Managing Innovation in Hospitals

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Resumo

A crise económica que afectou vários países e os governos estão a pressionar os hospitais a reduzirem custos e a melhorarem o tratamento médico para corresponder às expectativas dos cidadãos. A crescente incerteza ambiental, o envelhecimento da população que vai causar um aumento do número de doenças crónicas, e as tecnologias disruptivas contribuem para o aumento dos custos dos hospitais. Além disso, a falta de tempo, de recursos e de cultura de inovação dos profissionais hospitalares torna a inovação um processo complexo e demorado. Como consequência, os hospitais gastam dinheiro e tempo em projectos de inovação que não criam valor para a organização, visto que passam das ideias para a implementação das soluções sem antes perceberem os problemas e necessidades que estão por detrás dessas soluções. Devido às dificuldades que os hospitais têm em inovar, nesta tese propomos um método para gerir inovação baseado no Innovator's Method, que tem quatro passos: Insight, Problem, Solution e Business Model. Nós concretizamos os passos do Innovator's Method com modelos, nomeadamente o Value Proposition Canvas e o Business Model Canvas. A tese vai ser guiada e estruturada de acordo com o Design Science Research Methodology. A proposta de tese vai ser demonstrada através de um field study, em que iremos instanciar o artefacto proposto com dois projectos de inovação, que foram atribuídos por um hospital público. Finalmente, iremos usar os resultados obtidos da demonstração para avaliar a proposta de tese e depois compará-los com os objectivos da proposta de tese usando entrevistas e questionários.

Palavras-Chave: Inovação em hospitais, Innovator's Method, redução de custos, Value Proposition Canvas, Business Model Canvas.

Abstract

The economic crisis that affected several Countries and the governments are pressuring hospitals to reduce costs, while simultaneously improving patient care to meet citizens' expectations. The increasing environmental uncertainty, aging populations that will cause an increase in chronic diseases, and disruptive technologies contribute to the soaring costs of hospitals. In addition, the lack of time, resources and innovation culture of hospital professionals makes innovation a complex and time-consuming process. As a consequence, hospitals often waste money and time in innovation projects that do not create any value for the organization, since hospitals implement solutions, without previously perceiving the problems or needs behind the proposed solutions. Due to the difficulties experienced by hospitals to innovate, in this thesis we propose a method to manage innovation in a hospital, based on the Innovator's Method, which has four steps: Insight, Problem, Solution and Business Model. We achieve the steps of the Innovator's Method with models, namely the Value Proposition Canvas and the Business Model Canvas. Our thesis will be guided and structured according to Design Science Research Methodology. We will demonstrate our thesis proposal through a field study, by instantiating the proposed artifact (the method to manage innovation in a hospital) with two real innovation projects assigned by a public hospital. Finally, we will use the results obtained from the demonstration to evaluate the thesis proposal and compare them with the objectives of the thesis proposal using interviews and questionnaires.

Keywords: Hospital innovation, Innovator's Method, costs reduction, Value Proposition Canvas, Business Model Canvas.

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1. Introduction

Issues such as population growth, climate change, lack of resources, and the rapid evolution of technology require significant changes in internal processes, products and services of an organization.

A major problem that organizations have to face is uncertainty. Uncertainty exists when *"details of situations are ambiguous and complex; when information is unavailable or inconsistent; and when people feel insecure about their own knowledge or the state of knowledge in general"* [1]. To deal with uncertainty, organizations need to innovate, since through innovation, new knowledge is created and diffused, expanding the economy's potential to develop new products and more productive processes [2]. For that reason, innovation adoptions are means to cope with the increasing environmental uncertainty [3].

According to the Oslo Manual, innovation is defined as *"the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations"* [2]. There are four types of innovation: product innovations, process innovations, marketing innovations and organizational innovations. Normally, hospitals adopt product innovations, such as a new treatment or a new diagnosis, or a process innovation like reducing the cost of a particular service [4]. Innovation in hospitals is normally related to new services, new ways of working and/or new technologies [5]. Hospital professionals always have to take into consideration that from the patient's point of view, the expected benefits are either improved health or reduced suffering due to illness [6].

Innovation can be classified as radical or incremental by its impact on stakeholders. Incremental innovations improve on something that already exists, allowing expanded opportunities to be met, or existing problems to be solved [7]. Radical innovations disorder old systems, create new players and new markets while marginalizing old ones, and deliver value to stakeholders [8].

According to a study performed by IDC (International Data Corporation) in Portugal, product and services innovation appears at the top of business priorities [9]. This can be explained by the fact that without innovation, organizations will be overcome by its competitors and probably disappear.

In hospitals, the cost and technical uncertainty in discovering new drugs is high [10]. Hospitals are suffocated with pressures to reduce costs and to improve their sustainability. According to Deloitte, total global health spending is expected to accelerate from 2.6 percent in 2013 to an average of 5.4 percent over the next four years (2014-2017), which will place enormous pressure on governments, healthcare delivery systems, insurers, and consumers to deal with issues like aging population, chronic diseases, increasing costs and disruptive technologies [11].

The need for innovation is recognized by hospitals, since advances in health technologies and data management can provide new diagnostic and treatment options [11]. However, these advances will probably increase costs as well. It is important to improve the quality of patient care, in order to meet patients' expectations and to follow international trends, but on the other hand there are political pres-

sures to reduce costs and budgets. As a consequence hospitals have difficulties to innovate, since hospitals often waste money and time in innovation projects that do not reach the desired end or do not create value for the hospital. For that reason in this thesis, we propose a method based on the Innovator's Method to manage innovation and validate ideas in a hospital.

We will demonstrate our proposed method in a hospital, by instantiating our artifact (the method to manage innovation) with two real innovation projects assigned by the hospital.

We will use the results obtained from the demonstration to evaluate the thesis proposal and compare them with the objectives of the solution using interviews and questionnaires.

This thesis follows the principles of Design Science Research Methodology (DSRM) [12][13] and it is structured according to the guidelines defined by this methodology. We start by describing in detail the DSRM used in this research (Section 2). Next, we will identify and describe the problem and motivation (Section 3), followed by the description of the topics related to this thesis (Section 4). Then, we provide a literature review of the subjects that support our proposal (Section 5). In "Proposal" (Section 6), we describe the solution objectives and the proposal that we will follow to solve the identified problem. Next, we will demonstrate our proposed method in a real hospital (Section 7). Finally, we will evaluate our proposed solution (Section 8) and draw some conclusions about our proposal and future contributions (Section 9).

2. Research Methodology

This research was performed using the Design Science Research Methodology (DSRM) [12]. According to Hevner et al., DSRM is defined as *"a system of principles, practices and procedures applied to a given branch of knowledge"* [13].

Seven guidelines are defined for understanding, executing, and evaluating the research: Design as an Artifact; Problem Relevance; Design Evaluation; Research Contributions; Research Rigor; Design as a Search Process; and Communication of Research [13].

In information systems researches, DSRM requires that knowledge and understanding of a design problem and its solution are acquired in the building and application of an innovative artifact. This artifact can be defined as: **constructs** (vocabulary and symbols), **models** (abstractions and representations), **methods** (algorithms and practices) and **instantiations** (implemented and prototype systems) [13].

In this thesis, we propose a **method**, i.e. the artifact will provide guidance on how to solve the problem found [13].

DSRM consists in an iterative process composed by six steps, which help information systems researchers conduct, evaluate and present design science research. The six steps of the process mapped on the topics of our research can be seen in Figure 1 and each step is explained and contextualized with this thesis below [12]:
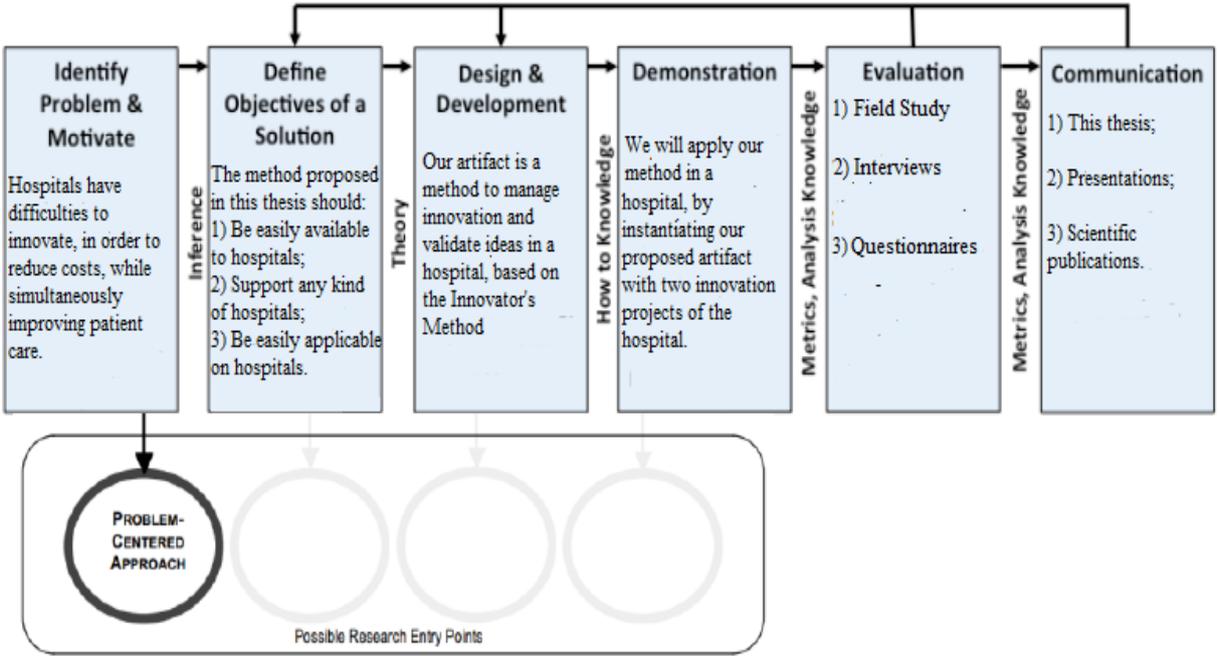

Figure 1 - DSRM Process Model (adapted from [12])

1. **Problem identification and motivation:** This step consists on defining the specific research problem and justifying the value of a solution. The problem definition will be used to develop an

artifact, in order to effectively provide a solution to the proposed problem. Current state and importance of the problem should be included in this step. This step corresponds to Sections 1, 3, 4 and 5.

2. **Definition of the objectives of a solution:** In this step we infer the objectives of a solution from the problem definition, related work and knowledge of what is possible and feasible. The objectives can be quantitative, e.g., terms in which a desirable solution would be better than current ones, or qualitative, e.g., a description of how a new artifact is expected to support solutions to problems not previously addressed. This step corresponds to Section 6.1.

3. **Design and development:** This step consists on creating the artifact, determining the artifact's desired functionality and its architecture and then creating the actual artifact. The artifact can be any designed object in which a research contribution is embedded in the design. This step corresponds to Section 6.2.

4. **Demonstration:** This step consists on demonstrating the use of the artifact to solve one or more instances of the identified problem. This demonstration can be done through experimentation, simulation, case study, or other appropriate activity. In our research we will instantiate our artifact in a public and portuguese hospital. This step corresponds to Section 7.

5. **Evaluation:** In this step we should assess how well the artifact supports a solution to the problem, by comparing the objectives defined with the actual results obtained in the demonstration step. This comparison may include interviews, experimentation, surveys, feedback, and the appraisal of the scientific community. At the end of this step, researchers might decide to iterate back to the design and development step. This step corresponds to Section 8.

6. **Communication:** In the last step of the process we communicate the problem and its importance, the artifact, its utility and novelty, the rigor of its design, and its effectiveness to relevant audiences. This step can be accomplished by submitting scientific papers and by presenting this thesis. This step corresponds to Section 9.4.

In order to use the DSRM, researchers do not have to start in the first step and follow the methodology sequentially until the final step. There are several starting points and more than a single iteration may occur before achieving the end result [12].

In this thesis, a single iteration of the DSRM has occurred. The six steps of the DSRM were very important to structure our research, enabling better results to be achieved.

3. Research Problem

This Section corresponds to the problem and motivation step of DSRM, which defines the specific research problem and justifies the value of a solution. We will present the problems that originated this research, and motivate for their resolution.

Evident threats are being created to hospitals, since globalization is advancing, which creates more competition between private hospitals and public hospitals and also expands markets around the world [14].

In Portugal, public health care covers all population and is ensured by the National Health Service (NHS), which is funded by tax revenues. Health care can be delivered by public and private providers.

Hospitals are very complex organizations that usually have an enormous number of employees from several different areas (e.g. technical, medical and administrative). Management, maintenance, transportation and other support services are included in healthcare staff. The core business of a hospital is to provide medical care to patients, but other important support services are provided like health examination and disease notification [15]. Public hospitals, which also include public hospitals with private management, are known by the extensive waiting lists and waiting periods, while in private hospitals [16]: Waiting periods and lists are way shorter when compared to public hospitals; The overall patient experience is better, due to more comfortable and convenient facilities and latest technologies; The perception of physicians' prestige increases the patients' reliability in medical care.

In 2014, Deloitte identified aging problems and chronic diseases, cost quality, unbalanced access to care and disruptive technologies as the top issues faced by hospitals. According to Deloitte, there will be an increase in the life expectancy from 72.6 years in 2012 to 73.7 years in 2017, so the number of people worldwide over age 65 will increase to around 560 million [11].

Aging populations will cause an increase in pandemics, hospital infections and chronic diseases, such as heart disease, stroke, cancer, and diabetes, which are the biggest causes of mortality in the world [11]. The increase in chronic diseases will require more health care spending and lead to long-term hospitalizations that often result in severe hospital inflections. UN Data Statistics[1] represent the world population over 60 from 1950 and make provisions about the upcoming years in Figure 2:
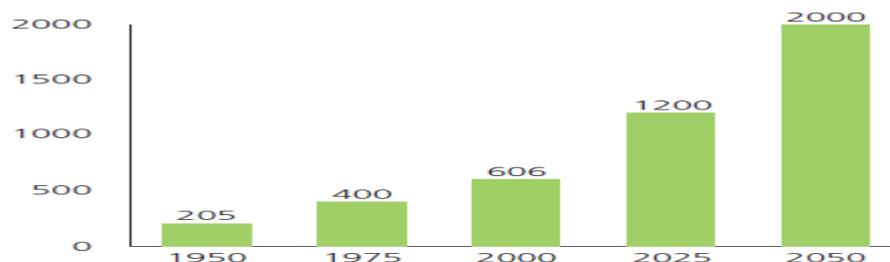

Figure 2 - World population over 60 (in millions) (from [11])

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[1] *In* UN Data Statistics: http://data.un.org/Data.aspx?d=PopDiv&f=variableID%3a22

As medical surgeries are more expensive and new diseases are constantly being discovered, improved diagnostics are increasingly needed [11]. With the increasing flow of knowledge and information, largely promoted by Internet and enabled by technology, product life cycles are getting shorter and patients are becoming more demanding [14]. The internet allows a global access to information that can be used to control habits, predict diseases and follow new trends. For these reasons, the rapidly increasing cost of healthcare and the pressures to improve the quality of patient care are major challenges that most of the countries are dealing with [11].

