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Resolving Gaps in Healthcare Using Design for Six Sigma

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Master in Management of Services and Technology

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The completion of my master's thesis represents for me one of the most important milestones of my life so far. None of this would be possible without the support of all the people who accompanied me on this journey. I must start by thanking my mother for always giving me the opportunity to continue studying and following my dreams.

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Resumo

A metodologia Design for Six Sigma (DFSS) centra-se em construir qualidade nos processos, identificando as necessidades dos envolvidos e incorporando características que respondem a essas necessidades na conceção do processo; por conseguinte, a metodologia DFSS segue a estrutura Define, Measure, Analyze, Design, and Verify (DMADV).

Esta investigação foi realizada no Departamento de Oncologia de um hospital em Lisboa, Portugal. Este departamento estava interessado em melhorar a comunicação interna do seu pessoal; assim, um primeiro passo nesta investigação foi mapear o fluxo de trabalho neste departamento, com particular ênfase nas formas como o pessoal actualmente comunica e partilha informação. Através de *shadowing* e entrevistas com o corpo técnico, rapidamente se tornou evidente que a maioria da comunicação era feita manualmente, quer verbalmente, quer através de notas manuscritas, o que era naturalmente propenso a erros.

Dada a necessidade de criar um processo formal para o pessoal comunicar e partilhar informações, primeiro as necessidades do pessoal do departamento foram identificadas; depois, as respostas às entrevistas foram traduzidas em declarações de necessidades concretas, sendo depois priorizadas através de um inquérito e em seguida, foram utilizadas estatísticas descritivas simples para identificar o subconjunto das necessidades mais importantes, e estas foram utilizadas para orientar a concepção do processo de comunicação do pessoal. Foram então desenvolvidas métricas para fornecer uma forma de medir a satisfação das necessidades mais importantes. Depois, foi desenhado o CRM que é um instrumento de comunicação eletrónico que permite satisfazer todas as necessidades previamente identificadas pelo staff do hospital.

Palavras-chave: Cuidados de saúde, oncologia, comunicação, Metodologia Design for Six Sigma, DMADV.

Abstract

The Design for Six Sigma (DFSS) methodology focuses on building quality into processes by identifying the needs of stakeholders and incorporating characteristics that address those needs into the process design; therefore, the DFSS methodology follows the Define, Measure, Analyze, Design, and Verify (DMADV) structure.

This research was conducted in the Oncology Department of a hospital in Lisbon, Portugal. This department was interested in improving the internal communication of its staff; thus, a first step in this research was to map the workflow in this department, with particular emphasis on the ways in which staff currently communicate and share information. Through shadowing and interviews with staff, it quickly became apparent that most communication was done manually, either verbally or through handwritten notes, which was naturally prone to errors.

Given the need to create a formal process for staff to communicate and share information, first the needs of the department's staff were identified, then the interview responses were translated into concrete needs statements and then prioritized through a survey, and then simple descriptive statistics were used to identify the subset of the most important needs, and these were used to guide the design of the staff communication process. Metrics were then developed to provide a way to measure the satisfaction of the most important needs. Then, the CRM was designed which is an electronic communication tool to meet all the needs previously identified by the hospital staff.

Key words: Healthcare, Oncology, Communication, Design for Six Sigma methodology, DMADV approach.

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List of abbreviations

BPR – Business Process Redesign

CTQ - Critical to Quality

CRM - Customer Relationship Management

DFSS - Design for Six Sigma

DMADV - Define, Measure, Analyze, Design, Verify

HFF - Hospital Professor Doutor Fernando Fonseca

HoQ – House of Quality

QFD – Quality Function Deployment

SIPOC - Suppliers, Inputs, Process, Outputs, Customer

VOC - Voice of the customer

1 INTRODUCTION

In this first chapter, initial contextualization will be provided, beginning with the exposition of the problem statement (1.1) where also some explanation about the theme will be presented; in sub-chapter 1.2 the research questions the study aims to answer will be shown, followed by the scope (1.3) and its main objectives (1.4). The methodology that is going to be followed is exposed in sub-chapter 1.5, and finally, to close this chapter, the project structure will be described (1.6).

1.1 Problem statement

Communication is the action of transmitting a message that one intends to convey; through different channels that are available to us, such as verbal or non-verbal communication, and formal or informal communication, to someone who is willing to receive it or is in need of it (Markovic and Salamzadeh, 2018). Communication is, thus, the process of transmitting, releasing, or delivering information/ideas from one individual to another or from one place to another, that is essentially a process of sharing between at least two people (Markovic and Salamzadeh, 2018). It is critical for integrating and optimizing processes of specific areas within different levels of any organization (Markovic, 2011). However, it is perceivable that there are differences in the message transmitted and the message received, because each person has their own way of communication and interpretation; hence, it is important to have a simple and uniform communication process (Rimal and Lapinski, 2009). If one of the entities involved does not understand the point that is attempting to be conveyed, the communication is not effective (Ratna, 2019). For any type of organization, communication is a key process, and managing it requires much more than simply understanding it. The reality is that poor management of any kind of communication system can result in negative outcomes (Markovic and Salamzadeh, 2018).

