that there are mechanisms to quantify these costs, the behavior of the agent can be more easily monitored and the possible variations of the contract with respect to real production can be understood.

4.5.2 Agency Relationships

Another aspect related to the responsibility centers is related to propositions 2 and 4 (in this chapter propositions 3 and 4 respectively) that emerged from the analysis and framework presented in Chapter 2 of this thesis, which mentioned the following questions.

Thus, proposition 3 states that within hospitals, the implementation of responsibility centers will only be successful to extent that they are supported by cost information systems and the intermediate managers are given autonomy to make decisions related to the management of resources.

One of the important elements for the use of responsibility centers is that they have information associated with production costs to identify efficiencies, inefficiencies and deviations from the contract by the responsible agents of the responsibility center.

Furthermore, this information could serve as an element of control on the part of the principal, since, as mentioned in Proposition 2, the more information the principal possesses, the better the behavior of the agent will be in relation to the interests of the principal. In this sense, the cost associated with the cost information (design, implementation, maintenance and utilization) can be considered an agency cost necessary to control the agents.

Another important element for the operation of the responsibility centers is associated with the fact that they offer real autonomy for the management of resources. As evidenced in the case study, this autonomy is null or near zero at lower management levels and reduced at the level of top management considering the limitations imposed by the state (ACSS, 2016b).

This lack of autonomy eliminates agency problems since decisions are centralized, however, it can generate inefficiencies that can exceed the agency costs that would be incurred when implementing the responsibility centers. In other words, the cost of centralizing decisions vs. the agency costs generated must be analyzed, giving real autonomy to the functioning of the responsibility centers. One of the disadvantages of centralization is that the health managers (at the middle level) do not have opportunities to apply their own strategic competencies, because the main strategic directions are defined by the top management or by the ministry of health (high level) (Supic, Bjegovic, Marinkovic, Milicevic, & Vasic, 2010).

On the other hand, proposition 4 states that the relationship between compliance with the contract and autonomy can generate virtuous circles for those who generate strategies to comply which will allow them to improve their management systems and, inversely, vicious circles for those that do not comply due to lack of autonomy to make decisions and deteriorate their administrative processes.

Proposition 4 draws attention to another important aspect that has to do with the complexity of agency relationships as agents comply with their contracts, since to the extent that contracts are fulfilled, agents will have more autonomy than for a side is positive (since in theory would increase efficiency) however more autonomy would generate more control costs and incentives (agency costs) that should be compared with the cost associated with efficiency gains.

These propositions have in common at least two elements, the contract and its level of compliance (mainly cost and quantity) and the delegation of power (or autonomy) via responsibility centers.

Regarding the contract, to evaluate its level of compliance, it is important not only to quantify how much was spent, but also how it was spent since cost is a fundamental element in the contracting process, this shows the importance of a cost management system for which the concern is not only about costing but also about cost management.

Regarding autonomy, it is shown that the success of responsibility centers will depend not only on a management system but also on the level of autonomy granted to the responsibility center by a higher level (top management or government). However, indexing autonomy to the fulfillment of contracts can generate positive (virtuous) or negative (vicious) situations in the case that we, respectively, do not or do comply with what has been contracted.

Taking into account these elements, Table 4.7 relates twelve characteristics that a responsibility center should have according to the NHS with the perspectives of cost management, hospital autonomy and agency theory.

Table 4.7. Characteristics of the Responsibility Centers

Number	Characteristic	Cost Management	Hospital Autonomy	Agency Theory
1	Decentralization of powers and responsibilities on the part of top management of the hospitals.		x	x
2	Sustainability, which reconciles the achievement of contracted objectives, control of costs and recognition of professionals.	x	x	
3	Transparency, which is reflected in the registration of the various stages of the processes, in the publication of results and in internal and external annual clinical and administrative audits published on the hospital´s website.			x
4	Cooperation and solidarity between the elements that constitute the responsibility center, and of each responsibility center before the remaining hospital			
5	Articulation, with the other structures and services of the hospital	x		
6	Evaluation, which should be objective, transparent and contractual between the parties, with repercussion in the responsibility center throughout the team that constitutes it.	x	x	x
7	Merit and objectification of recognition, which results from the evaluation of each element, resulting in its public recognition.			x
8	Ethical behavior, deontological behavior and a sense of public service, each responsibility centers professional being responsible for safeguarding legality and public interest, protecting the patient's interests, pursuing the best performance of the responsibility centers and the institution in which it operates. Honesty, smoothness and in accordance with deontology and good practices.			x
9	Clear definition of quantified, scheduled and time-bound objectives.			x
10	Control of the use of the human and material resources that are affected.		x	x
11	Internal Contracting through the conclusion of annual contracts between the directors of the responsibility centers and the top management that set the objectives and the means necessary to reach them and define the periodic evaluation mechanisms, which include, annual activity plan of the responsibility center, the annual program-budget project, the investment plan and the training and research plan.	x	x	x
12	The contract referred to in point L shall take into account the general objectives of the hospital and those defined by the guardianship, in particular as regards production, service and quality of care established in the hospital's contract.	x		x

Source: Based on SNS (2017a).

With respect to the elements related to cost management, it is evident the importance of existing metrics that allow an evaluation and better management of the costs associated to the different responsibility centers.

In addition to this, as was mentioned by Simões et al. (2017) one of the objectives of responsibility centers is their contribution to coordinate medical specialties, contain costs, and strengthen competition. Here arises a natural relationship among autonomy via responsibility centers, the agency theory due to the existence of the delegation of power and the agency problems that this generates and the agency costs (including the costs of obtaining information to control the agent).

The hospital autonomy and the agency theory are related, since to the extent that power is delegated, there is a contract that is facing an agency problem. For example, the characteristic number 1, highlights the idea of delegation of power and decentralization with the creation of responsibility centers in hospitals, the characteristic number 8 highlights elements related to the behavior of the individuals that belong to the center of responsibility, the characteristic number 3 emphasizes the importance of control, the characteristics number 2 and 7 underscore the importance of incentives (agency cost). All these elements are part of the agency theory and also highlight the importance of autonomy in the management of resources.

The characteristic number 10 shows how the responsibility centers contribute to the autonomy for the management of resources. Currently, there is no autonomy for the management of resources at the intermediate management levels since it is centralized in top management. The delegation of autonomy to the lower levels will allow to increase the efficient with respect to some desired goal, such as reducing costs or improving the quality of care. However, autonomy will also increase agency costs related to control (London, 2013).

4.5.3 Multiple Agency Theory

The need or existence of responsibility centers in hospitals generate an interesting phenomenon that deserves to be studied and that has to do with the multiplicity of contracts that exist and their relationship among them as can be seen in Figure 4.1.

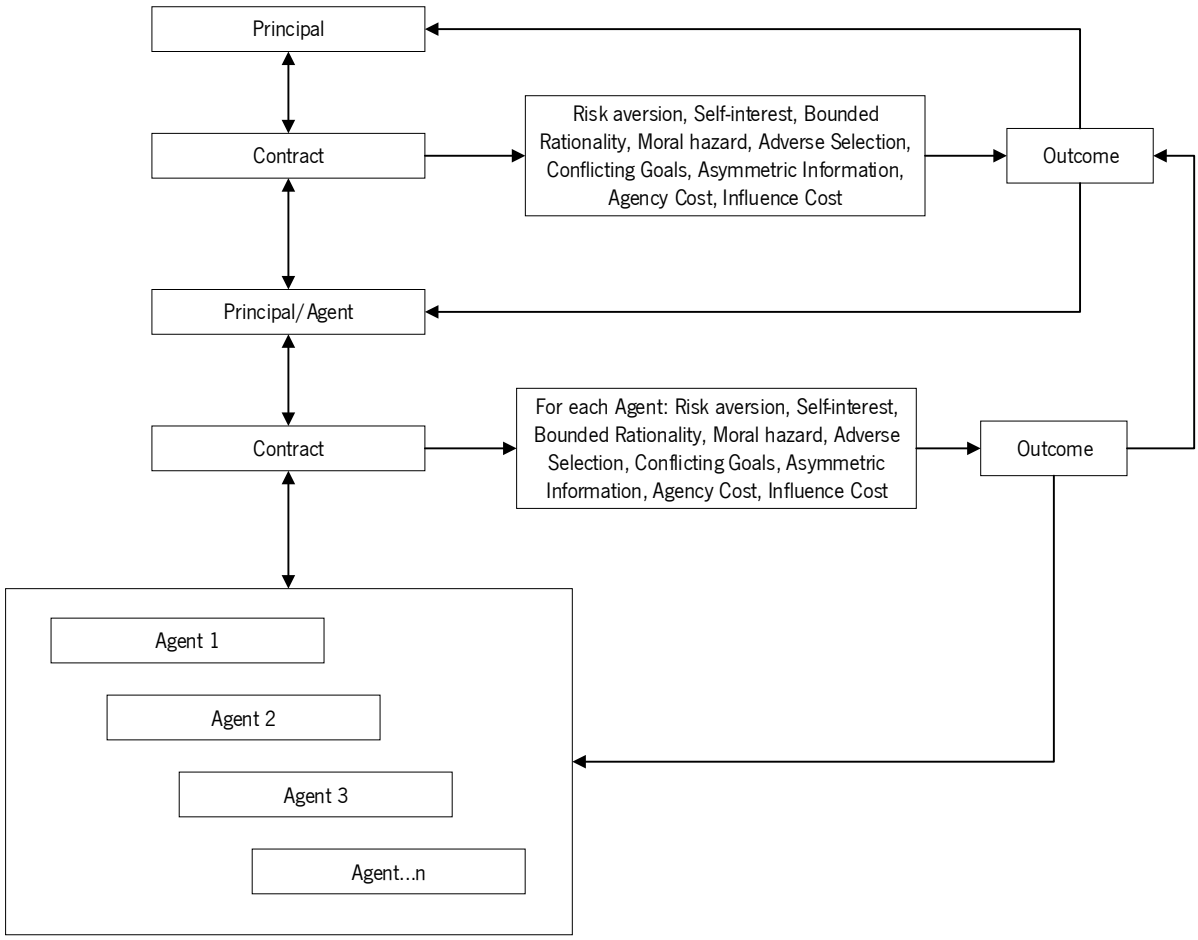

Figure 4.1. Agency Problems in External and Internal Contracting Process in Hospitals

Figure 4.1. Highlights the fact of the existence of multiple agency relationships firstly between top management and government and the secondly between top management and the different centers of responsibility.

In this last relationship, it is worth noting that the alignment of the objectives must be thought for each service since in some cases, as it was discussed, producing more does not mean to obtain more resources but certainly it costs more, which can affect the fulfillment of the contract.

The existence of the intrinsic complexity of health processes, together with variables such as the variability in the quantity and quality of patients, will cause higher agency costs because the control and the incentives to comply will be greater.

Taking into account that each patient can consume resources which are related to different agents, we see the importance of having good information and cost management systems that allow us to analyze the consumption of resources not in a specific center, but in all those that have interactions with the patients, what complicates a little more the analysis of the fulfillment of the contract since from the point of view of a production system, the agency problem with multiples agents can be seen as a problem of costs transfers between the different centers of responsibility.

The existence of multiple agents is a new field of studies that has been called "multiple agency theory" (Bruton, Filatotchev, Chahine, & Wright, 2010; Deutsch, Keil, & Laamanen, 2011; Hoskisson, Castleton, & Withers, 2009). Multiple agency refers to a situation in which there is more than one party in agency relationships, either as principals, agents or both (Arthurs, Hoskisson, Busenitz, & Johnson, 2008). Indeed, hospitals are framed in an organization with multiple agents and here a new path for research and additional contributions to agency theory is opened. Multiple agency theory requires new forms of governance that are integrated with the structure of the organization (i.e. integrated with the responsibility centers) such as: the cooptation of employees and junior partners into ownership and governance, more inclusive forms of control, mutual monitoring and the promotion of trust (Child & Rodrigues, 2003).

However an increased efficiency, mitigated by agency costs, will not necessarily guarantee compliance with the contract, as this can be affected by other elements such as patient behavior and variability in the demand and pathologies which should be also be the object of attention.

4.5.4 Conclusions

There is a contracting process between hospitals and government entities. Within a hospital it can be considered as a complex, interconnected and vital process to guarantee the provision of health services to a population.

To that extent, the government has designed different strategies for a more efficient management of resources, one of these strategies has to do with the creation of responsibility centers in hospitals. Although they have been regulated since 1998 (ACSS, 2010), the creation of the such responsibility centers has not been successful, but the government persists in its implementation (Simões et al., 2017). The concept of responsibility centers is based on the delegation of responsibilities.

The delegation of responsibility and contracting processes will involve agency problems and agency problems.

The agency theory mentions that when the agent's and the principal's objectives are aligned the agent will act in benefit of the utility function of the principal. However, when the objectives are not aligned, and there is asymmetry in the information (i.e. there is no system for determining costs to monitor the behavior of the agent) the agent will act in benefit of its own utility function, going over the interests of the principal (Michael Jensen, 1983).

To avoid these behaviors and to align the objectives of the agent and the principal, agency costs are generated which are normally related to incentives and control. With respect to the incentives, it was evident that the current legislation offers few incentives, which may generate little motivation for the agents to fulfill the contract carrying out their activities efficiently (HOSPITAL 1/INTERVIEWEE 1). This lack of incentives makes it difficult to align the objectives of the principal with the objectives of the agent. As it is a complex system, control costs are high. An element that can contribute to control in a responsibility center has to do with a cost estimation system. However, the cost estimate itself is a complex and expensive process to manage. A serious strategy is not to control and wait for outcomes. However, here the principal could be affected by the agents' bounded rationality and opportunism. Therefore, the principal must evaluate the marginal cost of acquiring such information, compared with the marginal gain of obtaining it.

Starting from the fact that the level of autonomy is limited for the top management (ACSS, 2016b), we can conclude that there is still no structure for the implementation of the centers of responsibility. This structure implies the existence of effective information systems, cost management systems and a culture of continuous improvement within hospitals. This is also related to Proposition 1 presented in Chapter 2 of this thesis. As evidenced in the case study there are not enough mechanisms to know agents' attitudes (due to the lack of cost management systems), there are multiple objectives and there are not many incentives that contribute to efficiency.

The autonomy has been a concern on the part of the NHS which has proposed to index this level to the fulfillment of the contract (SNS, 2016), which, put in that way, can be dangerous, since it cannot only influence the quality of the service, as it can do with the fact that the best institutions are getting better and the worst getting worse.

Another element associated with the existence of decentralized structures has to do with the existence of opposing objectives. In a hospital, the natural thing is that the doctor cares about the patients and little about the management processes.

If this is not corrected it can also generate breaches in the contract and although the idea of standardizing health services is practically impossible to raise awareness among the medical staff in the importance of cost and resource management and that they understand how their processes impact the financial health of the institution can contribute to improve efficiency, of course all this involves costs (agency costs) which can be greater than the benefits.

It is noteworthy that compliance with the contract will depend on the incentives that agents have for this, that they can be controlled and that their objectives can be aligned with the principal, not only from the financial point of view, but also from the personal recognition that it is very important in health services.

5. The Design and Implementation of Costing Systems through the Use of Project Management Practices

5.1 Introduction

With the growing demand for health services due to increases in population, a generalized increase in people's life expectancy, the complexity of diseases and the new treatments that appear to combat them, the expenditure that countries determine to meet their needs, health systems' budgets have been increasing, and of this expenditure most are used to finance them; patients just pay directly a small part of the costs (Kruk & Freedman, 2008; Simões et al., 2017). Indeed, health services are a strategic variable within the economic context of almost countries, for example EU spent about 9.9% of its GDP on health care (OECD, 2016), and, with the increase in the age of populations the cost of health services increases. This is one of the reasons why knowledge and cost control is increasingly important within organizations providing health services.

The need for a well-developed public health system will always be essential. In recent years, mainly public health systems have had a positive and decisive impact on the health status of populations. Nevertheless, since decades many public health institutions have been faced with limited resources and management problems but the option of continuing to plan for efficient management of public health systems rather than privatization has not been much discussed in the international debate (De Vos, Orduñez-García, Santos-Peña, & Van der Stuyft, 2010).

Among organizations, hospitals stand out, which in many countries consume more than 70% of the total costs that governments dedicated to health. According to (Dictionary, 2012), a hospital can be defined as: *an institution providing medical and surgical treatment and nursing care for sick or injured people,* the definition of a hospital is usually accompanied by elements such as that hospital policies are aligned with government policies or that the service is universal, that it is available at all times and that there is supervision and control by the caretakers to provide treatment to users (Cox, 1888).

Due to these conditions, the management of resources within a health system and by extension within a hospital is increasingly a strategic factor. For many hospitals, to maintain or improve the management of their resources, controlling and reducing costs has been a viable alternative to survive. In an atmosphere of competition and changes in the contracting and financing processes, costs have a dramatic impact on many decisions facing hospital management. In many cases, the price offered by the state to hospital

entities for a given treatment is fixed, limiting the maximum cost of operation to the price offered by the financing entities, therefore the objective is to reduce the cost of activities, increase productivity and efficiency without sacrificing the quality of services (Nackel et al., 1987). These goals can only be achieved with the development of cost management tools.

It is therefore important that hospitals must be increasingly efficient in managing their costs, not only to meet the growing demand, but also to ensure that what has been contracted or budgeted is fulfilled and in this way can guarantee the financial stability of the National Health Service (NHS). For that, it is fundamental that these organizations have systems that allow to determine and manage the cost associated with the services they offer. A costing methodology widely used in hospitals and other organizations is the methodology Activity-based costing (ABC) (Arnaboldi & Lapsley, 2004)

The technical aspects of activity based methodologies such as the selection of activities, cost drivers and process design have been widely discussed in the literature. However, in recent years a concern that has arisen has to do with the problems with the implementation of the ABC systems in organizations and in extreme cases the failure of this implementations.

An example of this happened in 2007 when the Portuguese Ministry of Health developed a pilot test with five hospitals for the application of an ABC costing system in hospitals. Despite the potential of the method for efficient cost management, the project was aborted and was not applied to the remaining hospitals in the country. One of the causes of failure was the high implementation costs (Borges et al., 2010; Escoval et al., 2010).

In addition to this, other problems for not being successful in costing projects are related to the fact that many firms have focused on the technical (e.g. software) aspects of costing systems and have given insufficient attention to behavioral and organizational factors particularly, top management support, relation to competitive strategies, relation to performance evaluation and compensation, training, ownership by non-accountants, and adequate resources (Shields, 1995). These factors must be taken into account when implementing a costing system within an organization in order to increase the probability of success. Success understood from a multidimensional perspective measured by efficiency, effectiveness and innovation (Svejvig & Andersen, 2015). A measure of success in a costing system was detailed by Anderson & Young (1999), where they propose 3 measures of evaluation which are accuracy, use and the overall. The accuracy is related with the improved accuracy of product cost information relative to the traditional or previous cost system (which in some cases may be non-existent). The use is related to the fact that the costing system is used for cost reduction and used to produce costing data for process improvements. The dimension overall is related to the general perception of stakeholders about

the costing system and its degree of acceptance, this perception can be in favor or can recognize the utility of the costing system.

Gosselin (2006) identifies at least four phases to ensure that a costing system is an effective support tool for decision making, these phases are: the adoption (i.e. decision to adopt), the design of the system, the implementation and the routinization.

In the adoption phase, the organization recognizes the need for a costing system and decides to adopt a particular one, this phase is characterized by high levels of uncertainty about the utility of the costing system, and several factors can lead to take a decision in favor of a new implementation namely, pressures from several stakeholders and institutions, the need to improve the management of resources or even aspects related to the market where the organization is inserted.

In the design phase, the organization works to develop the necessary infrastructure for the project to begin and to be executed. In the implementation phase, the organization introduces the innovation and evaluates its impact and during the last phase, the routinization, the costing system is part of the day-to-day use of the organization (Gosselin, 1997).

In terms of design and implementation (Shields, 1995) highlights that it is important to create an organizational culture that guarantees that once the costing system is implemented it will be effectively a decision making tool, For this to happen it is essential to have the support of the organization particularly top management. It is important that the cost system and the information that is generated are aligned with the strategy of the organization and that there is an appropriation and assimilation of the system by the personnel of the organization.

Taking into account these issues in the implementation of costing systems and considering that the function of project management can be defined as the process of controlling the achievement of a project's objectives, the latter can be viewed as useful for the improvement of costing systems design and implementation. The use of project management concepts, approaches and tools can increase the probability of success in designing and implementing a costing system (Munns & Bjeirmi, 1996; Rose, 2013; Too & Weaver, 2014). Furthermore, in addition to the technical aspects of the implementation of a costing system, it is important to carry out an adequate management of the resources and also of the expectations of the stakeholders, for which project management contributes greatly (R. Atkinson, 1999). Indeed, for project management there are several tools that have been developed over the decades, these tools are not only focused on technical aspects, but also on behavioral ones. For example, the PMBoK standard of the Project Management Institute (PMI) provides information on the processes that can be carried out for effective management, and different techniques and useful tools, but the exposed contents

must be adapted to the peculiarities of each project. According to this approach, all projects are composed of processes, which must be previously selected, which need a range of knowledge areas to be applied, and whoever manages a project must be able to manage the scope, time, cost, quality, human resources, communications, risk, procurement and the relationship with the stakeholders in an integrated way (Rose, 2013).

Another methodology of project management is the IPMA Competence Baseline (ICB) develop for the International Project Management Association (IPMA). This methodology identifies the characteristics of those who lead and manage a project, these competencies are grouped in: contextual, behavioral and technical competences (Gaupin et al., 2006).

With the advent of the era of information and telecommunications, a number of methodologies known as agile methodologies have been developed in recent years (Senapathi & Drury-Grogan, 2017). These methodologies have been designed mainly for the development of information systems and the most common agile methodologies include Extreme Programming (XP), Scrum, Crystal, Dynamic Systems Development Method (DSDM), Lean Development, and Feature-Driven Development (FDD).

These methodologies are highlighted by a great communication and interaction among the various stakeholders throughout the project, including those that are end users. They are related to repeated cycles of reflection and action, which help to create a learning and adaptation environment (Nerur, Mahapatra, & Mangalaraj, 2005).

Although it is true that these methodologies are presented as new, they are not exclusive of approaches such as the PMBok standard or ICB, but are complementary, in other words, agile methodologies can work in conjunction with methodologies such as the PMBOk standard or ICB and must be adapted to the particular characteristics that each project have.

So far, two important elements have been presented: the first are the problems in designing and implementing a costing system and, secondly, the tools or methodologies of project management that can be used to tackle this type of projects.

This chapter will present an agile project management methodology for the design and implementation of a costing system and shows an application in an imaging service of a Portuguese hospital.

Scrum Costing was choose to support the design of the new costing system. Besides the capability to determine the cost of relevant cost objects, it is necessary to have a really functional system accepted by the medical staff and all participants in the process. For the implementation of the costing system it was selected the project methodology Scrum and there were taken into account some considerations in the development of the costing system. Firstly it was defined who would be the product owner and who will

integrate the project team. The product owner was the person responsible for making decisions in the imaging area. The team composed to implement the costing system included, medical staff, systems engineers, industrial engineers, and the administrative staff. After a first meeting, the essential requirements of costing system were established.

Once defined the stakeholders, we proceeded to define the product Backlog, i.e. the list of requirements that the costing system should meet once implemented. The requirements include: the identification of the cost objects, processes analysis, activities analysis, estimates of the cost of the services and the development of tools for decision makers, all this with the involvement of the stakeholders (i.e. medical, administrative and operational staff) and the information systems that were in use in the imaging area.

Among the assumptions in applying this methodology is the fact that the complexity of a costing system is not only technical but that aspects of individual and organizational nature must be recognized. It was also found that in complex environments such as hospitals there must be a balance between accuracy in cost determination, the cost of such accuracy, and the relevance of that precision determined by the marginal improvement in decision making.

This chapter is organized as follows: after this introduction the second section of this chapter is related to literature review where a brief description of the state of the art on problems related to the design and implementation of costing systems and possible aids for improvement or mitigation of such problems using agile project management methodologies are presented. In section three an approach based on agile project management methodologies is proposed for the design and implementation of costing systems. Section four describes the research methodology that was used for the application of this approach, which was action research. Section five shows the application in the imaging service of a Portuguese hospital and finally, section six presents the discussion of the findings and the conclusions.

5.2 Literature Review

5.2.1 Project Management

The role of project management encompasses the definition of work requirements, the definition of scope, the distribution and management of resources, the planning of work execution, work monitoring, project adjustments, and management with stakeholders (Kolltveit, Karlsen, & Grønhaug, 2007; Munns & Bjeirmi, 1996). These activities are carried out in order to meet project constraints; such restrictions are usually related to: scope, time, cost, quality, risk, and benefits (Cooke-Davies, 2002; Rose, 2013). Project

management is a productive ground for creative, spontaneous and intuitive applications of particular models, theories, or methodologies to meet the stated goals in a continually changing environment (Klein, Biesenthal, & Dehlin, 2015).

For (Rose, 2013; Wysocki, 2014) a project "is a temporary endeavor undertaken to create a unique product, service, or result whose value must satisfy the expected and desired needs of the customer. To ensure that the project meets the needs of the client, different theories and project management tools have been developed which have been redefined or adapted to be used in the new economic environments which are characterized by their complexity and high degree of uncertainty (Fernandez & Fernandez, 2009).

Typically, the methodologies used can be characterized as traditional and agile methodologies, the former use a linear or incremental approach to project management according to (Wysocki, 2014), and the latter use an iterative, adaptive and extreme approach. Agile methodologies are a characteristic of environments where the value of the project is clear, the client has active participation throughout the phases of the project and a high content of software is necessary in the design and implementation of the project (Hass, 2007). To relate the recommended project management approach to goal and solution strategy (Wysocki, 2014) has defined 4 quadrants as shown in Figure 5.1.

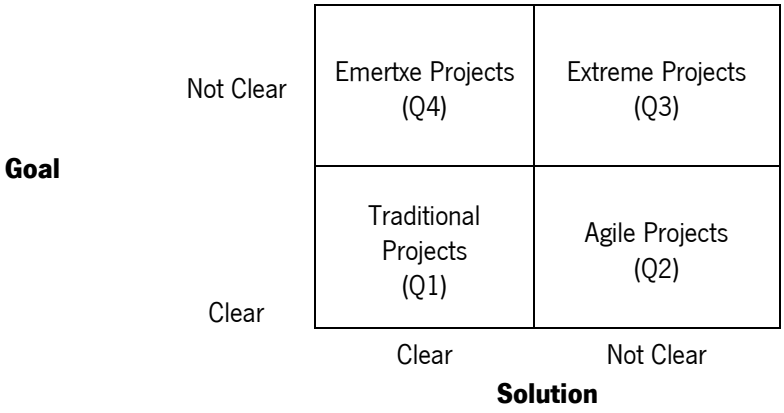

Figure 5.1. The Four Quadrants of the Project Landscape
Source: Wysocki (2014)

The first quadrant identifies traditional projects, agile projects are located in quadrant 2, extreme projects are located in quadrant 3 and emertxe projects in quadrant 4.

In quadrant 1 we can find projects where the goal and the solution are clear, it is a simple situation where following a detailed plan leads to the achievement of the project objective; this type of projects is increasingly rare due to the rapidly changing environment in that the organizations are inserted nowadays.

In quadrant 2, projects have clear objectives, however the path to an "optimal" solution is not known a

priori, in this quadrant plans undergo iterative modifications throughout the execution of the project in order to find a solution that converges with the project objective.