In Figure 3, we represent the health expenditure as a share of Portugal's GDP (Gross Domestic Product) and we compare it with the average of European Union (EU) member states:
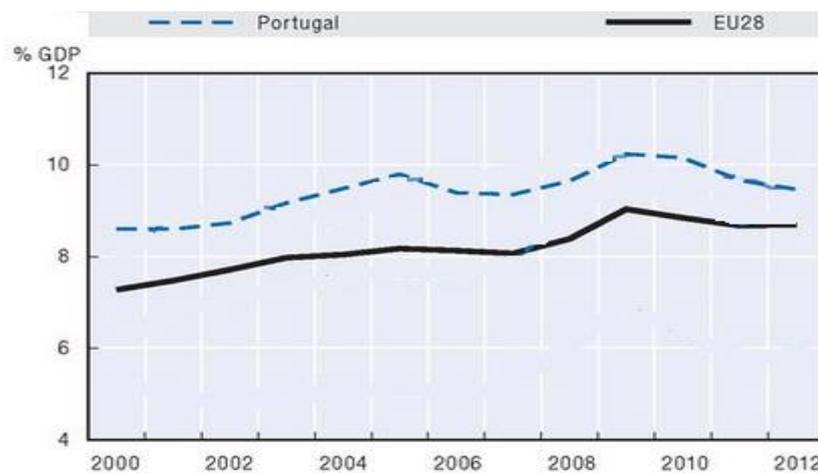
Figure 3 - Health expenditure as a share of GDP between 2000 and 2012 (adapted from [17])

Portuguese financial crisis has a negative impact on hospitals and on innovation, since there is a decrease in investment and political pressures to control costs, which explains that health expenditure in Portugal is dropping, as illustrated in Figure 3. In Portugal, health spending is unlikely to start recovering until 2017 [11]. As stated by Publico, portuguese government had to strengthen the capital of hospitals with 455 million euros, in order to pay debts incurred by hospitals till September 2014. For that reason, portuguese hospitals are facing enormous pressures to maintain economic sustainability in 2015[2].

Hospitals are very complex and highly regulated, and there are barriers to change, because change generates new challenges and risks. Since people are being diagnosed and treated, failure can have major implications in a hospital and, as result, is feared by many hospital professionals [18]. There are also several bureaucratic complexities (national and international) that must occur before implementing an innovation project in a hospital, such as ask SPMS ("Serviços Partilhados do Ministério da Saúde") and ethics committee for permission. As a consequence, several projects are delayed and for that reason this is a time-consuming process.

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[2] *In* Jornal Público: http://www.publico.pt/sociedade/noticia/governo-reforca-capital-dos-hospitais-com-455-milhoes-de-euros-1680164

Several hospitals have Information Technology (IT) departments to manage innovation, but despite their good will and investment, there are more urgent needs that must be solved (like fixing computers, so physicians can treat patients and make prescriptions), which leads to delays in innovation projects.

As the main concern of hospitals is to provide relief to patients, it is very difficult to have a culture of innovation, since hospital professionals typically do not have time to innovate, due to routine tasks and processes that must be executed [10]. Physicians and nurses only know that innovation is the road for success, but they don't really know what innovation is and how to achieve it, because some training is required to understand that managing uncertainty requires a different approach [10]. On the other hand, cultural issues in hospitals such as professional hierarchies, risk-aversion, and the relatively short lifespan of many interdisciplinary health teams create barriers to team process improvement [19]. For all these reasons, the process of generating ideas is compromised, which negatively impacts innovation.

Gathering and implementing ideas that have a positive and immediate impact in a hospital is not an easy task. It is important to note that in hospitals, some starting points of an innovation process may lead to death, disability, or permanent discomfort [5]. This, together with the physicians' trends to preserve their reputation and autonomy, can promote a culture of blame and secrecy that compromises organizational learning and the generation of innovations [20].

Hospital innovations are expensive and entails high research costs, so one of the biggest challenges for innovative approaches is finding finance, since in a hospital there are limitations in the resources available [8]. Innovation involves relevant investment, which can include acquisition of fixed and intangible assets, as well as other activities (such as salaries, or purchase of material or services) [2].

In Figure 4, we illustrate the main challenges that hospitals are facing:
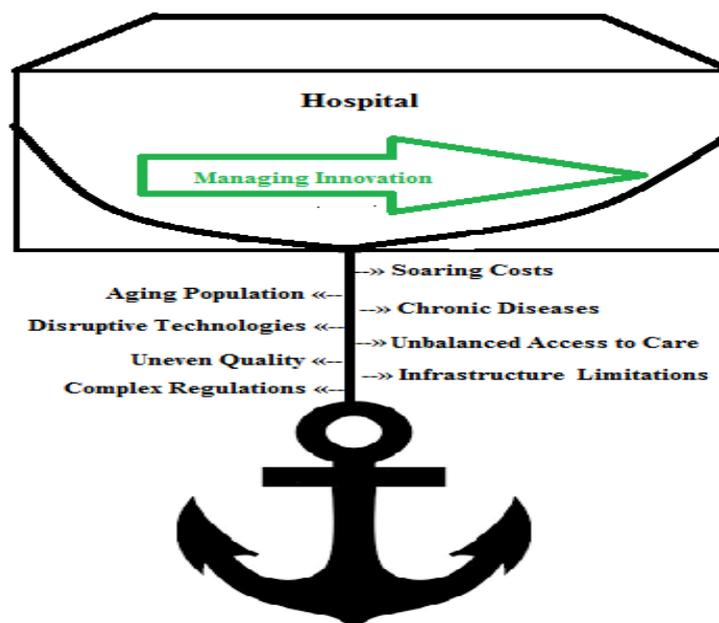

Figure 4 - Illustration of the main challenges faced by hospitals

Although the health sector has considerably evolved and innovated in the last decades, hospitals often waste money and time in innovation projects that do not reach the desired end (for example the solution chosen by the IT department does not meet the physicians' expectations) or do not create value for the hospital. This is due to the fact that hospitals implement solutions without first clearly understanding the problems and needs of the projects' customers.

Hospitals need to innovate to stay successful in this super-competitive world, giving their employees all the conditions to be creative and motivated, in order to create the appropriate environment for innovation. Innovations can provide hospitals with a significant differentiating edge over competitors in the industry, such that new patient bases can be probed with new technology, making newer, better, and faster services [3]. Innovation is also to develop partnerships, in order to find more innovative solutions and conduct talks and discussions about current problems and needs.

Innovative hospitals are more competitive, productive and efficient, because innovations are one of the most important contributors to improve the quality of care, reduce the costs of care and improve patient outcomes [11]. Innovation can also contribute to hospitals' main goal of reaching more and more people and delivering the best health care, since a healthy country allows its citizens to develop their full potential. For these reasons, innovation is essential to build and sustain a competitive advantage [21], because without innovation any hospital will fail in the long term [22] [23].

There is an urgent need for innovation to improve the quality of healthcare services while reducing costs, but due to the challenges represented in Figure 4 and discussed in this Section, **hospitals have difficulties to innovate**, since everything that is new is not necessarily better and for that reason innovation is a messy and unpredictable process [10]. As a consequence, innovation has become a critical capability of all hospitals [5] and the economic future of all hospitals will largely depend on the creation and advancement of innovations [14].

4. Related Work

In this Section, we present a literature review of the topics related to this thesis. We start by Service Innovation approach. Next, we will explain the Canvas models that we will use in our thesis proposal, which are Business Model Canvas and Value Proposition Canvas. Then, we present Open Services Innovation approach, followed by Lean Startup methodology. Finally, we present an overview about the technological trends of innovation in hospitals.

4.1. Service Innovation

The success and efficiency of innovation depends on understanding all the needs of customers before generating ideas and solutions to address those needs [24].

According to Lance Bettencourt, Service Innovation is defined as *"the process of devising a new or improved service concept that satisfies the customer's unmet needs"* [24].

In order to create services that customers really want, organizations must focus on the customers, understanding the type of information they need from customers and how to capture that information [24].

Without useful customer inputs, organizations will end up with high service failure rates and disorientation about what new services to offer [24]. For that reason it is important that organizations guide the process of innovation taking into account the customers' needs, in order to create services that customers want and value.

Lance Bettencourt defines the service concept as a *"description of the service and how it satisfies customer needs"* [24].

A service strategy defines the position that an organization wants to take with its services, which must be one that is valuable to customers [24].

As reported by Lance Bettencourt, in order to develop a successful service strategy, organizations need to [24]:

- **Select the innovation focus:** Decide who is the customer and the job area to investigate.
- **Uncover customer needs:** Talk to the customers and ask the right questions.
- **Prioritize customer needs:** Measure importance and satisfaction.
- **Develop a service strategy**: Define the service concept and a unique and valuable position.

There are the following approaches to find service innovation opportunities [24]:

- **New Service Innovation:** Focuses on discovering new and related jobs, which the customer wants to accomplish and which there are no solutions in the market.
- **Core Service Innovation:** Relies on discovering opportunities, in order to help customers get a particular job done better.

- **Service Delivery Innovation:** Focuses on improving how a service is delivered to customers, by discovering the outcomes used to evaluate the success in obtaining the service.
- **Supplementary Service Innovation:** Reveals opportunities for new and better services by understanding customer's problems with owning and using a product. The targets for innovation are the outcomes that customers classify as most important and with which customers are unsatisfied.

The focus of any organizations should be on customers' needs, but several organizations link customers' needs to solutions and therefore the management of innovation will also be linked to solutions [24]. As a result, organizations often waste resources developing solutions that no one wants or no one values.

Understanding customers' needs is not an easy task, so Lance Bettencourt suggests to capture customer jobs and outcomes, in order to understand why customers exchange, without having any solution in mind [24].

Some opportunities can be better pleased with product innovation, but service innovation as the name implies, focus on the innovation of services rather than product innovation [24]. Since innovations in healthcare sector are not only related to services, this approach is not enough. Furthermore, several key ideas and practices proposed by Lance Bettencourt are difficult and complex to implement in the day-to-day of a hospital, where the main focus is to provide relief to patients.

4.2. Business Model Canvas and Value Proposition Canvas

Business Model Canvas is based on Alexander Osterwalder's PhD thesis (2004)[3] and is presented in Alexander Osterwalder and Yves Pigneur's book, namely Business Model Generation [25].

Value Proposition Canvas is presented in Alexander Osterwalder et al.'s book, namely Value Proposition Design [26].

In the next sub-Sections we will explain Business Model Canvas and Value Proposition Canvas, since both models will be used in the thesis proposal.

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[3] *In* Osterwalder, A. (2004). *The Business Model Ontology - A Proposition in a Design Science Approach*. PhD Thesis University of Lausanne.

4.2.1. Business Model Canvas

According to Alexander Osterwalder and Yves Pigneur, a business model "*describes the rationale of how an organization creates, delivers, and captures value*" [25]. Business models allows organizations to create value for a certain business and to capture some of that value to the organization itself [14].

Business Model Canvas is a tool for describing, analysing and designing business models, which allows groups of people to start sketching and discussing the elements of the business model [25]. The Business Model Canvas promotes creativity and discussion.

As stated by Alexander Osterwalder and Yves Pigneur, a business model can be described through nine basic building blocks. In Figure 5, we represent the Business Model Canvas and we explain each block below [25]:
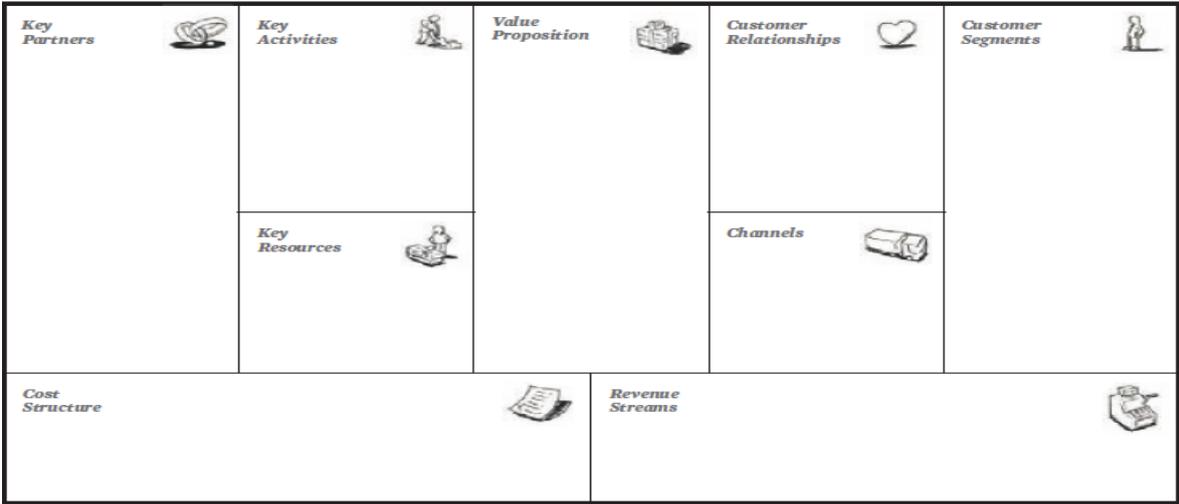
Figure 5 - Business Model Canvas (from [25])

- **Customer segments:** This block identifies customers. One or several customer segments may be defined by the business model, so an organization must decide which segments will be served and which segments will be ignored.
- **Value propositions:** This block allows to understand why customers buy or use the product/service. Value proposition aggregates the benefits that an organization offers to customers, in order to solve a customer problem or satisfy a customer need.
- **Channels:** This block clearly defines how an organization communicates with and reaches its customer segments, in order to deliver a Value Proposition. Value Propositions are delivered through communication, distribution, and sales channels.
- **Customer relationships:** This block plans the interactions and the types of relationships established with specific customer segments. Several categories of customer relationships can be distinguished, such as personal assistance, self-service, user communities, etc.
- **Revenue streams:** This block determines how the value propositions will make the business earn revenue. This block represents the earnings from each customer segment.

- **Key activities:** This block determines the uniquely strategic things that the business does, in order to deliver its proposition. This block describes what an organization must do to make its business model work.
- **Key resources:** This block determines the strategic assets that the business must have to compete. These assets are required to make the business model work. Key resources may be physical, financial, intellectual, or human. These resources can be owned or leased by the company or acquired from key partners.
- **Key partnerships:** This block describes the suppliers and partners that make the business model work.
- **Cost structure:** This block identifies the business major cost drivers and how are they linked to revenue. It is important to describe all costs incurred to operate the business model.

After becoming successful, a business model develops considerable inertia, which can cause an organizations to lose innovation opportunities [14]. One way to follow the inertia of a business model is by taking into account the metrics used to measure the success of the business model.

Business Model Canvas does not solve the difficulties that hospitals have to innovate, since there is no apparent visibility to how the business is consolidated, which is an important criterion to start, run, sustain and evaluate a business. However, this can be achieved through the blocks "Key Resources" and "Key Partnerships". In addition, Business Model Canvas lacks support designing relationships concerning investors and beneficiaries.