When it comes to healthcare, the quality of the services delivered may be negatively affected by poor communication (Ratna, 2019). Medical errors can occur under a myriad of circumstances and for many reasons, but overall, they can be divided into errors of judgment, execution, communication, or expertise, with errors due to communication being the most typical cause of medical mistakes; yet these can be avoided through the use of well-structured and designed communication systems (Murphy and Dunn, 2010). An efficient communication

process within healthcare requires healthcare knowledge, cultural competence, and overcoming language barriers. To deliver the best possible service to patients, all the links in a health service (e.g., nurses, physicians, administrative staff) must communicate clearly with one another. If any part is not aligned with the others, there is a high likelihood of negative patient outcomes (Ratna, 2019). Nonetheless, this matter is highly dependent on all the associated surroundings, and pressure and target-driven conditions like the ED, can be distraught to convey data to patients, as this is already stressful in itself with patients normally requiring critical care (Bongale S, et al., 2013). This can of course lead to miscommunications and those can adversely affect a patient's well-being and prosperity (Engel et al, 2009).

These communication difficulties are in fact often recognized in the healthcare sector, such as it is the case at *Hospital Professor Doutor Fernando Fonseca* (HFF) in Lisbon, Portugal, specifically in the Oncology Department. At the beginning of this project, this department had a manual (paper-based) system for doctors to communicate follow-up tasks to secretaries. This system of communication compromised patient care in two ways: 1) when task lists got lost, patient appointments, exams, treatments, etc. were not scheduled and 2) patient appointments were often interrupted by doctors/secretaries to clarify or check on something related to a follow-up task. Hence, this research project is focused on redesigning the Oncology Department's internal communication process. While there are many approaches to redesigning a process, such as design thinking, engineering design, and innovation, this project used the Design for Six Sigma (DFSS) methodology to deeply engage with customers and develop a design based on their specific needs.

1.2 Research question

Based on the contextualization given above, the research questions that this case study will answer are:

Q1: “What” are the key design elements of a system for internal communication between HFF Oncology Department doctors and secretaries regarding follow-up tasks, etc.?

Q2: “How” should these elements function to achieve the ultimate goal of effectively addressing the needs of both HFF Oncology Department doctors and secretaries while minimizing negative impacts on patient care (e.g., lost requests, and appointment interruptions)?

1.3 Scope

Since it is not feasible to optimize all the processes within HFF's Oncology Department, the scope of this research was to design a system for internal communication between doctors and secretaries regarding follow-up tasks, [OBJ] And for this research the aim is not to:

- Focus on any other processes within HFF's Oncology Department apart from internal communication between doctors and secretaries regarding follow-up tasks, etc.;
- Design processes for use outside of HFF's Oncology Department;
- Involve patients in research activities.

1.4 Objectives

The objective of this research was to improve patient care by designing a system for internal communication between HFF's Oncology Department doctors and secretaries regarding follow-up tasks, etc. that effectively addresses their needs. In order to achieve the stated objectives, the following undertaken:

- Map the internal communication process at a high-level;
- Identify doctors and secretaries' main needs using different tools;
- Establish how each need should be measured;
- Conduct brainstorming and feedback sessions to gather design ideas;
- Propose and implement a new communication process;
- Collect verification measures and compare them to the baseline, to assess the new process

1.5 Methodology

This research project follows two complementary methodologies: **Action Research** and **Design for Six Sigma**.

Lewin (1948) conceived the term “**Action Research**” as a method of systematic investigation for every party in the search for higher efficiency through active participation. Based on cooperation between the researcher and the customer, action research relies on this team to carry out their intervention in the organization (the action), to research problems, and to create data about the organization and its development (the research activity). Simultaneously with these activities, the team also analyzes the effects that the actions have, both intended and unintended (Coughlan and Coughlan, 2016).

DFSS is a methodology for building quality into the design of new products and services (Deming, 1982). The aim of this approach is to identify customer needs and satisfy those using what the organization is already capable of doing, as much as possible. To accomplish this, five stages will be followed, which are known as DMADV:

1. Define phase
2. Measure phase
3. Analyze phase
4. Design phase
5. Verify phase

1.6 Project structure

The structure for this discussion of this research project is organized into five chapters:

- First, an **(1) Introduction** of the key theme of the research project and the respective objectives are discussed, as well as the scope of the research and its methodology;
- Second, a **(2) Literature Review** is presented to support the discussion of the research project;
- Third, a **(3) Methodology** where the path followed in the research project are discussed, including the phases and tools used to collect and analyze data;
- Hereinafter, the **(4) Case Study** is described following the methodology presented. This illustrates the work done in the Oncology Department to develop and implement a new design for internal communication.
- To conclude, there will be a final chapter that will present the **(5) Conclusions** and limitations of the research project.

