

Managing Innovation in Hospitals

Summary of dissertation for the degree of Master in Information Systems and Computer Engineering

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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.

1. Introduction

The need for innovation is recognized by hospitals, since advances in health technologies and data management can provide new diagnostic and treatment options [1]. 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 pressures 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.

This thesis follows the principles of Design Science Research Methodology (DSRM) [2][3]. 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 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 (Section 9).

2. Research Methodology

This research was performed using the Design Science Research Methodology (DSRM) [2].

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. In this thesis, we propose a **method**, i.e. the artifact will provide guidance on how to solve the problem found [3].

DSRM consists on 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 [2]:

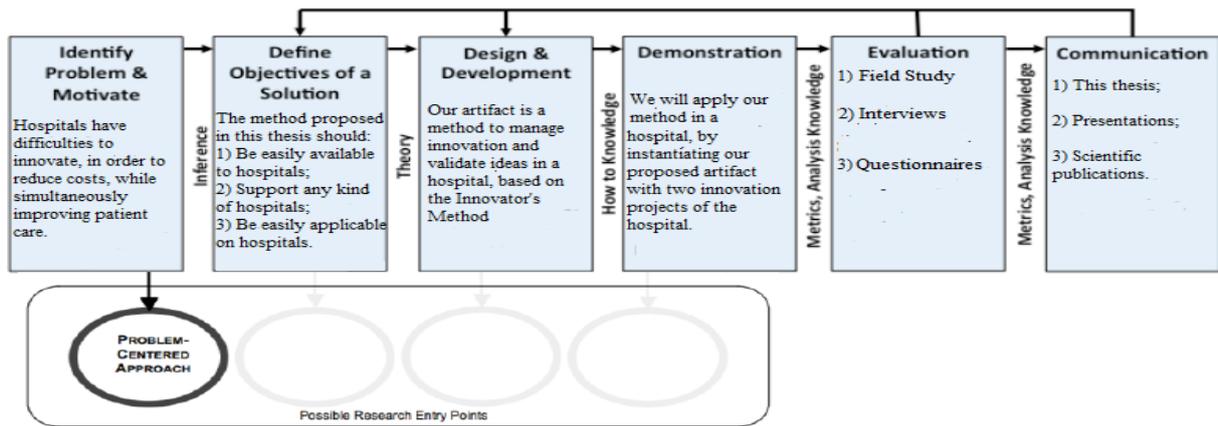


Figure 1 - DSRM Process Model (adapted from [2])

3. Research Problem

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 [1].

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 cause of mortality in the world [1]. The increase in chronic diseases will require more health care spending and lead to long-term hospitalizations that often result in severe hospital infections.

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 in recent years. In Portugal, health spending is unlikely to start recovering until 2017 [1].

Hospitals are very complex and highly regulated, in which there are barriers to change, because change generates new challenges and risks. 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.

In Figure 2, we illustrate the main challenges that hospitals are facing:

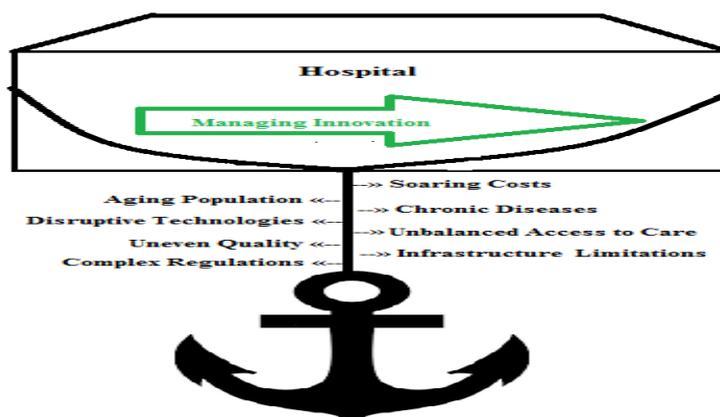


Figure 2 - Illustration of the main challenges faced by hospitals

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.

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 [1]. 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.

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 [4].

4. Related Work

In this Section, we present a literature review of the topics related to this thesis.

4.1. Service Innovation

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 [5].

Without useful customer inputs, organizations will end up with high service failure rates and disorientation about what new services to offer [5]. 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.

There are the following approaches to find service innovation opportunities [5]:

- **New Service Innovation:** Focuses on discovering new and related jobs, which the customer wants to accomplish and which there 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.