4.2.2. Value Proposition Canvas

As reported by Alexander Osterwalder and Yves Pigneur, a Value Proposition "*creates value for a Customer Segment through a distinct mix of elements catering to that segment's needs*" [25]. Values can be quantitative (e.g. price, speed of service, etc.) or qualitative (e.g. design, customer experience, etc.).

Value Proposition Canvas helps design, test and deliver what customers want, by perceiving the patterns of value creation, leveraging the productivity of the team and minimizing the waste of time with ideas that won't work [26].

The following elements can contribute to customer value creation [25]:

- **Newness:** Some Value Propositions satisfy a new set of needs that customers did not notice, since there was no similar offering.
- **Performance**: Improving a service or product performance is a common way to create value.
- **Customization:** Adjusting products and services to the specific needs of customers creates value.
- **"Getting the job done":** Helping a customer get some job done is a simple way to create value.
- **Design:** A product can be positively distinguished due to his superior design.
- **Brand/status:** Customers can find value by using and displaying a certain brand.

- **Cost reduction:** Helping customers reduce costs is an important way to create value.
- **Risk reduction:** Reducing the risks in products or services purchases is valued by customers.
- **Accessibility:** Making products or services available to customers is another way to create value.
- **Convenience/usability:** Making a product/service more convenient or easier to use, can create considerable value.

Value Proposition Canvas makes value propositions easier to discuss and manage, and explains in detail two of the building blocks of the Business Model Canvas, which are [26]: Customer Segment and Value Proposition.

Value Proposition Canvas is composed by two sides: **Customer Profile**, where we elucidate our customer understanding, and **Value Map**, where we describe how we will create value for the customer [26].

In Figure 6, we represent the Value Proposition Canvas and we explain each block below [26]:
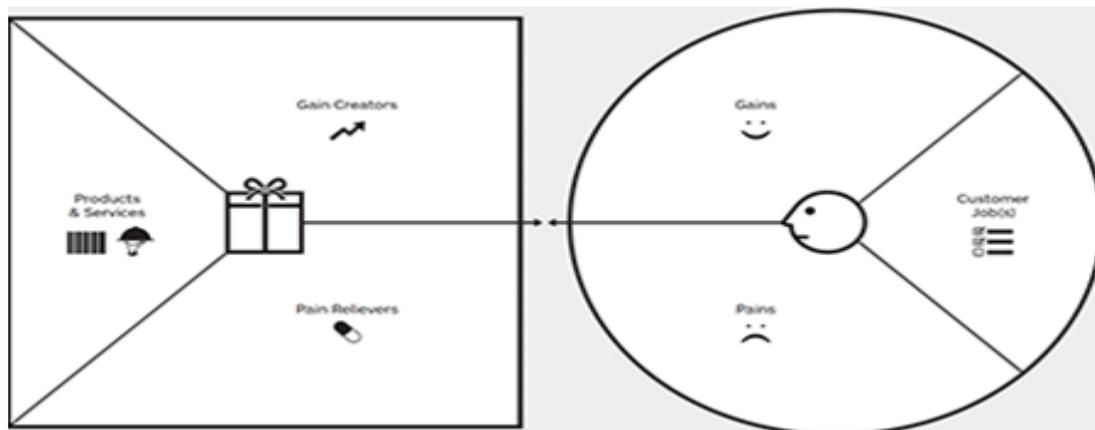
Figure 6 - Value Proposition Canvas (from [26])

- **Gains:** Description of the outcomes that customers want to achieve or the actual benefits that they are looking for.
- **Pains:** Description of the bad outcomes, risks and obstacles related to customer jobs.
- **Customer jobs:** Description of what customers are trying to do in their work and in their lives.
- **Gain creators:** Description of how products and services create customer gains.
- **Pain relievers:** Description of how products and services alleviate customer pains.
- **Products & services:** List of all the products and services, in which a value proposition is built around. More specifically, this is a list of what is offered.

Fit is achieved when customers get enthusiastic about the value proposition, which happens when important jobs are addressed, extreme pains are alleviated or essential gains that customers care about are created [26].

Value Proposition Canvas does not solve the difficulties that hospitals have to innovate, since the redundancy between gains/pains and pain relievers/gain creators is not avoided. Consequently, people can struggle with these terms when using the Value Proposition Canvas in their daily work (e.g. Time to customize the product as pain, and quick customization as gain).

4.3. Open Services Innovation

Open Services Innovation is a new approach offered by Henry Chesbrough, which demonstrates how open innovation, combined with a services approach to business, is an effective way to grow and compete nowadays [14].

According to Henry Chesbrough, organizations must rethink their approaches to innovation and growth, in order to maintain sustainability and compete effectively, by [14]:

- Confronting and then transcending the commodity trap. The commodity trap is made up of several business realities such as:
  - Knowledge and insights are widely distributed by Internet, which becomes problematic for organizations to differentiate their products and sustain that differentiation over time.
  - Manufacturing of products is going to areas of the world with very low costs. Computers and networks are spreading product designs and process tools around the world, where products can be produced cheaply.
  - The shrinking amount of time a product remains in the market before a new and improved one takes its place.
- Stop thinking like product manufacturers and start thinking about business from an open services perspective, in order to discover new ways to generate profitable growth.

As reported by Henry Chesbrough, innovation in services is "*a clear and sustainable way to grow a business and fight off the pressures that companies are facing with the commoditization of products*" [14].

The framework offered in Henry Chesbrough's book is based on the following concepts [14]:

- Consider the business as an open services business, to create and sustain differentiation in a commodity trap world.
- Invite customers to co-create innovation, in order to generate the experiences they will value and pay. Co-creating is a way to create a solid relationship with customers, since customers can tell what they want and identify improvements, which improves customer loyalty and satisfaction.
- Use open innovation to improve services innovation, making innovation faster, less expensive and less risky.
- Use open innovation to turn the business into a platform for others to build on. Service platforms motivate others to invest their time, money and ideas in your own initiatives.

> ➤ Use Open Services Innovation to transform the business model into a platform, in order to foster innovation activities and increase profit. After the platform business model is built, the organization can also profit from others innovations as well.

Open innovation assumes that organizations should transform products into platforms, in order to use external ideas and internal ideas, and take those combinations to new markets, in order to advance and improve the business [14]. Service platforms attract several firms for collaboration and persuade people to invest their own ideas and money.

Information technology plays a vital role in any organization, since it can guide services innovation. By gathering and analysing large amounts of data related to customers, organizations can learn from customer's behaviours and predict customer's future needs [14].

There are two kinds of openness that can be complementary in the open innovation model. In **outside in**, a company makes greater use of external ideas and technologies in its own business. In **inside out**, company allows some of its own ideas and technologies to be used by others [14].

One of the major benefits from open innovation is due to the participation of many more individuals and firms in the market, which allows more knowledge to be diffused in the organization, reducing the cost of innovation, sharing the risks and rewards of innovation and accelerating the time required to deliver innovations [14].

Open Services Innovation does not solve the difficulties that hospitals have to innovate, since this approach is difficult and complex to implement in the day-to-day of a hospital, where the main focus is to provide relief to patients. Furthermore, Open Innovation can reveal information not intended for sharing [14].

4.4. Lean Startup

Lean Startup comes from Lean Thinking, which was a management approach famously applied in Toyota's factory production system. Lean Startup enables an organization to make changes with agility and is a method for developing businesses and products, which was first proposed in 2011 by Eric Ries [27].

According to Eric Ries, Lean Startup is a "*new approach being adopted across the globe, changing the way companies are built and new products are launched"* [27].

As reported by Eric Ries, Lean Startup has the following principles [27]:

- **Entrepreneurs are everywhere:** The concept of entrepreneurship includes anyone who works in a startup.
- **Entrepreneurship is management:** A startup has a context of extreme uncertainty, so a new kind of management specifically oriented to that context is required.

- **Validated learning:** Validated learning is a rigorous method that demonstrates progress, which takes into account empirical data collected from customers. Validated learning also helps organizations in growing with sustainability, by learning what customers really want, not what they say they want. This learning can be validated scientifically through frequent experiments with customers, which allow entrepreneurs to test each element of their vision.
- **Build-Measure-Learn:** The main activity of a startup is to turn ideas into products, measure how customers respond, and then learn whether to pivot the original strategy or persevere. A pivot is a major change that tests a new fundamental hypothesis about the product, service or business model.
- **Innovation accounting:** To improve entrepreneurial outcomes and hold innovators accountable, it is important to focus on how to measure progress, how to set up milestones, and how to prioritize work. Innovation accounting allows to determine if the product development efforts are making progresses and discover if validated learning is being achieved.

The Build-Measure-Learn feedback loop of Lean Startup is represented in Figure 7.
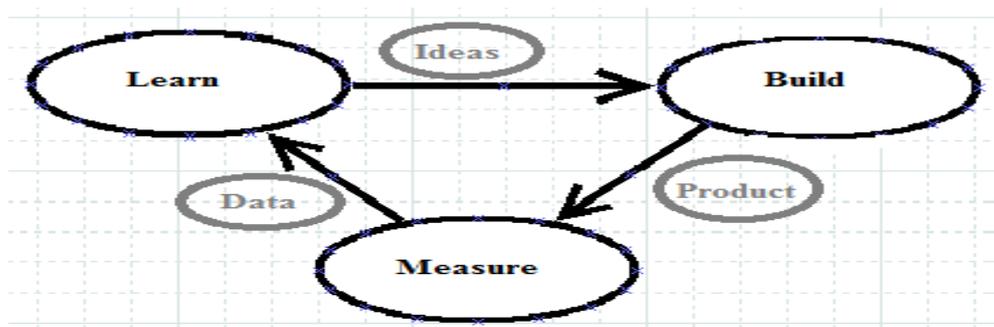
Figure 7 - Build-Measure-Learn feedback loop of Lean Startup (adapted from [27])

First of all it is important to enter the **Build phase** with a minimum viable product (MVP), sooner as possible. Eric Ries defines MVP as *"the version of the product that enables a full turn of the Build-Measure-Learn loop with a minimum amount of effort and the least amount of development time"* [27]. The goal of the MVP is to test fundamental business hypotheses, beginning the process of learning, so any additional effort beyond what was necessary to start learning is waste.

After entering the **Measure phase**, the biggest challenge is determine if the product development efforts are leading to real progress. The method recommended by Eric Ries is innovation accounting, which is defined as "*a quantitative approach that allows us to see whether our engine-tuning efforts are bearing fruit*" [27].

In the **Learn phase,** it is important to focus on validated learning, in order to learn where and when to invest and avoid wasting resources and time [27].

Eric Ries recommends that before new products can be sold successfully to customers, they should be sold to early adopters. Early adopters are defined as a special breed of customer that accept and prefer

an 80 percent solution, because what they really care about is being the first to use or adopt a new product or technology [27].

Once an organization perceives which activities and processes create value and which just waste resources, the lean techniques can start being used, in order to increase the efficiency of the activities and processes that create value and drive out waste [27].

Nowadays, organizations continue to stimulate workers to try harder, but that is precisely the problem, since workers are working too hard at the wrong things, and consequently the real goal of innovation is being lost: to learn that which is currently unknown [27].

Lean Startup does not solve the difficulties that hospitals have to innovate, since it was designed for startups and hospitals are established organizations. In addition, Lean Startup often provides little guidance on generating ideas or determining if a problem worth solving has been found [10]. Furthermore, Lean Startup does not provide a tool to help people discuss and test a value proposition that meets customer's needs.

4.5. Innovation in hospitals – technological trends

Despite hospital reforms to reduce costs, the rise in disruptive technology over the years opened new fields and allowed several healthcare innovations to occur. Advancements such as electronic health records and e-prescribing allow a better understanding of diseases and potential new treatments [11].

Innovative medical technologies allow hospitals to manage environmental uncertainty and achieve sustainable competitiveness [28]. Healthcare innovations enables healthcare practitioners to offer cheaper, faster and more efficient patient care.

The costs and pressures of an ageing population require a better health care. The focus cannot be only in patients' treatment, it is crucial to also focus in preventive care. New applications and sensors focused on preventive care will allow to reduce costs and avoid the appearance of late stage diseases that require complex and costly treatments.

We participated in the Healthcare Innovation Forum[4], which was organized by SPMS. In this Forum, four technological trends were identified: The Healthcare Internet of Things (IoT), Telehealth, Natural Language Processing (NLP) and big data analytics. We will explain each of these trends in the next sub-Sections, since these trends will allow hospitals to deliver a better, faster and customized medical care, improve preventive care and mobilize patients for collaborative solutions.

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[4] *Available at:* http://spms.min-saude.pt/blog/2015/03/19/spms-realiza-forum-inovacao-na-saude-em-abril/

4.5.1. The Healthcare Internet of Things (IoT)

The Internet of Things (IoT) is composed by hardware and software technology, which produces, gathers and shares large amounts of data, in a quick, accurate and reliable manner, through connecting multiple devices and sensors with the cloud [29]. These connected devices can also provide alerts to health professionals, in order to ensure a faster and better response [30].

There are several examples of IoT in Healthcare, such as clothes with sensing devices, glucose monitors, any wearable technology device (sleep sensors, smart glasses, smart watches, etc.) and pulse oximeters.

The emergence of the IoT is crucial for four reasons [29]:

1. Advances in sensors technology allows patients and health professionals to diagnose, monitor and store patient data (such as heart rate and blood pressure, as well as levels of glucose or oxygen saturation in the blood), which can be used in preventive care.
2. Due to the fact that devices store data on their own, the risk of human errors in entering data and any other complication is reduced.
3. IoT increases the availability and quality of care, through constant monitoring, and allows a radically cost reduction, by replacing the process of having a health professional that checks the patient's vital signs regularly.
4. The patient will take control and participate more in his own treatment.

There are clearly some risks involved with IoT, since if a health professional can change parameters remotely, a criminal or a terrorist can also do it. On the other hand, if for some reason a failure occurs in a device, severe consequences may occur for patients.

4.5.2. Telehealth

Telehealth is the delivery of healthcare services to remote locations, giving patients the tools to manage their health, increasing access to care in rural areas, and enabling specialists to take action in real time [31]. Telehealth reaches all citizens, since it allows to monitor, diagnose, and sometimes even treat patients who are in different locations than health professionals. Telehealth also provide large amounts of data that can support health professionals making better decisions [29].

Telehealth is an expansion of telemedicine, which includes interactions between physician and patient, education and information services that increases the quality of diagnoses and medical treatments, and good health practices [31].

Telehealth establishes real-time communication between patients and health professionals, by using video conferencing, telephone, emails, transmission of still images, monitoring of vital signs via sensors, specialist consultations, in order to create a better relationship between patients and physicians. [31] In Portugal, SPMS has developed PDS live, which is a telemedicine platform that will allow to connect two

health professionals or patient and physician in different locations, through audio chat or video. PDS live also allows to share documents and images.

Mobile health, also known as "mHealth", is a form of Telehealth, which uses mobile phones, personal digital assistants (PDAs) and other wireless devices to support medical care. Mobile health solutions use communication, information and motivation tools, such as medication reminders or tools offering fitness medical advices, and can measure vital signs, such as heart rate, blood glucose level, blood pressure, body temperature and brain activities [32].