2 LITERATURE REVIEW

Having in mind the general objective of this project, which is mainly focused on the design of a new communication process for an oncology department, different design approaches are addressed, such as design thinking, quality function deployment (QFD) and Business process reengineering (BPR), with examples concerning the design of communication systems being presented whenever possible. Next, the Design for Six Sigma (DFSS) is further developed as it will be the methodology to be followed within the scope of this thesis.

To carry out the current research, the following search engines were used: google scholar, Elsevier and B-on, using the keywords healthcare, DFSS, DMADV approach and communication (in isolation or in combination).

2.1 Design Approaches

Design is broadly viewed as a key to improving something - regardless of how well the assembly, creation, sales and so on are performed, if an item is inadequately designed, the final result will not succeed (Haik and Shahin, 2011). Different approaches have been proposed in the literature for design purposes, such as Design Thinking, QFD, BPR and DFSS. This section briefly presents the basics of the first three approaches, also providing some examples of applications in healthcare settings. The DFSS is afterwards explored in more detail in Section 2.2, since it represents a key approach for the purpose of this project.

2.1.1 Design Thinking

Design thinking is an approach that relies on the work of a multidisciplinary team in which the goal is to develop empathy and proximity with users, using action-oriented prototyping solutions. This design approach enhances contact with all parties involved and innovates only after passing several pre-defined phases such as ideation, prototyping and testing. Due to the proximity to stakeholders, it allows researchers to include user needs and receive feedback throughout the process, which helps to close the gap between intervention development and implementation (Altman et al., 2018).

Design Thinking has been widely applied in a variety of sectors, including in healthcare. Nevertheless, when analyzing healthcare applications, although a diversity of purposes can be identified, only one study was found aimed at improving communication. This study was

developed by Lin et al. (2015), who have used design thinking with the purpose of improving the way correspondence is shared across 14 clinics in California. Particularly, this study highlights that the Joint Commission Public Patient Security Objective on handoffs expected healthcare associations to execute normalized ways to deal with handoff correspondence, and this has motivated Kaiser Permanente Southern California to start carrying out NKEplus (Medical attendant Information Trade) in 125 nursing units across 14 clinics, with the utilization of human-focused design standards. The methods used by this team of researchers was to engage directly with the nurses (as people) and thus understand what their experiences and preferences were in order to build together a shared understanding of why NKEplus was an important practice for quality of care. Instead of the research team telling them straight away what needed to be improved, they let them find out for themselves, creating awareness of what could be improved and creating in the nurses a collective desire for change.

But, as noted above, the vast majority of applications of design thinking in healthcare are not focused in improving communication. For instance, and as an example, Helou et al. (2019) relied on design thinking to redesign an Electronic Medical Record (EMR) system in a Japanese antenatal unit, in order to make it more productive, successful, and information driven. This study followed a user-centered design paradigm, in which design activities follow the users' preferences (in this case, obstetricians, midwives and pregnant women).

2.1.2 Quality function deployment

Quality function deployment (QFD) is one of the most utilized client-driven approaches for new or further developed product/service plans and advancement to satisfy customer requisites and increase clients' loyalty (Carnevali and Miguel, 2008). One of the main purposes of QFD is to transform any organization into being proactive concerning quality issues, instead of being reactive to client grievances. It is possible to classify QFD as design-in quality instead of the conventional inspected-in quality, since it reorganizes the organization though. As indicated by Yang (2003), QFD can decrease time and cost, and improve management quality, customer satisfaction and market share. It can also work with continuous improvement by focusing on the learning effect of an association in development. The center idea of QFD is to gather and afterward interpret the costumer expectations into engineering characteristics, and then into part characteristics, process parameters and production requirements. Therefore, the usual QFD process comprises four stages: product planning (house of quality (HoQ)), parts deployment, process and production planning (Chen and Ko, 2010).