4.2. Business Model Canvas and Value Proposition Canvas

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.

4.2.1. Business Model Canvas

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 [6].

As stated by Alexander Osterwalder and Yves Pigneur, a business model can be described through nine blocks. In Figure 3, we represent the Business Model Canvas and we explain each block below [6]:

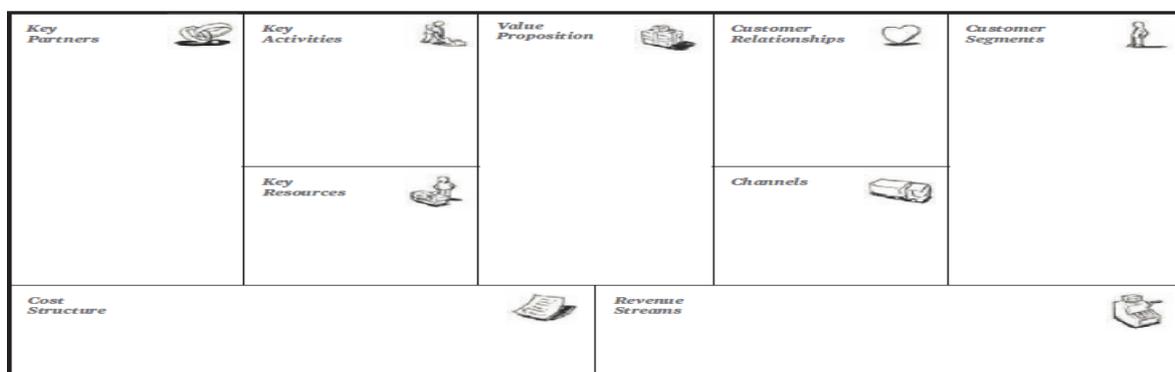


Figure 3 - Business Model Canvas (from [6])

- **Customer segments:** This block identifies one or several customer segments.
- **Value propositions:** This block 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.
- **Customer relationships:** This block plans the interactions and the types of relationships established with specific customer segments.
- **Revenue streams:** This block determines how the value propositions will make the business earn revenue.
- **Key activities:** This block determines the uniquely strategic things that the business does, in order to deliver its proposition.
- **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 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.

4.2.2. Value Proposition Canvas

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 [7].

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 [7].

In Figure 4, we represent the Value Proposition Canvas and we explain each block below [7]:



Figure 4 - Value Proposition Canvas (from [7])

- **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 [7].

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 [8].

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 [8].

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 [8].

4.4. Lean Startup

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 [9].

As reported by Eric Ries, Lean Startup has the following principles [9]:

- **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.
- **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.
- **Innovation accounting:** Innovation accounting allows to determine if the product development efforts are making progress and discover if validated learning is being achieved.

The Build-Measure-Learn feedback loop of Lean Startup is represented in the following Figure:

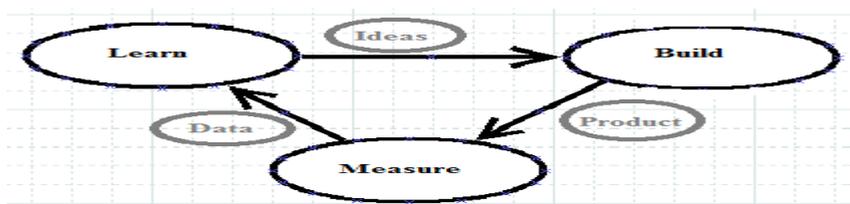


Figure 5 - Build-Measure-Learn feedback loop of Lean Startup (adapted from [9])

Once an organization perceives which activities and processes create value and which just waste resources, the lean techniques can start being used to increase the efficiency of the activities and processes that create value [9].

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. 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, 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.

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 [10].

The emergence of the IoT is crucial for four reasons [10]:

1. Advances in sensors technology allows patients and health professionals to diagnose, monitor and store patient data, 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.
4. The patient will take control and participate more in his own treatment.

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 [11]. Telehealth allows to monitor, diagnose, and sometimes even treat patients who are in different locations than health professionals, in order to reach all citizens.

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) [11].

4.5.3. Natural Language Processing (NLP)

Natural language processing (NLP) processes and analyses unstructured textual information automatically [12].

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 [13].

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 [14].

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 [15]. 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 [16].