In March 2015, Apple presented ResearchKit, which is an open source software framework that facilitates the creation of medical research applications by developers and researchers [33]. ResearchKit uses iPhone's sensors and capabilities, in order to track movement, take measurements and record data, wherever people are.

Telehealth improves patient care and patient satisfaction (there is no need to wait in long queues to see a healthcare professional), makes healthcare more collaborative (by improving the communication between the doctor and specialists), and lowers the costs (by reducing the number of hospitalizations and readmissions) [31].

There are clearly some risks involved with Telehealth, because the patient is not present in person. Another challenge is to perceive how to use Telehealth in the context of the economic crisis that certain countries face, since it involves a significant investment.

4.5.3. Natural Language Processing (NLP)

Natural language processing (NLP), also referred to as computational linguistics or "text mining", processes and analyses unstructured textual information automatically [34]. NLP is presented in several technologies, such as voice-mail phone trees and e-mail spam detection.

There are two NLP approaches to understand the meaning of the text: Rule-based NLP and Statistical NLP. In Rule-based NLP a set of deterministic rules are written by a group of experts, in order to implement the mappings in the NLP components, whereas in Statistical NLP the mappings are learned by the NLP components through processing several examples [35].

There are five main NLP applications: Machine translation (Google Translate), speech recognition (telephone voice response systems), question answering (IBM Watson), knowledge extraction (computer-assisted coding of medical record data) and classification (e-mail spam filters). On the other hand, most NLP systems include the following steps: tokenization, sentence and structure detection, part-of-speech (POS) tagging, normalization, named entity resolution and parsing [35].

IBM Watson is an example of a NLP application and is a medical question answering system, which extracts useful information from the text, queries multiple sources for each question and then identifies optimal responses to clinical questions, in a faster way than the human mind [36].

Natural language processing (NLP) can be used to reduce costs and improve the quality of the health professionals, through a clear understanding of the diseases' origin, in order to improve the treatment, avoid common cognitive mistakes and consider low probability but potentially severe cases [35].

4.5.4. Big Data Analytics

Big data is the capacity to analyse massive quantities of unstructured data from several different sources, by linking data and extracting insights for making better informed decisions in an automated way [32].

Big data in healthcare is related to large and complex electronic health data sets, which are difficult to manage with traditional software/hardware or data management tools. A faster management of the data is required, because there are several data types [37].

Big data includes clinical data and clinical decision support systems, such as physician's written notes and prescriptions, medical imaging and pharmacy; patient data in electronic patient records (EPRs); sensor data, such as vital signs monitoring; social media posts, which includes blogs, status updates on social networks (such as Facebook and Twitter), and web pages; and articles in medical journals [37].

Potential benefits of Big data include detecting diseases at earlier stages, which will allow to treat patients more easily and effectively; helping physicians, researchers and scientists improve patient care, by looking for patterns and trends on a larger scale; drawing new conclusions on the relation between the development of a certain disease and environmental factors; help in the development of better mechanisms for early detection and prevention of diseases, which will allow to save lives and reduce costs [37].

As big data analytics becomes more popular, issues related to the patient's fundamental rights to privacy and data protection are being raised [37].

5. Theoretical Background

In this Section we present the theoretical background of our proposal, which will be based on the Innovator's Method.

Traditional management techniques are not enough when applied to the context of uncertainty, since time and resources are wasted in ideas and projects that sometimes do not represent any value for the organization [10].

Established organizations already have a familiar business model, for that reason they often fail to realize that, for an innovative product, a different business model is needed, which must include new ways to communicate with customers [10].

Innovator's Method is a series of experimentation cycles that manage the uncertainty of innovation and is adapted for large organizations [10]. Innovator's Method resolves the uncertainties around a problem worth solving, the proposed solution and the business model to take the solution to market.

We represent the four steps of the Innovator's Method in Figure 8 and we explain each step below [10]:
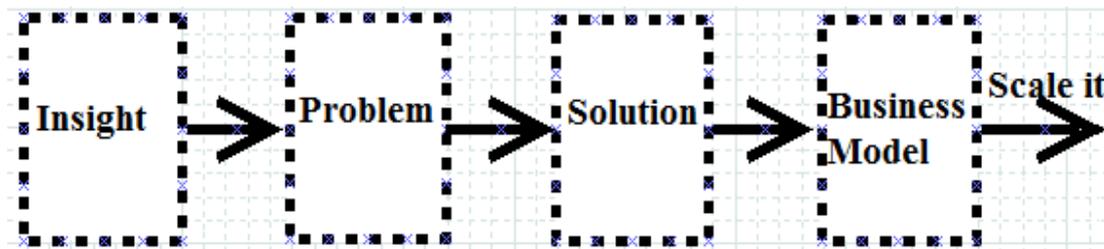
Figure 8 - Steps of the Innovator's Method (adapted from [10])

1. **Insight:** Search broadly for insights about problems or needs worth solving. According to Nathan Furr and Jeff Dyer, an insight is *"the ability to connect seemingly unrelated information or ideas and put them together in new ways".* We can open new possibilities by questioning, observing and experimenting. Interviews and observations provide data, which will allow to develop customer profiles and a list of problems faced by them. Experimenting will validate the best insights.

2. **Problem:** Discover the job-to-be-done by starting to explore the needs and problems of the customers, rather than starting with solutions. This ensures that we are going after a problem worth solving, which avoids wasting resources in a solution that nobody wants. Most managers start with the solution first, developing a solution that no one want to buy, so the product or service fails. For that reason, it is important to deeply understand the problem before trying to solve it.

3. **Solution:** Prototype the minimum awesome product, instead of developing full-scale products. Next, iterate on each solution, in order to develop a minimum viable prototype and eventually a minimum awesome product. It is important that we do not discard any proposed solution too

early. After generating several solution options, we select the most promising ideas to test with customers. Once the critical assumptions have been made explicit, the team can design experiments and use prototypes to test the assumptions.

4. **Business model:** Validate the go-to-market strategy (business model), which includes validating the pricing strategy, the customer acquisition strategy and the cost structure strategy to successfully take the solution to market.

Organizations are not very good taking advantage of ideas, because they want to avoid risk and since few organizations provide ongoing time to generate and test ideas, Nathan Furr and Jeff Dyer suggest to [10]:

- Give time to people, in order to allow the exploration of new ideas. At first ideas may not make sense, but if we test as many ideas as possible, the probability that some idea will prove valuable will be higher.
- Run experiments with potential customers, since quick and easy access to several types of customer can facilitate rapid experimentation.
- Obtain all the feedback from customers, through direct interaction, observation or interviews, in order to get new ideas and better understand customer's needs and challenges.
- Create external connections with universities and companies.
- Provide helpful tools and an environment where employees are motivated, in order to increase employee's participation.

There are two tests that allow us to know that we have nailed a problem worth solving [10]:

1. **The cold call test.** In this test, we start by identifying the hypothesized customer segments and the job-to-be-done. Next, via phone or email, we reach out to each customer group to briefly describe the problem, and ask advices on our theoretical prototype. Then we observe who called/emailed back, why they called back and what they said.
2. **Smoke test.** In this test, we start by creating a web site, advertisement, phone number or other channel, which will describe the problem and the theoretical solution. Several options must be provided, such as "learn more", "buy now", "reserve now", or some other call to action. If customers activate the call to action, then they demonstrate interest in the problem.

Every prototype should answer a specific question and the team should put only the justified effort into the prototype. Since prototyping minimizes investments, accelerates the learning and tests the assumptions that can kill an idea, three types of prototype are defined [10]:

- **Theoretical prototype:** This prototype is fast and cheap, since we express the idea as a well-structured mental image, in which we draft the general shape of the solution.
- **Virtual prototype:** Answers key questions and avoids the costs of developing expensive and unwanted solutions. The objective is to start answering key questions or hypotheses about what customers want.

- **Minimum viable prototype:** Helps learning crucial lessons about what customers really want. Several MVPs can be used to test minimal features as quick as possible, in order to get multiple points of feedback from target customers.

After having a minimum viable prototype and validating the core assumptions, we must develop a minimum awesome product, which is something that customers cannot resist, something awesome that inspires positive emotion in customers [10].

Speed of learning is the new competitive advantage, so organizations will have to reorganize for innovation, in order to create new and better products, services and solutions [10].

Organizations all across the world are adopting the Innovator's Method, since this method helps managers applying a set of tools, concepts and techniques that emerged from the Lean Startup approach, such as techniques to deeply understand customer's needs and to rapidly experiment and test prototype solution to those needs, in order to manage innovation and ideas generation in an established organization [10].

6. Proposal

This Section is divided into two sub-Sections. Sub-Section 6.1 corresponds to the "Objectives of a Solution" step of DSRM, where we infer the solution's objectives, taking into account the related work and our analysis. Sub-Section 6.2 corresponds to the "Design and Development" step of DSRM, where we present and explain our proposal to solve the identified problem.

6.1. Objectives

We propose a method to support hospitals manage innovation and validate ideas, which will make the process of managing innovation easier and more efficient, in order to reduce costs and reduce the number of innovation projects that do not reach the end or do not create value for the organization, despite time and money were wasted. Our proposal has the following objectives:

1. The method should be easily available to hospitals.
2. The method should support any kind of hospitals.
3. The method should be easily applicable on hospitals.

6.2. Proposed Method

By taking the research problem described in Section 3 into consideration, we propose a method to manage innovation in hospitals, based on the Innovator's Method. This method should be incorporated into the organization's processes and in the day-to-day behaviour of employees, since the process of innovation and ideas generation will be easier and more productive [10].

As described in Section 5, Innovator's Method has four steps. For each step of the Innovator's Method, we are going to achieve it with models, namely the Value Proposition Canvas and the Business Model Canvas. In Figure 9, we illustrate the method proposed by this thesis, and we explain each step below.
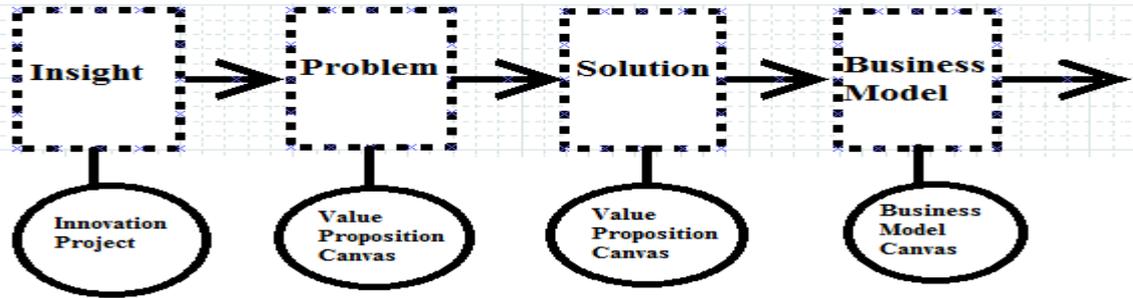

Figure 9 - Method proposed by this thesis

- **Insight:** The search for insights is normally based on an ideas management system, in order to gather ideas and opinions from all employees, evaluate them and implement the best ones.

Since two innovation projects were assigned to us by a public hospital, we will apply our proposed method to those projects.

- **Problem and Solution:** To be sure we are going after a problem worth solving, we will use Value Proposition Canvas, which allows to understand the problems and needs that customers have and quickly clarify what is required to start building and testing the desired solution. Value Proposition Canvas is a simple tool that is designed to create value for customers, by helping in designing products or services that customers want or need [26].
- **Business Model:** We will use Business Model Canvas to develop and validate the business model. Business Model Canvas allows to describe, design, challenge, invent and pivot the business model [25].

We chose Business Model Canvas due to the following reasons:

- Business Model Canvas allows a high level of interaction between all the people involved, since promotes participation, cooperation and imagination.
- Business Model Canvas is a simple, visual and intuitive model that can be easily used by any person.
- The basic blocks of Business Model Canvas work in all sectors: profit, not-for-profit, etc.

We chose Value Proposition Canvas because it complements the Business Model Canvas. Value Proposition Canvas focus on two building blocks of Business Model Canvas, the Value Proposition and the Customer Segment, in order to help projecting, testing and building a solution that customers want.

We consider that, by implementing a method with these characteristics, we will be able to provide hospitals with an easier and more efficient method to manage innovation, which can reduce the number of innovation projects that do not reach the desired end (because, for example, the solution chosen by the IT staff does not meet the physicians' expectations) or do not create value for the hospital. By applying our proposed method to every innovation project, we can assure that we are going after a problem worth solving, because before implementing solutions we understand the problems and needs of the projects' customers. If a certain innovation project does not solve any problem or need, then there is no point in implementing it, which can reduce costs and save time for other projects. On the other hand, our proposed method is simple and easy understandable, so any person can use it without demanding significant or specialized expertise.

7. Demonstration

This Section corresponds to the demonstration step of DSRM, in which we will demonstrate that our proposal, described in Section 6, can be used to solve the problem described in Section 3. According to DSRM, our demonstration will consist in an instantiation, since we will demonstrate our proposed method in a hospital, by instantiating our artefact (the method to manage innovation) with two real innovation projects of the hospital.

We performed a field study in a hospital, in which we instantiated our proposed method in the Information Systems department of the hospital, which is the hospital's IT department. In a meeting with the director of the Information Systems department, we discussed some projects till two innovation projects were assigned, BI-Solution and ISO-20000 certification, so that we could apply our proposed method. First we will present some information about the hospital. Next we will demonstrate our method with the BI-Solution project. Finally we will demonstrate our method with the ISO-20000 certification.

7.1. Hospital

This thesis proposal is generic for every hospital, although the demonstration has been performed in a public hospital, in which we were three months working. We have chosen this hospital due to its importance in our country. Due to confidentiality problems we cannot mention the hospital's name in this thesis.

The hospital has nearly four thousand patients per day, six thousand and five hundred employees, forty eight different clinical areas and more than twenty thousand persons circulate on the hospital's facilities per day. The hospital has several stakeholders, such as hospital administrators, board of directors, physicians, nurses, patients, service director, etc. Each clinical area, such as intensive care medicine, cardiology, pediatrics and ophthalmology, has specific protocols.

A protocol of collaboration was signed between Instituto Superior Técnico and the hospital, in order to allow the demonstration of this thesis proposal. During the time that we were at the hospital, we were placed in the Information Systems department, in order to develop our work. This department has thirty six employees, which must fix and maintain three thousand and six hundred computers and more than two thousand printers. In addition, the Information Systems department receives nearly fifty requests per day from physicians, nurses and other hospital staff.

In the first week, we have interacted and talked with several employees of the Information Systems department, in order to get insights and explain our proposed method.

The hospital has assigned us the BI-Solution innovation project and ISO-20000 certification, so we can apply our thesis proposal, since the hospital plans to implement these two projects by the end of this year.

7.1.1. BI-Solution

The first innovation project assigned by the hospital was the BI-Solution, which is a decision support system for the critical care. The hospital wanted to provide physicians from the Intensive Care department the BI-Solution, since Pyxis, which is the system currently in use, does not allow physicians to obtain and work medical information in a computerized form and as a consequence several research projects are at standstill. If the Intensive Care department achieves good results, then the BI-Solution will be implemented in all hospital services that use Pyxis as the registry and therapeutics system.