In quadrant 3 stand out projects whose solution and objectives cannot be defined a priori or are simply unknown, are framed here projects related to research and development.

Finally, in quadrant 4, there are projects where the solution is known but the objective is not, in this category are framed projects such as new technologies or new products that are developed and the potential of their applications, or new materials that are discovered and their possible applications for the future are not yet known.

In this context, for the implementation of a costing system in a hospital, two elements must be taken into account. First, that hospitals are complex organizations and secondly that Portugal has evidence of implementation projects of costing systems that have failed (the goal is known but no solution has been found). These two elements place the design and implementation of a costing system in quadrant 2.

Project management is done by applying and integrating processes that can be grouped into five groups, which are initiation, planning, execution, monitoring and control, and project closure (Rose, 2013).

In what concerns the initiation is where the project is defined and authorized. With respect to planning, it is where the objectives are defined and refined, and the activities necessary for the fulfillment of the project's objectives are planned.

In the execution is where people and other resources are integrated to carry out what has been planned.

In the monitoring and control is where the progress of the project is measured and monitored in order to identify variations with respect to the plan and corrective measures are generated to meet the objective.

Finally the closing formalizes the acceptance of the product, service or result and finishes the project or a phase of it (Rose, 2013).

Based on these groups five groups, Wysocki (2014) defines 5 project management life cycle (PMLC) models (Linear, Incremental, Iterative, Adaptive, and Extreme). Figure 5.2 shows the use of each of these PMLC models. It is noteworthy that the methodology defined in the PMBoK standard for project management and other methodologies such as agile methodologies are not mutually exclusive, rather they are complementary. In other words, the structure defined in the PMBok standard can be used by modifying the way the process groups (initiation, planning, execution, monitoring and control, and project closure) interact throughout the project. These modifications will depend on the purpose of the project and the proposed solutions (Wysocki, 2014).

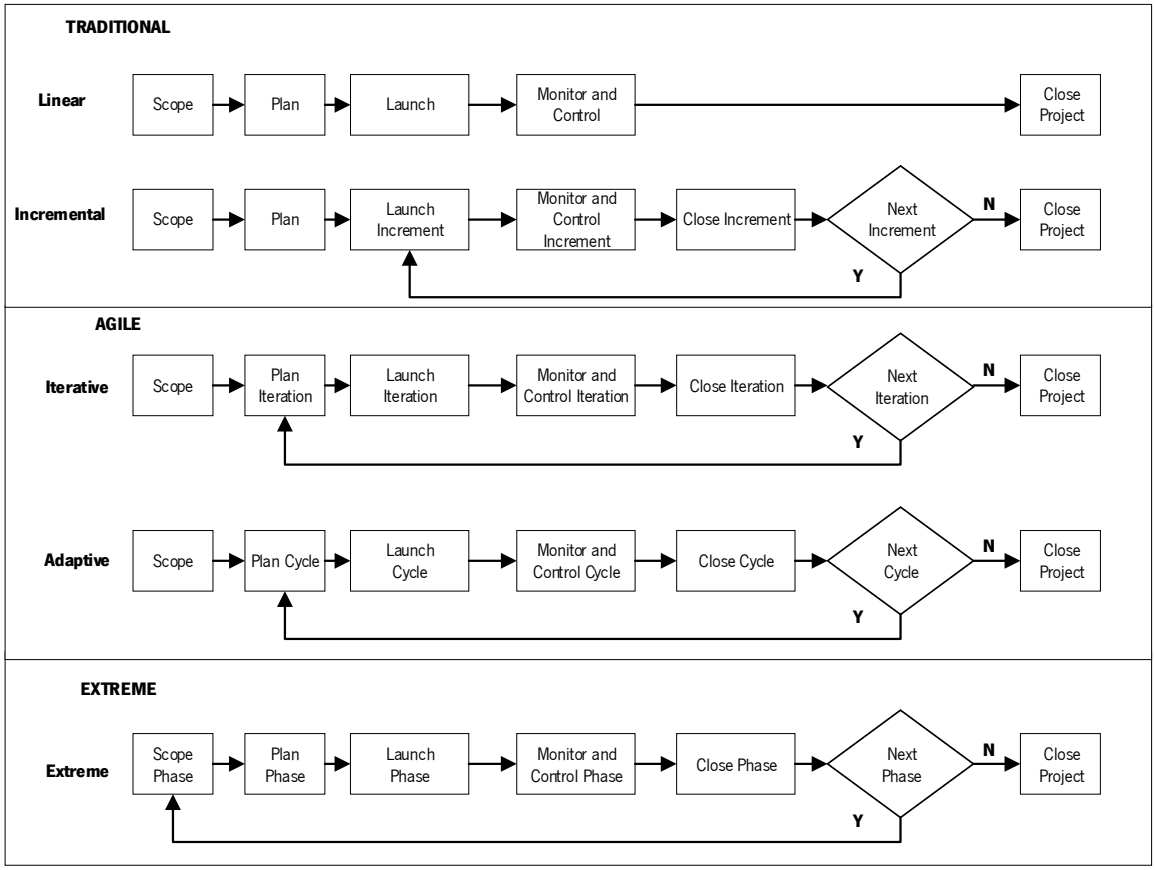

Figure 5.2. The Five Project Management Life Cycles
Source: Wysocki (2014)

In linear models the project phases are executed sequentially without feedback, and the deliverables are only presented at the end of the project. This approach is appropriate when the solution and scope are clear and well-known, in this type of projects the management of time and resources is not complex and has the disadvantage of inflexibility to changes and little orientation towards value for the client and end user. The most significant difference between an incremental and a linear strategy is in the deliverables, in an incremental strategy the deliverables are split and must be ready according to a schedule, each deliverable is a partial solution that is increased throughout the project until the final solution (Fernandez & Fernandez, 2009; Rose, 2013; Wysocki, 2014). The linear and incremental methodologies are appropriate for projects framed in quadrant 1.

The iterative approach is interesting when the solution is not clearly defined. This approach is similar to the production of a prototype. A solution is delivered in each interaction, the client analyzes the solution, which is incomplete or intermediate, and gives feedback and about what would change or want to see in the product, accordingly, these changes are integrated into the prototype and another (incomplete)

solution is made over and over again, satisfying the customer. It is similar to an incremental approach with a significant difference, because changes are given by the customer or end user.

The adaptive models are appropriated to environments of great change where the uncertainty in processes and the final result are present, in addition they are characterized by having a continuous and exhaustive participation by part of those interested in the project. These methods are also adaptive and incremental but differ in that they have short iterations, usually a few weeks. The iterative and adaptive models are appropriate for projects framed in quadrant 2.

The extreme models are appropriated for projects whose objectives and solution are not clear or cannot be defined a priori. Here you are in the world of pure R&D, new product or new service development, and process improvement project. In many cases, they are also high-speed projects. Failure proportions are frequently very high. The extreme models are appropriate for projects framed in quadrant 3 and 4.

As already mentioned, we propose to locate the design and implementation of the costing system in the quadrant 2 using an agile methodology.

In agile methodologies are performed several processes in each iteration, not neglecting in the first iterations project planning activities. The scope of the project is divided into a set of job requirements called product backlog. When an iteration begins, the project team must work to determine which and the priority elements of a list of outstanding records can be delivered in the next interaction. At the end of each iteration the product must be functional and be ready to be checked by the customer. Each iteration must increase the value and functionality of the product, which does not indicate that the product is finished at 100% plus the increments must be finished.

The agile methodologies are inspired on the philosophies presented in the "Agile Manifesto", a proclamation created by a group of leading software practitioners responding to the growing failure of IT-related projects. This proclamation is based on four fundamentals or principles (Cubric, 2013; Fowler & Highsmith, 2001):

- ✓ individuals and interactions over processes and tools,
- ✓ working software over comprehensive documentation,
- ✓ customer collaboration over contract negotiation and,
- ✓ responding to change over following a plan.

In general, agile methods are lightweight processes that:

- ✓ employ short iterative cycles,
- ✓ actively involve users to establish, prioritize, and verify requirements, and

- ✓ rely on a team's tacit knowledge as opposed to documentation.

A truly agile method must be (Boehm & Turner, 2005):

- ✓ iterative (take several cycles to be completed),
- ✓ incremental (not deliver the entire product at once),
- ✓ self-organizing (teams determine the best way to handle work), and
- ✓ emergent (processes, principles, and work structures are recognized during the project rather than predetermined).

Table 5.1 shows the main agile methods and offers a short description of each one.

Table 5.1. Agile Methodologies

Agile Methodology	Short Description	Reference
Scrum Methodology	The Scrum methodology emerged from companies of technology products, and it is appropriate for projects with unstable requirement and for those who require speed and flexibility. In the Scrum methodology, some main components are defined namely, the product backlogs which contain a wish list of all the user stories of a product, the sprint backlog which is related with the product backlog and contain a list of elements that must be completed for each sprint.	(Ken Schwaber, 1997)
Extreme Programming	Instead, analyzing and designing the entire project, this methodology realize activities throughout the project in an iterative way. This methodology is based on 13 principles which are: Planning game, small release, metaphor, simple design, test, refactoring, and pair programming, and continuous integration, collective ownership, on site customer, 40 hour weeks, open workplace and just rules.	(Beck, 1999)
Lean Software Development	Lean development is a product development philosophy based on Lean Philosophy. The principles of this methodology are the following: create value for the customer, eliminate waste, the optimization of value stream, empowerment and continuous improvement.	(Ebert, Abrahamsson, & Oza, 2012)
Adaptive Software Development	The adaptive software development is based on the complex adaptive system –CAS- which assumes that the adaptation of a system to its environment occurs from the adaptive efforts of individual agents that try to improve their own remuneration. ASD uses CAS principles, being focused on the interaction between product, stakeholders and process.	(Meso & Jain, 2006)
Crystal Methodologies	Crystal Methodologies are a group of methodologies classified by color- Clear, Yellow, Orange, Red, Maroon, Blue and Violet, the color of Crystal-, where the intensity of the colors is associated with two key project variables, the facility of communication and the level of complexity of the project.	(Cockburn, 2004)

There are many kinds of projects where to apply agile methods. An agile methodology frequently used is the Scrum (Cervone, 2011). The Scrum methodology was initially identified and defined by (Takeuchi & Nonaka, 1986) who analyzed how new products were developed in companies such as Canon, Honda, Epson among others. Although (Takeuchi & Nonaka, 1986) introduced the idea of scrum this was used as a structured methodology and presented only later by (Ken Schwaber, 1997). Among the advantages of the Scrum Methodology we may highlight: generates anticipated results, allows a regular management of customer expectations, high flexibility and adaptation, risk mitigation, productivity and quality, alignment between customer and project team and a motivated team.

Scrum is a methodology widely used in software development; however, the logic of this approach can be used in other types of projects. Scrum is an iterative technique and assumes that the development of a project is unpredictable and uncertain. In Scrum, projects are split into cycles called sprints. A sprint represents a time box within which a set of activities must be performed. The features to be implemented in a project are kept in a list that is known as product backlog. At the beginning of each sprint, a sprint planning meeting is held, that is, a planning meeting in which the product owner prioritizes the product backlog items and the team selects the activities that it will be able to implement during the starting sprint. Tasks allocated in a sprint are transferred from the product backlog to the sprint backlog.

In a pure sprint, each day the team makes a brief meeting (usually in the morning) called the daily Scrum. The goal is to disseminate knowledge about what was done the previous day, identify impediments and prioritize the work of what is started. At the end of a sprint, the team presents the features implemented in a sprint review meeting and receives feedback if the sprint is approved and if there are still features missing, the team goes to the next sprint and so the cycle restarts.

In Scrum methodology all the stakeholders, including customers or end users, must be continuously committed to the project and provide feedback on the functionality of the deliverables to identify if the product or service complies with their needs at each instant of time or at least every one that is reviewed. Adaptive methods are generally preferred in environments of uncertainty where requirements and scope are difficult to predict in advance and when the project can be divided into parts such that small value increases can be defined, perceived and valued by stakeholders (Rose, 2013).

5.2.2 Costing Systems from the Perspective of Project Management

In terms of costing systems for hospitals is very interesting an useful take into consideration the study carried out by Tan, Rutten, Van Ineveld, Redekop, & Hakkaart-Van Roijen (2009). These authors describe 4 possible approaches for costing systems. At the lower or simpler level is what the designated as the

top down gross costing (TDGC) approach, intermediate levels include bottom up gross costing (BUGC) and top down microcosting (TDMC) and at a higher level the bottom up microcosting (BUMC).

The fundamental difference has to do with two factors: first with the desired level of detail (gross costing versus microcosting) and second with the way costs are obtained which results in the level of cost accuracy (top-down versus bottom-up costing).

At the level of gross costing, costs are defined at a more aggregated level (for example, the cost of the imaging department); on the other hand, the microcosting level is concerned with the detail of those costs (for example, the costs per treatment, by a group of physicians specifically, or by each patient).

Seen from the perspective of the way costs are obtained, in the top-down approach costs are determined from aggregate costs (typically from financial information) and in this case the unit cost would be an average cost. From the bottom-up approach, costs are calculated by identifying the amount of resources used in each process, department or service provided and accumulated successively to be obtained the total costs of all cost objects.

The ideal would be to use a bottom-up-microcosting scenario. However, such a level of precision and detail in determining costs entails a large consumption of resources, and therefore increases the costs of obtaining information.

Which approach should a hospital use? The answer goes through the cost-benefit analysis of obtaining more precise and detailed information, and the effect this has on decision-making. For that, the costing system can be evaluated from the perspective proposed by Anderson & Young (1999), i.e. to determine the success of a costing system, we should not only evaluate its level of accuracy, but also in terms of its use and the overall perspective.

The level of accuracy will be determined by which of the four approaches proposed by Rutten, Van Ineveld, Redekop, & Hakkaart-Van Roijen (2009) the organization decide to use. However, the perspectives of use and overall dimension of the costing system are aspects that depend not only on the costing technique used but also on the culture and structure of the organization in relation to cost management.

Starting from the fact that the ideal scenario would be the bottom-up microcosting, this situates in the scenario of the techniques that have developed in the last years such as the ABC and the TDABC. These models have been analyzed mainly from a technical point of view (i.e. conceptual logic and its mathematical structure to calculate costs) and there are a number of applications that have been showing their effectiveness. But what is rarely discussed has to do with the level of success of the costing system which is related to accuracy but also to its effective use and other aspects that compose the overall dimension, without neglecting the cost-benefit analysis of obtaining and use information on costs.

With respect to the factors that affect the success in the design and implementation of a costing system, (Fei & Isa, 2010; Gosselin, 2006; Liu & Pan, 2007) identify four groups of factors, which are the following. Firstly, technical factors: related to the practical knowledge of the operation of an ABC system in an organization which includes the identification of cost objects, activity identification, resources, and cost drivers, which allows to calculate the cost of the products. Secondly, in addition to analyzing existing information and communication systems to support ABC systems. Thirdly, organizational factors namely, support from top management, organizational structure, training resources for implementation, organizational culture and competitive strategies. Fourthly, behavioral factors namely, the participation of users in the process of design and implementation of costing systems and the behavior of each of the users namely, resistance to change. Finally, other factors: competence, quality and relevance of cost information for management decision making, size of the organization, and incentives for the use of the costing system. Although these factors are focused on the ABC system, which has been one of the most discussed costing methodology in recent decades, these factors can be applied to the design and implementation of any costing system.

The combination of these factors means that the design and implementation of a costing system can be considered a complex project for an organization. In this context, organizations are faced with two decisions, the first one is related to the use or not of tools and methodologies of project management to carry out the design and implementation of costing systems, and, in the case of using to what degree it will be such use second, it has to do with determining the level of detail and precision of the costing system that is appropriate for the organization, these decisions are portrayed in Figure 5.3.

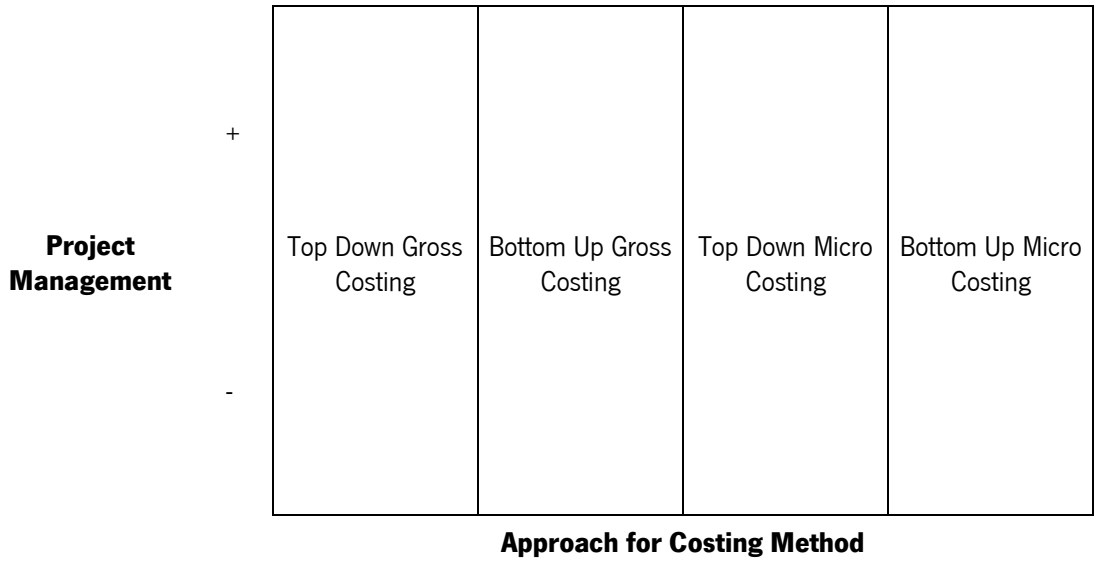

Figure 5.3. The Quadrants for Costing System Design using Project Management Tools

In Figure 5.3, four quadrants are highlighted for the design and implementation of costing systems. In the lower left quadrant (-PMTDGC) there is little use of project management, and costs are determined following the logic TDGC. At the other extreme, the upper right limit (+ PMBUMC) stands out in the case that an organization uses project management tools (and in the extreme case, an organization whose organizational culture is to work on projects) and to decide to implement a system of cost determination from the BUMC perspective.

The decision to be in each of the quadrants will depend on such factors as the use that will be given to the information and the cost of the implementation and the cost of keeping the system in operation, variables that must be balanced and taken into account in each one of the quadrants.

In the same line of reasoning and knowing that in the case of the projects of implementation of a costing system the objective is related to the determination of cost, however the way for its design and implementation can be more or less complex, once it is decided to use the tools of project management, the organizations must choose which approach will be used to carry out the project, with this in mind and taking into account the premises mentioned in Figure 5.1, Figure 5.4 appears.

Methodology of Project Management	**Approach for Costing Method**			
Agile	+Project Management for Top Down Gross Costing (+PMTDGC)	+Project Management for Bottom Up Gross Costing (+PMBUGC)	+Project Management for Top Down Micro Costing (+PMTDMC)	+Project Management for Bottom Up Micro Costing (+PMBUMC)
Traditional				

Figure 5.4. Costing System Design using Agile or Traditional Approach

Taking into account Figure 5.4, when deciding to implement a costing system hospitals are clear about the project objective (to determine the cost of their processes, services or departments), however, they are not very clear about the solution, the more difficult it is to define it a priori it would be more necessary to move from traditional project methodologies to agile project methodologies.

5.3 The Use of the Scrum Methodology for the Design and Implementation of Costing Systems

As mentioned by Rose (2013), the activities in a project can be grouped in: initiation, planning, execution and closure. On the other hand, as already defined, the stages in the implementation of a costing system (in this case the product) can be defined as adoption, design, implementation and routinization. In this research adoption and routinization are not addressed.

It is important to highlight two elements: the project with its phases (initiation, planning, execution, control and closure) and the product (which would be within the execution phase of the project). The proposed Scrum methodology is focused on the design and implementation of the product, which places it in the execution phase of the project.

The following is a brief description of the reasons to use Scum methodology, then how it works in general terms and lastly our proposal of how it can be adapted for the design and implementation of a costing system.

One of the important elements of a cost management system is the level of detail and quality of the information needed to track costs. If a large organization will attempt to record all of the data manually, the amount of human resources would make the marginal benefit less than the marginal cost of having detailed information. This is why cost management systems go hand in hand with the development of information and communication systems within organizations (Laurila et al., 2000).

As shown above, in order to create costing systems that effectively support decision-making, organizations must take into account technical aspects (for example, the cost methodology to be used) and non-technical ones (such as organizational culture and stakeholders). Otherwise it is important to manage the design and implementation of a costing system as a complex project.

In the pilot implementation of the ABC costing system in Portuguese hospitals, Borges et al (2010) highlight some difficulties related to the implementation of the system, among them, the difficulty to obtain information to feed the system, resistance to change by those responsible for generating the data that would feed into the system and the difficulty of managing a hospital-wide project (they recommend that it is better do it for sections or departments) with an already defined plan which generated delays because not all areas reported the required information to the same time. These limitations probably contributed to the failure of the project.

In the study conducted by Borges et al (2010) they does not discuss factors such as the cost of obtaining detail and accuracy, as well as whether such precision was needed for decision makers. In this sense we propose that the way of designing and implementing a costing system for hospitals should not be defined

a priori, but should be built in conjunction with stakeholders. The project must be completed when the system has a level of accuracy and detail suitable for decision making and is accepted by the staff of the organization, and should not forget the balance between the marginal cost of acquiring information and the marginal benefit for decision makers.

In this sense, the process design and implementation of a costing system must be iterative and that is why we propose to use an agile project methodology to develop this type of projects, the methodology chosen was the Scrum methodology. Figure 5.5 shows how the entire project life cycle would be, emphasizing that the proposed solution only focuses on the design and implementation of the costing system.

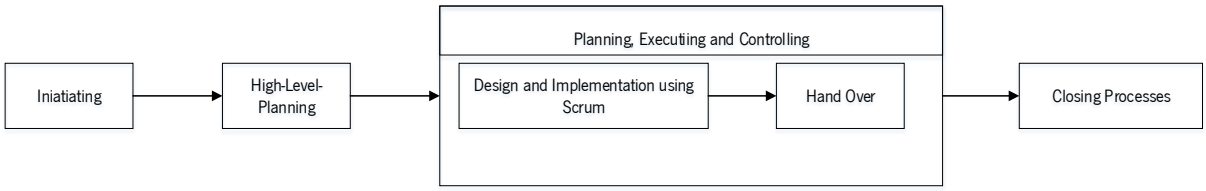

Figure 5.5. Life-Cycle of the Project

With this in mind, we present the logical sequence normally used in the Scrum methodology; in general, terms and then the adaptation for the design and implementation of costing systems.

The Scrum methodology is the most popular agile methodology, being characterized by frequent iterative and incremental inspection and adaptation (Wang, Conboy, & Cawley, 2012). Three columns/pillars support every project implementation within the Scrum methodology: transparency, inspection and adaptation. Transparency is related to the definition of rules so that stakeholders understand the information and project outcomes in the same way. In the inspection, the stakeholders must inspect part of a sprint goal to detect possible problems in the final product and when problems are detected these must be corrected. Finally, the process being developed must be adjusted or adapted immediately.

This methodology can be applied in a costing project because in this type of projects (e.g. ABC) requirements often change during the project and there are unpredictable challenges that cannot be easily faced in a planned predictive way. Figure 5.6 provides a simple explanation of how the Scrum methodology works.

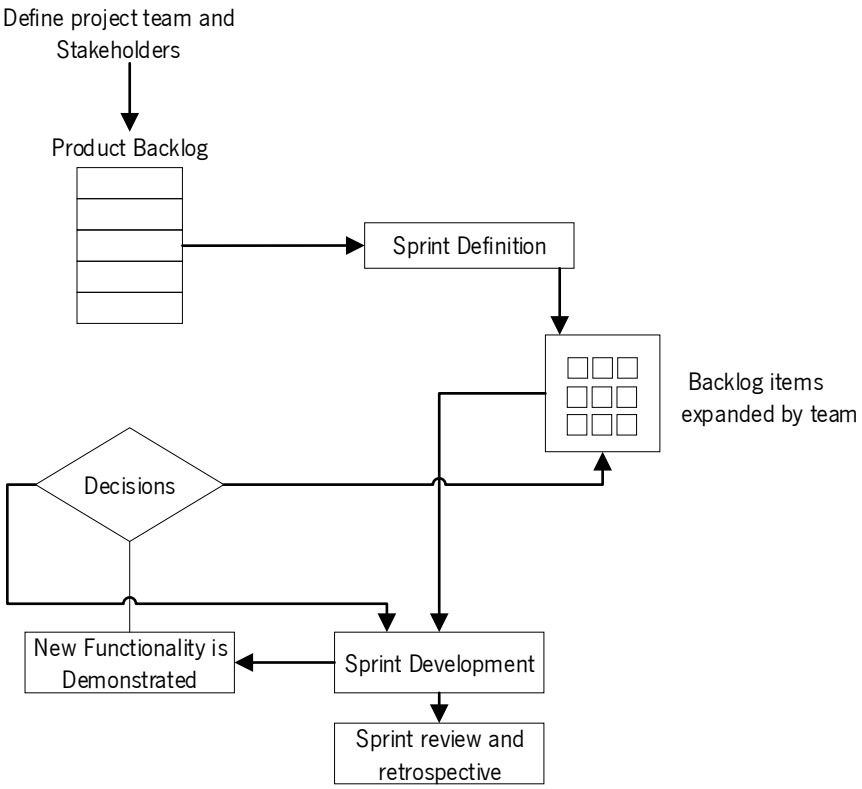

Figure 5.6. Scrum Life-Cycle

Firstly, it is important to define the stakeholders and the project team. The Scrum Methodology define three roles in the project:

- the product owner, is the sole person responsible for managing the Product Backlog,
- the development team, who work to achieve a potential increase in the value of the product at the end of each sprint,
- the Scrum Master who is responsible for Scrum Team to adhere to Scrum theory, practices and rules.

The definition of stakeholders and project team can be performed in parallel with the product backlog definition. The Product Backlog is an ordered list of everything that might be needed in the product or service, but not necessarily all requirements of the products are placed because the requirements can be modified over time. Once the product Backlog is defined, the next stage is defining the sprint. The heart of Scrum is a Sprint, a time-box of one month or less during which is added value to the final product, and that value can be measured and tested by the customer. A new Sprint starts immediately after the conclusion of the previous Sprint. A sprint contain: the Sprint Planning, Daily Scrums, the development work, the Sprint Review, and the Sprint Retrospective (K Schwaber & Sutherland, 2013).
The three main elements presented in the Scrum model are the roles, artifacts and events.

Figure 7 shows a graphical representation of these elements and how their interactions would be along the design and implementation of a costing system, these elements are also represented in more detail in Figure 5 after the high level planning.