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; help in the development of better mechanisms for early detection and prevention of diseases, which will allow to save lives and reduce costs [16]. As big data analytics becomes more popular, issues related to the patient's fundamental rights to privacy and data protection are being raised.

5. Theoretical Background

Our thesis proposal will be based on the Innovator's Method, which is a series of experimentation cycles that manage the uncertainty of innovation and is adapted for large organizations [4]. 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 6:



Figure 6 - Steps of the Innovator's Method (adapted from [4])

6. Research Proposal

In Sub-Section 6.1 we infer the solution's objectives, taking into account the related work and our analysis. In Sub-Section 6.2 we present and explain our proposal to solve the identified problem.

6.1. Objectives

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.

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 Business Model Canvas and Value Proposition Canvas. In Figure 7, we illustrate the method proposed by this thesis, and we explain each step below:

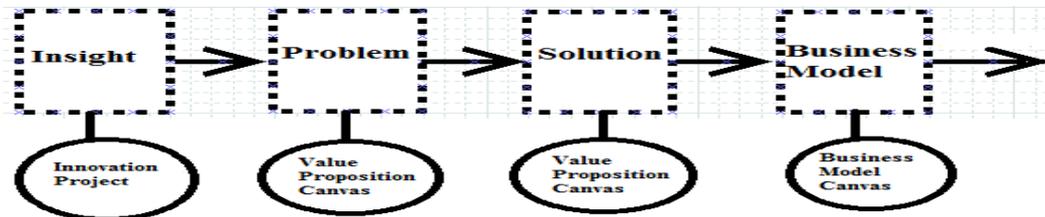


Figure 7 - Method proposed by this thesis

- **Insight:** Since two innovation projects were assigned to us by the 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.
- **Business Model:** We will use Business Model Canvas to develop and validate the business model.

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 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

We performed a field study in a public hospital, in which we instantiated our proposed method with two innovations projects, BI-Solution and ISO-20000 certification, assigned by the hospital, so that we could apply our proposed method.

For both projects we scheduled and performed interviews with the projects' customers (physicians of the Intensive Care department and engineers from the hospital's IT department), since our proposed method includes talking face-to-face with people.

The first step of our proposed method is the Insight, which is the BI-Solution project and the ISO-20000 certification. 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 and IT staff, 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 goals and desired features of the physicians and IT staff, in order to ensure that the solution will correspond to the expectations of projects' customers. The last step of our proposed method is the Business Model, in which we developed the Business Model for both projects. Through interviews we validated some fields of the business models (Customer Segments, Channels, Customer Relationships and Key Partners). We did not validated the remaining fields of the business models due to time constraints, in order to deliver this thesis in this semester.

8. Evaluation

According to Nicolas Prat et al., Information Systems (IS) artifacts are evaluated as systems that have five dimensions: goal, environment, structure, activity and evolution [17].

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. 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 [17].

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.
2. **Interviews and Questionnaires:** We will collect feedback and other important data about the proposal by interacting personally with the demonstration's participants, in order to evaluate our thesis proposal.

8.1. Demonstration

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 easily used and applied in a hospital, despite several difficulties that we had to face.

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 properly evaluated and tested with our demonstration.

8.2. Interviews and Questionnaires

Through interviews and questionnaires, 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.

We interviewed three physicians and two engineers from the IT department, who have participated in the demonstration. 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.

We also delivered a brief questionnaire to those involved in the demonstration, so that we could evaluate our proposed method. 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, as well as if our research proposal solves the research problem. 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. We will now briefly present the results per question:

- **Question 1:** The answer average in this question was 4.2. 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. One of the proposal's objectives is that the method should be easily applicable on hospitals, so 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. 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. 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. 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.
- **Question 5:** 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 feedback obtained was positive and the evaluation criteria and the proposal's objectives seems to have been achieved.

9. Conclusion

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. As a consequence, our artifact is a method to manage innovation in a hospital, based on the Innovator's Method.

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 demonstrations. 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.

9.1. Lessons Learned

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, since the communication is mainly done by e-mail. As a consequence, several projects take longer than expected. Our proposed method is applied face-to-face, which can reduce these communication gaps.

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) 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 demonstration's participants, who have 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 although our thesis proposal is generic, we cannot clearly state that our proposed method can be applied in all hospitals, since we could only demonstrate our proposed method in one hospital.

9.3. Future Work

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.

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