In a meeting with the director of the Information Systems department and the chief engineer of the Information Systems department, we started by understanding the context of the project.

Since our proposed method includes talking with people face to face, we scheduled and performed interviews with physicians of the Intensive Care department, in order to collect information about current problems, needs and goals and promote a better understanding and acceptance of our proposed method. These interviews were also crucial to obtain the data, in order to fill the Value Proposition Canvas and the Business Model Canvas.

The first step of our proposed method is the Insight, which is the BI-Solution innovation project. Next we have the Problem step, in which we filled the right side of the Value Proposition Canvas (Customer Profile) to detect problems and needs of the physicians, in order to be sure that the hospital is going after a problem worth solving. The third step is the Solution, in which we filled the left side of the Value Proposition Canvas (Value Map) to understand the physicians' goals and desired features, in order to ensure that the solution will correspond to physicians' expectations, creating value for the hospital. The Value Proposition Canvas was filled in interviews with the physicians, in which we asked some of the questions proposed by Alexander Osterwalder, such as [26]:

> ➢ What are the main difficulties and challenges that physicians encounter?
> ➢ What risks do physicians fear?
> ➢ What would make physicians' jobs easier?
> ➢ What are physicians looking for most?

The last step of our proposed method is the Business Model, in which we developed the Business Model for the BI-Solution project.

Through interviews with the physicians of the Intensive Care department, who are the project's customers, we also validated some fields of the business model (Customer Segments, Channels, Customer Relationships and Key Partners). The physicians saw the business model and confirmed the information presented in the fields listed above. We did not validated the remaining fields of the business model due to time constraints, in order to deliver this thesis in this semester.

We represent in Figure 10 our proposed method, adjusted to this project, and the tools used to produce and visualize the Value Proposition Canvas and the Business Model Canvas.

Figure 10 - Illustration of the method proposed by this thesis with BI-Solution

In order to develop the Value Proposition Canvas for this project, we used the Casefier[5] application, which allows to develop the canvas and produce a PDF document with all the information (presented in Appendix A). The Business Model Canvas was produced using Canvanizer[6] and is presented in Figure 11 (part 1 of 2) and Figure 12 (part 2 of 2).

Figure 11 - Business Model Canvas for BI-Solution (part 1 of 2)

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[5] *Available at:* https://casefier.herokuapp.com/
[6] *Available at:* https://canvanizer.com

Figure 12 - Business Model Canvas for BI-Solution (part 2 of 2)

We were able to complete all steps of the Innovator's Method with the BI-Solution project and the proposed models were successfully used and accepted by the physicians.

7.1.2. ISO-20000 Certification

The hospital provided us another project, so that we could apply our thesis proposal to more than one project. The ISO-20000 certification was the second project assigned by the hospital, which is the international standard for IT Service Management. ISO-20000 is aligned with the ITIL model, creates culture of continual improvement and describes several management processes, in order to improve the delivery of services to the business and customers [38]. The hospital intends to achieve ISO-20000 certification by the end of 2015, since it is becoming more demanding in the market.

We took the same approach in comparison with the BI-Solution project. We scheduled and performed interviews with engineers of the Information Systems department, in order to present the context of our thesis and promote a better understanding and acceptance of our proposed method. We also perceived current problems, needs and goals, in order to fill the Value Proposition Canvas and Business Model Canvas.

The first step of our proposed method is the Insight, which is the ISO-20000 certification project. Next we have the Problem step, in which we filled the right side of the Value Proposition Canvas (Customer Profile) to detect problems, needs and necessities of the engineers from the Information Systems department, in order to be sure that the hospital is going after a problem worth solving. The third step is the Solution, in which we filled the left side of the Value Proposition Canvas (Value Map) to understand the engineers' goals, in order to ensure that the project will correspond to everybody's expectations, creating value for the hospital. The Value Proposition Canvas was filled in interviews with engineers of the Information Systems department.

The last step of our method is the Business Model, in which we developed the Business Model for the ISO-20000 certification project.

Through interviews with the engineers of the Information Systems department, we also validated some fields of the business model (Customer Segments, Channels, Customer Relationships and Key Partners). The engineers saw the business model and confirmed the information presented in the fields listed above. We did not validated every field of the business model due to time constraints, in order to deliver this thesis in this semester.

We represent in Figure 13 our proposed method, adjusted to this project, and the tools used to produce and visualize the Value Proposition Canvas and the Business Model Canvas.
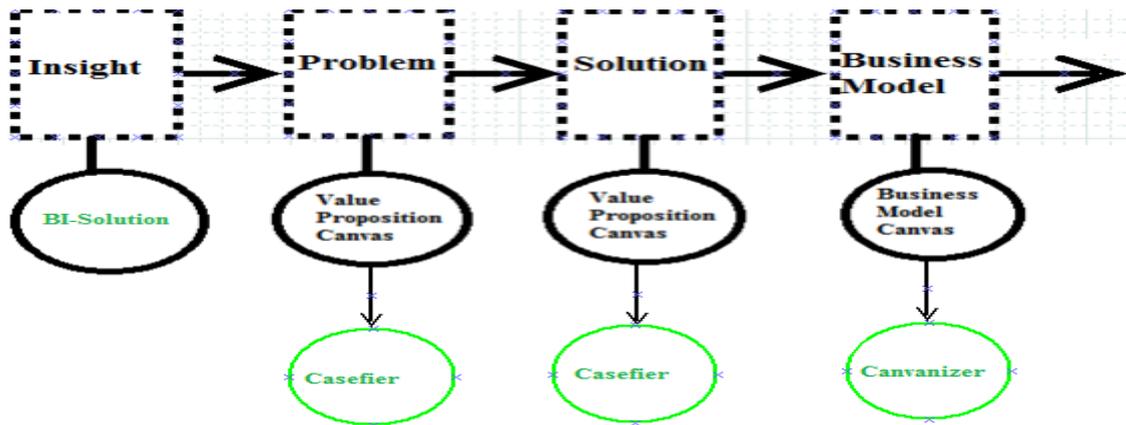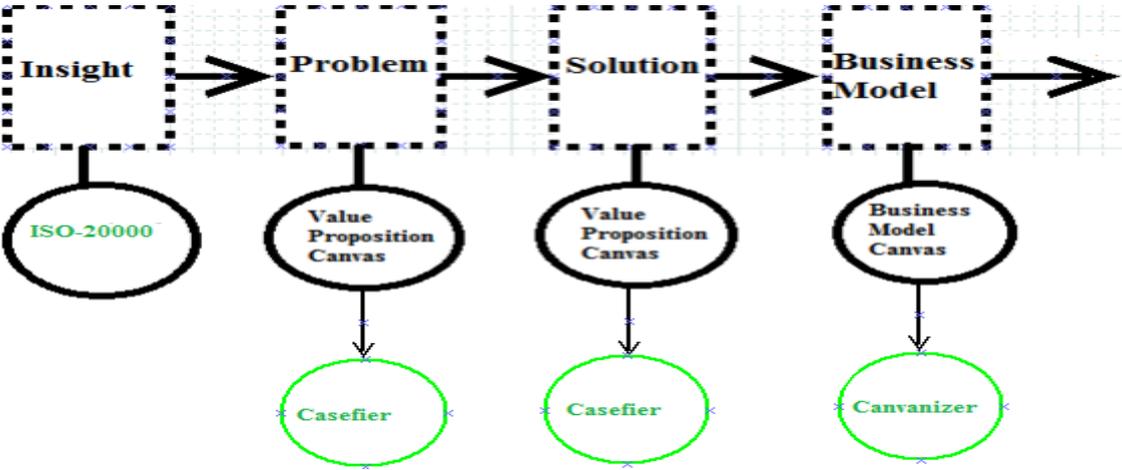

Figure 13 - Illustration of the method proposed by this thesis with ISO-20000 certification

The Value Proposition Canvas of this project is presented in Appendix B. The Business Model Canvas is presented in Figure 14 (part 1 of 2) and Figure 15 (part 2 of 2).

Key Partners ? Insert

International Organization for Standardization (ISO)

Fornecedores de serviços TI

Key Activities ? Insert

Comparar os processos e actividades da organização com a norma internacional para o ITSM

Adopção da metodologia PDCA (Plan-Do-Check- Act) para os processos de planeamento e implementação de serviços

Selecção de uma solução de automatização compatível com os processos ITIL e que integre totalmente os vários processos ITIL

Procurar uma solução que utilize uma base de dados de gestão de configuração CMDB (Configuration Management Database)

Definição de critérios de auditoria e realização de controlos regulares da qualidade da ITSM

Procurar uma solução de automatização que suporte BSM (Business Service Management)

Planear os custos financeiros futuros com maior precisão e clareza

Value Proposition ? Insert

Integração total dos processos, adicionando uma maior clareza, consistência e resistência aos processos

Redução da exposição operacional a riscos e do tempo de resposta a problemas e incidentes

Melhora a imagem e credibilidade da organização, aumentando a qualidade dos serviços de TI

Diminuição do risco de imprevistos e de desentendimentos com os clientes

Certifica e demonstra que os ambientes de TI são bem geridos e de elevada qualidade

Auxília os gestores de TI na realização de mudanças comportamentais

Está alinhada com o modelo ITIL e com as normas ISO 9001 e ISO 27001

Customer Relationships ? Insert

Atendimento presencial

Auto-atendimento

Customer Segments ? Insert

Clientes a quem o hospital fornece serviços de TI

Hospital

Figure 14 - Business Model Canvas for ISO-20000 certification (part 1 of 2)

Key Resources ? Insert

Arquivo de documentação auditável cobrindo, entre outros aspectos, alterações, incidentes e questões de segurança

"Código de Práticas para Gestão de Serviços", que expõe os elementos chave das melhores práticas ITIL

Directrizes de qualidade para a gestão de serviços de TI (ITSM)

Requisitos para a implementação de um Sistema de Gestão de Serviços de Tecnologia da Informação efectivo

Processos de Suporte de Serviços, de Gestão de Segurança de Informação, de Orçamentação e Contabilidade de Serviços de TI, de Gestão de Lançamento, de Gestão de Incidentes e Gestão de Problemas, de Gestão de Relações Negociais e Gestão de Fornecedores, de Gestão de Capacidades, de Contingência de Serviços e Gestão de Disponibilidades e de Gestão de Nível dos Serviços

Channels ? Insert

E-mail

Dispositivos móveis

Reuniões presenciais

Intranet

Ofício/protocolo

Cost Structure ? Insert

Custos de infra-estrutura

Custos de preparação

Custos de manutenção

Revenue Streams ? Insert

Redução de custos

Aumento da satisfação do cliente e da equipa

Profissionais de TI mais capacitados, motivado e reconhecidos

Redução da resistência à mudança
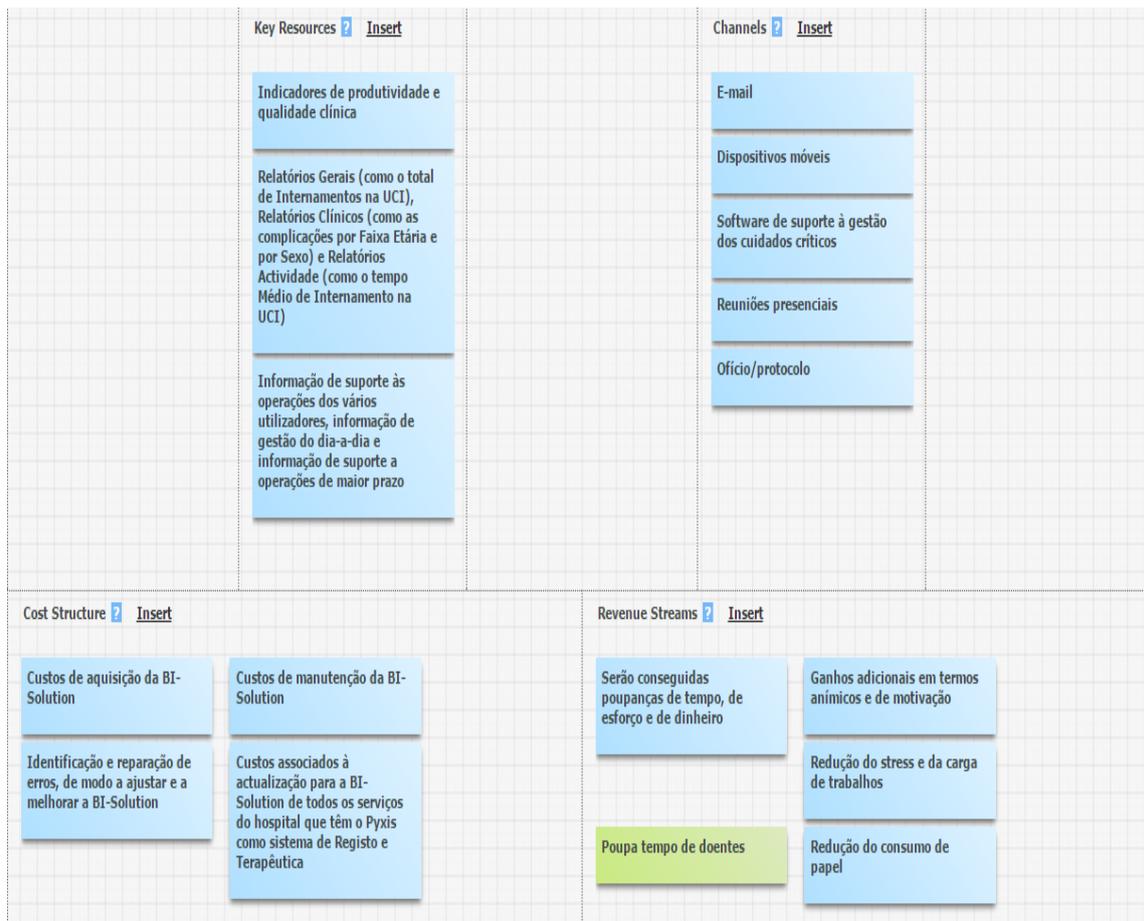
Criação de uma cultura de melhoria contínua

Figure 15 - Business Model Canvas for ISO-20000 certification (part 2 of 2)

We were able to complete all steps of the Innovator's Method with the ISO-20000 certification and the proposed models were successfully used and accepted by the IT staff.