Although numerous QFD studies and applications can be found in various manufacturing and services organizations, not many have been identified in the health area. Hashemi et al. (2015) utilized QFD to work on the nature of chemotherapy unit administrations. The HoQ was used in this study in combination with a Delphi study and data envelopment analysis, in order to identify patients' expectations and associated priorities, respectively, and a Person Correlation was used to determine the relations between service elements. In the end, the service components were derived by matrix calculations. Keshtkaran et al. (2016) also applied a QFD strategy to improve the quality of care provided in the burn unit services at a medical clinic in Iran. Similarly, to Hashemi et al. (2015), the Delphi technique was also used to identify key patients' expectations, which turned out to be much more connected with clinical staff and received medical services. More recently, Tripathi et al (2019) created a new model of surgical rounds, making use of the HoQ together with an affinity diagram and focus group to identify the most critical customer requirements. It should also be noted that no study relying on the use of QFD was identified presenting proposal to improve communication in healthcare.

2.1.3 Business process reengineering

BPR was created by industry workers and can be characterized as an extremist redesign of business processes to accomplish huge enhancements in basic contemporary measures of execution, like costs, quality and speed (Hammer and Champy, 1993). BPR has been applied in the healthcare sector to carry out organizational changes towards more client-centered and financially savvy care. The review performed by Elkhuizen et al. (2016) allowed to conclude that most of the existing BPR studies are aimed at diminishing the lengths of stays, trailed by the objective of lessening waiting times and cost decrease.

Penrose et al. (2018) intended to further develop access to cataract surgery by redesigning the process. They began by checking and mapping the conventional outside pathway, and afterward brainstorming sessions with a surgeon, a manager, the clinical director, and community members were performed in order to eliminate as many pointless steps in the surgical process as possible, with particular focus on grouping the procedures performed, in the same space, and having better coordination between the different levels of health care. Harris et. Al. (2019) also followed BPR to redesign clinical processes in order to reduce care variance and improve quality, safety and satisfaction for people with Parkinson's disease. The methods used included a pre-post medical record audit, that helped to identify gaps in the service that tend to lead to poor health practices by comparing the length of stay and the different processes

in use; a survey answered by nurses, that served to evaluate the impact that the program they wanted to implement would have; and phone interviews to patients, with the goal of getting feedback on their experience after the process was redesigned and implemented. Redesign approaches can offer a pragmatic method to improve care integration, change physician behavior, and reduce outcomes with any clinical setting. Nevertheless, and similarly to the use of QFD, no application was found focused on redesigning the communication process in healthcare settings.

2.2 Design for Six Sigma

DFSS was first created for product development (Edgeman & Dugan, 2008), but it is also applicable to the design of processes. It makes a solid plan for processes and services that addresses customers' needs while reducing costs (Antony, 2002). DFSS is an appropriate method to use when simply improving the process will not yield the desired change; hence, rethinking the design of the process is needed in order to make it more efficient and significantly increase process performance. DFSS is a methodical strategy that utilizes design (e.g., QFD, the theory of inventive problem solving (TRIZ), axiomatic design, Taguchi method, amongst others (Harolds, 2022)).

Since the aim of this project is to rethink the communication method currently employed at the Oncology Department of HFF and design a new method that meets the requirement of both doctors and administratives, rather than simply improving the current system, DFSS is deemed to be an appropriate approach for that purpose. When the aim is to depart from an existing process, and even to keep some of its characteristics, it would not be appropriate to use such an extreme redesign method such as the BRP. In fact, redesigning processes is often the best way to further develop their performance, since designing new processes includes more than modifying work processes, it helps organizations eliminate non-value-added activities, associated costs that may exist, and errors (Hammer, 2007).

DFSS has previously been used in a wide variety of different industries, from additive manufacturing (Liverani et al. 2019) to construction (Lee et al., 2020). With respect to service processes, DFSS has been used to design new housing concepts (Johnson et al., 2006), as well as to improve telecom services (Yang et al. 2018) and animal care and use programs (Okpe and Kovach, 2017). Mitchell and Kovach (2016) demonstrated how the DMADV approach can be applied to improve communication, specifically information sharing in supply chain operations

(Mitchell and Kovach, 2016). And within these diversity of studies, one can find different DFSS methods, amongst which the most commonly used are as follows (Yang, K., 2005):

- I. IDOV (Identify, Design, Optimize and Verify) - essentially used when creating new designs;
- II. DMADV (Define, Measure, Analyze, Design and Verify) - most suitable for redesign processes.

2.2.1 Design for Six Sigma: Applications outside the services sector

Several DFSS applications exist in the manufacturing sector, with recent studies being developed by Liverani et al. (2019) and Lee et al. (2020).

Recognizing the increasing competition for products and services at a worldwide scale, as well as that such a wide variety of offers not always fulfill the expectations of the final consumer, Liverani et al. (2019) focused on the analysis of techniques that foster the identification of customers' needs, thus anticipating design mistakes and, consequently, reducing development costs. And as a particular case study, these authors aimed at designing and prototyping a creative multifunctional fan (Light, Fragrance Diffuser and fan) through the Multi Jet Fusion of HP. First, DFSS and the QFD were used to distinguish the fan prerequisites, according to the users' point of view. Then the advanced CAD (computer aided design) design systems and the CAE (computer-aided-engineering) techniques are used for the design of a virtual model of the product (in this case, the fan). And finally, additive manufacturing was used to produce the initial prototype.