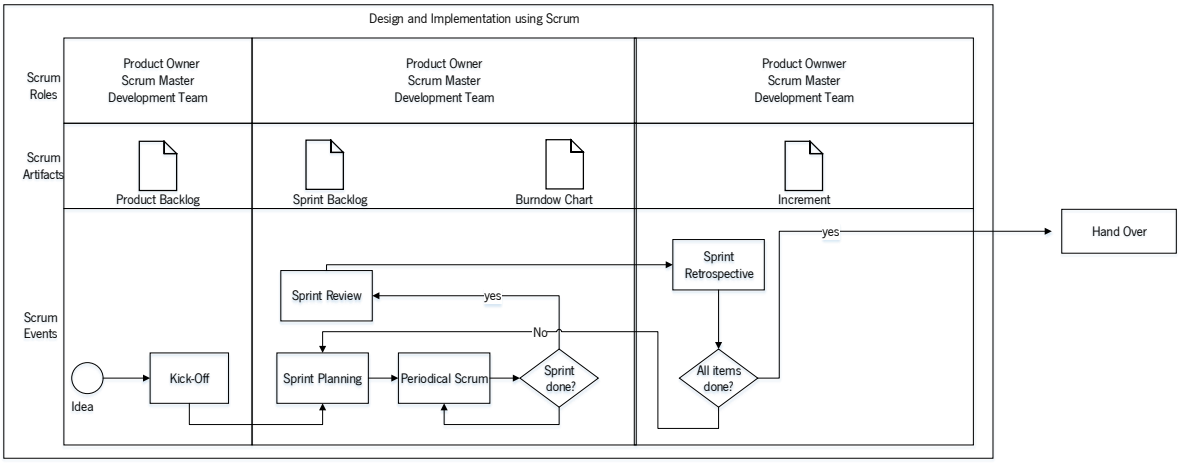

Figure 5.7. Elements of the Scrum Life Cycle
Source: Adapted from Streule et al. (2016)

In the case of "roles", in the Scrum model, the Scrum Teams have the ability to organize themselves and also perform various functions in the development of the project. In a hospital, who will be the product owner will depend on the project. If the project is for the whole hospital this person can be someone from the top management or someone appointed by the top management to represent it. If the implementation is for a specific department or service the product owner may be the director of that service or someone designated by the service who has the ability to understand how the decisions are made, how the processes are performed and how the costing system can help to improve the decision-making process. The scrum master will be someone in charge of leading the project team either from the top management of the hospital or a director of a service, it will also depend on the level of autonomy that is handled within the hospital. With regard to the project team, it must include medical staff, information system personnel, production managers, people from the financial area, external staff (consultants), among others.

The Scrum artifacts represent work or value to provide transparency and opportunities for revision and adaptation. Artifacts defined by Scrum are specifically designed to maximize transparency of key information so that everybody has the same understanding of the artifact (K Schwaber & Sutherland, 2013). Some artifacts are already defined in the Scrum framework, these are the product backlog (for example, determining the costing system that suits the structure of the hospital or a department, creating

a costing system for the hospital, integrating the information of costs with computer systems) and sprint backlog which contains a number of items that are selected by the product owner and the development team from the backlog product (e.g. identification of the list of activities, information system to determine an average cost).

With respect to Scrum events these allow to create regularity and to minimize the need of meetings not defined. Here game rules should be established, as and when the iterations between the stakeholders are to be realized, this allows to have a notion of the time of the project and of the time that must be dedicated to a specific sprint.

A kick-off meeting should be conducted based on the customer's demands and at that meeting the product owner creates the product backlog of the product to meet that demand.

Once the product backlog is known, sprint planning is made, here the most important elements of the product backlog are divided into sprints, for example, if the product backlog contemplates creating a costing system, probably the sprints may be related to the analysis of the initial situation to determine if there is structure for an ABC costing system, analyze pros and cons of a gross costing system with respect to a microcosting system, perform an identification of cost objects (i.e. exams, treatments, patients), identification of activities (administrative and care activities performed to patients that deal with objects of cost), identification of resources (doctors, administrative staff, equipment) and identification of drivers (human resources hours, machines use, electricity consumption, among others).

Once the sprint is identified, tools such as the burndown chart are used to plan the elements, as well as the time and the amount of resources necessary to perform the sprint. For a sprint that demands a month's work the literature recommends 8 hours of planning, this can vary and in the case of hospitals depends on factors such as the availability of human resources, the complexity of the work and the difficulty to collect information.

Once planned, the team proceeds to execute the sprint, during the execution of the sprint no changes are allowed to the elements of the sprint unless the value or scope of the elements is increased, answering to a request of the product owner. At the end of each sprint, items that cannot be considered are brought back to the product backlog and will be taken into account in the next sprint planning.

For example, if the objective is to determine the cost of each service in a department, however, the cost of obtaining such information exceeds the benefits of obtaining more detailed information, one solution could be to group the different services and determine average costs.

Other important events are related to regular meetings between team members (whose timing will depend on the size of the sprint and in hospitals depends heavily on the availability of resources) to determine

the state of progress of the sprint, the difficulties that have arisen in its development and how they are or can be overcome. On the other hand, meetings are also held with the product owner to know the new characteristics of the product resulting from the sprint and to determine the course of the project.

Based on the elements presented in Figure 5.7 and all the elements mentioned above, we present below how the Scrum model can be adapted to the case of design and implementation of a costing system. For the design and implementation of a costing system we should define some key elements. Particularly, in the design stage, the organization has to develop the infrastructure needed to support the system. Once this phase is finished, the next phase will be the implementation.

The next stage for the implementation is the product backlog. In the particular case of the costing system, the list include the cost objects, a list of decisions that can be taken with cost information, requirements related to information systems, information transmission needs and reporting requirements, legislative requirements, among others.

Once the product backlog is defined, the next step is the definition of sprints and their characteristics. In the costing system implementation, the first sprint contains the definition of a detailed list of cost objects and their characteristics, this will help not only to determine the costs but also contributes to the principle of transparency, which is one of the pillars of Scrum. Once developed this sprint, interested parties should validate that the definition of cost objects is correct and the product owner must give approval.

Another sprint must be related to an initial diagnosis of what would be the logic of the cost system (gross or micro), its pros, cons and its impact for decision making. This diagnosis will depend on factors such as available resources and relevance of the decisions that can be taken with more or less detail, or with more or less accuracy. This will depend on the type of decisions that can be made with the information on costs and that both these decisions affect the financial stability or provision of services in the hospital. In addition to the structure created to support the costing system (human and computer resources) and the culture developed within the hospital related to the importance of cost management at all levels of the organization.

In the logical of the costing system, the sprint to follow are related to: the process analysis, the definition of the activities, resources, cost drivers, the computation of costs, the systematization and automatization of the costing system.

During the development process it is important to define the process as each sprint will be reviewed, as should be included adjustments, when a sprint is approved and at what point can proceed to the next sprint, this in order to meet two of the three pillars of the scrum: inspection and the adaptation.

Table 5.2 shows the fundamental elements of the Scrum model and how these were adapted for the design and implementation of a costing system. It should be noted that each project can present different characteristics so the model must be adapted to each reality.

Table 5.2. Scrum Approach for Design and Implementation of Costing Systems

Scrum Roles	
Project Team and Stakeholders	Product Owner: Manager director, Administrator, Leader, etc. Team: Project team
Scrum Artifacts	
Product Backlog	Identification of cost objects Model for cost determination Report for decision making
Sprint definitions and development	Initial diagnostic Cost determination (gross or micro) Identification cost objects Activities, resources and cost drivers identification Cost determination and creation of the structure of the costing system
Scrum Events	
Rules for acceptation, review and retrospective	Periodical meetings Verification of models for approval.

One of the advantages of the Scrum methodology is that when the artifacts are verified they must be functional, which for a costing system is very important because it can be the case that to obtain a marginal level of detail, the marginal cost of obtaining it exceeds the benefit and the project must stop, however at that moment the costing system may already provide useful and enough information for decision making. In other words, the project can be completed when the stakeholders are satisfied or the level of detail achieved with the costing system is viable.

5.4 Methodology and Research Methods

The following is the methodology used in this research. The research methodology that was used and its main theoretical elements are highlighted, as well as its advantages and disadvantages; and how it was applied in a real case.

To apply the proposed model for the design and implementation of costing systems using the Scrum methodology, structured approach driven by action research was used. The model was validate and discussed through its application in an imaging service of a hospital.

One of the first times the term action research was used was in the work of Lewin (1946). It is developed through a series of cyclical steps composed of cycles of planning, action and analysis of results.

In an action research, the researcher and the participants need to interact constantly with the data and learn from the results. The three essential phases of design are observe (construct a sketch of the problem and collect data), think (analyze and interpret) and act (solve problems and implement improvements), which occur cyclically, time and time again , it suffices that the problem is solved from the perspective of the interested parties, or the change is introduced satisfactorily in a context.

Action research differentiates itself in that it is interventionist and committed to the creation of knowledge useful to both practice and theory (Lindgren, Henfridsson, & Schultze, 2004). In an action research the system users and the researcher are benefited and learn from the process of developing the project.

This type of methodology can be used in specific projects with particular characteristics and although the generalization is not one of the strengths of this method, the results can be adapted to projects with similar characteristics. On the other hand, an advantage of action research is that its characterized by being a reflexive and collaborative methodology (Cassell & Symon, 2004a; Coghlan, 2007).

Different applications have been made using action research in the field of management. For example Hoorn (2016) applied an action research approach in project management following 5 steps: diagnosis, action planning, action taking, evaluating and learning, which are applied cyclically. Else, Takey & Carvalho (2015) developed a study using action research for competency mapping in project management and considered 7 steps that are used repeatedly in a cyclic way, these steps are: selection and analysis of the organization, the definition panel of experts, relationships between experiences and competencies self-assessment method definition, self-assessment questionnaire, assessment process and training path.

These studies outline the basic structure of an action-research which is based on diagnosis, planning, execution and evaluation in successive cycles throughout the investigation. These activities are related to

the approach proposed by Saunders (2009), for an action research which consists of a series of incremental steps, as shown in Figure 5.8.

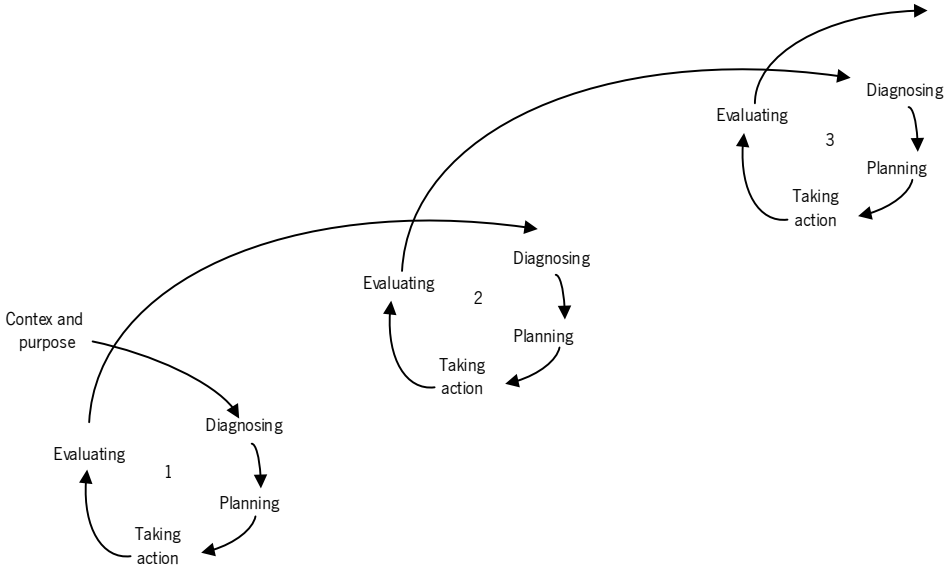

Figure 5.8. The action Research Spiral
Source: Saunders et al (2009)

In Figure 7 the action research spiral begins with a clear and definite context and purpose, it is likely that this is expressed as a research objective or research question. The diagnosis is carried out to allow the planning of the actions that must be carried out. Once the actions are performed these should be evaluated (this way the first cycle is fulfilled). The subsequent cycles imply an additional diagnosis, taking into account the previous evaluations, planning new actions, executing and evaluating, all this until fulfilling the objectives of the project (Saunders et al., 2009).Following the logic presented by Saunders et al. (2009), Takey & Carvalho (2015) and the context of this particular research, they were considered a series of four steps arising from the repeated cycles, which are described below.

Context and purpose: Context and purpose is defined as a need for the imaging department to know the costs associated with the provision of its services, in order to identify possible future improvements and better tools for decision making.

Diagnosing: Once the study object was identified, the department was analyzed, some antecedents of previous studies, resources available for implementation, potential limitations and future problems that could be found in the development of the project. In order to carry out the diagnosis of the situation, periodic meetings were held with the project group (a person from the administration, the person in

charge of the imaging service, a person in charge of the hospital's computer department and the researcher) who initially was made in weekly periods, However, as the project progressed, diagnoses of subsequent cycles were required. AT that moment, the periodic meetings became monthly or bi-monthly. These diagnostic meetings aimed to identify the work done so far and to identify the course that the research should carry out.

Planning: Whenever a situation was diagnosed, the next step planned a series of activities that should be carried out to arrive at a future situation better than the present one. The work was divided in stages to meet the objectives, including the identification of inputs and outputs of the costing system and the integration of each of them in the determination of the cost of products or services for decision making.

Taking action: Each of the tasks defined in the planning process was carried out, including the identification of cost objects, activities, resources, and the estimation of the costs of each of the objects of cost.

Evaluating: In order to determine the costing system appropriate to the needs of the imaging services, an incremental system was used, which in each one of the deliverables went through an evaluation process by clinical knowledge personnel as well as by administrative personnel.

It is noteworthy that for planning, take action and evaluating it was used the Scrum methodology which was presented in the previous section. Following this series of steps, it was possible to construct the tools for determining the cost, according to the existing infrastructure in the hospital and taking into account the needs of decision makers.

For the analysis of the information, the researcher took notes of the aspects considered in the meetings highlighting lessons learned, activities to be carried out and some difficulties that were found in the implementation process. In addition to this there was production information and costs for different cost centers defined by the hospital. For the qualitative information treatment no software was used because the researcher managed to maintain an accompaniment and a perspective of the whole process and of the most important elements. For the treatment of quantitative data, Microsoft Excel spreadsheets were used, which were strengthened as progress was made in each sprint.

5.5 The Empirical Application

Hospital costing systems are a strategic tool for good internal management, however, so that they can meet their objective, administrative, clinical, and administrative and support staff must be involved in its design and implementation. In addition it was possible to verify that expressed by (Borges et al., 2010), that the services are heterogeneous and that the level of maturity of the computer services is not equal for all. In this sense it is recommended for the design and implementation of a system, first prioritize the services where the system must be designed and implemented and then applied according to this prioritization. Among project methodologies, an agile -iterative methodology could contribute to a good management of this type of projects.

Hospitals are organizations where the application of agile methodologies can have a great reception, this is due to complex organizations, with high degree of uncertainty and different professional backgrounds that in many cases have found objectives, are organizations with a great complexity and diversity in their information systems that in many cases are not interconnected with each other. In addition, bearing in mind that in hospitals the cost issue is considered strategic and vital for its good performance, agile project management methodologies can contribute to the implementation of a costing system and its use as a project management tool attractive not only for the administrative staff but also for the medical staff and all those interested in the development of efficiency indicators with the objective of improving not only the quality but also the coverage of the health services, the iteration of the methodologies is presented in the Figure 5.9.

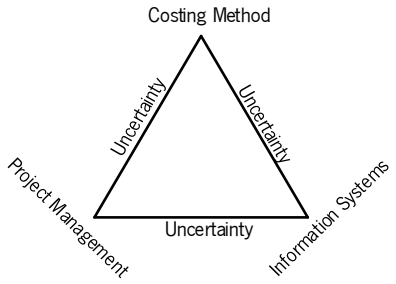

Figure 5.9. Integration between Costing Method, Project Management and Information System

For the management of design and implementation we propose the use of the Scrum methodology, since it has been used in environments with high intensity of software and environments where uncertainty is an important variable.

The Scrum Costing Methodology was applied in the Imaging service of a hospital. The service studied performs diagnostic imaging using techniques such as X-radiation and ultrasounds.

The exams performed in this service are mostly diagnostic in nature but are often supplemented with techniques of interventional radiology (e.g. biopsies directed by ultrasound or Computed Axial Tomography). For the development of its activities, the service has the appropriate technical equipment namely, conventional radiology rooms, ultrasound rooms, a mammography room and a computed tomography room. Its scope of activities extends mainly to the hospital in which it is inserted, providing support to areas of inpatient, outpatient and emergency.

The team and the product backlog

To begin with the application of the model it was necessary to define the roles of the people involved in the project namely, the product owner, the scrum master and the project team. The product owner was the production manager of the imaging service. The researcher played the role of Scrum master.

Normally, the Scrum presents these two roles (product owner and scrum master) as different roles to the development team. In our case and because of limited resources, the Scrum master and the product owner were also part of the project development team. In addition to these elements, the team was composed of the director of the services and the person in charge of information systems. There was also the collaboration of the support staff (administrative staff of the service).

In later studies we can evaluate the impact of this modification on the Scrum structure which can be a difficulty that can be overcome with enough resources and the Scrum master, the product owner and the team are roles performed by different people.

The development group of the costing system was composed by: the product owner, the scrum master, the person in charge of the information systems area, and the person in charge of the clinical area of the imaging service. Once defined the roles, it was defined the product backlog, which emphasized what the costing system should do:

- ✓ To allow to determine the cost of each of the services offered by imaging services;
- ✓ To generate reports that allow the identification of relevant cost objects;
- ✓ To generate reports to identify inefficiencies in activities and resource utilization;
- ✓ To be computerized and automated.

With the product backlog defined, periodic meetings were scheduled first weekly, then monthly. Some difficulties arose related to the availability of time by the element of the development team that made it difficult to hold some meetings. This happened because the team members as well as working on this project had their day to day work, each in their respective area, which often forced to cancel meetings, or delay work that was planned for a certain time. Here we learned another lesson and is related to have

to do with that for projects to implement costing systems in hospitals or their departments functions, all stakeholders should have a specific time to work on the project, which for a public hospital can be a challenge because of the high occupancy rates and workloads they handle.

The structure of the product owner and scrum master within the project development team can be an enhancer factor for the success of the design and implementation of a costing system.

As expected, the product backlog raises basic elements of a costing system (the goal is clear) but leaves the way open to different solutions (solution is not clear).

On the other hand, both the creation of the team and its interactions as the product backlog make clear the importance of stakeholder engagement with the costing system and also the importance given by the support of information systems in the design and implementation of the costing systems, these factors are related to the first proposition raised in Chapter 2.

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The following describes each of the six sprints that were defined from the product backlog, how they were developed and the results or lessons learned.

First Sprint: diagnosis

The first sprint was related to the accomplishment of a diagnosis that allowed to determine the more adequate costing system for the department.

To see the requirements of this diagnosis, a meeting of 4 hours was scheduled, in which it was defined that in the period of one month, with weekly meetings we would have a complete diagnosis of the problem that we were facing. As a result of the diagnosis, we conclude that: much of the information needed for a costing system such as recording resource consumption for each patient and activity maps were non-existent, information related to resource consumption was aggregated and found in different systems of information that did not communicate with each other, it was also concluded that the cost information was relevant to identify possible inefficiencies in the process or at least to propose projects for improvement in the service.

Second sprint: choosing the costing approach

With these results we went to the second sprint, which was related to choosing the costing methodology that would be used considering the needs of the decision makers, having a good balance between the

cost of the information, the use that would be given and the accuracy, completeness and timeliness of costs.

Given the conditions found in the first sprint, a bottom-up costing system was not adequate due to the lack of information and also the limitation of financial resources to create a structure that would allow costing at the micro level each patient. That is why we opted for the top-down approach, this is to take financial information existing in different information systems, compile it in Microsoft Excel spreadsheets and determine the average cost of each of the services developed by the service of imaging.

The first two sprints are common in the implementation of a costing system, however one of the advantages of the Scrum methodology is that it allows constant validation by the stakeholders which increases the engagement with the costing system which is one of the key factors for success as presented in Chapter 2.

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Third sprint: accuracy and completeness

The previous considerations were taken into account when performing the third sprint that was related to designing a way to calculate the cost of the services offered by the department: Here arose a difficulty related to the fact that all the cost information was accumulated in a single cost center, which means that for determining the cost of each exam the procedure has been dividing the full cost associated with this department by the total number of exams. Total costs comprises the cost of materials, labor and overhead costs.

This method presents two problems, the first has to do with distortions in the value of the costs among products. And the second issue is the unreliability by decision makers and medical staff of the produced cost information.

It is evident the need of a much better costing system that would serve to determine more accurate costs and also to contribute to an effective cost management.

From this arose the need to improve the accuracy of the system for that it was necessary to create more cost centers related to the services performed. From here it was suggested to have from one to six cost centers related to the imaging services.

With respect to the previous costing system, the imaging department had only one cost center. Furthermore, here we found another problem: the large number of exams offered by the department, about 200 different, which must be added to the lack of information. Here we are confronted with a

decision that generated one of the greatest learning and showed the potentiality of the Scrum methodology for the design of costing systems. In a traditional approach probably an effort would have been made to determine the cost of each of the 200 types of exams; however, to do so was going to be unsustainable not only from the point of view of the calculation but would be too much information for the decision makers what could not be practical for real decision making.

Fourth sprint: a simpler cost model

After analyzing this situation, we conclude that we should perform a fourth sprint related to the reduction of the number of cost objects. Several solutions were thought, among them, a Pareto analysis or grouping the exams by homogeneous groups, the latter being the chosen option. Thus, the four sprint was related to grouping the exams into homogeneous groups to reduce the number of cost objects.

After a detailed analysis it was possible to create homogeneous groups of exams, these groups turned possible to reduce to 13 the total number of relevant cost objects. For the determination of these costs, a weekly meeting was conducted to verify that the homogeneous groups were representative of all services offered in the imaging area.

Once this sprint was developed, we proceeded to the process of approval by the administrative staff and medical staff of the imaging area. After check one by one all services offered in the area and the approval of the proposed homogeneous groups, we proceeded to the realization of the fifth sprint.

An important aspect that we found when using the scrum methodology was that a simpler model (result of sprint 4) was more appropriate considering the characteristics of the service and the structure of the hospital. This was important because instead of walking for a more detailed model (sprint 3) it was possible to go back (sprint 4) and think a simpler model nevertheless more appropriate to the interests of the decision makers, and that fits better the information systems. This generates an important practical conclusion, not the best costing system is not the most complete or most accurate, but the one that is most useful and adapted to the needs of the organization.

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Fifth sprint: an activity based costing model

After a first analysis and validation of what should be the cost objects we proceeded to the design of the costing model. Thus, the fifth sprint was related to the design of the structure for the computation of the cost of the relevant cost objects. For them it was thought in a structure analogous to ABC, where cost

objects, products and resources could be identified, the following is the summary of the results of this sprint.

- *Activities Identification:* activities were grouped into five macro-activities; namely, scheduling the patient, receiving the patient, making the exam, processing the exam and preparing the report.

- *Resources Identification:* resources were classified into human resources, equipment, informatics resources, materials and others. In more detail they were identified: physicians and all the staff at the imaging area, 8 different information systems, all the machines and equipment (e.g. Scanner, Ultrasonography machine, Interventional radiology) used for the realization of exams and the clinical material used in the service delivery.

- *Cost drivers identification:* cost drivers were: the number of exams, the direct labor hours, and the number of patients, machine hour and the square meters.

- *Cost Estimation:* once identified the cost objects, activities, resources and drivers we were able to calculate the cost of the cost objects.

One of the problems encountered in assigning direct materials was the lack of records of materials for each exam. A driver related with the number of exams was used for the distribution of the cost with direct materials, because it could not be performed by direct assignment as shown in Figure 5.10.

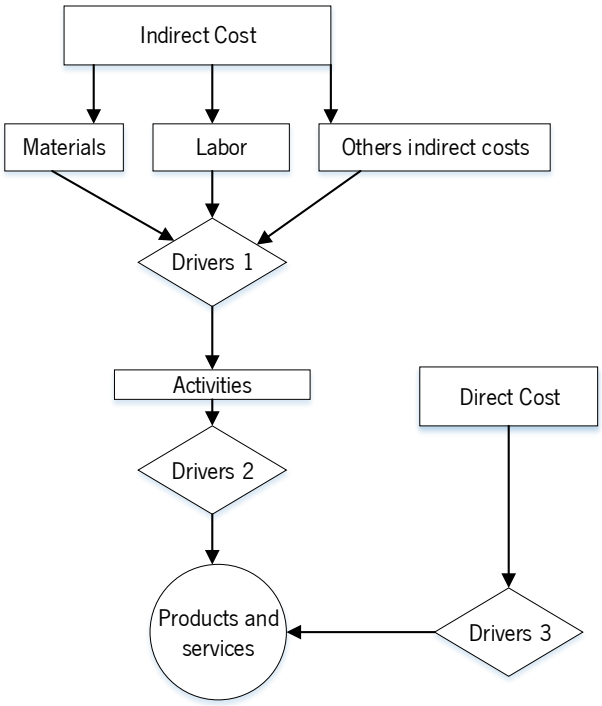

Figure 5.10. Proposed Costing System for the Imaging Service

Figure 5.10 presents an interesting aspect with respect to direct materials. In a traditional costing system direct costs will be allocated directly but, due to the complexity and specificity of hospitals it is possible that direct allocation is not possible and in this case the creation of drivers can be a solution. This element raises an interesting discussion on costing systems and is that the organization does not necessarily have to adapt to the costing system however the costing system must be adapted to the organization. Furthermore, costing systems are not black boxes which need to be just applied, deconstruction and innovation are necessary to turn costing systems relevant.

Sixth sprint: adding variability

Once the structure for cost determination was created, we proceeded to the sixth sprint, here we find some problems. First, there were no records for the use of human resources for each service, neither administrative nor other medical. Second, there were no process diagrams. Third, there is the notion of the existence of a high variability in the use of examination resources for examination; however, this variability was never measured. To solve some of these problems, some solutions arose.

First, in order to include the variability in the analysis we decided to begin to calculate the cost associated with the materials. A model that would allow to include the variability in these resources was built. Besides this, it was important to carry out a study to estimate working times (taking into account the variability)

for all homogeneous groups of products (the latter to be carried out) to obtain labour costs associated to studied cost objects. Some results related to materials are mentioned below.

A first analysis involved comparing the computed costs per unit with the results of the hospital's traditional costing approach. Given that the traditional costing divides the total cost over the number of exams is then assumed that the cost of each type of exam is more or less equivalent. Considering only the direct costs (in this case, materials consumed), using the proposed new costing model the results obtained are shown in Table 5.3 and are impressive.

Table 5.3. Comparing Unit Costs per Exam

Type of exam	Cost of materials per Exam using proposed model	Cost of materials per Exam with one cost center	Difference
Support to other services	0,4171	0,0388	975,00%
Gastrointestinal imaging	0,2485	0,0388	540,46%
Ultrasound	0,0039	0,0388	-89,95%
Mammography	0,1139	0,0388	193,56%
X-ray	0,0046	0,0388	-88,14%
Interventional/vascular radiology	0,5542	0,0388	1328,35%
Contrast-enhanced mri	0,3547	0,0388	814,18%
Non contrast-enhanced mri	0,0128	0,0388	-67,01%
Contrast-enhanced computed tomography	0,5219	0,0388	1245,10%
Non contrast-enhanced computed tomography	0,0125	0,0388	-67,78%
Urologic imaging	0,6377	0,0388	1543,56%

As can be seen there is a huge variability in the cost of each type of exam. Direct Costs per exam range between 0,005 and 0,638 currency units. Comparing these results with the average cost of materials provided by the traditional costing system of 0,039 we may state that the traditional costing approach is very biased not reflecting the reality of what is happening in this service (values were modified to maintain the confidentiality of the information, however the scale of the results was maintained).