8. Evaluation

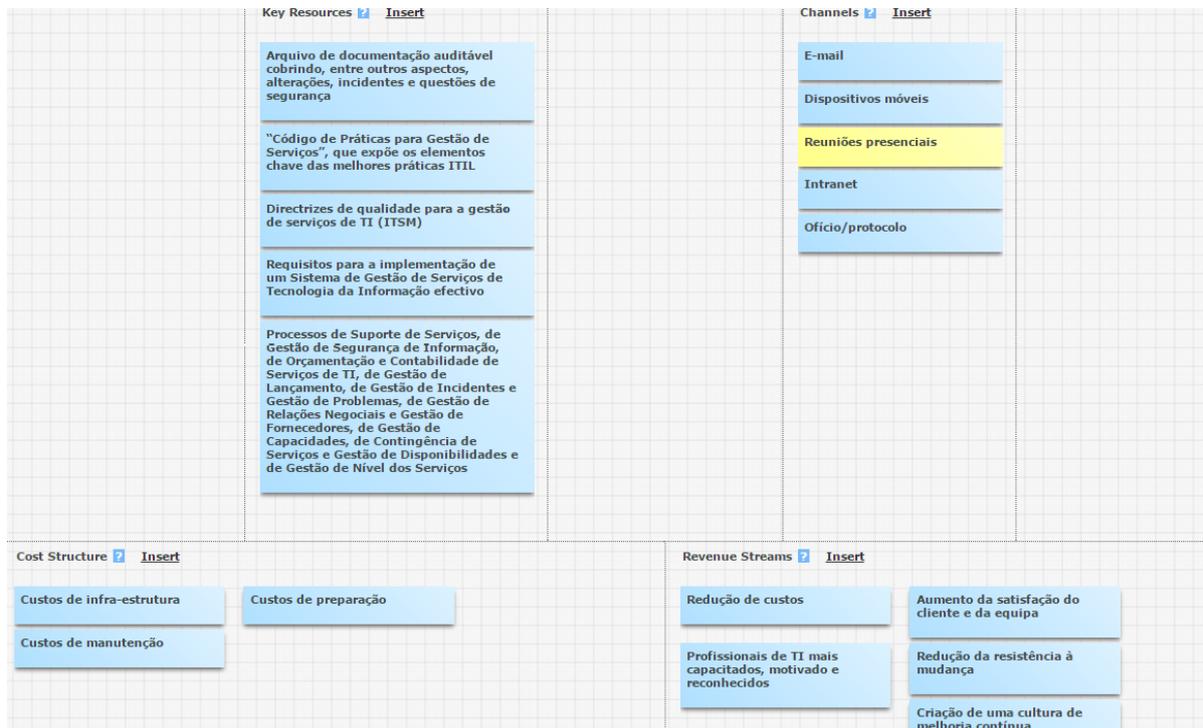This Section corresponds to the Evaluation phase of Design Science Research Methodology (DSRM), where we will determine if the solution proposed in Section 6 solves the problem stated in Section 3.

Evaluation is a crucial component of the research process, because the evaluation step validates the contribution of the solution to the identified problem as well as their utility, quality and efficacy [13]. The researcher must choose evaluation criteria and assess the artifact performance against those criteria [39].

According to Nicolas Prat et al., Information Systems (IS) artifacts are evaluated as systems that have five dimensions: goal, environment, structure, activity and evolution [40]. Each dimension has several evaluation criteria, in Figure 16 we represent the hierarchy of criteria for Information Systems artifact evaluation and the criteria chosen to evaluate our proposed method.
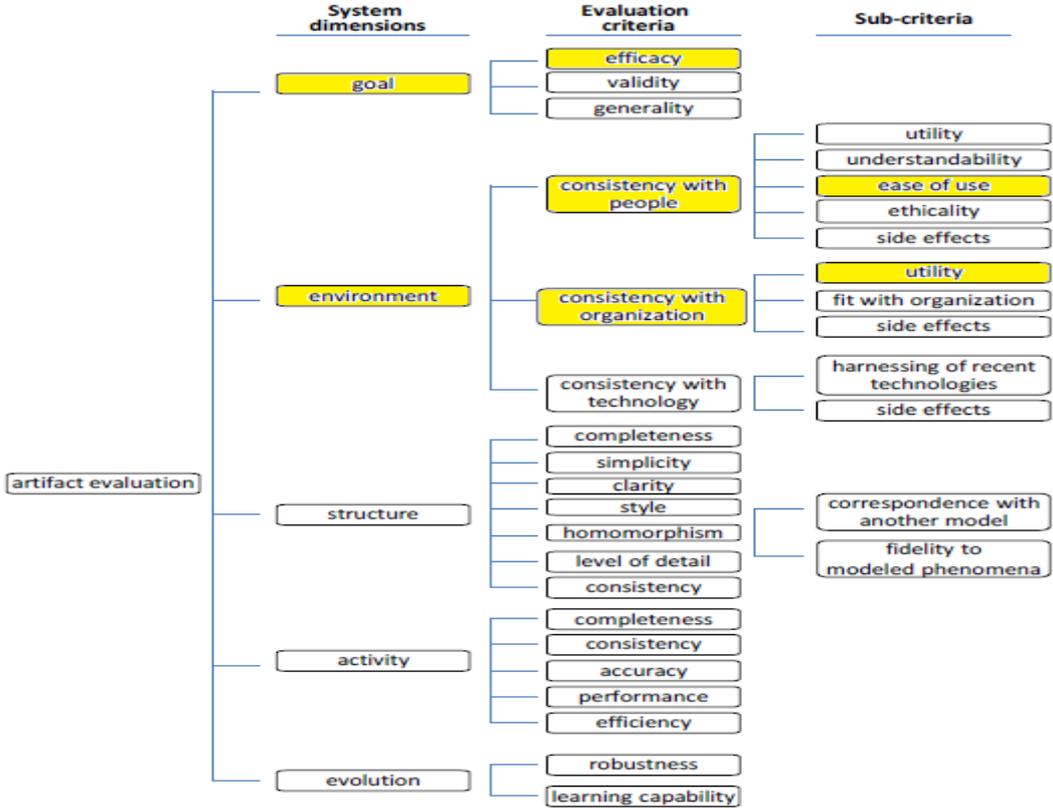
Figure 16 - Hierarchy of criteria for Information Systems artifact evaluation (adapted from [40])

We have chosen the goal and environment dimensions, in order to evaluate the usefulness of the proposed method. Goal efficacy criterion will confirm if the artifact produces its desired effect, which is to achieve the goal of reducing the difficulties that hospitals have in managing innovation [40].

Environmental consistency was also chosen, since it measures the consistency of the proposed method with people and organizations. The ease of use criterion will measure how well the proposed method is

used by hospital professionals. The utility criterion will measure the quality of the artifact in practical use [40].

The evaluation criteria and the proposal objectives will be assessed by an evaluation method, which will include:

1. **Demonstration:** We will evaluate our proposal through its demonstration, in which we have demonstrated the use of the proposed method with two projects in a real hospital. We will also consider the feedback obtained.
2. **Interviews and Questionnaires:** We will collect feedback and other important data about the proposal by interacting personally with the demonstrations' participants, in order to evaluate our thesis proposal and identify improvements.

8.1. Demonstration

The evaluation of the demonstration has a major importance, since it provides evidence of the proposed method's application and essential input, which will contribute to improve our proposal.

Our proposal was demonstrated in a hospital, more specifically in the hospital's IT department. We can consider that our proposal was assessed and validated properly, through our demonstration, since we were able to complete all steps of the Innovator's Method for the two projects assigned by the hospital. Physicians and IT staff perceived and accepted the proposed method, praising the simplicity of the Value Proposition Canvas and Business Model Canvas, which requires no or few expertise to apply it properly. Therefore, we can conclude that our proposed method can be used in a hospital, despite several difficulties that we had to face.

Ethical issues were raised on the first day in the hospital, since the projects assigned by the hospital had confidential data. It took three weeks till the collaboration protocol was signed between the hospital and Instituto Superior Técnico. Since we could not advance in our demonstration, we started to talk with the IT staff, in order to gain their trust and explain the context of our thesis.

Initially the hospital assigned to us the BI-Solution project and the Nursery Desktop project. We had a meeting with nurses, in order to explain our thesis and appoint a day for the interviews, in which we would fill the Value Proposition Canvas and Business Model Canvas. The nurses have shown interest to participate in our proposed method, but till today they did not answer our e-mails or the e-mails sent from the director of the Information Systems department. We have waited two months, till one engineer from the IT department said that the nurses had no free time to participate in research projects. As a consequence, the IT department assigned us the ISO-20000 certification project, since we wanted to demonstrate our proposed method with at least two projects of the hospital.

The BI-Solution project lasted a considerable period of time, since the director of the Intensive Care department had an accident and for that reason he was absent from work. Once the director returned to work, a meeting was scheduled between us and the director of the Intensive Care department, in

which we presented our thesis and what we intended to do. The physician was particularly interested, since he was also a teacher, and immediately made available the necessary means, especially the physicians' availability to perform interviews with us, so that our thesis proposal could be applied. Our proposed method has proved to be quick and easy to apply in a hospital.

With ISO-20000 certification, the process was quicker than BI-Solution, because we easily scheduled and performed interviews with the IT staff, since we were all working in the same building. Once more our proposed method has proved to be simple and easy understandable by all the persons involved in the demonstration.

We have noted that the communication between different hospital services has serious problems, since on the one hand it is done by e-mail, which delays several ongoing projects. On the other hand, the hospital often has an idea or an innovation project, and then tries to implement the solution for that idea or innovation project, not realizing the problems or needs that will be solved by the solution. As a consequence, the hospital often wastes time and money in innovation projects and ideas that do not create any value for the organization or do not achieve the customers' expectations.

Despite all the difficulties, we have demonstrated that our proposed method can be easily applied in a hospital and used by hospital professionals. For each project we were able to detect the problems and needs of the physicians and IT staff, as well as their expectations and desires, with considerable accuracy. By using our proposed method in all innovation projects, the hospital would be able to clearly identify the actual problems and needs of each project's customers and perceive whether it is feasible to implement those projects.

For these reasons we consider that our research was proper evaluated and tested with our demonstration. The next sub-Section contains the evaluation conducted through interviews and questionnaires, in which we will assess the demonstration results against the proposal's objectives defined in Section 6.1. We will also assess if the three evaluation criteria chosen in Section 8 were achieved.

8.2. Interviews and Questionnaires

The main objective of the interviews is to validate our research, the problem, the proposal and the results from the demonstration.

The fastest way to learn is by talking with customers, so we can obtain qualitative information from interviews and meetings, which allow the interviewee to give his opinion and expertise on a specific topic [41]. The interviewer can ask questions and explore experiences [42].

Interviews can be divided into three types [43]:

- **Structured interviews:** When the researcher has fixed questions for every interviewee. The list of questions has a specific order and after reading each question, the researcher notes the interviewee answer.

- **Semi-structured interviews:** When the researcher uses a questions and topics guide to be covered.
- **Unstructured interviews:** When the researcher has a predefined plan, but the control on the interviewee's answers is minimum.

First we tried to validate the research problem and its relevance through interviews with the following roles: Projects director at COTEC Portugal, Professor of International Health Management and Innovation, Information Systems director and Professor in Health Innovation and Healthcare.

We also interviewed three physicians and two engineers from the IT department, who have participated in the demonstration, in order to understand their point of view, since they work daily at the hospital. We also discussed and validated the research in general, the research problem, the proposed method and the results of the demonstration. By understanding the point of view of the professionals who work in our research area, we obtained valuable inputs from those who daily work with these questions, rather than making assumptions. For all the interviewees the method was easily understandable and the two engineers from the IT department recognized the proposed method as being quick, simple and appropriate to a hospital.

The interviews were semi-structured and consisted in face-to-face meetings with a duration of approximately thirty minutes.

After demonstrating the proposed method and its application, we delivered a brief questionnaire to those involved in the demonstration, so that we could evaluate our proposed method and obtain more feedback. The three physicians and two engineers from the IT department completed the questionnaire.

The questionnaire had five questions, which allowed us to evaluate the method's utility and the achievement of the proposed objectives and evaluation criteria, in a more structured manner. The questions were:

1. Do you consider that the proposed method can be easily used and applicable in a hospital?
2. Do you consider that the thesis proposal is generic, therefore can support any kind of hospitals?
3. Do you consider the use of this proposed method in your hospital?
4. Do you consider that by applying this method to every innovation project, the number of projects that do not create any value for the hospital can be reduced?
5. What feature, listed below, do you consider the most important in this method?
   1) To clearly understand the problems and needs before implementing solutions and ideas, in order to reduce costs.
   2) The method is simple, so can be easily used by all hospital staff.
   3) The method is quick, which can help reducing the time that projects usually take until they are implemented in a hospital.
   4) The method can help facilitating the communication between the different services that are part of the hospital.

The first four questions were measured on a scale of one to five, in ascending order of consideration. In our opinion, these questions address the most important topics that will allow to perform a correct evaluation of our research. We will now present the results per question:

- ➢ **Question 1:** The answer average in this question was 4.2, because four participants answered with 4 and one participant answered with 5. Since one of the evaluation criteria was the ease of use, the results were very interesting and this evaluation criterion seems to have been achieved. Our proposed method can be used by any person without demanding significant or specialized expertise, and since one of the proposal's objectives is that the method should be easily applicable on hospitals, we can also conclude that this objective seems to have been achieved, because our proposed method has been demonstrated successfully with two innovation projects assigned by a hospital.

- ➢ **Question 2:** The answer average in this question was 3.8, since four participants answered with 4 and 1 participant answered with 3. The interviewees noted that we could apply our method in one of the largest hospitals in Portugal, in which the communication between the different services is complex and time-consuming. Therefore, applying our proposed method in a private hospital or in a smaller hospital would be easier, since those hospitals usually do not have so many services and are more specialized. Our proposed method is generic, and since one of the proposal's objectives is that the method should support any kind of hospitals, we can conclude that this objective also appears to have been achieved.

- ➢ **Question 3:** The answer average in this question was 3.8, since four participant answered with 4 and one participant answered with 3. The participants showed some concerns about the availability of the physicians and nurses to help filling the Value Proposition Canvas and Business Model Canvas in future projects, despite with this thesis we have proved that this method can be used in a hospital.

- ➢ **Question 4:** The answer average in this question was 4.0, since two participants (two physicians) answered with 5, the two engineers from the IT department answered with 3 and the remaining physician answered with 4. This question was particularly interesting, since the physicians praised the fact that this method can help in filling the communication gaps between them and the IT department, since several projects take longer than expected and in some cases, the results do not correspond to physicians' expectations. On the other hand, the two engineers from the IT department showed some concerns about the availability of the physicians and nurses to participate in the method. With this thesis, we can confirm that physicians are willing to help the IT department, so that physicians can receive the solutions they need and want.

- ➢ **Question 5:** Two participants (the two engineers from the IT department) answered with 1, two physicians answered with 3 and the remaining physician answered with 2. The answers of the two engineers from the IT department appears to confirm that our thesis proposal could help in solving the research problem, by reducing the difficulties that hospitals have in innovate, in order to reduce costs. Therefore, we can conclude that the goal efficacy evaluation criteria appears to have been achieved. The physicians' answers confirms that our proposed method

is easy to use and can reduce the time that a project takes until it is implemented in the hospital, which confirms that the ease of use evaluation criterion is achieved. These three answers shows that our proposed method has some utility for the organization, which also shows that the utility for the organization evaluation criterion is achieved.

The interviews provided us feedback and important data, which helped us evaluate our thesis proposal. Through these interviews and questionnaires, we tried to assess if the evaluation criteria and the proposal's objectives were achieved, as well as if our research proposal solves the research problem. The feedback obtained was positive and the evaluation criteria and the proposal's objectives seems to have been achieved.

9. Conclusion

Managing innovation has always been a concern to all organizations across the world, since without innovation any organization will be overtaken by the competition. In this thesis we focus on hospitals.