Lee et al., (2020) propose the development and utilization of a high-level composite material-based concrete form that solves the problems found in the most commonly used system forms, such as the heavy weights and low productivity. The DFSS is used for that purpose, by following the DMADV cycle. Client needs are identified in the Measure phase of the DMADV cycle by making use of the HoQ (as discussed above, a key tool of the QFD technique). Afterwards, in the Analyze phase, TRIZ was employed to generate innovative ideas and solutions. And similarly, to Liverani et al. (2019), the design of a first virtual form was achieved using CAD design systems and CAE techniques. Once concluded, this study has demonstrated that DFSS is an important method for innovation improvement and efficient dynamics in building development.

2.2.2 Design for Six Sigma: Applications in services

Several DFSS applications also exist in the service sector, with recent studies being developed by Okpe and Kovach (2017) regarding animal care services, Mitchell and Kovach (2016) respecting marine transportation services and Yang et al (2018) concerning a telecommunication service company.

Okpe and Kovach (2017) used an action research approach to improve the services provided by animal care and use programs, which are services key to ensure the humane care and treatment of research animals. Relying on the use of the DMADV approach, the researchers used the SIPOC diagram, developed to fully understand the process as a whole; surveys and interviews, to identify the users' needs and convert them into actual statements; matrixes to prioritize the needs and move forward with those of greatest importance to the users; metrics to have a common basis for evaluating the design, before and after it is implemented; and affinity diagrams, to group the requirements in categories. This study thus contributes to science with respect to the outstanding use of the DFSS philosophy in service operations in which the new process successfully satisfies the requirements for which it was redesigned.

Yang et al (2018), developed an improvement process in a telecommunication service in a company in Shanghai by applying DFSS tools. To begin with, a House of Quality (HoQ) was developed where the relationship between customer needs and the quality traits that satisfy them could be observed. The organization's staff gave their satisfaction scores on each identified need and overall satisfaction using a scale of 1 (not satisfactory) to 10 (Satisfactory) to confirm the correlation of each need with the overall quality of the service, and to assess its current level of quality. To identify the correlation of each need with perceived satisfaction, a regression analysis was used using these same ratings. In order to clarify customer preferences and categorize them into attractive, single-dimensional, and required quality, the KANO model was used. To transition the requirements from qualitative to quantitative, and if possible, into features of the service itself, the QFD plan of required quality was followed. It was through brainstorming sessions that the central aspects that the new system should have, to satisfy the needs presented, were arrived at. One of the main complaints about this process was still how time-consuming it was, and so a Value Stream Map was drawn up to find its causes. To conclude, after redesigning the service, the company has greatly increased its performance and also had great financial gains.

An example of redesigning the communication process was also found, being proposed by Mitchell and Kovach (2016). This study was applied to a marine transportation services organization, aims to optimize the exchange of information in a SC regarding the movement of materials via inland tank barges, using the DFSS methodology for that purpose (Mitchell and Kovach, 2016). To develop this design, the research team worked closely with the transportation coordinators of this organization to understand their specific needs, starting by building a flowchart to understand exactly how information is exchanged between the parties involved and look at the process, and then later by creating a SIPOC diagram to synthesize the process. The DMADV methodology was followed to identify the most significant points for improvement according to the employees' points of view, as well as what they agree with the current process and what they don't, obtaining this information through surveys and interviews and then translating the information into needs, examining this information through a user needs analysis. Later on, a prioritization survey was handed to the participants, asking them to rate the needs using a 5-point scale. When the highest score needs were identified, a needs-metrics matrix was elaborated and metrics were defined for each need, with the aim of analyzing it before and after the redesign. In the final stage, and to select the design to implement, a concept selection matrix was used, where the research team rated each design (on a 3-point scale) and the design with the highest score was deployed. The project turned out to be successful because it met all the needs for which it was designed, and the organization improved its communication and the way they made decisions regarding the supply chain (Mitchell and Kovach, 2016).

2.2.3 Design for Six Sigma: Applications in healthcare

Multiple DFSS applications exist on healthcare, with recent studies being developed by Kovach, J., and Pollonini, L. (2022) regarding devices in ICU, Kroft and Murphy (2016) concerning hospital in-patient food. Although examples of DFSS applications for communication improvements are not common, a study was however found being developed by Yun and Chun (2008) respecting telemedicine.