Another analysis that was done permitted to identify what is causing the cost and which are the most expensive materials as shows in Table 5.4.

Table 5.4. Cost structure of Direct Cost per Exam

Type of exam	Treatment Material	Medicines	Electro-medicine Material	Other Materials	Total cost
Support to other services	1,616%	0,512%	0,507%	0,332%	2,966%
Gastrointestinal imaging	0,660%	0,874%	0,000%	0,015%	1,549%
Ultrasound	0,014%	0,427%	0,102%	0,966%	1,509%
Mammography	0,000%	0,000%	2,491%	0,035%	2,526%
X-ray	0,059%	0,396%	2,581%	4,389%	7,425%
Interventional/vascular radiology	3,824%	0,046%	0,000%	0,224%	4,095%
Contrast-enhanced mri	0,334%	23,448%	0,333%	0,213%	24,327%
Non contrast-enhanced mri	0,006%	0,001%	0,007%	0,004%	0,018%
Contrast-enhanced computed tomography	0,460%	48,173%	0,459%	0,297%	49,390%
Non contrast-enhanced computed tomography	1,323%	0,066%	1,538%	0,995%	3,922%
Urologic imaging	0,374%	1,313%	0,000%	0,586%	2,273%
Total	8,671%	75,255%	8,018%	8,056%	100,000%

As evidenced, only medicines, and treatment materials consumed about 85% of the total cost with materials. This is a very important information because it is known that cost reduction efforts will be relatively reduced if nor centered on these 2 categories. In this case, the costs of treatment materials may be inferred through information provided by the cost accounting system, which allocated costs to cost centers according to the Cost Accounting Plan for Hospitals, or through information obtained in the information system of each department or area of activity.

An interesting aspect that can be highlighted has to do with an innovation in the traditional ABC model which is related to the importance of considering in the cost model the variability of direct costs which is an inherent element in the provision of hospital services.

It should also be noted that the costing method has been considered by the project team as the most efficient method to measure the costs of services, since it allows viewing the expenses incurred at each stage of production process, thus enabling the knowledge of the real costs of activities. However, the implementation of a costing system requires a high financial and organizational effort, particularly in restructuring the hospital information system.

The application of these sprints ultimately led to the determination of the cost according to the operating conditions of the Imaging service. Each sprint went through a validation process by the operational personnel and the administrative personnel associated with the services of the imaging area.

The project changed the structure of the costing system, and implied a modification in the cost information system. Cost centers associated with each the homogeneous groups were created. In this aspect the help of the accounting staff of the hospital was fundamental. One of the problems identified

has to do with the variety of information systems, and the difficulty of collecting cost information automatically this problem takes up the idea presented in proposition 1 presented in Chapter 2.

Further sprints

After analyzing the behavior of the materials and generated intervention measures the following sprint have to do with the analysis of the labor used, and the implementation of an information system that allows to perform the process automatically, these sprints are considered, however due to time constraints and resources are under development.

In this moment the project team is working in the automatization of the cost system and the routinization. At this time the project team is working on a sprint that will automate the costing system following the structure defined in the previous sprint and be able to read the information in the different information systems.

5.6 Discussion and Conclusions

The following discussion is based on the fact that the focus of this chapter is related to the design and implementation of a successful cost management system in hospitals, which depends not only on the costing technique used but also on elements related to the organizational structure (i.e. information and communication systems) and the organizational culture (i.e. engagement and cost conscious). These aspetcts fit with proposition 1 presented in Chapter 2.

On the other hand, the evidence of projects that have failed in the implementation of costing systems in Portuguese hospitals is displayed and analyzed, and project management tools are introduced to improve the design and implementation of costing systems efficiently and effectively.

Then, the discussion focuses on the Scrum methodology for the design and implementation of costing systems presenting its advantages, disadvantages and possibilities for improvement, and finally, it will highlight some important elements for the design and implementation of costing systems mentioned in the literature which will be triangulated with data obtained from the interviews undertaken in this research project mainly with aspects related to cost management and project management.

Cost management within hospitals can be analyzed from various viewpoints, from the point of view of the financial director, administrative staff, doctors, nurses, logisticians, production managers, among others. Despite if there are different ways of looking at cost management, it is essential to have a consensus among the different stakeholders, since cost management influences operational, tactical, strategic,

clinical, financial and quality issues, which at the end are linked to all levels of management and operation in hospitals (Nackel et al., 1987).

Within hospitals, a cost management system should provide cost information for strategic positioning, for negotiation processes with the funding entities, for planning, monitoring, control of administrative operations and clinics. In order to achieve this objective, the costing systems must be able to determine the cost of the relevant cost objects, so that budgets can be constructed and forecasts can be compared with real performance (Nackel et al., 1987).

To meet these objectives (Nackel et al., 1987) proposes five characteristics that a cost management system must contain so that it can be considered useful for decision making. These characteristics are: allowing/supporting effective costing, allowing activity forecasting, allowing functional cost center budgeting, allowing performance reporting on a product level and on a functional level.

These characteristics must be adapted taking into account the complexity of each hospital, current legislation, technical conditions and communication tools and hospital's own organizational culture as discussed in Proposition 1 of Chapter 2.

There is then no single "standard" costing system that can be applied to each hospital, but rather each costing system must be adapted to the particular conditions. Failing to consider particular characteristics can be one of the causes of failure in the design and implementation of costing systems in hospitals.

Particularly, the information of costs in a hospital must be contrasted with the production of services offered to the patients. Such information is basic and helps to a great extent administrators and governments to make decisions about how to improve hospital performance, where and how resources should be allocated, identify critical resources and therefore resources that need to be addressed in more detail, or to compare efficiency or performance across hospitals. Indeed, cost information helps hospitals to improve their efficiency, increase their efficiency and, above all, provide quality services to users (Newbrander & Lewis, 1999).

This chapter has a focus mainly on the process of design and development of costing systems. Although methodologies exist for the calculation of costs and several costing systems have been proposed in theory and applied in practice, the implicit process of such implementation is not so simple and has not been widely discussed in the literature.

In recent years companies have made great efforts in determining the costs of their products or services, for that different methodologies for estimating costs have been designed and implemented, a methodology that has had a lot of acceptance has been the activity-based costing (ABC). Although it is technically a methodology that helps to allocate costs in a logical way and in many cases better than

other costing methodologies, there is evidence that some organizations have had problems with its implementation, and in extreme cases have not been successful (Shields, 1995). An example of this is what happened in recent years with hospitals belonging to the Portuguese health system. The Portuguese Ministry of Health wanted to implement an ABC costing system in the country's hospitals and a pilot project was carried out but it failed (Escoval et al., 2010). One of the causes of this failure is related to the fact that the focus was on technical aspects and little attention was paid to the organizational culture and to the particularities not only of the hospital sector but also of each hospital.

Other problems and difficulties in implementing ABC costing systems in hospitals were identified by (Borges et al., 2010); these problems are related to:

- ✓ Problems in the identification and classification of Pareto activities in the contribution to the cost of cost objects.
- ✓ Difficulties in the definition of resource and activity drivers for lack of information, and also the heterogeneity of hospitals' information systems since some had more information than others.
- ✓ High variety of participants in the projects - health professionals, administrative, technical, financial and consultants-, and difficulties with the definition of communication mechanisms and incentives, and the involvement of stakeholders in the design and implementation process.
- ✓ The scope of the project, since usually it was intended to apply it to the entire hospital and there are departments less prepared than others, causing a delay in the implementation of the project and the expected results, so at the end it is concluded that it would have been better to divide the project by departments or sections.
- ✓ Concern of medical and administrative personnel that the costing system can evidence inefficiencies in the processes they carry out.

Here, we discussed the need for better costing systems and cost information based on more sophisticated costing models in order to support a better economic evaluation of hospital services. Furthermore, implementing cost management successfully requires utilizing appropriate standards, concentrating efforts for maximum effectiveness, and being consistent. Managers must be able to determine the long and short-run costs of activities and processes as well as the costs of goods, services, customers,

suppliers, and other relevant cost objects. A costing system must be allows determining the cost of a clear and efficient manner, although the logic of the ABC methodology is easy to understand and is fully explained in the literature, implementation is not necessarily easy, this due to problems related to system acceptance by the interested parties or the system does not reflect the reality of the processes, all of these problems associated with the system design. To improve the likelihood of success costing system not only in its design phase but also in its implementation.

Hospitals are complex organizations, not only because of the type of service they offer but also because of the diversity of human, physical and computer resources that must be integrated to provide the service. In addition, given budget constraints should be organizations committed to improve the efficiency of their services. In this context, a costing system can help in such type of organizations because their complexity and the design and implementation of a costing system must be accompanied by a good project and cost management which come together to increase the likelihood of success of such projects.

To the implementation of a costing system be effective it requires that administrative staff is truly devoted to its implementation after having an active part on its development. But also the operational personnel must also make part of the design and implementation process because they are the ones who "create" information that will feed the costing system.

This result is related to Proposition 1 presented in Chapter 2 and highlights the importance of engagement (individual) and organizational culture (cost consciousness) for success in the design and implementation of a costing system within a hospital.

Applying the Scrum methodology for the design and implementation of costing systems is very interesting because allows the active participation of stakeholders, which increases the degree of acceptance of the system by the operating and medical personnel related to the processes.

The definition of the product backlog and the several sprints allowed to have an idea of what should be the final result, and the iterative process allowed to build a system that reflects the reality of the services provided.

Among the problems encountered in applying the proposed methodology we may highlight the need of regular meetings for give and receive feedback. The methodology suggests meetings every day but in practice it is difficult to accomplish and more when project members are working in other projects. Other difficulty is related to the automation of information, this problem is related to the lack of information for some activities, and also with the variety of information systems. In addition when the group is interdisciplinary, often the only way to see things a little different and can cause delays or conflicts during the project.

This research proposed the use of the Scrum methodology, although this methodology has been used mainly in software development. Nevertheless, it is assumed that its principles can be applied to a wide range of projects.

In the future, this methodology can be applied in other departments of the hospital contributing for the use of a Scrum methodology in design and implementation of costing systems. Tailored to the hospital's needs. The use of this methodology will help to increase stakeholder engagement regarding cost management, as well as adapting cost management tools and costing systems to the structure (technique, resources, and information need) of the hospital.

Furthermore, this project management based methodology for the design and implementation of costing systems can be improved and extended in order to augment its effectiveness and efficiency and be applied to other situations, companies and industries.

This methodology proved to have advantages in the design and implementation of a costing system for its flexibility and the promotion of stakeholder participation. However, it must be taken into account that there are many factors to consider to achieve a better understanding of the conditions for the success of a costing system. Table 5.5 shows some of the factors considered by Shields (1995) for the success in the design and implementation of costing systems and how the proposed methodology can contribute for that ranging from extremely positively (++), positive (+), negative (-), extremely negative (- -) or neutral (0) in each of the categories defined therein. For this analysis we took into account the lessons learned in the application of this methodology and the interviews carried out in different hospitals, which were discussed extensively in chapter II and III of this thesis, using section two of the script proposed in Appendix 1.

Table 5.5. Scrum Methodology and its Implications on Key Factors of the Design and Implementation of Costing Systems

		Contribution of Scrum in Costing System Design and Implementation				
	Type Of Factors	++	+	0	-	- -
Technical Factors	Cost Objects Activities Resources, and Drivers Analysis of Existing Information and Communication Systems to Support ABC			X		
Organizational Factors	Support of the top management Organizational structure Training resources for implementation Organizational culture Alignment with Competitive Strategies		X			
Behavioral Factors	Participation of Users in the Process of Design and Implementation Behavior of Each of the Users. Resistance to Change	X				
Other Factors	Competence Quality Relevance of Cost Information for Management Decision Making Size of Organization Incentives for use the Costing System Management of Uncertainty			X		

With regard to technical factors, the level of involvement of this methodology can be defined as null, this is because these factors must be taken into account when using any methodology that wishes to design and implement a hospital costing system.

However, it must be taken into account that it is a category that can create difficulty in implementing a costing system, for example, in the identification of cost objects, there may be several differences, for example for some respondents the object of cost was the treatment, for others the patient treated, and still others interviewed assured the importance of the traceability of the patient to determine the cost, i.e. taking into account that the patient returns or not to a treatment with the same disease. While it is true that these differences exist, the system of payments and financing of hospitals is based on patients treated and not in terms of examinations or procedures performed during their treatment, so that the costing system must be designed to integrate information from different services covered by the patient during his stay in the hospital unit.

With regard to activities, resources and drivers, some hospitals are able to know very well the activities performed by the clinical staff, with a difficulty the existence of variability in the application of the activities by the medical staff, which in many cases cannot be questioned since it is evoked the importance of

service quality over other organizational interests, the designed costing system must also be able to recognize this variability or uncertainty. For the identification of resources, and drivers all use analytical accounting and in the majority to know the imputation of these resources to a specific procedure or patient, a specific study must be carried out. One of the hospitals even has a department dedicated to specific studies of atypical behavior in costs, based on reports of analytical accounting.

As far as information and communication systems are concerned, there is a great deal of heterogeneity. For example, one of the hospitals has an information system that integrates information from several services and can produce reports within a few hours with information in a reasonable degree. Detail, and then can communicate to the different departments of the hospital in periodic meetings the results obtained, on the other hand there are hospitals where information is not very restricted, little and in some cases does not exist or cannot compile quickly given that information systems And communication have not been developed in this regard. One of the explanations for this phenomenon according to one of the interviewees is that in years ago there was an abundance of resources, there was not much concern with control and there was no clear direction by the state on which information systems should be implemented, each hospital Was implementing its information systems and developing its policies in this regard and this generated heterogeneity.

Regarding the Organizational factors, the Scrum-based methodology can have a positive effect on the factors, mainly in the training resources for implementation since it is a methodology where the participation of the stakeholders is fundamental. In this category it is important to emphasize that all interviewees expressed their desire to support any project aimed at creating a system of costing for decision making. With respect to the organizational structure to support an activity-based cost management system, because of the changes in thinking, the amount of time and resources required for implementation, no structures have been created beyond that developed in the study of (Borges et al., 2010). In some hospitals interviewed, there is no training or organizational culture related to the importance of cost management; in others, training programs have been developed for administrative and clinical staff on the importance of cost management, which has generated Environment of continuous improvement and that these hospitals are open to implement new tools, one of these hospitals was carrying out a pilot test in one of its services for the implementation of the TDABC methodology. More than a competitive strategy, the function of hospitals to attend to the highest number of people with the best quality possible, this is only achieved with an efficient management of resources, in this sense for most to have a system to calculate the profit, The losses and inefficiencies of their services rendered, will always be welcome, only that for some the road is still unclear.

With regard to behavioral factors, this is where the methodology has an extremely positive effect since the idea is to build the system with all stakeholders including users which would help reduce resistance to change. With regard to this point there is no general cost-based system in the hospitals interviewed, administrative and medical personnel have not yet been involved in this type of project, however, some hospitals have worked to educate Medical and administrative personnel in the importance of cost management which contributes to the way for an implementation is easier, and in other hospitals change is difficult and mainly as expressed by some interviewees for some medicine and management are not Compatible.

And finally with respect to the other factors, the effect could be neutral because these factors must be faced, regardless of the methodology used. With respect to the other factors it can be highlighted that in most hospitals there are no clear incentives to switch to a cost management system, and management uncertainty is a factor that has not yet been considered as it is seen as a step in front of an implementation.

6. MEASURING RISK IN COSTING SYSTEMS: CONCEPTUALIZATION AND APPLICATION

6.1 Introduction

Many firms are interested in determining costs more accurately in order to support decision making and firm's strategy as well as to improve the quality of their efficiency indicators and increase profitability (A. Gunasekaran & Sarhadi, 1998). Thus, models of product costing should reflect business and production processes and the firm's cost structure as accurate as possible. However, organizations' internal and external circumstances are changing rapidly (Alnestig & Segerstedt, 1996). In this context, where endogenous and exogenous variables vary, cost behavior might be not fully understood if old-fashion costing models are used.

The data used in costing systems is uncertain due to a heavy reliance on parameter estimation. This primarily exists because gathering the necessary information to generate product costs is an expensive process and a very time consuming task. In some cases the processes are highly varied and difficult to standardize. Since costing systems data are historically based and often estimated, the true values of these data are uncertain, and the input data are likely to be imprecise. The need to take into account the uncertainty in planning decisions dating back to the models of functional planning, where resources for the future had been allocated based on current data and future projections. Given that, the true value of each data parameter may never be known. Thus, it is important to acknowledge and handle the uncertainty within cost estimation and costing systems. This will allow the system user to acknowledge that the system results are not certain and potentially improve decisions affected by the system output by accounting for the inherent risk (Gupta & Maranas, 2003; Nachtmann & Needy, 2003b)

In the case of hospitals, there are countless elements that induce variability in the cost of a process or service delivery, elements such as morbidity, heterogeneity of patients, heterogeneity of medical treatments, among others. These elements make the cost of treatments vary from one patient to another. In a hospital, a program contract or budget is composed of services and processes which have inherent variability, which will be reflected in the variability in costs and therefore the contract itself will have variability over time so the contract is prepared in an environment of uncertainty.

The quantification of cost variability is the object of study in this chapter, since this will allow answering questions such as: What is the cost risk of the contract? What variables, products, processes or services

are the cause of greater variability and therefore should be subject to greater control? Or simply to define measures of risk mitigation or uncertainty related to the costs of hospital services.

In management accounting, such simulation can be used to value certain financial instruments and to derive risk measures, when they are not available or when an analytical model is inapplicable. In this context, the analyst describes, in a probabilistic sense, the variables that determine the value by their respective probability distributions. Then, using a random number generator, a possible value of the variable under analysis can be obtained.

Indeed, it is important to consider uncertainty in costing systems. However, even ABC costing systems which are known as more advanced and complex than traditional methods, generally does not consider the uncertainty inherent in resources, activities, processes, cost drivers and cost objects. An activity-based costing (ABC) system is based on the premise that activities consume resources and cost objects (e.g. products and services) consume activities. The development of effective costing systems requires a good design of processes and activities. But some business and production systems can be characterized by high levels of uncertainty. In the particular case of hospitals, the amount of resources consumed for the same type of examination by two different patients can be completely different, which may hinder costs and to bias the process of budget planning.

Traditionally, researchers and practitioners have been focused on deterministic costing models without acknowledge and handle conveniently cost uncertainty. This chapter presents and discusses a methodology for measuring the risk within costing systems, the risk measure was called Costing at Risk (CaR).

CaR can be defined as the maximum expected cost for a product or service for a future period, given a certain level of confidence. It takes into account the worst expected outcome in terms of cost in a certain period, considering a pre-defined confidence level. Process and product variability can have a considerable impact on budgeting processes and consequently in cost management effectiveness. The general idea of CaR is to have a cost model that identifies the variables that generate cost variability, modelling statistically those variables to quantify the level of risk associated with that cost. In this case, in particular, the proposed costing model is based on the logic of Activity-Based Costing (ABC).

ABC can be used to report precise and relevant information to health care professionals. In this particular industry there is an unavoidable need to refresh cost models and costing techniques in order to allow managers and clinicians to obtain more relevant, precise and transparent information on costs. Current financing systems for hospitals are not flexible enough and they are based on the controversial concept of Diagnosis Related Groups (DRG). ABC costing models could be considered as effective alternative to

manage costs in hospitals by supporting the decision making process in many levels, such as decisions of make or by, expand or reduce services based on the patients' needs and services efficiency (i.e. costs versus reimbursement schemes). Nevertheless, ABC models have some limitations. Namely, as other costing systems, ABC models are typically deterministic even if some important variables could have a stochastic pattern. This is the case of the imaging service in a hospital. The amount of resources consumed by two patients for the same type of exam can be completely different, which may hinder an effective process of budgeting and cost management.

In the model proposed in this chapter, it is used a matrix representation of the activity based costing system, from where the necessary steps for the quantification of CaR are established. However, this methodology can be adapted to any costing system.

Considering CII's (2017) maturity model, it can be said that cost management models that include uncertainty are a fundamental basis for decision making and are at the highest level of maturity or can be categorized as *exemplary*. Thus, a matrix cost model that includes uncertainty and includes risk estimation for decision making is the main contribution of this chapter. Among the major contributions of this model, we can highlight the use of an ABC cost model which is not a common approach, the analysis of the correlation between variables, the empirical determination of data distribution via statistical tests, determining CaR and carrying out a sensitivity analysis. All these aspects are important in order to create an appropriate cost model for managing uncertainty and risk associated with product costing.

The design and adoption of a control and risk management model should be supported by risk assessment models such as: techniques based on variance and covariance (e.g. VaR), Historical Simulation and Monte Carlo Simulation. This models should be aligned with the strategic objectives of the organization.

Using the logic of the Decision-analytical modelling (DAM) the proposed model was applied to the Imaging Service of a hospital where the level of costs uncertainty is considerable. One of the methods used to understand and attempt to manage uncertainty has to do with the Monte Carlo Simulation. A Monte Carlo simulation was made and interesting results were obtained. Indeed, probabilistic ABC costing models are tools that can be used to turn costing systems more relevant, contributing to improve decision making. This new model can be used to deal with uncertainty in an extended ABC model (which includes uncertainty) that offers additional and very valuable information for budgeting and cost management in the imaging service and can be used for other hospital services and departments as well as in different types of organizations.

This chapter is organized as follows: after this introduction the second section is related to literature review, which addresses issues related to the importance of risk management in the budgeting process and cost estimation. The third section presents the model for estimating CaR. The fourth section shows the materials and methods used, highlighting the use of DAM and some technical characteristics of the computational tools used to perform the calculations. Then, the final section highlights and discusses the main results of the application of the proposed model and finally the conclusions are presented.

6.2 Literature Review

6.2.1 Risk and Uncertainty in the Decision Process

Many simple decision problems involve quantitative attributes that are relatively easy to define, measure, and understand. The most common measure is the monetary quantification because many attributes such as the use of machines, labor power and quality can be translated into monetary terms. However, more complex decision problems include attributes that are difficult to define and measure. Examples include people's mood, customer satisfaction, reputation in the community, appearance, and aesthetics, health risk from exposure to toxic substances, (Dutta, 2017; Sirakaya & Woodside, 2005). These attributes are known as qualitative. Multiple attribute decision models integrate quantitative and qualitative attributes to produce an aggregate performance measure (He, He, Wang, & Cheng, 2015). Decision making is the process of transform into action, the process of selection possible courses of action from all the available alternatives (Hwang & Masud, 2012), the process goes from the definition of the problem, through the identification of objectives, the definition of models and the selection of alternatives, which will have repercussions on the future, which in most cases is uncertain (Newnan, Eschenbach, & Lavelle, 2004).

The need to take into account uncertainty in decision planning goes back to functional planning models, where resources are allocated for the future on the basis of current data and future projections (Gupta & Maranas, 2003). The most important consideration in incorporating uncertainty into planning decisions is the determination of adequate representation of uncertain parameters. Two distinct methodologies are clearly identified for the representation of uncertainty, the first is based on scenarios and the other on probability distributions. In the first one, uncertainty is described by a series of discrete scenarios which represent the way in which uncertainty can influence results in the future. Each of the scenarios is associated with a probability level representing the expectations of decision makers; however, the

applicability of the scenario-based approach is limited because it requires predicting all possible outcomes of uncertain parameters. In cases where a discrete set of possibilities cannot be identified, and where what can be predicted is only a continuous range of possibilities, the second approach based on probability distributions is useful since it is not necessary to determine the possible scenarios in an accurate way.

There is not a definitive definition for uncertainty. Perhaps there is some consensus in very specific domains (Goh, Newnes, Mileham, McMahon, & Saravi, 2010). For example, in the financial sector, when authors and practitioners make a distinction between what is uncertainty and risk, it is common to speak of risk when the future is not known, but the probability distribution of likely future is known. On the other hand, uncertainty occurs when the probability distribution is itself unknown (Miller, 1977). Zimmermann (2000) proposes the following definition: "uncertainty implies that in a certain situation a person does not dispose about information which quantitatively and qualitatively is appropriate to describe, prescribe or predict deterministically and numerically a system, its behavior or other characteristic".

Uncertainty can be defined as a state that exist when an individual defines himself as engaging in directed behavior based upon less than complete knowledge of (a) his existing relationship with the surrounding environment, (b) conditional and functional relationships between his behavior and environmental variables which may explain the occurrence of a future self-environment relation and (c) the place of future self-environment relations within the longer time frame of a self-environment relations hierarchy (Downey & Slocum, 1975). On the other hand, in a situation under risk, the decision maker knows the probabilities for the occurrence of various states (Zimmermann, 2000). Uncertainty is an integral and unavoidable part of risk assessment (Dutta, 2017).

Some authors argue that probability theory is sufficient to model all kinds of uncertainty. However Zimmermann (2000) says that the choice of the appropriate method depends on the context and suggests that the context should be studied in order to be possible to choose an appropriate method for modelling uncertainty.

Several methods have been designed for handling uncertainty through mathematical models. The Monte Carlo simulation and fuzzy methods can be highlighted among such methods (Chansaad & Rattanamanee, 2012). Particularly, some authors have approached the subject of uncertainty in costing systems using either the Monte Carlo Simulation or Fuzzy methods, e.g. (Chansaad & Rattanamanee, 2012; Victor Jiménez, Duarte, & Afonso, 2015; Nachtmann & Needy, 2001, 2003b; Rivero & Emblemsvåg, 2007).

The main difference between these two methods is related with the different techniques used for describing uncertainty of input parameters. For example, fuzzy methods use membership functions for describing an uncertain parameter while stochastic methods use a probability density function. The similarity of them is that all of these methods try to quantify the effect of input parameters' variability on model's outputs. These methods can be classified as: probabilistic approach, possibilistic approach, hybrid possibilistic-probabilistic and robust optimization. Probabilistic methods are often used to handle uncertainty in cost models. Nevertheless, they can be inappropriate when uncertainty is explained by fuzziness of the estimations rather than randomness (Choobineh & Behrens, 1992).

The Monte Carlo simulation (MCS) method is a process that can be included in the experimental branch of mathematics that deals with experiments on random numbers based on statistical probabilities, MCS is a computational and probabilistic method that can be used to disseminate the uncertainty coming from inputs to the model output (Abed, Safadi, Adrot, & Flaus, 2015; Hammersley & Handscomb, 1964). It is often used to deal with different phenomena and specialized software is available to facilitate the process of design and analysis of these models. In a Monte Carlo model, a probability distribution must be selected for each uncertain parameter (Nachtmann & Needy, 2003b). In terms of simulation software there is a great variety of them among those stand out: @Risk, Crystal Ball, Risk Simulator, Simular, Analytica, Ormonte, Tam3, Simlab, among others (Bhat & Kumar, 2008).

Modelling a problem, a physical system or a socio-economic system allows the decision maker to be better informed to describe, prescribe and predict. When a phenomenon is modeled, the decision maker must decide whether or not to include the uncertainty associated with it. In certain cases, an approximation to the uncertain phenomenon by a deterministic (certain) model might be enough. Nevertheless, if uncertainty is significant and appears to be important to understand the phenomenon under study, it should be included in the model. In such cases an appropriated method for modelling uncertainty need to be selected (Zimmermann, 2000). Uncertainty is present in many real-life phenomena. Uncertainty can result from several aspects namely, lack of information, abundance or complexity of information, conflicting evidence, ambiguity, measurement and beliefs (preconceptions) (Zimmermann, 2000). The level of uncertainty is directly related with the complexity and amount of information that exists about a phenomenon. For Nachtmann & Needy (2003b) uncertainty is related with the possibility of error as a result of not having total information about the phenomenon and its surrounding environment.