Hospitals are suffering political pressures to reduce costs and maintain their financial sustainability, mainly due to the recent economic crisis, but on the other hand the society has growing demands for patient care and requires improved medical units. For these reasons it became crucial to have an efficient management of innovation, but hospitals have difficulties to innovate, since several innovation projects take longer than expected and sometimes time and money are wasted in innovation projects that do not create any value for the organization or do not meet the customers' expectations.

Our research was conducted in line with the guidelines defined by the Design Science Research Methodology (DSRM). Our artifact is a method to manage innovation in a hospital, based on the Innovator's Method, which has four steps: Insight, Problem, Solution and Business Model. We propose models, namely the Value Proposition Canvas and the Business Model Canvas, in order to achieve the steps of the Innovator's Method.

We demonstrated and validated our thesis proposal in a public hospital, in which we instantiated our proposed method with two innovation projects of the hospital. We have completed the four steps of our proposed method for the two projects, and the proposed models were easily applied and accepted by health professionals.

We formally evaluated the thesis proposal using an evaluation method, in which we evaluated our proposal through its demonstration and performed interviews and questionnaires with people who were involved in the demonstration, in order to assess if the proposal's objectives and the evaluation criteria were achieved. We assessed our proposal's utility and the results were satisfactory, since the interviewees considered our proposed method as being generic and easy to use, which indicates that our proposed method can be used by other hospitals.

In the next sub-Sections, we will detail our conclusions by presenting the lessons learned during this thesis, the limitations that we have identified, how we intend to communicate our thesis and future work that would bring extra value to this thesis.

9.1. Lessons Learned

One of the most important lessons learned is connected to the research methodology used in this thesis. DSRM provided us guidance on how to conduct a well-structured and successful research thesis.

We believe that our thesis proposal makes the process of innovation and ideas generation easier and more productive and can reduce the number of innovation projects that do not reach the desired end or do not create value for the hospital. By applying our proposed method to every innovation project, we

can assure that we are going after a problem worth solving, because before implementing solutions we clearly understand the problems and needs of the customers. If a certain innovation project does not solve any problem or need, then there is no point in implementing it, which can reduce costs and save time for other projects. On the other hand, our proposed method is simple and easy understandable, so any person can use it without demanding significant or specialized expertise.

Our proposed method can also help in filling the communication gaps between the different hospital's services and IT department, since the communication is mainly done by e-mail. As a consequence, several projects take longer than expected and in some cases, the results do not correspond the expectations of the persons involved in the projects. For example, the BI-Solution project took longer than expected, because the communication between the two service directors (IT department and Critical Care department) was done by e-mail. This is clearly inefficient in large organizations, such as hospitals. Our proposed method is applied face-to-face, which can reduce these communication gaps.

We observed that there is a clear effort to innovate, since hospital professionals know that innovation is the road for success, but often they have no availability to participate in the innovation process, because the main concern is to provide relief to patients. This was the reason given by the nurses for not participating in the demonstration of the proposed method.

We also noted that organizations have fear to participate in research thesis, even if data privacy is ensured by official protocols. As an example, we tried to apply our proposed method in a public hospital with private management, but the response was negative.

9.2. Limitations

Some limitations were found in this thesis research, since after developing the business model for the two projects assigned by the hospital, we only validated some fields of the business models (Customer Segments, Channels, Customer Relationships and Key Partners) through interviews with physicians and IT staff, who were the customers of each project and have participated in the demonstration of the proposed method. We did not validated the remaining fields of the business models (Key Resources, Key Activities, Value Proposition, Revenue Streams and Cost Structure) due to time constraints, in order to deliver this thesis in this semester.

It is also important to note that we have only performed five interviews with three physicians and two IT engineers, who have participated in the demonstration of this thesis proposal and answered a questionnaire to evaluate our thesis proposal. We would like to perform more interviews to evaluate our thesis proposal and deliver more questionnaires, but several persons have declined our request due to availability issues.

Another limitation of this research is due to the fact that our demonstration occurred in the same hospital, because of time and resources limitation. The interviewees noted that we could apply our method in one

of the largest hospitals in Portugal, in which the communication between the different services is complex and time-consuming, so applying our proposed method in a private hospital or in a smaller hospital would be easier, since those hospitals usually do not have so many services and are more specialized. Although our thesis proposal is generic, we cannot clearly state that our proposed method can be applied in all hospitals, since we could not demonstrate our proposed method in more than one hospital.

9.3. Communication

This is the last step of DSRM, in which the problem and its importance, as well as the developed artefact to solve it and its contributions, are presented to the proper audience. We presented our thesis proposal to practitioners and healthcare and innovation experts.

We performed interviews with physicians, nurses and IT staff, who have participated in the demonstration, in order to present our thesis proposal and evaluate it. These interviews were useful to assess that the proposed artefact is valid.

9.4. Future Work

In this sub-Section we present the future work that can bring extra value to this thesis.

We consider that applying the proposed method in more hospitals would be a valuable contribution, especially in a private hospital, in order to validate even further the method to manage innovation proposed in this thesis.

Another relevant aspect would be to study and apply an efficient form of business model validation. In this thesis we validated only some fields of the business models through interviews, due to time and resources constraints. On the other hand, physicians and IT staff who participated in the demonstration, raised concerns related to some fields of the Business Model Canvas, in which they had not the knowledge to validate them, such as the Cost Structure field.

References

[1] Brashers, D., *Communication and uncertainty management*, Journal of Communication, 51: 477-497, 2001.

[2] Tanaka, N. Glaude, M. and Gault, F., *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, 3rd Edition, OECD Publishing and Eurostat, 2005.

[3] Tabak, F. and Jain, B., *Predicting Hospital Innovativeness: An exploration of the perceived organisational context*, Journal of Applied Management Studies, 9 (2): 217-233, 2000.

[4] Zweifel, P., *Diffusion of hospital innovations in different institutional settings*, International Journal of the Economics of Business, 2 (3): 465-483, 1995.

[5] Lansisalmi, H. et al., *Innovation in Healthcare: A Systematic Review of Recent Research*. Nursing Science Quarterly, 19: 66-72, 2006.

[6] Faulkner, A. and Kent, J., *Innovation and Regulation in Human Implant Technologies: Developing Comparative Approaches*, Social Science and Medicine, 53: 895-913, 2001.

[7] Harvard Business Essentials, *Managing Creativity and Innovation: Practical strategies to encourage creativity*, Boston: Harvard Business Press, 2003.

[8] Omachonu, V., *Innovation in Healthcare Delivery Systems: A Conceptual Framework*, The Innovation Journal: The Public Sector Innovation Journal, 15 (1), 2010.

[9] IDC Portugal, *IDC apresenta previsões para a evolução do setor das TIC em Portugal*, 2014. Retrieved from: http://www.idc.pt/press/pr_2014-02-10.jsp

[10] Furr, N. and Dyer, J., *The Innovator's Method: Bringing the Lean Startup into Your Organization*, Harvard Business Review Press, 2014.

[11] Deloitte, *Global health care outlook: Shared challenges, shared opportunities*, 2014. Retrieved from: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/dttl-lshc-2014-global-health-care-sector-report.pdf

[12] Peffers, K., Tuunanen, T., Rothenberger, M. and Chatterjee, S., *A Design Science Research Methodology for Information Systems Research*, Journal of Management Information Systems, 24 (3): 45-77, 2007.

[13] Hevner, A., March, S., Park, J., and Ram, S., *Design Science in Information Systems Research*, MIS Quarterly, 28 (1): 75-105, 2004.

[14] Chesbrough, H. *Open Services Innovation: Rethinking Your Business to Grow and Compete in a New Era*, San Francisco: Jossey-Bass, 2011.

[15] Sadleir, B., *Environmental and occupational health issues in hospitals*, Rural and Remote Environmental Health I, 15, 2001.

[16] Cadete, E., *Healthcare services merger highlights dominant position of NHS*, 2015. Retrieved from: http://www.mlgts.pt/xms/files/Publicacoes/Artigos/2015/Healthcare_services_merger_highlights_dominant_position_of_NHS.pdf

[17] OECD, *Health at a Glance: Europe 2014*, OECD Publishing, 2014. Retrieved from: http://dx.doi.org/10.1787/health_glance_eur-2014-en

[18] Cannon, M. and Edmondson, A., *Confronting Failure: Antecedents and Consequences of Shared Beliefs about Failure in Organisational Work Groups*, Journal of Organisational Behaviour 22: 161-77, 2001.

[19] Plaza, C. et al., *Innovation in Healthcare Team Feedback: Development of an innovative feedback tool for interdisciplinary healthcare teams in the clinical environment*, Healthcare Quarterly, 14(2): 61-68, 2011.

[20] Huntington, J. et al., *Organisational Development for Clinical Governance*, British Medical Journal, 16: 679-682, 2000.

[21] Dess, G. and Picken, J*., Changing roles: Leadership in the 21st century*, Organisational Dynamics, 28(3): 18-34, 2000.

[22] Christensen, C., *The innovator's dilemma: When new technologies cause great firms to fail*, Boston: Harvard Business School Press, 1997.

[23] Drucker, P., *Innovation and entrepreneurship: Practice and principles*, New York: Harper & Row, 1985.

[24] Bettencourt, L., *Service Innovation: How to go from customer needs to breakthrough services*, The McGraw Hill Companies, 2010.

[25] Osterwalder, A. and Pigneur, Y., *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. John Wiley & Sons, 2010.

[26] Osterwalder, A. et al., *Value Proposition Design: How to create products and services customers want*, John Wiley & Sons, 2014.

[27] Ries, E., *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*, New York: Crown Business, 2011.

[28] Ghodeswar, B. and Vaidyanathan, J., *Organisational Adoption of Medical Technology in Healthcare Sector*, Journal of Services Research, 7(2), 2007.

[29] Niewolny, D., *How the Internet of Things Is Revolutionizing Healthcare*, Freescale Semiconductor, 2013. Retrieved from: http://cache.freescale.com/files/corporate/doc/white_paper/IOTREVHEALCARWP.pdf

[30] Villasenor, J., *How Connected Healthcare Today Will Keep the Doctor Away*, Freescale Semiconductor, 2014. Retrieved from: http://cache.freescale.com/files/corporate/doc/white_paper/CNHLTHTKPDCAWWP.pdf

[31] NTT Data, *Trends in Telehealth: Making healthcare more collaborative, affordable, and effective*, 2014. Retrieved from: http://americas.nttdata.com/Industries/Industries/Healthcare/~/media/Documents/White-Papers/Trends-in-Telehealth-White-Paper.pdf

[32] Europen Commision, *Green Paper on mobile Health ("mHealth")*, 2014. Retrived from: http://ec.europa.eu/digital-agenda/en/news/green-paper-mobile-health-mhealth

[33] Apple, *ResearchKit Technical Overview*, 2015. Retrieved from: https://developer.apple.com/researchkit/researchkit-technical-overview.pdf

[34] Popowich, F., *Using Text Mining and Natural Language Processing for Health Care Claims Processing*, SIGKDD Explorations, 7(1): 59, 2005.

[35] Wolniewicz, R., *Computer-assisted coding and natural language processing*, 3M Health Information Systems, 2015. Retrieved from: http://multimedia.3m.com/mws/media/756879O/3m-cac-and-nlp-white-paper.pdf

[36] Yuan, M., *Watson and healthcare: How natural language processing and semantic search could revolutionize clinical decision support*, IBM Corporation, 2011. Retrieved from: http://www.ibm.com/developerworks/library/os-ind-watson/os-ind-watson-pdf.pdf

[37] Raghupathi, W. and Raghupathi, V., *Big data analytics in healthcare: promise and potential*, Health Information Science and Systems, 2: 3, 2014.

[38] APMG International, *ISO/IEC 20000 White Paper*, 2012. Retrived from: http://www.apmg-international.com/nmsruntime/saveasdialog.aspx?IID=4587&fileName=ISO_20000_White_Paper.pdf

[39] March, S. T., and Smith, G. F., *Design and Natural Science Research on Information Technology*, Decision Support Systems, 15(4): 251–266, 1995.

[40] Prat, N., Comyn-Wattiau, I. and Akoka, J., *Artifact Evaluation in Information Systems Design-Science Research - A Holistic View,* 2014. Retrieved from: http://pacis2014.org/data/PACIS_mainconference/pdf/pacis2014_submission_593.pdf

[41] Maurya, A*., Running Lean: Iterate from plan A to a plan that works*, O'Reilly Media, 2012.

[42] Oates, B., *Researching Information Systems and Computing*, SAGE Publications, 2005.

[43] Bryman, A., *Social Research Methods*, Oxford University Press, 2012.

Appendixes

Appendix A – Value Proposition Canvas for BI-Solution

Customer Profile

Jobs

- Acompanhar todo o plano de cuidados desde a consulta pré-cirúrgica, passando pelo bloco, recobro e os cuidados intensivos (10)
- Promover uma tomada de decisão mais rápida, informada e baseada na evidência, optimizando a gestão dos cuidados críticos (10)
- Retirar todo o tipo de informação médica da base de dados e trabalhá-la informaticamente (9)
- Possibilidade de avaliar o que os médicos fazem e melhorar a qualidade do serviço (por exemplo saber que se teve X pessoas com delirio e Y fizeram um certo tratamento) (9)
- Optimizar a actividade dos profissionais de saúde, potenciando ganhos em saúde para a população (8)
- Avaliar todos os indicadores médicos disponíveis e não apenas os indicadores mínimos (como por exemplo o tempo de tratamento) (8)
- Promover a melhoria contínua da qualidade dos processos e dos seus resultados (7)
- Ter uma gestão eficiente das informações médicas dos pacientes (6)

Pains

- Os médicos não conseguem ter a melhoria de qualidade pretendida para se fazer investigação ou para atingir os objectivos pretendidos (10)
- Barreira de comunicação com as entidades responsáveis do hospital, pois o projecto tem demorado meses e meses (9)
- Vários projectos de investigação são deixados a meio porque os médicos não conseguem as informações médicas que precisam (9)
- Toda a informação médica está num sistema (Pyxis), mas os médicos não conseguem retirar essas informações da base de dados e trabalhá-las informaticamente (8)
- O processo actual é muito demorado (os médicos têm que manualmente registar numa folha e só depois do doente ter alta é que passam a informação para uma base de dados feita em Access) (8)
- As informações estão incompletas e dão muito trabalho para transferir de um sítio para o outro (8)
- Muitos dos projectos de investigação que não progridem, poderiam retirar conclusões que no futuro iriam permitir ao hospital poupar recursos (7)
- Barreira económica (o orçamento tem sido reduzido) (7)
- O BI-Solution não é uma prioridade para todos os sectores do hospital (o empenho não é o mesmo) (6)