Kovach and Pollonini (2022) developed a case study with the main objective of finding essential characteristics for a device to detect hospital acquired pressure injuries. Similarly, to many other DFSS applications, the goal was to design this device with the participation of nurses, with the main objective of reducing the severity degree of pressure injuries, reducing as much as possible the interruptions in their work process. The tools used to understand the nurses' needs were shadowing and interviews. A nurse was observed for the duration of a shift

while being shadowed, and notes on her daily chores and routine were made. Conversely, interviews were carried out to learn more about their needs and to take into account how that device should transmit the detection of hospital acquired pressure injuries. These interviewees' responses were transformed into need statements, which detail the specifications the device must meet. Finally, brainstorming sessions were conducted where suggestions for how the devices should promptly inform the ICU staff were addressed, in a timely manner.

Taking the customer experience and healthcare aspects as a starting point, Kroft and Murphy (2016) created a new process using DMADV and lean concepts at Deaconess Hospital that provided a positive inpatient food experience. The patient experience is something that directly affects a hospital's reputation and indirectly will affect the hospital's financial return. Since patients today expect more than just clinical care and quality interventions in a hospital, the patient food experience was identified as a key factor in the length of a patient's stay. As tools used in this project, Gemba walks were used to identify opportunities in operational flows and to record the Voice of the Customer (VOC) in the food delivery process. Gemba walks, in which the work done by participants is observed on site, are a tool that assists in identifying potential for process improvement (Dalton, 2019). A SIPOC diagram was employed to clarify the procedure, and swim lane diagrams were also used to depict the various tasks carried out. Patients were asked to rank their experiences as bad, acceptable, good, or very good using patient questionnaires. A Gantt chart was created to aid the research team in project management, and daily meetings were held at the start of the project to go through what had already occurred and what was required to address any new problems. Due to the reduction and optimization of food using a Kaizen technique, the new work process was effectively implemented, and the hospital is now saving money.

With the evolution of technology and telecommunications, the medical community has also changed and has begun to give greater importance to telemedicine, making the services it provides more efficient. Within this setting, Yun and Chun (2008) developed a study focused in the improvement of telemedicine in a Korean hospital using DFSS and the SERVQUAL (Service Quality Framework) as a basis. Since telemedicine is about using communication and IT to provide health care, this represents the single study identified proposing DFSS for communication improvement purposes. With a step-by-step method, the telemedicine process was evaluated and all the significant CTQ features were recognized through a case study, utilizing service process mapping. This research implemented a checklist on the full process, and it can be utilized as an administrative ratio of how the patients perceive the service. Also,

it can offer the hospital KPI's that will let them know where they are and makes them think about where they want to be and how to get there (Yun and Chun, 2008).

2.3 Conclusion

This review shows that several different design approaches are used in previous studies, such as Design Thinking, Quality Function Deployment, Business Process Reengineering and Design for Six Sigma (DFSS), with DFSS representing the one that better fits the purposes of this project given that the aim is to redesign a process and not only to improve it. Literature also shows that, although there are several studies on DFSS in healthcare, a lack of literature exist regarding internal communication problems. This project thus contributes to fill this gap in the literature.

3 METHODOLOGY

As mentioned previously, this research project uses two complementary methodologies: Action Research and DFSS. This chapter describes these methods in detail.

3.1 Action Research

This research project follows Action Research as main methodology. Lewin (1948) conceived the term Action Research as a method of systematic investigation for every party in the search for higher efficiency through active participation. It is a research method focused on how processes are being done and on wished outcomes (Leedy and Ormrod, 2021). Accordingly, this project relies on close cooperation between the researcher and the organization (the HHF's Oncology Department), with both parts having an active intervention in the research by building together practical solutions to overcome the difficulties faced with the current approach followed to ensure the communication between doctors and secretaries belonging to the department. And such a proposal of alternative solutions is achieved through an action research process of planning, taking action and reflection. And simultaneously with these activities, the evaluation of the action (i.e., the proposed solution) impacts, both intended and unintended, is also performed (Coughlan and Coughlan, 2016). And along with these different stages, information is gathered using a variety of tools, such as interviews, focus groups and surveys (Coughlan and Brannick, 2014). Gummesson (2000) highlights some characteristics of action research including that the researchers are not just watching but taking action and that they have a problem-solving mindset and a desire to contribute. The developed work in the organization has to be seen as teamwork, where both the researcher and the human resources of the company make an effort to reach a common goal (Shani et al., 2008). It is fundamental to recognize that action research is focused on change (Slack and Lewis, 2015) and that it requires a profound understanding of the particular organization that one is working at (Coughlan and Shani, 2005; Holian and Coughlan, 2013; Coughlan and Brannick, 2014).