Among these methods we may identify interval mathematics, probability theories, the fuzzy set theory, the rough set theory, the evidence theory, etc. which, in general, propose mathematical models to deal

and measure uncertainty. Interval mathematics is the simplest form of representing uncertainty. It requires the definition of a lower and an upper bound. Such representation does not consider probabilities (Choobineh & Behrens, 1992). The theory of fuzzy logic was introduced in the 1960s to quantify the lack of accuracy and uncertainty. The main goal in fuzzy sets is quantify imprecise information (Nachtmann & Needy, 2001; Sarokolaei, Bahreini, & Bezenjani, 2013). The theory's body of knowledge includes fuzzy sets, fuzzy logic, and fuzzy numbers.

6.2.2 Risk and Uncertainty and the Budgeting Process in Hospitals

The two primary functions of managers in an organization are planning and control operations (Welsch, 2005). In business, government and most group activities, a system of planning and control, also known as administrative planning, is widely used in order to anticipate possible future events and maintain internal harmony within the organization (Ekholm & Wallin, 2000). Uncertain events introduce risk at the time of execution.

The current organizational context, in particular the demand market, is characterized by lack of an easy reading for the choice of decision alternatives. The contemporary era unfolds in the midst of uncertainty and risk, unlike the industrial era, in which the area of certainty prevailed (Libby & Lindsay, 2010).

Planning is one of the fundamental functions within a company, since it involves designing a desired future state and efficient ways of achieving it. One tool for the planning process are budgets, which in the case of hospitals must be adjusted or must be performed in order to comply with the contract made with the State.

Budgets represent one of the most important channels of communication within an organization and are intimately related to the process of control within organizations (Armstrong, Marginson, Edwards, & Purcell, 1996; S. C. Hansen & Stede, 2004). A budget is the quantitative expression of an action plan proposed by the administration for a given period and an aid to coordinate what must be done to implement the plan and to communicate it within the organizations (Horngren et al., 2012b). A fundamental basis for financial budgets are non-financial budgets, for example the budget of units manufactured or sold, the number of employees and the number of new products entering the market.

Other important criteria that need to be taken into account when designing a budget are those whose measurement is not so easy, for example those of a qualitative nature and those difficult to measure using mathematical models, and which also generate risk and uncertainty in organizational decision-making (Klibi, Martel, & Guitouni, 2010). Qualitative criteria include brand positioning, service level, government policies, public infrastructure, human, financial and information resources (Narasimhan &

Talluri, 2009). Organizational risk management is a growing field that seeks to develop an approach to identify, assess and address areas of vulnerability and potential risk (Neiger, Rotaru, & Churilov, 2009). Because it is relatively new, organizational risk management is still a disorganized field; many of the methodologies for risk management focus on predicting problems rather than focusing on the root causes of uncertainty (Trkman & McCormack, 2009).

Generally, budget models are constructed under the assumption that certainty exists and that decisions taken at any time are difficult to modify over long periods of time, which is not necessarily true because of the existence of uncertainties in endogenous variables and such as inflation, changes in demand, prices and market rates, production rates, sales volumes, cost of materials, etc. (Trkman & McCormack, 2009). In the hospital case, they are, for example, the diversities in the pathologies and the heterogeneity of the patients.

This is why, in addition to the essential requirements for budget design, it is important to include components related to the flexibility associated with uncertain environments in which organizations operate; taking into account that flexibility has a cost which must be valued and contrasted with the benefits that can be generated, so that the need to own it can be justified (Nembhard, Shi, & Aktan, 2005). It is interesting that although flexibility is not a new concept and is often mentioned among gliders, it is rarely discussed from a theoretical point of view. With respect to flexibility, investments often follow a natural sequence of steps with multiple decision points with respect to continuing, postponing or abandoning; allowing an organization to respond to changes in the market, government rules or adapt to technological advances, that is to say, there are always alternative decision options (Brach, 2003). All these elements make the management of organizations increasingly complex (Lee, 2002), so the challenge of the management process is the development of methodologies for making decisions that are adapted to the organizations (Narasimhan & Mahapatra, 2004). All of these considerations introduce a large number of variables and constraints, adding complexity to decision making, complexity that cannot be addressed simply from intuition or experience. It is for this reason that we must look for tools that allow us to incorporate the endogenous and exogenous variables into the decision process in considerably short periods of time, which are adapted to the demands of both the clients and the market in which they are developed. Hence the importance of making budgets that incorporate the uncertainty of the business variables implicit in the organizations and that allow to be an important element when making decisions. In the case of hospitals the contract represents the plan of what the hospital intends to achieve in the budgeted period.

One of the most important variables in the contract is the cost of treatments or services which is established according to the DRGs and assumed as without variability. However, as evidenced in this research is that there is internal and external variability that can affect such cost, so that the estimation of the cost and the inclusion of such variability can be an important tool in the hands of the decision makers, not only for quantify such variability, but also to establish measures to mitigate or control this uncertainty, or to understand the reason for compliance with the contract. In this sense this part focuses on developing a methodology for estimating costs including the inherent variability of processes, so that in the future it could be integrated into the process of design and monitoring of the contract.

Today, health care organizations face one of its most important challenges: to decrease the total expenditure without affecting the quality of the services provided to patients. The key to the success to accomplish the so expected financial viability relies on the development of relevant and strict cost information to support strategy, price adequacy and management decision (Demeere et al., 2009).

Current financing system for hospitals is relatively rigid and is based on Diagnosis Related Groups (DRG), as well as more strict financing rules. Regarding the situation faced by health care sector, it is recognized that there is an urgent need to evaluate all priorities of investment and expenditure. In addition, we also have the recognition from external entities that cost accounting systems must be reformulated in order to give reliable information for the funding and pricing process, without underline the lack of usage of advanced cost accounting practices (such as Activity-Based Costing -ABC-) in health care organizations. ABC could be considered as a more effective alternative to manage hospitals by supporting the decision-making process in many levels, such as the decision to expand or contract services based on the patients' needs and their profitability.

Cost management in health care organizations should support the effort to accomplish positive financial results and higher efficiency without adversely affect the quality of health care services provided to the patients, supply information to optimize resources and ensure quality and continuous improvement (Baker & Boyd, 1997). The traditional cost accounting systems applied to health care services have not accomplished these objectives once they fail to empathized the role given to the activities performed in order to meet the patients' needs and because their departmental analysis does not reflect the process work flows that go through different departments in the organization (Lawson, 2005).

An ABC system can be used to balance the health care delivery perspective and the financial dimension that makes the sustainability of the organization possible, as well as to report accurate and relevant information to health care professionals, as this information should support health care services, achieve financial accounting and drive higher performance in the organization (T. K. Ross, 2004).Several studies

have been conducted to show the applicability of ABC in hospitals (e.g. Laurila et al. 2000; Ross 2004; Baxendale & Dornbusch 2000). Even though there is a great recognition of the benefits and value of the ABC model, the implementation of this method is not yet to be generalized (R. Kaplan & Anderson, 2007). Indeed, the development of an ABC system requires extensive data collection and analysis.

Yet, in health care there is a progressive need to refresh the techniques for the cost accounting system in order to allow managers and clinicians to obtain more accurate information so that it may be possible to analyses the profitability of each department, service and other relevant cost objects, supporting future investments.

Considering that work requirements are now more complex, more uncertain, and changing, control systems cannot be static and formal (Davila et al., 2009). Even ABC data are often estimated due to cost and time constraints, which leads to inherent imprecisions and uncertainty (Nachtmann & Needy, 2003a).

6.2.3 Costing Systems under Uncertainty

There are significant sources of uncertainties which impact in cost estimation. The inclusion of this uncertainty in the estimation of costs has been addressed in different environments, sectors, organizations and for different types of products or services. Table 6.1 shows some recent applications of models for cost estimation including uncertainty ranging from cost of products, services, projects, costs associated with failures or failures, among others. Table 6.1 highlights several important elements, such as that there are several methodologies to model and then try to measure uncertainty or otherwise calculate the risk associated with cost, methodologies ranging from mathematical models, econometrics, neural networks, simulation among others. All the models emphasize that these models can yield more reliable results as you have a large amount of input data, and in the case of absence of information the opinion of experts together with simulation techniques can help recreate scenarios close to reality. It is also emphasized that the variables for estimating the risk associated with the cost will depend on the context, and may be internal variables (associated with the product, project or service, such as technical specifications) or external variables (variables that affect the product and therefore generate a cost, such as environmental or economic variables)

Table 6.1. Relationship between Cost Estimation and Uncertainty

Author(s)	Technique	Variables	Findings
(D. W. Seo & Caracoglia, 2013)	Monte-Carlo Simulation	The buffering, the fluttering and the aeroelastic coefficient	They create a model that allows to determine the cost of maintenance and repair of damages caused by the wind on a bridge. The incidence of uncertain external variables on cost is highlighted.
(Qu, Li, & Zhang, 2013)	Gaussian simulation and transfer functions	Amount of Nickel	They create a model to determine the cost to health due to the concentration of nickel in a Chinese region. This study highlights the application of models that include uncertainty in the service area.
(Dziadosz, 2013)	PERT	Time, Cost	They show how in the planning stage of a project the time and cost risk can be estimated by analyzing the expected probabilities of time and cost.
(Chen, 2013)	Artificial intelligence	Expected Cost	Starting from the information given by experts for the production process and cost of an innovative product, several iterations are made up to a convergence cost value.
(Khodakarami & Abdi, 2014)	A Bayesian networks	Cost of items and all possible common causes to cost items	This study highlights the use of a Bayesian model to include the dependencies, probabilities and correlations between the variables that induce the cost.
(Zhaodong, Rongxuan, & Jing, 2015)	Monte Carlo Simulation	Maximum engine thrust. Aircraft empty weight, The maximum speed	Taking into account the expected performance of a product, which is variable, these authors construct a model that allows determining the cost associated with production. While this research considers a number of technical elements, one of the weaknesses is not to consider the correlation that exists between them.
(Brotons Martínez & Sansalvador Selles, 2015)	Fuzzy Method	The Crosby's Maturity Grid (the variables depend on the maturity of the quality system)	This study is notable for trying first to develop a methodology for calculating intangible costs such as hidden quality costs (such as loss of revenue due to customer dissatisfaction with an organization's products) and second to include the uncertainty in such estimation through fuzzy methodology.
(Schwabe, Shehab, & Erkoyuncu, 2016)	Literature Review	Confidence, Forecast, Volatility, Metric	This research presents which elements should be taken into account when developing a cost model including uncertainty, in which MCS stands out as a widely accepted tool for uncertainty modelling.
(Schell, Claro, & Guikema, 2017)	Null mode, Linear mode and Econometric learning curve mode	Submarine cable route(km) Maximum depth (m), Number of cables (Units), Cumulative length, worldwide (km), Market price, copper (USD/ton), Voltage (kV),Project length, Contract year (year)	This research highlights the use of econometric models to include the uncertainty associated with technical elements of the problem and thus determine possible future risks. However, the need to analyze the marginal benefit of using more complex models derived from the need to incur costs to obtain more accurate information is emphasized.

The uncertainty in cost estimation can be reduced if more information is available namely, in terms of product design and manufacturing details (Goh et al., 2010). In the domain of cost estimation and costing systems various methods have been used for this purpose. One of the first approaches that have been used to measure and to understand costs' uncertainty and measure the level of risk is the sensitivity analysis. It offers a first look for the decision-maker on stage about what would happen if the most relevant inputs change considering both a more optimistic and a more pessimistic situation around the prevalent or expected scenario. Nevertheless, this approach as its limitations. For example, when there are a great number of variables it is more difficult to determine what might happen and how the interaction among variables can affect future results. In order to mitigate this limitation, tools based on probabilistic methods have been designed. In these tools, uncertainty in the cost data is represented by probability functions. Although probabilistic methods provide more information to the decision maker, one disadvantage is that they require large amounts of information and greater handling statistical that sensitivity analysis (Datta & Roy, 2010).

After analyzing several models of costing models in environments of uncertainty in trough-life cost (TLC) processes Goh et al. (2010) highlights the existence of two types of uncertainty: random uncertainty and epistemic uncertainty. Random uncertainty is associated with the inherent variability of a phenomenon and cannot be reduced, but epistemic uncertainty is related to the uncertainty derived from a lack of knowledge of a phenomenon, which decreases to the extent that the level of knowledge of the phenomenon increases. For example, in costing processes of new technologies such as carbon capture technologies the epistemological variability is given by the use of different methods of sizing equipment and estimating the cost of purchasing components (van der Spek et al., 2017). When analyzing a model in uncertain environments, tools should be identified and used to model them such as: sensitivity analysis, fuzzy methods, Time-series analysis models, or Monte Carlo simulation (S. Kim et al., 2017).

A well-known approach in this context is the Monte Carlo method. It is based on the analogy between probability and volume. The mathematics of measure formalizes the intuitive notion of probability, associating an event to a set of outcomes and defining the probability of the event to be its volume or measure relative to that of a universe of possible outcomes. The Monte Carlo method uses this identity in reverse, calculating the volume of a set by interpreting the volume as a probability. In the simplest case, this means sampling randomly from a universe of possible outcomes and taking the fraction of those random numbers and analyzing them, the estimates given by the random values are expected to converge to the correct value as the sample size increases. The central limit theorem provides information about the likely magnitude of the error in the estimate after a finite number of draws (Glasserman, 2004).

The simulation can be used to value certain instruments and to derive risk measures, when they are not available or when an analytical model is inapplicable. Essentially, the analyst describes, in a probabilistic sense, the variables that determine the value by their respective probability distributions. Then, using a random number generator, possible values for the variable under analysis are obtained. By repeating this process thousands of times, the analyst gets a considerable number of possible values for the object variable. From these values we can determine a distribution of possible outcomes and the probabilities that these values will occur and a set of statistics that provide a quantification of uncertainty. Nachtmann & Needy (2003b) have applied the Monte Carlo simulation using two different distributions for input parameters: a triangular distribution and a normal one. The triangular distribution is a simpler approach to model uncertainty. Furthermore, the Normal distribution is frequently used to model the relative frequency distribution of errors such as errors of measurement.

Seo & Park (2017) also apply MCS to predict what would be the costs of repairing an infrastructure after an earthquake. In this case the cost of repair is the output variable which is subject to damage in the pier, abutment and the bearing, given the different possibilities this study allows to determine the expected maximum cost of repair when the seismic phenomenon occurs.

Assuming that a major limitation of ABC systems is the insufficient attention given to uncertain and incomplete data (Dean Ting, Zhang, Wang, Deshmukh, & Dubrosky, 1999), some authors have been proposing extended ABC models which include uncertainty; namely, Jahan-Shahi, Shayan, & Masood (1999) and Sarokolaei et al. (2013).

Jahan-Shahi et al (1999) applied fuzzy sets and probability distribution methods to address uncertainty in cost estimation. For several references on technical approaches on uncertainty in cost estimation, particularly the use of fuzzy methods see Jahan-Shahi et al (1999). They also mention the existence of published work on the use of neural networks to provide more accurate estimates of costs. Nachtmann & Needy (Nachtmann & Needy, 2001) developed a methodology based on fuzzy set theory to handle estimation imprecision and uncertainty in ABC systems. The authors considered that they have created a new ABC system: a fuzzy activity based costing (FABC). This FBAC is explained using the example of a mid-sized pharmaceutical company. Nachtmann & Needy (2003b) have studied and compared different methods for handling uncertainty in ABC systems. The methods that have been studied were: interval mathematics, Monte Carlo simulation (with triangularly distributed input parameters and normally distributed input parameters) and fuzzy set theory. The authors concluded that Monte Carlo simulation and fuzzy set theory are better than interval mathematics for handling uncertainty in such costing systems.

Sarokolaei et al. (2013) used fuzzy logic to improve the model proposed by Namazi (2009). Using the ABC logic, Namazi (2009) creates a model called Performance Focused Activity Based Costing (PFABC) which integrates the cost of products with the evaluation of the performance in their elaboration. The Namazi's (2009) model calculates standard rates for costing products which are assumed deterministic. Sarokolaei et al. (2013) considers that such standards have some degree of uncertainty and to model such uncertainty they used fuzzy logic and created a model called Fuzzy Performance Focused Activity Based Costing (FPFABC) which is recommended when there is no accurate data associated with the development of the activities.

The model proposed by Chang et al. (2017) uses a costing methodology that includes uncertainty in the production factors for products that are in the early stages of development- They made an application in products related to the generation of energy and emphasize uncertain variables like the production cost, the depreciation, the throughput and the performance of the product itself.

6.3 Proposed Model

The measurement of a problem poses many problems, ranging from the identification of the best statistical model to represent the behavior of prices, to the creation of methodologies that are capable of measuring the precision of the models, through the construction of the necessary databases. A methodology to address this problem was developed by Group (1999) and presented in the document "Corporate Metrics Technical Document", which aims to focus on the financial results of the company for the measurement of market risk, this measurement is known as Value at Risk (VaR) and the measurement procedure can be summarized in the following five steps:

1. Metric specification
2. Exposure mapping
3. Scenario generation
4. Valuation
5. Risk measuring computation

In this research project, the proposed model is the computation of CaR making an analogy with the computation of VaR which is a statistical measure of market risk that estimates the maximum loss that could register a portfolio in an interval of time and with a certain level of confidence. Nevertheless, unlike

VaR which considers the left tail of the distribution of output (i.e. lower income), CaR highlights the right part of the distribution (i.e. higher costs).

With regard to step 1 of the metric specification, it is necessary to define the financial measure to which the risk will be measured, usually earning or cash, specifying a time horizon and a certain level of confidence. In this research, the metric selected is related with the cost of provision of medical services. In this case, the marginal gain in the calculation of the risk (or quantification of the variability) must be analyzed with the marginal cost of obtaining it. It should be defined in which products or services this analysis has value for decision makers, it is possible that such identification should be prioritized using for example a Pareto analysis: But, in this case, that prioritization is not so obvious due to the existence of multiple attributes of the services and it will be necessary the use of some technique of multi-attribute prioritization such as: the analytic hierarchy process (AHP) to determine which products worth measuring risk.

With respect to the cost, the production cost of goods and services refers to the sum of the value of resources used in the production or manufacture of a given quantity of a product. It is presented in terms of raw materials, labor and general expenses or overhead incurred. Thus, the production cost is composed of three main components as it is presented below.

$$C(x) = F1(x) + F2(x) + F3(x) \quad (1)$$

The production cost can be presented also in two components instead of three: Prime Costs (i.e. direct materials and labor costs) plus Overhead or Direct Materials plus Conversion Costs (labor costs and overhead). The relative weight of the cost related with these components may vary significantly from product to product and when different production and business processes in different industries are compared.

As already mentioned, several methodologies for cost estimation can be used, one of them most used in recent years is the activity based costing methodology (ABC). Which is based on the logic that activities consume resources, and products are consumers of activities. The knowledge of the process is essential for the design of an accurate costing model in general and of an ABC system, in particular. It includes identifying products and other relevant cost objects (e.g. services) as well as the processes and the activities which are necessary for the completion of such products. Commonly, this is achieved by performing an analysis and mapping of the processes of the organization.

Resources supply and support activities and, in general terms, can be classified in human resources, equipment, informatics resources, materials and others. Resources' variability, will have a direct impact in the number of calculations that must be performed to calculate the cost associated with products or services.

For the distribution of indirect costs, appropriate drivers should be selected to relate resources to activities and the later to products. The most common drivers are volume-based, such as the number of machine hours, number of man-hours, number of products, number of lots, number of setups, etc.

Default rates for associating resource consumption with activities and also between activities and the associated products must be computed in this step. These default rates are obtained dividing total costs by the quantity of the selected driver.

Below is a matrix representation of the ABC model. For the estimation of costs, the following model was used, taking into account the following parameters.

$A, Activities\ (i = 1, \dots\dots\dots\dots, m)$

$R, Resources\ (j = 1, \dots\dots\dots\dots\dots, n)$

$CO, Cost\ Objects\ (k = 1, \dots\dots\dots\dots\dots\dots, o)$

$TR_j = \ Predetermined\ Rate\ allocation\ for\ each\ resource$

$AR_{ij} = \ Total\ consumption\ resource\ for\ each\ activity$

$P_{ki} = \ Normalized\ activity\ consumption\ for\ each\ product$

$CP_k = \ Cost\ of\ \ each\ product$

$CA_i = \ Cost\ of\ \ each\ activity$

$CR_j = Total\ cost\ of\ \ resources$

$U_j = Cost\ of\ \ unused\ capacity\ \ for\ each\ resource$

$e = Parameter\ estimated$

$IT_t = \ number\ of\ \ iterations\ (t = 1, \dots\dots\dots\dots\dots, s)$

With this information, the following matrices can be constructed.

$$\begin{bmatrix} P_{11} & \cdots & P_{1m} \\ \vdots & \ddots & \vdots \\ P_{01} & \cdots & P_{om} \end{bmatrix} \qquad (1)$$

$$\begin{bmatrix} AR_{11} & \cdots & AR_{1n} \\ \vdots & \ddots & \vdots \\ AR_{m1} & \cdots & AR_{mn} \end{bmatrix} \quad (2)$$

$$\begin{bmatrix} TR_1 \\ TR_2 \\ TR_3 \\ \vdots \\ TR_n \end{bmatrix} \quad (3)$$

In the Matrix 1 it is represented the normalized activity consumption for each product, where:

$$\sum_{k=1}^{o} P_{ki} = 1, \qquad \forall i \quad (4)$$

This expression ensures that the activities are associated with the products. In the Matrix 2 it is represented the consumption of resources for each activity. The Matrix 3 represent the predetermined rate for each resource, this rate can be calculated as:

$$TR_j = \frac{CRj}{Resource\ Driver(labor, hours, kg, etc.)} \quad (5)$$

The computation of the cost of products is done in two stages. Firstly, the cost of activities is obtained. Secondly, the cost of the products is computed. For the cost of the activities it is necessary to proceed as explained below, when Matrix 2 is multiplied by Matrix 3.

$$\begin{bmatrix} AR_{11} & \cdots & AR_{1n} \\ \vdots & \ddots & \vdots \\ AR_{m1} & \cdots & AR_{mn} \end{bmatrix} * \begin{bmatrix} TR_1 \\ TR_2 \\ TR_3 \\ \vdots \\ TR_n \end{bmatrix} = \begin{bmatrix} CA_1 \\ CA \\ CA \\ \vdots \\ CA_m \end{bmatrix} \quad (6)$$

Where the result is the cost associated with each activity. With this result, the cost of the products can be obtained as it is explained below.

$$\begin{bmatrix} P_{11} & \cdots & P_{1m} \\ \vdots & \ddots & \vdots \\ P_{o1} & \cdots & P_{om} \end{bmatrix} * \begin{bmatrix} CA_1 \\ CA \\ CA \\ \vdots \\ CA_m \end{bmatrix} = \begin{bmatrix} CP_1 \\ CP_2 \\ CP_3 \\ \vdots \\ CP_o \end{bmatrix} \quad (7)$$

In addition to the cost of the products, the model allows calculating other indicators. An important indicator is the unused capacity of each resource which is given by:

$$U_j = CR_j - TR_j * \sum_{i=1}^{m} AR_{ij} \ , \qquad \forall j \qquad (8)$$

With this equation it is possible to calculate the cost of unused capacity, comparing the resources used versus the resources that were available within a period of time. It gives an idea of the waste or the variability between projected and what is actually consumed, i.e.

$$U = \sum_{J=1}^{n} U_j \qquad (9)$$

Considering that:

$$CR = \sum_{j=1}^{n} CR_j \qquad (10)$$

And,

$$CP = \sum_{k=1}^{o} CP_k \qquad (11)$$

Then:

$$CR = CP + U \qquad (12)$$

This model allows to calculate the cost of products in a deterministic way. It is important to note that due to the large amount of information that a production process can have, once the calculation of the cost of products, a Pareto analysis must be performed to identify products, activities and resource worth continuing to study in depth and which can be used in the model with uncertainty. This allows us to reduce the information needed to support more efficiently the decision making.

Step two for the quantification of the CaR is defined as exposure mapping, i.e. for the metric defined in step 1, which may be the cost of a treatment or the total cost of a service, the sources of uncertainty or risk must be identified. This step is fundamental to be achieved an effective inclusion of uncertainty in the cost estimation model. For that, it is necessary to identify probability distributions which allow to understand the variability of the process.

In the case of a costing system it is possible to identify uncertainty related to the variability in how activities consume resources for each product or service provided, or variability in how products consume activities. If there is sufficient historical data, several methodologies and statistical tests of fit can be used in order to determine the empirical distribution of the data.

For example, the Anderson-Darling (AD) test is a non-parametric test on whether the data in a sample come from a specific distribution (T. W. Anderson & Darling, 1954). The Kolmogórov-Smirnov (K-S) test is also a non-parametric test that determines the goodness of fit of two probability distributions to each other. In case of wanting to verify the normality of a distribution (Massey, 1951), it is the Lilliefors test which brings some improvements with respect to the one of Kolmogorov-Smirnov (Lilliefors, 1967). The Shapiro-Wilk test is one of the most powerful tests for the normality contrast, particularly for small samples (n <50) (Shapiro & Wilk, 1965).

When there is little information to find the empirical distribution, a theoretical distribution can be used that fits the studied phenomenon. Among the theoretical distributions associated to real-life phenomena, the most used are: binomial distribution, poisson distribution, uniform distribution, normal distribution and exponential distribution, the first two are discrete and the last three continuous. these distributions can be obtained from similar studies, by analogy or from the opinion of experts as illustrated by studies such as Page et al. (2014)in which expert opinion is used to construct probability distributions functions of the variable sources of uncertainty.

Step three is related to the generation of scenarios, for each measure identified in step 2, it is generally a long list of scenarios or possible values that the variable should take. Historical Simulations, Delta-Normal Approach and the Monte Carlo Simulation can be used for this generation. Through the simulation analysis it is possible to estimate the expected cost of the selected cost objects and their corresponding probability distributions.

To build the model with uncertainty, it is assumed that$\mathrm{AR_{ij}}$, $\mathrm{P_{ki}}$ and $\mathrm{TR_j}$ are uncertain parameters. A sample $\mathrm{AR^e_{ij}}$, $\mathrm{P^e_{ki}}$ and $\mathrm{TR^e_j}$ are generated for each input parameter $\mathrm{AR_{ij}}$, $\mathrm{P_{ki}}$ and $\mathrm{TR_j}$, using their probability density function (PDF) Which is derived from the analysis performed in step 2.

It is important to note that some variables may have some relationship to each other. Such relationships can be determined statistically by calculating the coefficient of Spearman between each of the variables. The Spearman correlation coefficient ρ measures the strength of the relationship between ordinal variables. Uses, instead of the observed value, only the order of the variables. Thus, this coefficient is not sensitive to asymmetries in the distribution, or the presence of outliers, thus not requiring that the data

come from two normal populations. For a sample of size n, the n raw scores X_i, Y_i are converted to ranks x_i, y_i, and the spearman correlation coefficient (ρ) is defined as:

$$\rho = 1 - \frac{6 * \sum d_i^2}{n(n^2 - 1)} \tag{13}$$

Where, $d_i = x_i - y_i$, is the difference between ranks.