Gains

- Serão conseguidas poupanças de tempo, de esforço e de dinheiro, que serão realocados em projectos de investigação e outros trabalhos (10)
- Melhora a prestação dos cuidados de saúde aos cidadãos, promovendo um acréscimo

contínuo e sustentável da sua qualidade (9)
- Possibilidade de trabalhar com os dados médicos sem complicações, de uma maneira mais fácil e eficiente, melhorando o desempenho dos médicos (9)
- Vai permitir avançar os projectos de investigação que o serviço tem e a longo prazo melhorar a qualidade do serviço (9)
- Definição atempada de ações específicas para o cumprimento dos targets estabelecidos (9)
- Redução do stress e da carga de trabalhos (8)
- Poupa tempo de doentes (8)
- Identificação sistemática de oportunidades e definição de prioridades (8)
- Ganhos adicionais em termos anímicos e de motivação (8)
- Redução do consumo de papel (7)
- Pode permitir transversalidade e colaboração entre serviços (6)

Value Map

Products & Services

• Benchmarking de indicadores de produtividade e qualidade clínica, como por exemplo complicações por faixa etária e por sexo, mortalidade por patologia, sinais e sintomas na admissão, tempo médio de internamento, entre muitos outros (10)

• São fornecidos 3 tipos de Relatórios UCI: Relatórios Gerais (Total de Internamentos na UCI, Destino dos Pacientes da UCI, Mortalidade Anual na UCI, etc), Relatórios Clínicos (Complicações por Faixa Etária e por Sexo, Mortalidade por Patologia Associada, Procedimentos mais comuns na UCI, etc) e Relatórios Actividade (Tempo Médio de Internamento na UCI, etc) (9)

• Permite ter os templates feitos para, por exemplo, tirar mensalmente um certo número de dados (8)

• Informação de suporte às operações dos vários utilizadores (8)

• Permite explorar a informação através de dashboards interactivos e relatórios detalhados (8)

• Informação de gestão do dia-a-dia, normalmente associada à gestão Departamental (8)

• Permite tirar listas e fazer formulários e tabelas (8)

• Informação de suporte a operações de maior prazo, na gestão de topo (8)

• Permite aos médicos receber resultados e notificações no seu email e em dispositivos móveis. (7)

• Vai permitir a cada serviço fazer as suas próprias queries (6)

Pain Relievers

Isto vai passar a ser feito de forma automatizada e os médicos só terão que trabalhar as informações e usar os formulários para retirar os dados pretendidos (10)	--> As informações estão incompletas e dão muito trabalho para transferir de um sítio para o outro
O BI-Solution vai permitir ganhar tempo, pois os médicos vão deixar de passar os dados manualmente (9)	--> O processo actual é muito demorado (os médicos têm que manualmente registar numa folha e só depois do doente ter alta é que passam a informação para uma base de dados feita em Access)
O BI-Solution potencia uma tomada de decisão e uma gestão em saúde mais informada, as quais são suportadas pela análise do desempenho e em benchmarking de indicadores de qualidade e eficiência. Desta forma é possível avaliar, em tempo real, o cumprimento dos targets definidos (9)	--> Muitos dos projectos de investigação que não progridem, poderiam retirar conclusões que no futuro iriam permitir ao hospital poupar recursos
Com todos os dados à disposição, vão-se abrir novos campos, pois os protocolos de investigação existentes poderão ser melhorados ou poderão ser criados novos protocolos (9)	--> Vários projectos de investigação são deixados a meio porque os médicos não conseguem as informações médicas que precisam
A ideia do hospital é que todos os serviços que já têm o Pyxis como sistema de registo e terapêutica, possam usar o BI-Solution, permitindo assim um melhor acesso a um conjunto variado de informações médicas e indicadores (8)	--> Toda a informação médica está num sistema (Pyxis), mas os médicos não conseguem retirar essas informações da base de dados e trabalhá-las informaticamente
O potencial de desenvolvimento do BI-Solution permite a sua constante adequação à realidade e à evolução das necessidades da organização, constituindo assim um instrumento vital para a garantia da excelência e qualidade dos cuidados prestados (8)	--> Os médicos não conseguem ter a melhoria de qualidade pretendida para se fazer investigação ou para atingir os objectivos pretendidos

Gain Creators

A identificação e definição de KPI's (Key Performance Indicators) permitirão identificar potenciais áreas de melhoria, mensurar ganhos em saúde e gerar um novo e melhor conhecimento a partir desta reunião de informação (10)

--> Vai permitir avançar os projectos de investigação que o serviço tem e a longo prazo melhorar a qualidade do serviço

A recolha eficaz da informação vai contribuir para o aumento do nível de conhecimento da eficiência e do desempenho operacional (9)

--> Possibilidade de trabalhar com os dados médicos sem complicações, de uma maneira mais fácil e eficiente, melhorando o desempenho dos médicos

Através da inovação e do uso efectivo dos sistemas de informação, o BI-Solution vai permitir fornecer melhores cuidados médicos, pois vai ser possível saber o que aconteceu aos pacientes no bloco operatório, que medicação fizeram, entre muitas outras informações (9)

--> Melhora a prestação dos cuidados de saúde aos cidadãos, promovendo um acréscimo contínuo e sustentável da sua qualidade

É garantida uma distribuição de recursos de forma mais eficiente e uma racionalização dos custos (8)

--> Serão conseguidas poupanças de tempo, de esforço e de dinheiro, que serão realocados em projectos de investigação e outros trabalhos

O registo passará a ser informatizado e automatizado (8)

--> Redução do consumo de papel

O BI-Solution a longo prazo irá permitir acompanhar tendências (nacionais e internacionais), fazer auditoria e depois com base nisso fazer planos de melhoramento e auto-crítica para se realizarem alterações (7)

--> Ganhos adicionais em termos anímicos e de motivação

Appendix B – Value Proposition Canvas for ISO-20000

Customer Profile

Jobs

- Reduzir os problemas com o TI e melhorar o tempo de resposta a esses mesmos problemas (10)
- Demonstrar altos níveis de qualidade e confiança dos serviços de TI, quer em concursos internacionais quer na expansão nacional de novos negócios (10)
- Possuir um critério de medição e validação do sucesso da organização na implementação das melhores práticas, conforme definido pelo ITIL (9)
- Manter os sistemas de TI actualizados e a funcionar adequadamente (9)
- Possuir um elevado nível de maturidade em processos críticos como as alterações, configurações e gestão de incidentes (9)
- Garantir a satisfação de todos os clientes, aumentando e melhorando a qualidade dos serviços disponibilizados aos clientes (9)
- Certificar e demonstrar que a organização possui ambientes de TI bem geridos e que a gestão de serviços em TI está de acordo com as melhores práticas do ITIL (9)
- Comparar os processos e actividades da organização com a norma internacional para o ITSM (8)
- Diminuir o risco de imprevistos e de desentendimentos com os clientes (8)
- Melhorar o entendimento dos negócios, funções e processos dos gestores e da equipa (7)
- Conseguir a atenção e o compromisso por parte da gestão senior (7)
- Planear os custos financeiros futuros com maior precisão e clareza (7)
- Garantir a aceitação e a adopção da gestão da mudança em toda a organização (7)
- Perceber como gerir e melhorar as TI (7)
- Necessidade de implementar ferramentas e soluções de automatização baseadas em sistemas, que auxiliem a organização a gerir ambientes complexos (7)

Pains

- É preciso uma supervisão constante aos sistemas de TI, para se manterem actualizados e a funcionar adequadamente (10)
- Complexidade dos processos de ITSM necessários para gerir as infra-estruturas de TI (10)
- A certificação ISO 20000 tem-se tornado uma exigência de mercado e será um pré-requisito para as organizações que oferecem serviços de TI (10)
- TI chegou a um ponto de maturidade em que poucas organizações poderão sobreviver sem a ISO-20000 (9)
- Complexidade e fluidez das infra-estruturas de TI (8)
- A prática de um melhoramento contínuo não é de forma alguma um empreendimento trivial (7)
- O ITIL foca-se no indivíduo (não se foca na organização) (7)
- Gasta-se muito dinheiro todos os anos com fornecedores de serviços (7)
- É difícil garantir a aceitação e a adopção da gestão da mudança em toda a organização (7)
- É difícil conseguir a atenção e o compromisso por parte da gestão senior (7)
- Dificuldade de interiorização dos processos pelos elementos da equipa (7)

- Dificuldade em alinhar os serviços de TI com a actividade empresarial (7)

Gains

- Redução de custos (10)
- Melhora a imagem e credibilidade da organização, diferenciando-a dos seus concorrentes (10)
- Redução do tempo de resposta a problemas e incidentes e da exposição operacional a riscos (10)
- Ajuda e promove a inovação (9)
- Adiciona uma maior clareza, consistência e resistência nos processos (9)
- Aumento da satisfação do cliente e da equipa (8)
- Integração total dos processos (8)
- Diminuição do risco de imprevistos e de desentendimentos com os clientes (8)
- Está alinhada com o modelo ITIL e com as normas ISO 9001 (qualidade) e ISO 27001 (segurança da informação) (8)
- Aumenta a produtividade dos trabalhadores e do sistema de TI (8)
- Profissionais de TI mais capacitados, motivados e reconhecidos (8)
- Criação de uma cultura de melhoria contínua (7)
- Redução da resistência à mudança (6)
- Aumento da capacidade de resposta às alterações por parte do negócio (6)

Value Map

Products & Services

- Arquivo de documentação auditável cobrindo, entre outros aspectos, alterações, incidentes, CIs e questões de segurança (10)
- É abrangido um "Código de Práticas para Gestão de Serviços", que expõe os elementos chave das melhores práticas ITIL (10)
- São definidas as directrizes de qualidade para a gestão de serviços de TI (ITSM) (10)
- São realizados controlos regulares da qualidade da ITSM (9)
- Processo de Suporte de Serviços (8)
- Processo de Gestão de Segurança de Informação (8)
- Processo de Orçamentação e Contabilidade de Serviços de TI (8)
- Processo de Gestão de Lançamento (8)
- Processo de Gestão de Incidentes e Gestão de Problemas (8)
- Processo de Gestão de Relações Negociais e Gestão de Fornecedores (8)
- Processo de Gestão de Capacidades (8)
- Processo de Contingência de Serviços e Gestão de Disponibilidades (8)
- Processo de Gestão de Nível dos Serviços (8)
- Entendimento e capacidade de resposta aos níveis de desempenho acordados entre o Cliente e Fornecedor através de SLA (Service Level Agreements) (7)
- São fornecidos requisitos para a implementação de um Sistema de Gestão de Serviços de Tecnologia da Informação efectivo (7)
- São estabelecidos critérios de auditoria, para ajudar nos negócios (7)
- Adopção da metodologia PDCA (Plan-Do-Check-Act) para os processos de planeamento e implementação de serviços (7)

Pain Relievers

A certificação ISO 20.000 estabelece critérios de auditoria, e fornece apoio e orientação ao pessoal de TI sobre como gerir e melhorar a TI (9)
--> Dificuldade de interiorização dos processos pelos elementos da equipa

A certificação ISO 20000 permite demonstrar altos níveis de qualidade e confiança dos serviços IT, quer em concursos internacionais quer na expansão nacional de novos negócios, oferecendo uma vantagem competitiva relativamente às organizações que não cumprem os requisitos desta norma (8)
--> A certificação ISO 20000 tem-se tornado uma exigência de mercado e será um pré-requisito para as organizações que oferecem serviços de TI

Com a certificação ISO 20.000 as organizações passam a ter um standard de auditoria para ajudar nos negócios (8)
--> Gasta-se muito dinheiro todos os anos com fornecedores de serviços

A certificação ISO 20000 certifica tanto profissionais quanto organizações (ou alguns dos seus serviços) (8)
--> O ITIL foca-se no indivíduo (não se foca na organização)

A certificação ISO 20000 permite a uma organização demonstrar que opera com integridade negocial e segurança, sendo fortemente valorizada em sectores críticos como a saúde, pois reforça a credibilidade e o pioneirismo (7)
--> É difícil conseguir a atenção e o compromisso por parte da gestão senior

A certificação ISO 20000 orienta a implementação das melhores práticas de gestão de serviços, sendo realizados controlos regulares da qualidade da ITSM (7)
--> É preciso uma supervisão constante aos sistemas de TI, para se manterem actualizados e a funcionar adequadamente

Deve ser procurada uma solução que alimente automaticamente a CMDB (base de dados de gestão de configuração) e que actualize a mesma quando são efectuadas alterações (7)
--> Complexidade e fluidez das infra-estruturas de TI

O pessoal de TI precisa de gerir os serviços de TI numa perspectiva de negócio, realizando uma Gestão de Serviços de Negócio (BSM-Business Service Management) (7)
--> Dificuldade em alinhar os serviços de TI com a actividade empresarial

A certificação ISO 20000 atesta o compromisso da empresa em busca da melhoria continua nos seus processos e serviços de TI, estabelecendo uma cultura de melhoramento contínuo da ITSM. É proporcionada uma forma normalizada para as organizações medirem os seus progressos "ITIL-izando" a ITSM (7)
--> A prática de um melhoramento contínuo não é de forma alguma um empreendimento trivial

As organizações necessitam de implementar ferramentas e soluções de automatização baseadas em sistemas (6)
--> Complexidade dos processos de ITSM necessários para gerir as infra-estruturas de TI

Gain Creators

Realização de controlos regulares da qualidade da ITSM, que assegura que os processos e serviços de TI vão sendo melhorados de acordo com o feedback dos clientes ou melhorias detectadas internamente (9) --> Criação de uma cultura de melhoria contínua

A certificação ISO 20000 é a única norma internacionalmente reconhecida para a gestão de serviços de TI e permite a uma organização demonstrar aos seus clientes e investidores que opera com integridade negocial e segurança, e que promove uma cultura de melhoramento contínuo da qualidade no âmbito da Gestão de Serviços de TI (9) --> Melhora a imagem e credibilidade da organização, diferenciando-a dos seus concorrentes

A certificação ISO 20000 fomenta a adopção de uma abordagem de processos integrada para um fornecimento eficaz de serviços de TI e define as directrizes de qualidade para a gestão de serviços de TI (9) --> Integração total dos processos

A certificação ISO 20000 auxilia os gestores de TI na realização das mudanças comportamentais necessárias aos processos (8) --> Redução da resistência à mudança

A certificação ISO 20000 cria uma ferramenta sólida de melhores práticas que apoia a inovação (8) --> Ajuda e promove a inovação

Através da diminuição da possibilidade de falhas e do número de incidentes e problemas, do planeamento da disponibilidade e da gestão da capacidade (8) --> Redução do tempo de resposta a problemas e incidentes e da exposição operacional a riscos

Simplificando os processos e tornando as responsabilidades claras (7) --> Aumenta a produtividade dos trabalhadores e do sistema de TI

A certificação ISO 20000 declara os requisitos obrigatórios de acordo com o ITIL para se efetuar a correcta gestão de TI (7) --> Adiciona uma maior clareza, consistência e resistência nos processos

Planeando os custos financeiros futuros com maior precisão e clareza (7) --> Redução de custos

Através da melhoria dos processos de gestão das alterações e de gestão das entregas (7) --> Aumento da capacidade de resposta às alterações por parte do negócio

A certificação ISO 20000 inclui um conjunto de requisitos mínimos para um fornecimento eficaz dos serviços, de forma a satisfazer os requisitos empresariais e dos clientes (7) --> Aumento da satisfação do cliente e da equipa

Todas as acções e pedidos são registados (6) --> Diminuição do risco de imprevistos e de desentendimentos com os clientes