3.2 DFSS and the DMADV Approach

In addition, DFSS is used as a quality planning tool in this study (Deming et al., 1982). DFSS can be viewed as a road map for implementing Interactive Design and Engineering, which is a user-oriented field of research that concentrates on effective dialogue of instruments through iterative and cooperative processes between people and technology (Livrani et al, 2019). Its use is deemed as adequate for this study since the aim is to design a new system to facilitate the internal communication between doctors and secretaries working in the HHF's Oncology

Department. Although other methodologies, including Six Sigma, Lean Six Sigma, and other improvement approaches, such as QFD, Design Thinking, and BPR, mentioned earlier in the literature review, primarily focus on developing and correcting the existing processes, in order to optimize it, DFSS uses an approach that relies on building quality by rethinking the entire process, highlighting the stakeholders' needs, and integrating characteristics that satisfy those needs into the design of a product or process (Okpe and Kovach, 2017). DFSS will be used to identify the customer needs (in this case, doctors and secretaries) and built a solution capable of satisfying those needs using what the organization is already capable of doing, as much as possible. To accomplish this, the Define, Measure, Analyze, Design and Verify (DMADV) framework (see Figure 3.1) is followed (Pyzdek and Keller, 2018).



Figure 3.3.1 - Steps of the DMADV approach

Define phase

The first phase aims at identifying the service, process or product that will be designed or redesigned. This starts with the development of a project charter (in which details are given related to the project scope, project objectives and team members' roles) and a project plan, where the project guidelines are defined and how the project is going to be organized (Hahn et al., 2000; Toepfer, 2009). Then, a high-level representation of the current method of communication at the HHF's Oncology Department is built using a Suppliers, Inputs, Processes, Outputs, and Customers (SIPOC) diagram, which illustrates the key elements of the process (Toutenberg, Knoefel, 2009). Many researchers also built swim lane diagrams to define every step of a process. In this project, the project team considered it unnecessary, given the fact that the SIPOC diagram already represented the communication process well enough.

Measure phase

The goal of this second phase is to collect data regarding the organization's needs and translate them into functional measures (Hahn et al., 2000). The "voice of the customer" is brought into the design process during the measure phase by gathering data on consumer requirements and turning the ambiguous language they frequently use to describe those needs into specific need

statements (Okpe and Kovach, 2017). To collect this data, interviews to doctors and secretaries were conducted, where 4 open-ended questions were asked, to understand the process as a whole (Q1: what they need the process for), what the intervenients liked and did not like about the current process (Q2 and Q3, respectively) and understand their ideas by asking for improvement suggestions (Q4). In this way, all critical to quality characteristics (CTQs) are identified (Johnson et al., 2006).

To be easier to read and analyze, the needs were afterward organized in an affinity diagram, where these needs are grouped by characteristics in the same category. Next, a project team brainstorming session is held to determine which needs are the most critical to resolve and to redesign the process that includes them, thus shortening the long list of needs.

To conclude this phase, the hospital staff was given a needs prioritization survey, where it is possible to understand which needs they consider most important in the communication process, where they were asked to rate each of the features using a Likert scale, from 1 to 5, where 1 represents something not desirable and 5 something critical (Okpe and Kovach, 2017).

Analyze phase

In this phase, all data collected to this point are analyzed and the project action plan is elaborated (Hahn et al., 2000). The work done here is focused on getting client feedback to rank the needs discovered, and those with the highest priority are utilized to lead the remaining redesign project. Based on the survey results from the previous phase, the project team developed metrics in this phase to measure the design process and indicate what should be done to carry out a specific need. The metrics used in this study can be classified as one of the following: objective, subjective, binary, discrete, or quantitative. To summarize this step, a needs metrics matrix was prepared that dictates which metrics are associated with each need (represented by a dot). In the case of this project, each need has at least two metrics associated with it, but theoretically, only one is required. This is completed when the collection of baseline measures begins (Okpe and Kovach, 2017).

Design phase

The Design phase entails creating and putting into practice concepts for addressing the main needs noted in the Analyze phase, and the main objective of this phase is to create and implement the new design.

To generate design ideas, brainstorming sessions were first conducted. It is important to note that every idea is considered valid - it is not supposed to evaluate the ideas at this first stage. Only after generating various ideas, it is necessary to evaluate them, so as to identify which option best addresses the customers' needs. A prioritization matrix was used for this purpose, where the hospital staff was asked to evaluate the previously generated ideas and move forward with the one that has the highest score. This phase is concluded when the new design is implemented (Okpe and Kovach, 2017).

Verify phase

Finally, in the Verify phase, the redesigned process is assessed. This is done by collecting and evaluating process performance data before and after implementing the new internal communication system. The same metrics used in the Analyze phase should be used for this evaluation stage (Okpe and Kovach, 2017). Based on this performance data it would be possible to assess if the new design fulfills the needs of both doctors and secretaries, and if it is the case, the new design is used (Pyzdek & Keller, 2018).