Step four is called valuation. In this case, the expected result must be calculated for the result or output defined in the first step, the value of $\mathrm{CP_k^e}$ are the outcome variable, which is calculated considering:

$$\mathrm{CP_k^e} = \mathrm{f}\left(\mathrm{AR_{ij}}, \mathrm{P_{ki}}, \mathrm{TR_j}\right) \tag{14}$$

Where:

$$\mathrm{AR_{ijt}^e} = \left[\, \mathrm{AR_{ij1}^e},\ \mathrm{AR_{ij2}^e} \ldots.,\ \mathrm{AR_{mns}^e}\right] \tag{15}$$

$$\mathrm{P_{kit}^e} = [\mathrm{P_{ki1}^e}, \mathrm{P_{ki2}^e} \ldots\ldots, \mathrm{P_{oms}^e}] \tag{16}$$

$$\mathrm{TR_{jt}^e} = \left[\mathrm{TR_{j1}^e}, \mathrm{TR_{j2}^e} \ldots\ldots, \mathrm{TR_{ns}^e}\right] \tag{17}$$

The procedure is repeated for s number of iterations. Finally, the outcomes are analyzed using statistic criteria, histograms, confidence intervals, among others statistics. When calculating the probability distribution associated with the cost of each product, it is possible to estimate the probability of a specific cost value, or which could be the maximum or minimum expected cost for a given product. It is known that each of the estimated output data has a probability of occurrence based on the random distribution used for the simulation. If the values are ranked from the highest to the lowest and confidence level is chosen for the cost of 95% when the cumulative probability reaches this value, we will found Cost at Risk –CaR–, Figure 6.1 shows graphically the determination of CaR.

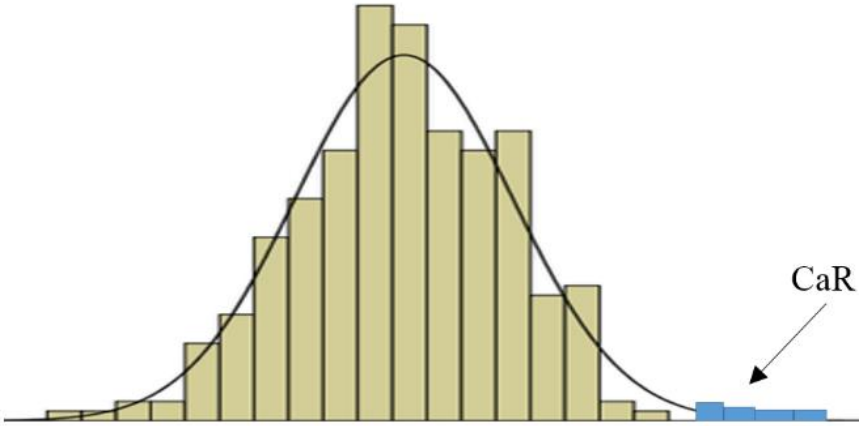

Figure 6.1. Costing at Risk

CaR will be important for policyholder decision makers and for identifying those products that deserve more attention, which products that can most affect the profit, and allows creating strategies to mitigate or eliminate the risk level. Unlike VaR which considers the left tail of the distribution of output (i.e. lower income) CaR highlights the right part of the distribution (i.e. higher costs), as shown in Figure 6.1

6.4 Materials and Methods

This chapter presents the application of the proposed model in an imaging service of a hospital. In addition, a description of the software and hardware used for the application of the model is presented. In order to structure the application of CaR and create a structure that can be replicated in other situations, it was followed the Decision-Analytical Modelling (DAM) logic.

DAM compares the expected costs and consequences of decision options by synthesizing information from various sources and applying mathematical techniques, commonly supported by computational tools (Petrou & Gray, 2011).

Uncertainty is one of the variables that must be taken into account in a DAM. Indeed, uncertainty is an essential part of the model construction process (Bilcke, Beutels, Brisson, & Jit, 2011). In terms of uncertainty, Bilcke et al. (2011) mention at least three types present in DAM processes which are: methodological uncertainty, structural uncertainty, and uncertainty in the parameters. The methodological uncertainty is related to the model that will be used. Structural uncertainty is related to the aspects that must be incorporated to capture the relevant characteristics of the element being investigated, and the uncertainty in the parameters is associated with what should be the value that each parameter should take, due to the fact that there is not enough evidence of parameter values, or the quality of the

measurement is unclear, or simply because the parameter estimation must be performed indirectly by combining other parameters because direct evidence of the parameter is not available.

Decision-analytical modelling is extensively used in health-care economic evaluations especially in circumstances where there is little data, and in circumstances where evaluations influence repayment prices (Peñaloza Ramos, Barton, Jowett, & Sutton, 2015; Sun & Faunce, 2008).

Among the techniques used to capture the uncertainty in DAM we can highlight: the Decision Tree, Markov and MCS (McAnany, Anwar, & Qureshi, 2015). With regard to the use of Decision Trees, this technique is characterized by presenting simple models easy to interpret. However, it is not appropriate to represent recurring events.

DAM, using Markov, models has been used to evaluate the cost-effectiveness of competing health care technologies that require the description of patient pathways over extended time horizons. Discrete event simulation (DES) is a more flexible, but more complicated decision modelling technique that can also be used to model extended time horizons (Cooper, Sutton, & Abrams, 2002; Karnon, 2003).

With regard to MCS, it is an appropriate tool to obtain numerical solutions to problems difficult to solve analytically and currently, computational tools allow modeling complex situations, offering quickly answers for decision making. Usually there are a logical sequence of steps to model an economic evaluation problem usually used in the construction of a DAM, ranging from problem identification, model building, and sensitivity analysis (Sun & Faunce, 2008). This logic sequence was used for the application of the model that allows the estimation of CaR as shown in Figure 6.2.

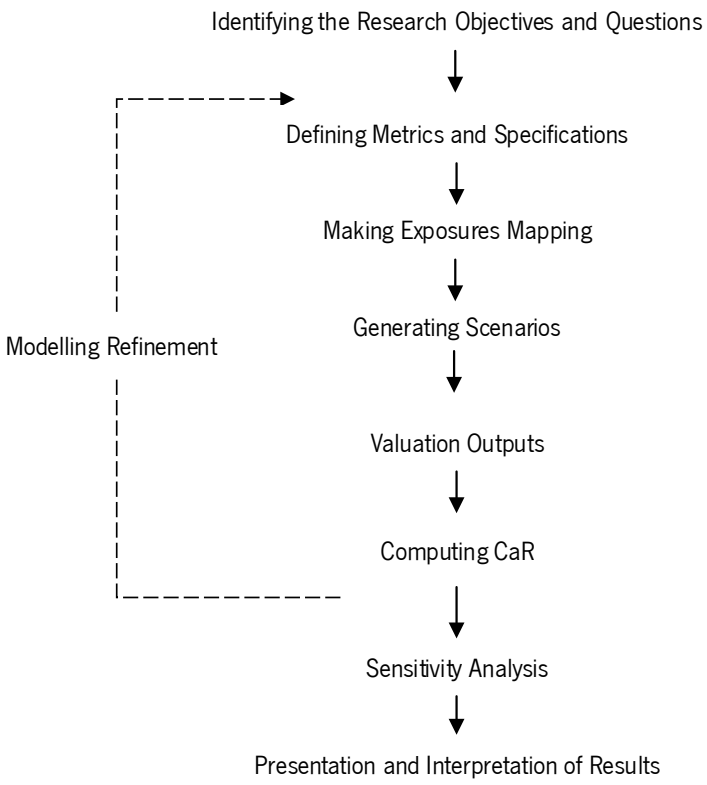

Figure 6.2. Decision-Analytical Modelling to Compute the CaR
Adapted from (Sun & Faunce, 2008)

In this context, identifying the objective and the research question should be clear as well as the potentialities and limitations expected of the model. In addition, it should be clearly defined what is the object of study, in the case of this particular investigation, which or which will proceed to define the products or services to which it is interesting to carry out a risk analysis and what advantages will exist for the borrowers of decisions.

The objective (the metric) in this case is related to the estimation of the CaR of the services offered by an imaging service with the purpose of generating information that allows knowing the risk associated to the budget; allowing to create measures not only for control but also for the mitigation of such risk.

Among the limitations of this application is the lack of standardized and detailed information on each service to be studied. To solve this problem, we proceeded to perform with the clinical and administrative staff the consumption of resources for the services offered. This work took several months of work.

For the calculation of deterministic values related with the metric selected, we proceeded to model the system using Microsoft Excel spreadsheets.

The cost information was collected from various information systems. Information related to the type of examinations performed by the service (the number of exams was around 200 and then grouped into 12

groups), information related to the activities of each of the defined groups (on average 30 activities per group), and resource-related information (8 human resources, 20 different equipment and more than 400 materials - direct and indirect). After analyzing this information, a deterministic model was constructed to determine the cost of the exams (i.e. the cost objects), which served as the basis for the determination of CaR.

Using a Pareto analysis, the most important cost objects were identified, which allowed us to know which services were a priority to carry out the risk analysis

For the following steps (scenario generation, valuation and risk measuring computation) were used the following tools.

For the computation of CaR and sensitivity analysis it was used the Software Crystal Ball, and a computer with Intel® Core ™ i5-2467M CPU 1.60GHz with an installed memory of 6.00 GB of RAM. Crystal Ball is a commercial software that is very suitable for performing MCS on spreadsheet models and to estimate the level of risk in a decision-making process (Gonzalez, Herrador, & Asuero, 2005).

The basic procedure for using Crystal Ball is to model a problem in a spreadsheet that describes a situation or problem and identify the sources or variables that generate uncertainty then, the PDFs for each identified variable must be defined, followed by the definition of the variables object of study and to which the risk will be calculated. The simulation is run by generating random numbers for the input variables which generates forecasted values for the output variables, then the results are analyzed and the reports are produced (Bhat & Kumar, 2008).

There are several commercial software that can be used to perform MCS, for example, @Riks (Palisade, 2017), Risk Simulator (ROV, 2017) and Crystal Ball (ORACLE, 2017). In this research it was used Crystal Ball, which is an easy-to-use simulation program, allowing the analysis of the risk and uncertainty associated to a situation that can be modelled in Microsoft Excel spreadsheets.

The analysis of risk using crystal ball consists of developing a deterministic cost model in Microsoft Excel. A model was constructed to consider the uncertainty. In this model, possible probabilities distribution functions (PDF) of the variables that affect the cost of the services were considered. For them, it was important to carry out a risk measurement. Several distributions of probability can be used namely, Uniform, Triangular, Lognormal, Weibull, Binomial, Poisson, among others. These PDFs can be used with expert information and be defined a priori when not enough statistical information is available. However, as soon as possible it should be collected information on the random variables. The distributions can be adjusted to the empirical distributions using a goodness-of-fit test. Crystal Ball allows to choose between Anderson-Darling, Kolmogorov-Smirnov and Chi-Square. Among the reasons for adjusting the

distributions, we may highlight the establishment of correlations between the input variables, which can have a great impact on the forecast results - Crystal Ball allows to include these correlations (Charnes, 2012).

Once parameterized the input variables, the output variables are defined, which will be the variables of interest, in the case of this study, the cost of production. The next step is about running the simulations. Crystal Ball allows to run thousands of simulations in a short space of time; for this project, they were generated 20,000 scenarios. Once the Simulation is done, the software allows to generate aids for the analysis of results such as: statistics (i.e. mean, median, mode, standard deviation, variance, asymmetry and kurtosis), percentiles, graph intervals, sensitivity data, iterations, tornado charts and sensitivity charts.

Once the objectives were defined and considering the methodology for the calculation of CaR defined in the previous section, the sensitivity analyzes and the respective analysis and interpretation of the results were performed

These analyzes allowed the identification of critical cost objects, critical resources and the quantification of risk, all in order to create intervention measures to mitigate such risk.

6.4.1 The Empirical Study

The model was applied in the imaging service of a hospital, which is a medical specialty that is based on obtaining images for diagnosis and therapy of various types of pathologies, using different types of radiation such as X-ray, ultrasound and radio frequency treatments. It is an interesting department because it is generally not a final destination department, but its function is to provide services to other departments of the hospital.

Receiving patients from different departments and specialties creates an implicit variability in the service that will be provided, as this will depend not only on the service that comes (i.e. an emergency patient may require more care and different services than an outpatient) and also of the pathologies the patient may possess and that is not anticipated by health care providers in general and hospitals in particular. In this research project it was important to study the different processes and the differences among the different types of exams performed in the Imaging services.

The variability not only generates uncertainty in the type of treatment to be performed, but also can generate a risk of complying with the expected cost of a given treatment. That is why it is not only necessary to quantify such variability but also to measure its impact on the fulfillment of the contract or budgeting for each service.

To determine the risk associated with the cost of services, a deterministic model was constructed for cost determination. For the design of the costing model, firstly, the exams were identified and grouped in families' exams. Secondly, they were identified the activities, followed by resource identification. In a third stage, they were identified the cost drivers, followed by the calculation of the allocation rate. Fourthly, we proceeded with the identification of probability distributions. Fifthly, the ABC model was designed. Finally, through simulation and analysis of results, costs were allocated to the exams.

Thus, after the identification of families' exams, the activities, resources and cost drivers were identified by this order and costs were allocated to the exams.

During a year they were performed over 150,000 exams, but further analysis showed that it was possible to create homogeneous groups of exams. These homogeneous groups are the following: Support to other services, Gastrointestinal imaging, Urologic imaging, Ultrasound, Mammography, X-ray, interventional/vascular radiology, Non contrast-enhanced MRI (magnetic resonance imaging), Contrast-enhanced MRI, Non-contrast-enhanced computed tomography and Contrast-enhanced computed tomography.

Activities, resources, cost drivers and cost objects are the elements necessary to implement an ABC model. Once identified the cost objects, the next step asked for the identification of the activities that supported each of the services provided. The process in the imaging service was divided into five activities namely, schedule the patient, receive the patient, make the exam, process the exam and prepare the report.

Resources were classified into human resources, equipment, informatics resources, materials and others. With regard to human resources, they were considered physicians and all the staff at the imaging area both administrative and production elements. In terms of informatics resources, they were considered the various information systems responsible to deliver or receive information. In this case, they were found a total of 8 different information systems, which in most cases have no communication with each other. In terms of equipment, they were considered all the machines and equipment (e.g. Scanner, Ultrasonography machine, Interventional radiology) used for the realization of the exams. Finally, among the materials found we must highlight direct materials (medicines and surgical items) and indirect materials (related to maintenance equipment, administrative materials, hotel equipment, treatment equipment, electro-medical equipment). Medicines are responsible for over 70% of total material costs.

For the distribution of indirect costs they were identified four cost drivers to relate the resources with the activities. The cost drivers identified were: number of exams, direct labor hours, number of patients, machine hours and square meters.

Furthermore, it is necessary to highlight that here was a problem with the assignment of direct materials. Normally, in a traditional ABC model, direct materials are assigned directly to the cost objects (e.g. products or services), this is possible when there are standardized processes for the development of the products or when there are reliable records of the consumption of resources by each activity and consumption of the activities by each service. In this case, we found a problem related to the lack of information on resource consumption by each test performed. To solve this problem, and with the help of the clinical and administrative staff, we found a driver for the allocation of direct materials.

Once the activities, resources, cost drivers and cost objects were identified we were able to design the costing model and apply the CaR calculation methodology.

For the regular use of such costing system, one of the problems encountered has to do with the amount and variety of information systems and the lack of communication between them, for that there are several possible alternatives, one of which is to develop an application that can communicate with all the existing applications. This is known as a Business Intelligence (BI) solution. An intermediate solution is to use a backup system for obtaining regularly the data from the existing systems and perform the necessary calculations. Currently, the service does not have any of these integrated information systems.

6.5 Analysis and Discussion

The following is a summary of the results and respective discussion of the application of the proposed model. First, we present the results from the deterministic model, which allowed us to identify the cost objects in which a risk analysis would make more sense due to its large contribution to the total cost. Then, it is presented how the variability was introduced in the deterministic model, which allowed the calculation of the CaR, and lastly it presents a sensitivity analysis and its impact in terms of decision making.

One of the most complex problems to deal in the imaging service is related to the consumption of materials, since it cannot be standardized to each patient. It basically depends on the patient's age and other personal characteristics. By applying the proposed model, they were found interesting results for the distribution of materials and consequently for the cost of exams by patient.

Table 6.2 shows the unit cost for each exam in terms of materials and also the percentage that each type of material contributes to the unit cost. These results come from the deterministic cost model that was built using Microsoft Excel spreadsheets for data processing. Values are displayed in percentage terms to maintain the confidentiality of the data.

Table 6.2. Material Cost by Type of Exam

Type of exam	Treatment Material	Medicines	Electro-medicine Material	Other Materials	Total cost
Support to other services	1,616%	0,512%	0,507%	0,332%	2,966%
Gastrointestinal imaging	0,660%	0,874%	0,000%	0,015%	1,549%
Ultrasound	0,014%	0,427%	0,102%	0,966%	1,509%
Mammography	0,000%	0,000%	2,491%	0,035%	2,526%
X-ray	0,059%	0,396%	2,581%	4,389%	7,425%
Interventional/vascular radiology	3,824%	0,046%	0,000%	0,224%	4,095%
Contrast-enhanced MRI	0,334%	23,448%	0,333%	0,213%	**24,327%**
Non contrast-enhanced MRI	0,006%	0,001%	0,007%	0,004%	0,018%
Contrast-enhanced computed tomography	0,460%	48,173%	0,459%	0,297%	**49,390**%
Non contrast-enhanced computed tomography	1,323%	0,066%	1,538%	0,995%	3,922%
Urologic imaging	0,374%	1,313%	0,000%	0,586%	2,273%
Total	8,671%	75,255%	8,018%	8,056%	100,000%

As can be seen, about 90% of the costs are concentrated in materials processing, medicine and medical imaging, and these costs are basically concentrated in two types of examination, which are contrast-enhanced MRI and contrast-enhanced computed tomography. Doing a thorough analysis it was determined that the largest proportion of these costs are due to two types of materials (of about 300 that are in total) used in the imaging area which represent about 65% of the total cost of materials throughout the service. The application of these materials depends on the age of the patient, the weight, and other parameters.

In this same line of reasoning, we analyzed the existing variability in the cost of materials in each of their categories of materials, Table 6.3 shows that the greatest variability exists in medicines.

Table 6.3. Statistics by Type of Material

Statistics	Type of Material			
	Treatment Material	Medicines	Electro-medicine Material	Other Materials
Min	0,00%	0,00%	0,00%	0,00%
Max	3,82%	48,17%	2,58%	4,39%
Mean	0,79%	6,84%	0,73%	0,73%
Standard Deviation	1,1426%	15,36%	1,00%	1,26%

The results shown in Table 6.3 allow to identify medicines as one of the sources of uncertainty that must be studied and included in the risk analysis and that should be subject to greater control by the decision makers.

On the other hand, Table 6.4 shows the greater variability in the materials related to Contrast-enhanced mri and Contrast-enhanced computed tomography, being the latter where the greatest variability occurs. This information is valuable because it allows prioritizing the way the efforts should be addressed and in the case of having to choose where to begin the risk analysis, we should take into account not only the contribution to the total cost, but also the level of internal variability of resources.

Table 6.4. Statistics for the Relationship between the Type of Material and the Exams

Type of exam	Statistics			
	Min	Max	Mean	Standard Deviation
Support to other services	0,00%	1,62%	0,34%	0,75%
Gastrointestinal imaging	0,00%	0,87%	0,17%	0,50%
Ultrasound	0,01%	0,97%	0,22%	0,41%
Mammography	0,00%	2,49%	0,28%	1,28%
X-ray	0,03%	4,39%	1,05%	2,73%
Interventional/vascular radiology	0,00%	3,82%	0,46%	1,96%
Contrast-enhanced mri	0,00%	23,45%	2,71%	13,41%
Non contrast-enhanced mri	0,00%	0,01%	0,00%	0,34%
Contrast-enhanced computed tomography	0,00%	48,17%	5,50%	27,77%
Non contrast-enhanced computed tomography	0,01%	1,54%	0,48%	0,94%
Urologic imaging	0,00%	1,31%	0,25%	0,61%

After analyzing the processes and results, it was evident that these two exams were the ones that had the greatest impact on the total cost of materials in the provision of services. Therefore, they were considered as critical variables to be monitored and there was also an interest in measuring their impact in the total cost. Table 6.3 and Table 6.4 shown the variability associated to both the resources and the cost objects, allowing to define the inputs that must be taken into consideration to be modeled a good analysis of risk and uncertainty.

Due to the lack of consumption records for each patient, and because the service did not have the human or computational structure to know such information, we proceeded to obtain the information about the possible behaviors that the consumption of medicines could have from the knowledge of clinical staff. After several meetings, it was defined an empirical distribution based on the following hypothesis: it is possible to make improvements in processes that contribute to improve overall efficiency by 5%, however given the increasing complexity of patients, deterioration of equipment and other external factors, consumption could increase by 15%. These assumptions allowed to construct a triangular distribution for each of the variables identified as critical or with greater uncertainty.

Triangular distributions have been used in models in various studies carried out in hospitals in which it is intended to analyze uncertainty but there is little information to determine an empirical distribution,

examples of which are the studies carried out by: (Bhattacharjee & Ray, 2016; Mestre, Oliveira, & Barbosa-Póvoa, 2014; Zimlichman et al., 2013). One of the reasons for its use is that it only depends on three parameters. Triangular distributions are continuous probability distribution functions with lower limit (a), upper limit (b) and mode (c), where $a < b$ and $a \leq c \leq b$. The limits a, b and c are easy to understand and perceive for the people who are responsible for prestart or manage the services.

It was evidenced that both human resources and medicines associated with critical cost objects were similar, therefore improvements in efficiency in one of the services would probably be similar to improvements in the other similar service and in that same logic for the deterioration, so a correlation coefficient of 0.5 was included between the consumption of the materials for each of the medicines related to cost objects. The estimation of the correlations in this way is a weakness of this application, since it is based on the experience of the clinical staff and not on the real data, this weakness can be corrected with the existence of information for each patient or for each group of patients with similar pathologies.

We proceeded to simulate 20,000 scenarios using Crystal Ball. The analyzes are presented below taking into account that the values are presented in percentage terms; it is to say the CaR with 95% confidence was estimated as the 95th percentile of the distribution of the percentage difference of the total cost. In order to do this, we defined the input assumptions related to triangular distributions in the consumption of the associated drugs, the critical cost objects, the correlations were included and the output variable was defined as the total cost associated with the drugs for the total group of procedures.

Table 6.5 shows the simulation statistics and due to the conditions predicted above it is possible to expect an average variation of the total cost of 1.91%. It can also be seen that the range of variability is asymmetric, having a positive asymmetry which in terms of cost indicates that there is more probability of having growth than a decrease in costs.

This asymmetry can partly be explained by the increase in patient complexity that is expected and has been perceived by clinical staff. In turn, it influences growth in the expected cost for successive periods also because the lack of incentives of the clinical staff to improve the efficiency of the processes. In terms of contracting, these elements have several implications. Namely, monitoring and control activities should be carried out to reduce the consumption of these resources without affecting the quality of the service and this can be done using consumption records for each of the patients procedures that of not being interned, in order to improve efficiency.

In addition, these results allow to predict what can happen to the contract program in these services, and also classify the situations as normal or within the expected or at risk, which is a valuable information for decision makers.

Table 6.5. Simulation Statistics

	Variability Contrast-enhanced computed tomography	Variability Contrast-enhanced MRI	Variability of total Cost
Trials	20 000	20 000	20 000
Base Case	0,00%	0,00%	0,00%
Mean	2,60%	2,92%	2,15%
Median	2,26%	2,56%	1,91%
Mode	—	—	—
Standard Deviation	3,29%	3,78%	2,39%
Variance	0,11%	0,14%	0,06%
Skewness	0,3002	0,2710	0,3725
Kurtosis	2,31	2,27	2,53
Coefficient of Variation	1,26	1,29	1,11
Minimum	-4,27%	-5,09%	-3,06%
Maximum	11,04%	12,49%	9,49%
Range Width	15,31%	17,57%	12,55%
Mean Std. Error	0,02%	0,03%	0,02%

With respect to CaR related to the contrast-enhanced computed tomography, the contrast-enhanced MRI and the Total cost of Materials they were produced several analysis which can be evidenced in Figure 6.3, Figure 6.4 and Figure 6.5 respectively.

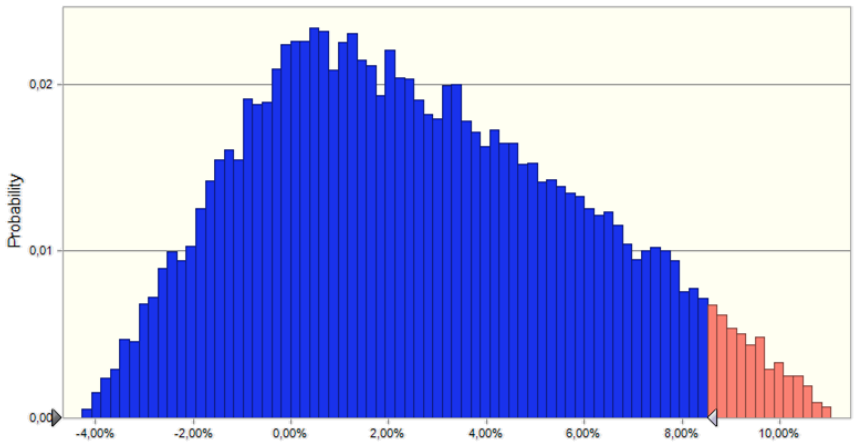

Figure 6.3. Variability of the Total Cost of the Contrast-Enhanced Computed Tomography

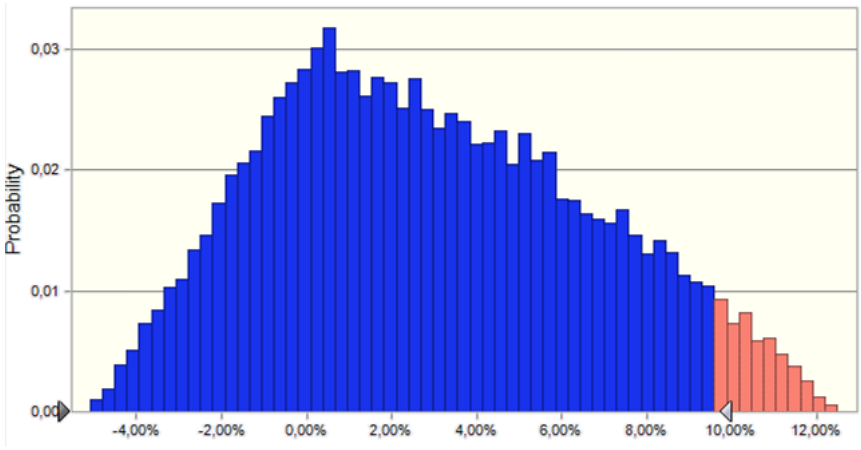

Figure 6.4. Variability of the Total Cost of the Contrast-Enhanced MRI

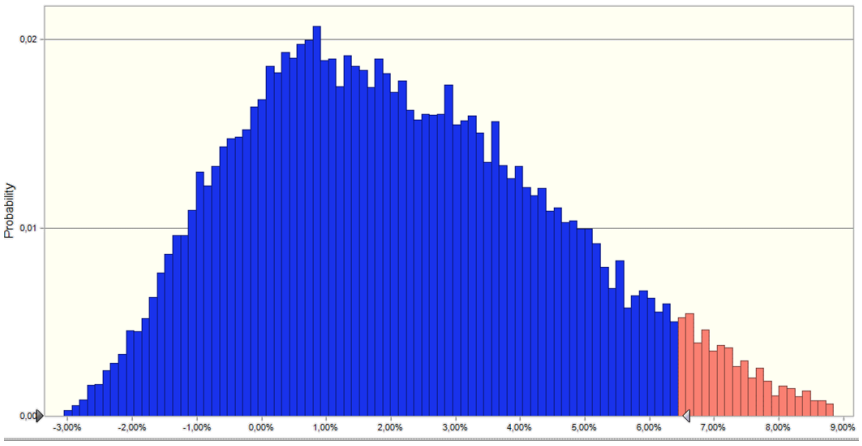

Figure 6.5. Variability of the Total cost of Materials

The figures show the percentage variation of these variables once the simulation process and it can be said that with the 95% confidence the CaR for each of them is 8.46%, 9.46% and 6.48% respectively, when considering these are critical since an increase of 6.48% could generate a non-compliance of the contract program in terms of cost.

In order to identify which of the variables has the higher impact in the total cost and therefore must be object of observation and control was performed a sensitivity analysis which is presented in Figure 6.

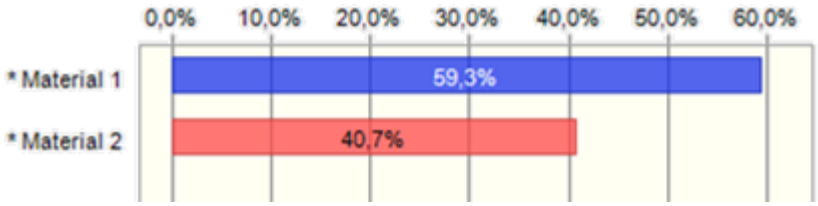

Figure 6.6. Sensitivity Analysis of Total Cost

This analysis showed that the material that contributes most to the variability of total direct costs is Material 1, which was considered critical and for which control measures were suggested, such as detailed records and greater control by the administrators of such resources.

Since the hospital is obligated to provide all health services demanded by patients' needs, this value indicates how important cost control and management is for the hospital and that measures should be taken in the logic of maintaining controlled activities that are critical and which can generate the increase in cost and can negatively influence the finances of the organization.

6.6 Conclusions

The model proposed here to deal with uncertainty and risk suggests that it is possible that the efficiency of a hospital does not only be function of internal processes and how costs are managed and allocated, but that results are also significantly influenced by the type of patients served by the hospital. In this case, unit materials cost is not constant, because such variable cost may vary significantly depending on the patient's own characteristics.

Managing the inherent uncertainty and imprecision associated to cost input parameters provides the user with information that can be useful for many proposes including product, activities and process decisions, bidding and budgeting activities, make-or-buy analyses, among others. Indeed, costing models that may deal adequately with uncertain are particularly beneficial in several contexts namely, when the company is operating in an uncertain environment, the input data is inaccurate or inadequate, when there is a lack of confidence in the accuracy of the estimated input data, when the level of overhead costs is large enough to affect relevant decisions, etc.

Measuring the uncertainty associated with costing systems will turn cost management more effective through for example a proper budgeting and a better financial risk management. Indeed, the identification of potential losses related to excessive or insufficient costs may permit to design contingency plans or propose intervention measures or strategies of risk mitigation.

Thus, cost management is really important for the understanding of the behavior of costs which is a task that is increasingly important given the variability in markets, prices, methods of work, among other aspects, which induce variability in the cost of the products or services. This variability can affect the efficiency of the organization by endogenous and exogenous elements; respectively, controllable and not controllable by the managers. Consequently, a better understanding of the process variability contributes for a better control of costs.

Cost management in hospitals is very important as hospitals and generally public services have fixed operating budgets and the only variable that can be controlled to improve their financial performance is the production cost. In addition, improving hospitals' compliance with budgets contributes to improved overall compliance in financial terms of the national health system, and non-compliance may also have negative impacts that may affect not only health financing but also the quality of the service provided. Furthermore hospitals are important because they absorb much of the budget dedicated to health within any country (Hellowell, 2013).

It is interesting that in hospitals there is an implicit variability due to the type of patients that are attended. This variability can affect the efficiency of the hospital by an exogenous element thus, not controllable by hospital managers and administrators. Furthermore, a better understanding of such variability contributes for a better control of costs.

The existence of variability generates risks in the fulfillment of the objectives namely, the fulfillment of what has been established in the contract or that has been budgeted. That is why risk measurement in costing becomes a key tool for decision making in organizations whose processes and services are subject to variability such as the case of hospitals. In addition, as mentioned by CII (2017) the most developed cost management models must consider the risk management associated with resources, activities and cost objects.

Within an organization, risk management is focused on achieving high performance objectives, as well as ensuring the stability and solvency of the company. There are different methodologies that allow companies to analyze the risk to which companies are exposed and that can be used to design strategies that can contribute to mitigating those risks. These methodologies range from the application of classical statistical models to computer simulations.

All this in order to generate decision-making tools that are consistent with the company's policies and strategies without affecting the expected returns and guaranteeing the fulfillment of what has been budgeted or contracted for a certain period of time.

In this sense, here it was proposed a methodology for the calculation of CaR. The model presented here for determining the CaR related to product costs is a model structured in two interrelated phases. Firstly, a deterministic model is constructed for determining the costs associated with the relevant cost objects. Secondly, a probabilistic model using Monte Carlo simulation is used to include uncertainty.

The Monte Carlo simulation models proposed here may allow to some extent to predict the risk associated with the variability in costs and support the necessary steps which should be taken to better manage such risk, whether from the point of view of processes rationalization and of management.

The existence of computational tools such as hardware (powerful computers) or software (i.e. Microsoft Excel and Crystal Ball) makes the Monte Carlo simulation a useful tool not only for risk measurement but also for organizational decision making at reasonable time and with a marginal cost lower than the marginal benefit of obtaining information related to the risk associated with the fulfillment of the contracted or budgeted objective.

Comparing our model with the models proposed by Nachtmann & Needy (2001), Namazi (2009) and Sarokolaei et al. (2013), we can highlight some advantages, in the first place the fact of presenting a structured matrix cost model for the determination of the cost, that can be adapted to a number of situations, taking into account the correlations between variables, the number of scenarios generated and the sensitivity analysis.

Another advantage is the fact of being structured following the logic of widely used models such as the VaR estimation proposed by (1999) and following the logic of the DAM what allows the model to be used in various situations following a series of logical steps (Sun & Faunce, 2008).

One aspect that stands out in this model is its flexibility to be adapted and applied in other environments. For example, this model was already applied in the estimation of the risk in coffee production (V Jiménez & Afonso, 2016), and is expected to be applied in other types of crops and production environments.

Furthermore, one of the advantages of use simulation has to do with the possibility of analyzing the impact of changes in production systems without having to incur in large costs. These changes can be derived from continuous improvement strategies, or derived from situations that cannot be controlled, in the specific case of hospitals can be derived from the patient's own pathologies, the number of patients, the installed capacity and their variability, among other factors. In other words, to the extent that reality can be modeled and simulated, the marginal benefit of the information obtained will greatly outweigh the marginal costs of obtaining such information.

These models take relevance in organizations to the extent that they serve to support decision making. For this reason, it is important that organizations understand the need to identify, quantify and manage

the cost associated with their products and services. Furthermore, they must understand the importance of including the uncertainty associated to resources and activities that influence the cost of the products and services. This will allow a proper management of the associated risk.

Further work can be done in order to develop and extend the proposed model and methodology. Namely, to compare the results of using a fuzzy technique versus the Monte Carlo method. On the other hand, it can be applied in other contexts or production environments. Also integrated computational tools can be considered to facilitate the access to the inputs and the generation of outputs.

7. CONCLUSIONS

Below are the conclusions of this research, first a summary of the most important aspects that were highlighted throughout the investigation is presented then, the main contributions are presented from a theoretical and a practical point of view; finally, the limitations of this study and the opportunities for future work are highlighted

7.1 Summary of the Research

A health system can be defined as the set of all organizations and resources whose sole purpose is to improve the health of individuals and communities. Within a health system, hospital organizations play a fundamental role not only because of the services they offer to the community, but also because they consume more than a half of the NHS budget in many countries (McKee & Healy, 2002).

Despite being an important element of modern societies, health systems in general face a set of problems, in both less or more developed countries. Some countries have large populations without access to care due to inequitable arrangements for social protection. Others struggle against the increase in costs due to inefficient use of resources, the increase in the complexity of diseases, or the increase in the aging population (WHO, 2005)

A more recent analysis shows that there is no better health system and that changes are needed. Health sector reform remains a key responsibility of the ministries of health (Kickbusch & Gleicher, 2012). In fact, there are many criticisms that the public sector has had in the last two decades for being insufficiently effective and efficient. New management accounting techniques have been developed in response to this criticism (van Helden et al., 2010).

In the Portuguese context, the situation is not different since approximately 8% of GDP is devoted to health. Hospitals play a relevant role in the NHS and a large part of the resources are dedicated to their financing, in a context where the costs associated with the provision of services are increasing. All these elements make cost management in hospitals a strategic tool to contribute to the financial health of the NHS.

There is evidence that the health system has some problems both in the structure and in the internal functioning of hospitals. The study by Deloitte (Deloitte, 2011) identified some problems associated with the Portuguese health system. Among these problems we can highlight the lack of financial sustainability of the system (weak or inexistent cost management), the inappropriate model and management of the organization, the lack of strategic planning, the inadequate planning and management of human

resources, the system is not centered on the citizen, lack of quality information, financing model and misallocation of resources, lack of clarity about the role of private entities, bureaucracy, legislative instability, little leadership and a culture of resistance to change.

In term of cost management in this investigation it was revealed that it is incipient since most of the hospitals only have a very basic cost accounting. It was also evident that the government has made efforts on the part of the government to implement measurement, control and cost management systems, however this has failed. The lack of appropriate cost management tools means that the measures that can be taken to contain costs do not really attack the inefficiencies in the system, which can lead to a reduction in the access of people to medical care. and, simultaneously, an increase in financing and the creation of (new) inefficiencies (Escoval et al., 2011).

One of the elements that evidenced these inefficiencies is related to the systematic breach in the contracts made externally (between hospitals and the government) and those made internally (between top management and its different services).

The internal or external contracting processes highlight two fundamental characteristics: the amount contracted and the price (cost) that the government is willing to pay. Here, cost management is relevant for decision makers, allowing to compare or corroborate whether the procurement processes accompany the real needs or characteristics of the provision of services.

With respect to production costs, one of the key challenges to ensure the sustainability of hospitals is the development of relevant and accurate information on costs to base strategic decisions, pricing and management (Capettini et al., 1998) of the (average) cost of the services offered in a hospital but given the large number of different activities, such intention is difficult and problematic (Llewellyn & Northcott, 2005)

The cost management in hospitals is very important since hospitals and, in general, public services have fixed operating budgets and the only variable that can be controlled to improve their financial performance is the cost of production. In addition, improving compliance with budgets by hospitals contributes to improving overall compliance in financial terms of the national health system, and non-compliance can also have negative impacts that can affect not only the financing of health but also the quality of the service provided. In addition, hospitals are important because they absorb a large part of the budget dedicated to health in any country(Hellowell, 2013).

Health hospitals have a series of characteristics that become challenges for the design and implementation of accounting and management control systems. Among these are: the complexity of the processes, the dominant control by the service providers or the producers of essential commercial

processes, the existence of multiple (and some conflicting) objectives, the rules imposed by internal and external entities that sometimes contradictory, highly politicized atmosphere because most hospitals are financed with public funds or depend on any philanthropic or religious entity, among others. In addition, organizational rules tend to avoid the use of monetary incentives as mechanisms to achieve congruence of objectives. While other industries may experience the effects of some of these factors, they do not face the confluence of all, such as hospitals (Abernethy et al., 2006).

The administration of costs in hospitals is a complex task, not only for the provision of services but also for the large number of variables that influence the consumption of resources and, therefore, the final cost of the provision of services. This chapter discussed cost management from a glance at transaction costs and its relation to the contractual process.

Given the structure of the NHS and the payment system in Portugal, the contract is a fundamental tool for the provision of quality services that guarantee the coverage of the population.

Because a system based on DRG is used, the payment received per patient attended is generally fixed, so improvements in financial results must be in two ways, maximizing capacity utilization or being more efficient in managing resources, which will be reflected in revenues above costs and generates financial sustainability of this type of institutions without sacrificing quality in the provision of the service.

The complexity of the system increases because in addition to the external contractual process, an internal hiring process must be carried out that must be integrated in order to comply with the requirements of this funder, which in most cases is the government.

Within hospitals, a cost management system should provide cost information for strategic positioning, for negotiation processes with financing entities, for planning, monitoring, control of administrative operations and clinics. To achieve this goal, costing systems must be able to determine the cost of relevant cost objects, so that budgets can be constructed and forecasts can be compared with actual performance (Nackel et al., 1987)

One of the objectives of this research was to understand the dynamics of cost management practices in Portuguese hospitals. Among the findings was the lack of adequate cost management systems in hospitals, however it was pointed out that a cost management system is not only part of having a cost determination tool but also part of the engagement and organizational culture around of the costs that in most of the hospitals participating in this investigation was practically non-existent.

Regarding cost management one of the pillars is the costing methodology that is used, . This thesis focused on the analysis of tools for cost management, highlighting the importance not only of the methodology but also of the importance of the design and implementation phases of a costing system.

Accordingly, it was proposed to use project management methodologies (Scrum methodology in this research) to increase the probability of success of a costing system.

The costing system must be designed taking into account the needs of each hospital and its organizational structure. Furthermore, it must be a process that is built with the stakeholders. In this sense, the Scrum methodology provided elements that allowed us to glimpse that the costing system must be built with the organization and not based on a predefined costing system that is simply applied.

Another element that can also affect the level of compliance with the contracts has to do with the internal and external variability. For that, this thesis also proposes the CaR model with the objective of having a model that allows not only the estimation of the cost but also the calculation of the risk associated with internal contracting processes carried out in hospitals.

A more relevant basic conclusion has to do with the fact that the contracting process is complex. And it is complex due to the existence of some problems or difficulties in the Portuguese health system which are related to the asymmetric geographical distribution of health facilities and human resources, poor sanitation, not universal population coverage (although there is no accurate estimate of coverage), there is no coordination between existing facilities and providers and little evaluation, multiple funding sources and a disparity of benefits among different population groups, centralized decision making, discrepancy between legislation and policy, and the low real provision of health services and the low remuneration of health professionals (Barros et al., 2011a).

Therefore, a significant number of problems of the health system are identified, many of them related to centralized decision making and the difference between the law and what is done in practice, these two were studied in this research focusing mainly in the impact they have on the management of hospital costs.

In addition, the debate between (more) centralization or decentralization is an important issue on the agenda of stakeholders. Some authors show that decentralization is an omnipresent feature of health sector reform worldwide (Collins et al., 2000). Indeed, decentralization is an important question in the debate about the Portuguese health system. The National Parliament that produces the law and defines the general rules of the NHS, repeatedly considers that one of the qualities that the system should have is to be more regionalized and decentralized and characterized by participatory management (Assembleia da República, 1990; Barros et al., 2011b; Simões et al., 2017)

This lack of autonomy has sought to be corrected by the legislation for the creation of responsibility centers which would give more autonomy to the intermediate management levels within hospitals and theoretically would increase the overall efficiency of the hospitals and therefore of the NHS.

Responsibility centers are organic middle management structures, dependent from top management of public hospitals of the NHS, which have functional autonomy and establish a commitment of economic and financial assistance, negotiated over a period of three years (ACSS, 2017b).

Nevertheless, the inherent delegation of authority implicitly would generate problems of agency and it is here that agency theory has a fundamental role to understand this type of relations. Normally, the agency theory argues that the delegation of power generates agency problems, which will be greater or lesser in the measure that the objectives of the principal and the agent are aligned.

When the objectives are aligned, the agent will work to maximize the utility function of the principal. When the objectives are misaligned and there is information asymmetry, the agent will work to maximize its utility function without taking into account that of the principal. To adjust the objectives, normally the principal will incur agency costs that are normally associated with control and incentives (M Jensen & Meckling, 1976; Segrestin & Hatchuel, 2011).Although the spirit of the law points to a decentralized system and the autonomy of the RHA with respect to budgeting and spending, it is not completely autonomous and the central authority still sets budgets. In addition to the same central authority, the Ministry of Health designates the boards of hospitals (Barros et al., 2011a)

An attempt was made to delegate at a hospital level the responsibility allowing the lower level managers to make the use of resources more efficient, for which responsibility centers were created. The objective of these was to better coordinate medical specialties, cost administration and strengthen competitive advantages. However, there are currently very few examples of responsibility centers because their creation was never effectively promoted. Few centers were created, many in practice, never have existed and some were rapidly eliminated (Barros et al., 2011a).

In this study it was corroborated that although it was legislated, responsibility centers practically are non-existent for departments or services within hospitals. Furthermore, this is not only a problem of the lower management levels, there is also a lack of autonomy in top management. In addition, it was shown that the responsibility centers will only become relevant if the autonomy is real and not simply theoretical, as it is until now, where most of the decision-making processes are centralized, whether in top management or in the government itself.

From the point of view of the agency theory there are at least two important elements that contribute to align the objectives, the control and the incentives. In the case of hospitals, effective control would force to have information and cost management systems and incentives which are nonexistent. Furthermore, in the case of hospitals, aligning objectives is not an easy task due to the multiplicity of objectives from the point of view of production, for example, for the image service, producing more is not necessarily

better, differently from the area of surgery, where the hospital is funded by each surgery. This diversity of objectives, and the existence of multiple agents, place hospitals as a typical case for multiple agency theory (Arthurs et al., 2008).In this context, other important costs are those related to the transactions themselves in the internal contractual process. Based on the model presented by Castaño & Mills (2013), it could be evidenced the existence of transaction costs that, given the complexity of the service provision. The contracts may be due to variables (such as intangible costs) that are not considered from a financial perspective, but that are related to the quality of service provision.

In some cases, the intangible cost are so high that even if a procedure outside the hospital is financially cheaper, the most appropriate and rational decision is to perform it within of the hospital. Normally intangible costs are related to aspects such as the psychological pain to the family and loved one, the pain, the anxiety and the depression and the reduction of the desire to consume food or medicines (Akazili et al., 2008; Haines & McPhail, 2011; Kirigia et al., 2009). These elements cannot be quantified by a costing system. The existence of intangible cost is related to the decrease of the quality of life of the patient or the worsening of his/her health condition.

An important conclusion of this research is that the contracting process and cost management must go hand in hand, and useful management tools should be designed and used to understand and deal with the inherent complexity of hospital systems.

7.2 Theoretical Contributions

The theoretical contributions of this research project are related to domains of the agency theory and the transaction cost economics, and considering the hospital autonomy and the responsibility centers. These topics were considered in Chapters two, three and four of this thesis. A first contribution is related to the fact that the implementation of responsibility centers will only be successful to the extent that they are supported by cost information systems and the intermediate managers are given autonomy to make decisions related to the management of resources.

This proposition showed that cost management systems should be considered as a fundamental element for control in where there is a principal and agent relationship. Here a relationship arises between the agency theory and the costing systems. In short, in the case of hospitals one of the agency costs is related to the cost of obtaining information, which should consider the cost of designing, implementing and maintaining a costing system in operation.

Furthermore, as the relationship between compliance with the contract and autonomy can generate virtuous circles for those who generate strategies to achieve which will allow them to improve their management systems and, inversely, vicious circles for those that do not comply due to lack of autonomy to make decisions and deteriorate their administrative processes.

The idea of hospital autonomy (and the problems of agency) linked solely to the fulfillment of the contract from the financial point of view as it has been raised from practice (SNS, 2016), and from theory with theories such as the agency theory can pervert the system since the agents could endeavor to comply with financial objectives and sacrifice quality, this is why the agency theory should consider variables such as the type and quality of the service.

One of the postulates of the TCE is that the organizations exist to replace the market when the costs of acquiring in the market added to the costs of controlling the relationship exceed the costs of carrying out the activities internally.

However, it can be observed that organizations such as hospitals do not necessarily comply with this postulate, since although the internal costs may be higher, the nature of the service, the installed capacity and the legislation does not allow outsourcing of the services ("buying" in the TCE language). This is in line with what Ghoshal and Moran (1996) and Balakriailshnan, Eldenburg, Krishnan and Soderstrom (2010). They mention, that organizations are not mere substitutes for the structuring of effective transactions when markets fail. Organizations have unique advantages to govern certain types of economic activities through a logic that is very different from that of a market.

TCE is "bad for practice" (Ghoshal & Moran, 1996),because it does not recognize this difference. That is, the decision of organizations to carry out their activities inside or outside of it must be analyzed not only from the point of view of costs but also variables such as the type of service, the quality of service and the regulation itself. In summary, the contribution presented here is related to Williamson (2005; 1985) approach which emphasize that the fact that transactions are organized within a company or between autonomous companies is a decision variable and that the selected form will depend on the transaction costs of each alternative. This premise is not met in all cases because in the case of hospitals it is not only the cost but also the quality of the service that matters. Or, in other words, it could be applied if the costs associated with the quality of the service were considered among the transaction costs. Another important element in the decision process in the TCE is the costs themselves. In TCE postulates, the process of obtaining costs is known, it is assumed (Tadelis & Williamson, 2012), or costs are considered easy to be calculated with the exception of the transaction costs. However, for hospitals and interesting factor has to do with the complexity that exists in the estimation of the production costs, which

are influenced by variables such as the number of medical prescriptions, the characteristics of the patients themselves have the same pathology, different secondary pathologies, the type of resources available in the institution, among others.

Something that stands out in the hospitals has to do with variables that can generate costs in addition to the cost of production and are related to the contractual process and there stands out the TCE when trying not only to recognize those costs but also to quantify them in some way.

In addition to these aspects, factors such as the support of information and communication systems, the receptivity to change, the existence of cost management policies, make it difficult to estimate the transaction costs, these topics are not widely discussed in this context of the TCE.

An important decision in TCE is related to make or buy a product or service, for Walker & Weber (1984) Williamson, Williamson (1988) and Tadelis & Williamson (2012) and this decision depends mainly on production costs and governance costs. In the analysis of the make or buy process of hospitals, other variables emerged that can be viewed as a contribution to the TCE.

One of the main contributions of this research was that in including two important variables in make or buy decision making, the first one has to do with the internal transaction costs derived from the hospital's own internal contracting process from the costs of administration. Internal transaction costs in turn generate transaction costs such retention costs of medical personnel and costs of control of the internal contract itself. That is, in the hospital structure there is a double decision process from the point of view of the TCE since the decision to make internally also has within it an internal negotiation process that generates transaction costs.

The second has to do with the costs of intangibles, which are related to those incurred or if the decision was to carry out a process that could deteriorate the patient's health or their critical situation, resulting in not only affecting the patient but also making the total cost, including treatment and possible re-hospitalizations, higher than the cost of having treated the patient internally since the initial cost was greater than treating the patient outside hospital facilities.

The consideration of these variables in the make or buy decision is in line with the study of Madhok (1996), where they show the importance of including variables associated with the organizational context and the benefits obtained by performing activities within the organization. This study shows specifically these two variables which were adapted to the hospital context.

7.3 Practical Contributions

The practical contributions are related to chapters five and six of this thesis. The contributions are related to the area of project management for the design and implementation of costing systems and with advanced techniques of costing for risk management. Last years, companies have made great efforts to determine the costs of their products or services, since different methodologies were designed and implemented to estimate the costs, a methodology that has had a lot of acceptance has been the cost based on activities (ABC).

Although technically it is a methodology that helps to allocate costs in a logical way and in many cases better than other methodologies for cost calculation, there is evidence that some organizations have had problems with its implementation, and in extreme cases it has not been successful (Shields, 1995).

An example of this is what happened in recent years with hospitals belonging to the Portuguese health system. The Portuguese Ministry of Health wanted to implement an ABC cost system in the country's hospitals and a pilot project was carried out that failed (Escoval et al., 2010). One of the causes of this failure is related to the fact that the focus was on technical aspects and little attention was paid to the organizational culture and the particularities not only of the hospital sector but also of each hospital.

Hospitals are complex organizations, not only because of the type of service they offer, but also because of the diversity of human, physical and computer resources that must be integrated to provide the service. In addition, because budget constraints, organizations must be committed to improving the efficiency of their services. In this context, a cost system can help in this type of organizations because its complexity and the design and implementation of a cost system must be accompanied by a good project and cost management that join together to increase the probability of success of said projects. For the implementation of a cost system to be effective, it requires that the administrative staff be really dedicated to its implementation after having an active part in its development. But also the operating personnel must be part of the design and implementation process because they are the ones who "create" the information that will feed the cost system.

Here the first contribution of this thesis which is related to them is related to include project management tools for the design and implementation of a costing system in hospitals, in this case in particular the use of the Scrum methodology, with the objective of increasing the probability of success of these systems.

Applying the Scrum methodology for the design and implementation of costing systems is very interesting because allows the active participation of stakeholders, which increases the degree of acceptance of the system by the operating and medical personnel related to the processes.

In addition, the Scrum methodology allows the costing system to be adapted to the needs of the organization and allows the early identification of problems that, in a traditional costing system, are only perceived at the end of the implementation. An example of this was the inclusion of cost drivers for direct materials instead of dedicating resources to their estimation. The use of this methodology highlights the importance of having a technique for determining the cost of information systems and organizational culture on the importance of cost management, cost conscious, which are factors that contribute to the success of a costing system (Gosselin, 2006). The application of the Scrum methodology for the design and implementation of cost systems is very interesting because it allows the active participation of interested parties, which increases the degree of acceptance of the system by operational and medical personnel related to the processes. Although the Scrum methodology has been used mainly in software development, it was evidenced that it can be used in other contexts.

One of the elements inherent to hospital processes has to do with the variability (internal and external). In this thesis it is highlighted the importance of recognizing variability in the contracting process. To help this contribution we proposed a matrix cost model that includes uncertainty using computational simulation processes. The model proposed here to deal with uncertainty and risk suggests that it is possible that the efficiency of a hospital is not only a function of internal processes and how costs are managed and allocated, but also that the results are also significantly influenced by the type of patients served by the hospital.

Managing the inherent uncertainty and inaccuracy associated with cost input parameters provides the user with information that can be useful for many proposals, including decisions about products, activities and processes, bidding and budget activities, manufacturing or purchase analysis, among others. In fact, costing models that can deal adequately with uncertainty are particularly beneficial in several contexts, that is, when the company is operating in an uncertain environment, the input data is inaccurate or inadequate, when there is a lack of confidence in the precision of the estimated input data, when the level of general costs is large enough to affect relevant decisions, which are typical characteristics of hospitals.

Comparing our model with the models proposed by Nachtmann & Needy (2001), Namazi and Sarokolaei et al.(2013), Our model presents some advantages, firstly, the fact of presenting a cost model of structured matrix for the determination of cost, which can be adapted to a series of situations with ease, the inclusion of correlations between the variables and the fact of using simulation allow multiple scenarios to be evaluated in a reasonable time for decision making.

Another advantage is the fact that it is structured following the logic of widely used models, such as the VaR estimation proposed by Group (1999) and following the logic of the DAM, which allows the model to be used in various situations following a series of logical steps (Sun & Faunce, 2008)

7.4 Final Considerations

A word that describes the body of our research is uncertainty. The uncertainty is present in all or almost all the elements raised in this research. The uncertainty generates that the estimation of the cost of services in hospitals is a complex process, practically impossible to standardize since each patient is unique, each pathology is unique and there are multiple ways to treat them.

The uncertainty in the number and type of patients can be the reason why the contract program is not fulfilled even if the hospitals work efficiently. Uncertainty influences the hiring process since its existence generates difficulty in controlling processes and increases the cost of controls. In addition for more controls that exist the uncertainty can come not only from the process, it can come from the behavior of the patient, from new and innovative processes, from the behavior of the doctors or from other elements that are difficult to control however that can arise at any time .

Uncertainty also generates that although the objective is clear in the implementation of a costing system, the way to implement it is not so clear. Despite so many cons of uncertainty, it can and must be measured in order to understand it, control it or simply eliminate it.

It is important that organizations understand the need to identify, quantify and manage risk as a complementary element to the development of the activities for which it was established. A proper management of risks allows hospitals to concentrate on the objectives of compliance with the contract, with high quality standards in the provision service, guaranteeing stability and financial solvency.

In this thesis, all the elements (theoretical and practical) addressed the problem of variability, uncertainty and risk inherent in hospital care from different perspectives, be it in the contractual process (Agency theory and TCE) or in the management processes. (Scrum Methodology and CaR).

All these tools allow hospitals to understand the risks to which they are exposed and to create measures to mitigate them.

7.5 Limitations of the Study

Below some limitations related to this study are presented, which in turn can be the origin for future research. One of the first limitations of the study has to do with the size of this research, since different areas of knowledge in economics, accounting, projects, engineering and management were covered. The mere complexity can be a difficulty and a limitation for the analysis.

Another limitation may be related to the theoretical approaches used in this thesis. Regarding the theory of the agency in analysis, it was based on an analysis from an economic perspective and aspects related to the quality of the service were not deepened (Segrestin & Hatchuel, 2011).

On the other hand, with respect to the TCE, the theoretical analysis is carried out mainly in the approaches of Williamson (1985) from the point of view of management and costs without exploring the behavior process (measurement of the level of opportunism and bounded rationality) of the stakeholders of the contractual processes (Hoti et al., 2011; Pepper & Gore, 2015).

With respect to research methodologies, one of the limitations was the number of participants in the interviews, despite having made a great effort on the part of the researcher, the number of people interested in responding to the interviews was small. However, this limitation was mitigated by having two of the five main hospitals in the country and having a public private partnership hospital. Furthermore, the use of a single case study does not allow the generalization of a phenomenon (Yin, 2009). To overcome this limitation, it is possible to carry out a multiple case study or a survey to validate the results obtained in this research.

7.6 Gaps and Suggestions for Further Research

The main suggestions for further research are related to various fields of knowledge, economics, cost management, engineering and hospital management.

Chapter 3 of this thesis highlighted the importance of TCE to understand the contracting processes in hospitals using semi-structured interviews. To validate some results and allow to generalize them, one of the future works has to do with the application of a survey to all Portuguese hospitals. To get a good response rate the idea is to present the project to the Ministry of Health and that the survey is applied by this means.

In order to broaden the spectrum of work, future work has to do with applying the results in other countries and carrying out a comparative analysis to determine if the results are typical of the Portuguese context or if they are typical of hospital systems.

Another important element of TCE has to do with the measurement of the transaction costs, a later work has to do with the design of costing systems to estimate the transaction costs.

Another future work is related to the adaptation to the hospital environment and the application of econometric models such as that of (Ludwig et al., 2009) which allows analyzing the impact that make or buy decisions have on efficiency.

In Chapter 4 was presented the relationship between autonomy, agency theory and cost management was highlighted using a single case study, the idea is to extend this study with a multiple case study that allows to reach more general conclusions on these topics.

Another future work has to do with the determination of strategies to align the objectives between the principal and agent in a multi-agent environment (Arthurs et al., 2008; Segrestin & Hatchuel, 2011).

In this work we also find that despite the idea of responsibility centers being conceived theoretically, after many years has not yet been implemented, in this sense a future work has to do with an action research for the implementation of a responsibility center taking into account the current legislation (SNS, 2017c), or another form of government allowed by the hospital's internal regulations, and that has autonomy for the management of resources (London, 2013; Simões et al., 2017).

In Chapter 5, the Scrum methodology was used for the design and implementation of a costing system in a hospital. In this topic, future work can go in several directions. Applying the methodology to other departments or hospitals. Apply another project management methodology and compare the results with the Scrum methodology. Perform a longitudinal analysis to measure the success of the costing system implemented with the Scrum methodology, and compare it with other implementations where the traditional approach has been used.

Finally, Chapter 6 presented the concept of CaR for estimating the cost of the products and the risk associated with the contracts. A future work is related to the application of this model to the entire hospital organization. Also work in conjunction with medical personnel and information systems to design and implement computer tools that make this tool friendly for the decision makers.

Thus, this thesis proposed a methodology to measure risk in the context of cost management activities and costing systems. Normally there are methodologies for measuring risk in financial elements but not in production environments and this is one of the major contributions of this work. Further work can be made to estimate CaR with other parametric, non-parametric and semi-parametric methods, in addition to applying this concept in other cases. A very natural extension of the model proposed in this research is its application to other contexts.

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APPENDIX I– THE INTERVIEW PROCESS

Interview protocol

- ✓ Get contacts from hospital administrators and top management
- ✓ Contact interviewees via email
    - Use institutional electronic mail, carry out standard mail and make telephone contact
    - Present yourself professionally
    - Define interview motives and objectives
        - Send page with interview information.
    - Talk about data confidentiality policy
        - Send a confidentiality term model
- ✓ Schedule interview…
- ✓ Conduct the interview
    - Brief presentation of interview project and objectives
    - Ask the questions in the guide
    - Record the interview (A Sony recorder ICD-PX33 was used)
    - Make copies of the interview on the personal computer and on the investigator's hard drive)
- ✓ Transcribing interviews (1 hour of interview involves 6-8 hours of transcription)
- ✓ Coding of the interviews (software Atlas Ti 8.0)
- ✓ Preliminary analysis and production of individual reports
- ✓ Further individual analysis of interviews and overall analysis of all interviews
- ✓ Produce key findings, findings and conclusions, and share final executive report with respondents

APPENDIX II– GUIDE FOR INTERVIEW SCRIPT DESIGN

Several months of research were used to design the script of the interview. An iterative process was used that took into account the research questions, the objectives, the bibliographical references, experiences in terms of research methods, case study, action research, etc. and discussions with my advisor.

In this process, can be defined in three great moments each of them with great discussion by means. The the first instance has to do with the definition of the topics to include in the interview. After a literature review and several weekly meetings with my advisor, a first version of the script was made, in this one, four main topics were defined: organizational structure, costing systems, variability and elements associated to TCE and agency theory. Once these topics were defined, we proceeded to validate with a hospital administrator if these topics made sense for the hospital environment.

After defining the topics, several bibliographical sources were consulted to analyze not only the form but the content that should have each of the questions contained in those great topics, among those sources are highlighted: ((Boučková, 2015; Cardinaels et al., 2004; Castaño & Mills, 2013; D. Collins et al., 1999; Fama, 1980; Gosselin, 2006; Michael Jensen, 1983; Toma, Chiriţă, & Şarpe, 2012; Verbeeten, 2011; Williamson, 1985)). After analyzing and discussing this literature it was allowed to have a second version.

Once with the second version, a pilot with a hospital administrator was conducted to see what aspects had to be refined, in order not only to have an interview that addressed the aspects of interest, but also to be coherent and within of a reasonable time, which allowed to create the third version that is shown in Appendix III.

The version in Appendix III contained the questions for the investigator i.e. those used to prepare and conduct the interview, from which a summary script was created, as shown in Appendix IV, in which it was sent to the respondents previously to the interview as explained in the protocol presented in the Appendix I

APPENDIX III– GUIDE FOR THE RESEARCHER

SEMI STRUCTURED INTERVIEW

Cost Management in Hospitals:

ORGANIZATIONAL STRUCTURE - AUTONOMY - VARIABILITY - UNCERTAINTY - TRANSACTION COSTS

Version 1.3

1. Organizational structure, autonomy and decision making

1.1. Organizational and hierarchical structure of the hospital and decision-making process. It serves to describe the structure

- 1.1.1. Vertically: Management, Managers, Directors, etc.
- 1.1.2. Horizontally: similarities and differences between departments and services, etc.
- 1.1.3. Is there conflict of objectives in the two previous dimensions? How these conflicts are managed.

1.2. Is the management of resources / costs through responsibility centers or in other ways? The importance of cost management / costing systems / adequacy to what is defined in the law

1.3. How is the decision making process in the planning, allocation and management of resources (acquisition and internal activities). It serves to see if it is more centralized or decentralized (autonomy) and to classify according to the TCE the governance structures: markets, contracts or vertical integration (this should be because it is an internal process)

- 1.3.1. Who has an active role in this process?
- 1.3.2. How decision making (process) is performed.
- 1.3.3. How much (amount) and Why (criteria) is distributed?

1.4. Degree of autonomy in the decision making in function of the organizational dimension. It serves to see in more detail the level of autonomy (concentration / decentralization) and under different dimensions (strategic, operational ...)

- 1.4.1. At the planning and strategy level (options and long-term decisions)
- 1.4.2. At the level of Operations (to connect with the 3 dimensions of the cost of prod)
  - 1.4.2.1. Decisions relating to human resources (labor).
  - 1.4.2.2. Decisions relating to the purchase of materials.
  - 1.4.2.3. Equipment and services, logistics decisions, suppliers and service providers.
- 1.4.3. At the level of Resource Distribution
  - 1.4.3.1. How is the allocation of budget resources accomplished?
    - 1.4.3.1.1. A default value for each department?
    - 1.4.3.1.2. Does it receive as a function of "production" (e.g. treatments performed)?
    - 1.4.3.1.3. A combination of the above? Otherwise?

2. Hospital cost management / Costing

2.1. Management of hospital costs (accounting, costing, control and cost reduction)

- 2.1.1. Who has an active role in this process.
- 2.1.2. How it is performed (process).
- 2.1.3. Why is it done this way?

2.2. Costing system (Design, operation and use of costing systems)

2.2.1. Is there a system of costing / criteria common to all departments of the hospital (Does information systems provide clear, continuous and consistent information)?

2.2.2. How is the process - design - the design and implementation of the costing system generally developed?

2.2.2.1. Problems in design or implementation.
2.2.2.2. Degree of satisfaction with the current costing system.
2.2.3. Costing methods: absorption, variable, standard, activity-based, ...
2.2.4. Most important resources and activities.
2.2.5. Relevant cost objects.
2.2.6. Calculation processes (information systems involved, costing systems, etc.).
2.2.7. Difficulties in calculating costs.
2.3. Use of cost information
2.3.1. What cost information is used / analyzed (outputs).
2.3.2. Who uses / analyzes this information and Why?
2.3.3. How this process is performed and how this information is presented.
2.4. Control costs of the costing system and other costs borne by the hospital (transaction costs)
2.4.1. Monitoring (Who, When, How, About?)
2.4.2. Other costs (e.g. legal cases or additional costs)
2.5. Control activities and incentive policy
2.5.1. Is cost information important for control activities?
2.5.2. Incentive Policy. Costs of retention of doctors and specialized personnel (Incentives to stay in hospital, compliance clauses).
2.5.3. Is there any compensation associated with the level of "production" of doctors?
2.5.4. Is this information associated with the incentive policy?
2.6. Satisfaction / success of cost management
2.6.1. Positive aspects to highlight.
2.6.2. Negative aspects to highlight (e.g. problems, limitations, ...)
2.6.3. Cost information quantity: low / abundant, width / depth.
2.6.4. Cost information quality: reduced / high.
2.6.5. Degree of Use of cost information for decision making: reduced / high.
2.6.6. Type of Decisions that are taken based on the available cost information: strategic / operational.
2.6.7. Impact of cost information on financial performance: reduced / high.
2.6.8. General perception of the advantages of cost management.

3. Variability, Uncertainty and Risk

3.1. Internal variability of costs # (Is related to variability in service delivery, i.e. variability from one treatment to another and how this affects the factors of production)
3.1.1. Does it happen? Where, departments, ... is important / significant, there is perception of this variability and its importance / impact / problem, ...
3.1.2. At the level of cost of activities and cost objects ...
3.1.3. At the level of the cost of production: in the materials, in the direct labor, in the general expenses.
3.2. External cost variability (Related to demand variability and capacity management).
3.2.1. At resource level (and capacity management)
3.2.2. At the demand level *
3.3. Are Uncertainty and Risk management models associated with cost variability?
3.4. Impact of variability on contract program?
3.4.1. With external entities (e.g. ministry of health).
3.4.2. Internally.
3.5. Level of uncertainty (Related: the system and information, doctors and administrators, the market)
3.5.1. Technological
3.5.1.1. At the level of information systems (substitution, changes, ...)
3.5.2. (E.g. at the level of health worker behavior)
3.5.2.1. How is the efficiency of doctors and administrators measured (indicators that are used)?
3.5.3. Of market
3.5.3.1. Quantity and type of patients.
3.5.3.2. Uncertainty of suppliers (Quantity, Price).

4. Theories (TCE and Agency Theory)

4.1. Context (Existence of asymmetry in cost information, and difficulties in measuring results and comparability of results)

4.1.1. Is there an asymmetry in the cost information between the Principal / Agent?

4.1.2. Difficulty defining the "production" and definition of relevant cost objects.

4.1.3. Difficulties in measuring / clearing and recognition / verification of the output / output of each department?

4.2. RSA / Relationship between Principal and Agent (eg Contract, Contractual, Formal, Informal, Implicit, Explicit, Degree of exclusivity of medical or administrative personnel, Degree of specificity of information systems and equipment used to provide services)

4.2.1. Can budget distribution change during the year? How are contingencies controlled (Will budget changes depend on what factors)?

4.2.2. Specificity of assets

4.2.2.1. Humans

4.2.2.1.1. Degree of specialization of doctors, hospital administrators? And hiring process (there is exclusivity of doctors).

4.2.2.1.2. Degree of difficulty in finding doctors who can substitute others (which, how it is managed when a doctor or administrator stops offering his services).

4.2.2.1.3. There are training programs for employees financed by the hospital (i.e. doctors or hospital administrators).

4.2.2.2. Physicists

4.2.2.2.1. There is specific software designed for medical processes or information exchange - who provides this software? How is the process of adapting to new information systems by users?

4.2.2.2.2. Specific equipment for the provision of services (how are decisions made to purchase equipment? Are there procedures for the sale of equipment that the hospital no longer uses?).

4.2.3. Existence of outsourcing and provision of equipment and human resources (eg specific equipment, medical) (% of outsourcing, what kind of processes?).

APPENDIX IV– GUIDE FOR INTERVIEWEES

SEMI-STRUCTURED INTERVIEW GUIDE

Cost Management in Hospitals

1. Organizational structure and decision making

1.1. How is the organizational and hierarchical structure of the hospital organized and how is the decision-making process developed?

1.2. How is hospital resource management performed? How do centers of responsibility or other forms of organization and management of resources work?

1.3. How do you make decisions regarding the planning, allocation and management of resources (acquisition of inputs and internal activities)?

1.4. How is the decision-making process developed at the strategic and operational level, particularly at the level of resource allocation?

2. Cost Management and Costing Methods

2.1. How is hospital cost management developed in accounting, costing, control and cost reduction (who, how and why)?

2.2. What costing systems does the hospital have? How are these systems designed and implemented? What are the most relevant features, activities, and cost objects.

2.3. How are cost management activities controlled and what are the costs involved in this process?

2.4. Control activities and incentive policy. Are there? How do they work?

2.5. How satisfied are you with costing systems and cost management?

3. Variability and Uncertainty

3.1. How is internal cost variability managed? (Related to materials consumed, processes, etc.). Where does the internal variability of costs take place?

3.2. Does uncertainty affect the contract program? In what way (internally, externally)?

3.3. Risk or uncertainty management models or practices are used.
How is uncertainty related to information systems managed, with the activity of doctors, administrators and the market / users?

4. Transaction Cost

4.1. Is there an asymmetry in the cost information that is available? Is the information provided not the same or does not have the same degree of detail for all stakeholders?

4.2. Is it difficult to define the "production", the definition of relevant cost objects, and the measurement of results, the verification of outputs and their comparability? Are there specific indicators for comparing results from different processes, services and departments?

4.3. How is the (contractual) relationship between the different actors involved in the decision-making process on the management of resources (costs): contract, contractual relationship, formal, informal, implicit, and explicit?

4.4. Is the degree of specificity (involving difficulties in replacement) of medical and administrative staff reduced or too high? Are there differences at the level of the various departments, services, functions, hierarchical levels?

4.5. Is the degree of specificity of equipment, information systems and equipment used (implying that they are targeted for specific applications) in the provision of services small or too high? Are there differences at the level of the various departments, services?

4.6. Is the level of outsourcing (external) and service delivery abroad of equipment and human resources (doctors and other employees) reduced or too high? Are there differences at the level of the various departments, services, etc.?

APPENDIX V– MODEL OF CONFIDENTIAL TERM

TERM OF CONFIDENTIALITY

Project title: **The dynamics of cost management practices in Portuguese hospitals**

Principal Investigator: **Victor Javier Jiménez Carabalí**

Institution / Department: Department of Production and Systems, **University of Minho**

Phone: +**351 964754371**

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Interviewee: **Name**

Location of data collection: **Hospital**

Date: **day / month / year**

This research project intends to understand the dynamics of cost management practices in Portuguese hospitals. The study will consist of a series of semi-structured interviews supported in a script sent in advance to the participants. The expected duration of the interviews is approximately 60 minutes. Interviews may be supplemented with additional material on the hospital if respondents consider it relevant. Whenever authorized, interviews will be recorded and then transcribed. The preliminary analysis of the interviews will be presented in the form of a brief report that will be made available to the participants in order to allow them to validate the results obtained and the analysis performed. Participants may opt for anonymity, in which case there is no mention or reference to the organization and interviewees in the material produced at the level of individual reports and the overall report. All information collected will be treated and disseminated within the academic scope of this research project. The results to be published will be based on the produced reports that will be sent and validated in advance by the participants.

The researcher of this project undertakes to preserve the privacy of the participants and the data obtained, through recording and interview notes, which will then be transcribed and analyzed. The information collected will be used in the scope of this investigation and will be treated in compliance with the law of protection of personal data - Law no. 67/98 "Personal Data Protection Law (transposes Directive 95/46 / EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data) ".

Best Regards,

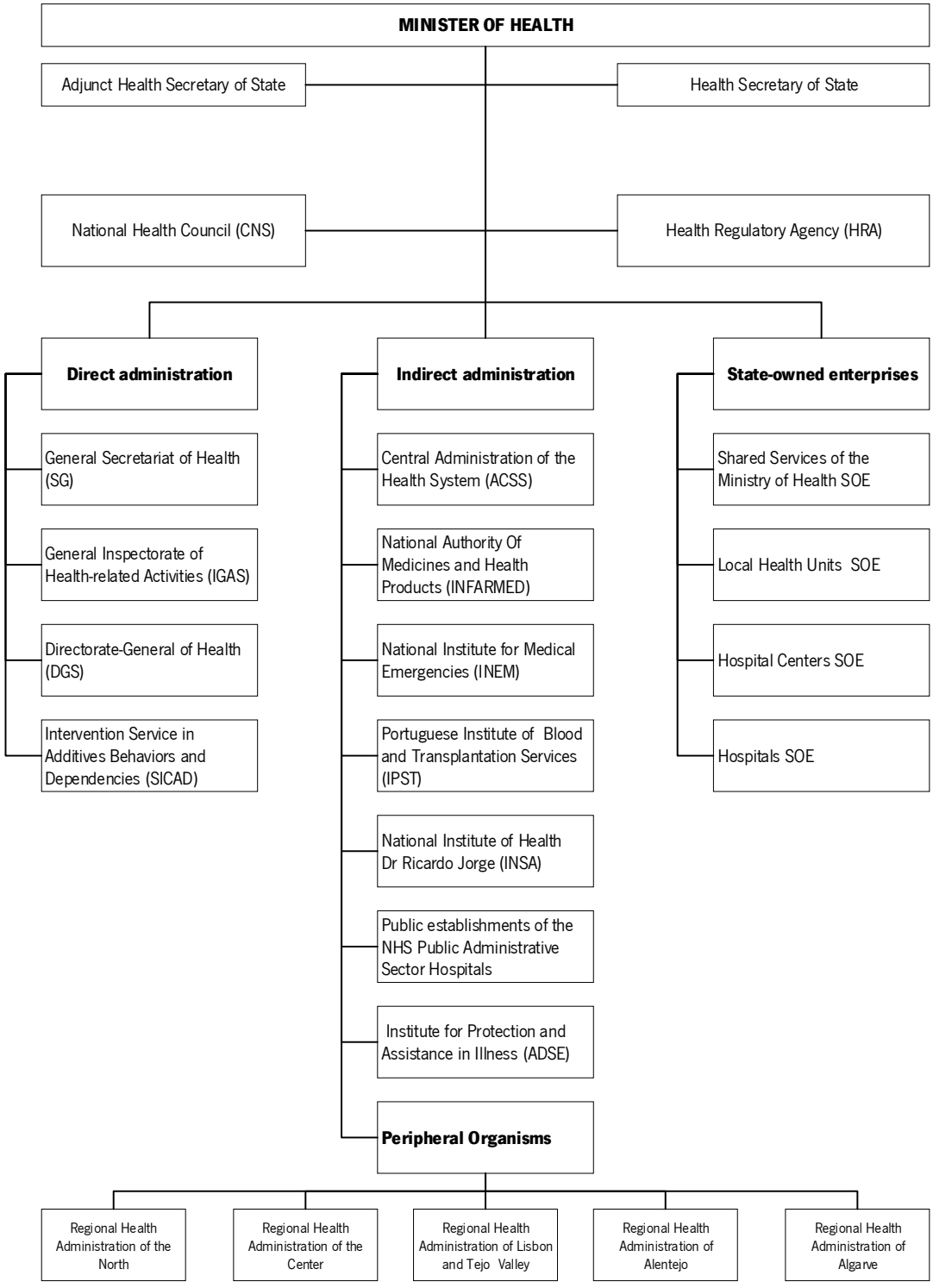
Victor Javier Jiménez Carabalí
(Doctoral Program in Industrial and Systems Engineering, UMinho)

APPENDIX VI– DETAILS OF THE INTERVIEWS

Hospital Number	Type of Organization	Interviewee Position	Background/ Degree	Code of interviewee	Interview Length	Additional info
Hospital 1	Public	Hospital administrator	Law	Interviewee 1	43''	1,2,3
	Public	Coordinator of Center	Radiology	Interviewee 2	30''	1,2,3
	Public	Top Management Member	Business and Administration	Interviewee 3	49''	1,2
	Public	Executive member	Business and Public Administration	Interviewee 4	49''	1,2
Hospital 2	Public and Private	Executive member	Industrial Engineering Management	Interviewee 5	52''	2
Hospital 3	Public	Top Management Member	Management	Interviewee 6	1' 17''	2
	Public	Production Manager	Management	Interviewee 7	1' 17''	2
Hospital 4	Public	Top Management	Business and Administration	Interviewee 8	54''	2

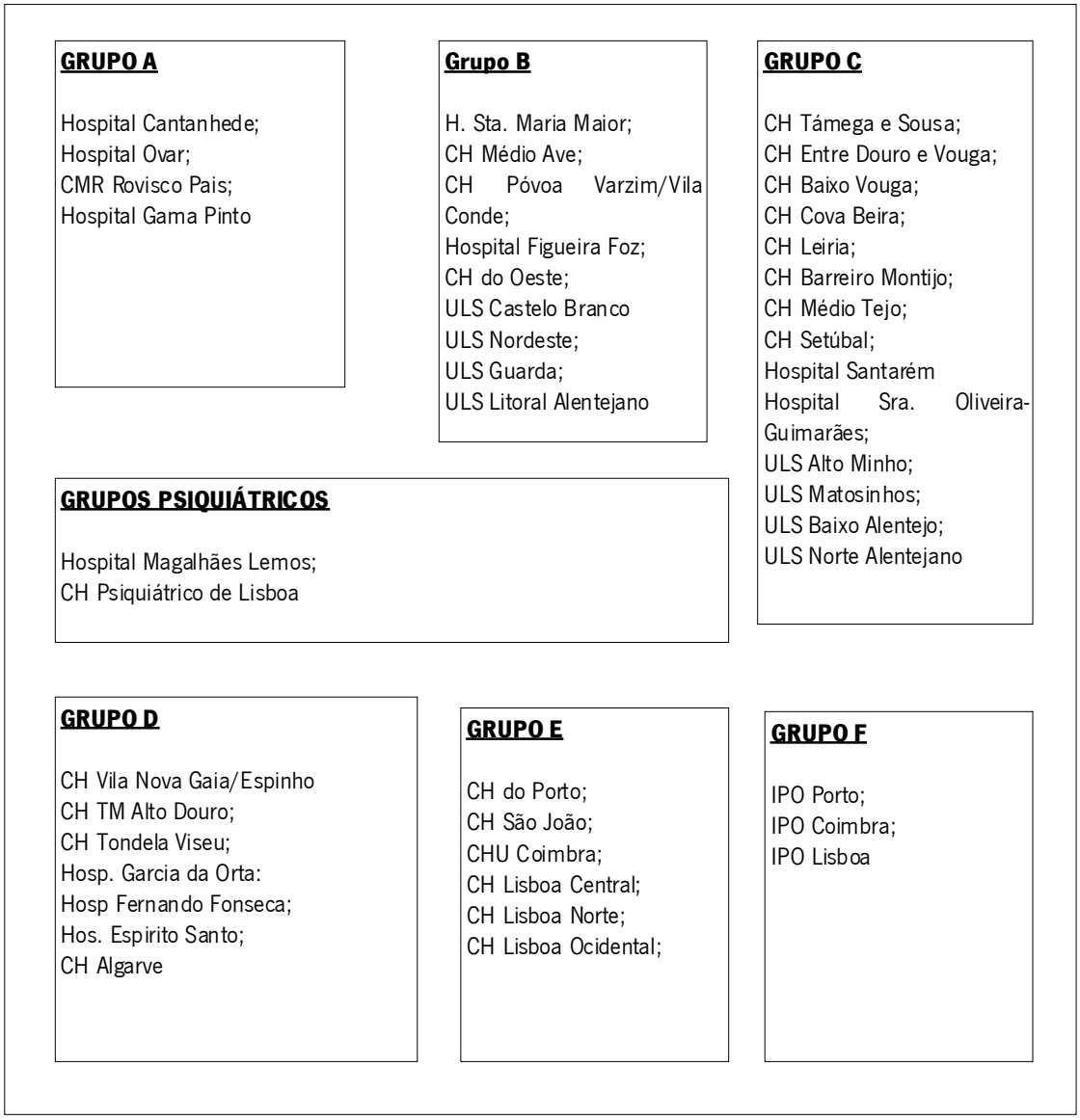
Additional information and observations: 1 – Visit to the organization; 2 – Additional documents (contract, financial reports); 3 – Periodical Meetings

APPENDIX VII– ORGANIZATIONAL CHART OF THE MINISTRY OF HEALTH



Source Translated from SNS (2017b)

APPENDIX VIII- GROUPING OF HOSPITAL ENTITIES INTO FINANCING GROUPS



Source: ACSS (2016c)