Tools

To summarize the tools that will be used in each phase above mentioned, and to present an overview of the steps, the following table is presented:

Table 3.1 - DMADV tools

<i>Phase</i>	<i>Tool</i>	<i>Characteristics</i>
<i>Define</i>	Project Charter	Mission and project team
	Kano model/ CTQ	Project requirements
	SIPOC	Identify target process
<i>Measure</i>	Surveys/interviews	Identify needs
	Affinity diagram	Group needs into categories
	Brainstorm sessions	Gather ideas
<i>Analyse</i>	Benchmarking	Inspect market best practices
	Needs metrics matrix	Measure and evaluate the redesign process

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<i>Design</i>	Priorization matrix	Evaluate ideas
<i>Verify</i>	Compare metrics to baseline Project closure	Assure the project success Release the project's outcomes

4 CASE STUDY

The main goal of this chapter is to answer the research questions introduced in Chapter 1. To start, a brief introduction of the organization and department where this research was conducted is given in subchapter 4.1. In subchapter 4.2 the details of how the DFSS methodology, as presented in Chapter 3, was applied are described.

4.1 Organizational context

Hospital Professor Doutor Fernando Fonseca (HFF) is a public hospital that is part of Portugal's National Health System (NHS). It is responsible for serving approximately 550,000 people that live both in Amadora and Sintra. HFF's main goal is to provide humanized, high-quality, time-effective, and proper healthcare.

HFF's Oncology Department serves approximately 500 patients per year and has 13 chairs available for intravenous treatment (two of which are reserved for emergencies). It has 10 nurses, eight doctors (two of whom are interns), and four secretaries.

This department provides chemotherapy, hormone therapy, and targeted therapies. Its services include oncology medical consultations, nursing consultations (when the patient receives their first treatment), nutrition consultations, and nursing follow-up (when oral treatments are administered). This department also offers an emergency support line in case patients need assistance in between their treatment appointments.

4.2 Research steps

4.2.1 Define phase

This project began by identifying the project's problem and mission, assembling the project team, and specifying a plan for the project. As described in Chapter 1, given the Oncology Department's use of a manual, paper-based system for communication between doctors and secretaries, and that led to lists getting lost (which includes not scheduling patients' appointments/treatments/-exams), the focus of this project was to redesign the system for internal communication between doctors and secretaries regarding follow-up tasks. The project team, which was headed by the lead doctor in the Oncology Department, included the action

researchers and select doctors and secretaries in the department. The project plan consisted of the following steps:

- Map the internal communication process at a high-level;
- Interview doctors and secretaries to identify their needs;
- Interpret and organize the needs obtained from interviews;
- Identify the top-rated needs through a survey;
- Develop metrics to address the top-rated needs;
- Establish baseline measurements for each metric;
- Conduct brainstorming and feedback sessions;
- Fully develop the final design of the new communication process;
- Implement the new process;
- After the new process has been in use for several weeks, collect verification measures for each metric;
- Compare baseline and verification measurements to determine how well the new process fulfills the needs for which it was designed.

To develop a better understanding of the Oncology Department's current internal communication process, the project team talked with doctors and secretaries in the department and documented the process at a high-level using a suppliers, inputs, process, outputs, and customers (SIPOC) diagram (Table 4.1). The process begins in the center column with doctors seeing patients, noting follow-up tasks on a blank sheet of paper throughout the day, and placing this list in the secretaries' box at the end of the day. This list contains tasks such as scheduling patient appointments, exams, transportation, etc. (i.e., non-urgent items) written in no particular order or format. The inputs to this process include patients, doctors, secretaries, and paper, and these inputs are supplied by the community and vendors. The outputs of this process include completed follow-up tasks, the customers of which are the patients and doctors.

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Table 4.1 - High-level view of the Oncology Department's internal communication for follow-up tasks

Suppliers	Inputs	Process	Outputs	Customers
Community Vendors	Patients Doctors Secretaries Paper	Doctors: 1. See patients 2. List follow-up tasks on paper 3. Place list in secretaries' box (at end of day) Secretaries: 4. Review lists 5. Complete tasks	Completed follow-up tasks	Patients Doctors

4.2.2 Measure phase

This phase used interviews with all doctors and half of the secretaries to identify their needs relative to the department's internal communication process (note that information shared during interviews indicated secretaries' work volume greatly exceeded the personnel resources available; hence, it was challenging for all four secretaries to participate in this project at any one time). All interviewees were asked four open-ended questions about what doctors/secretaries 1) needed the process for, 2) liked about the current process, 3) disliked about the current process, and 4) suggested as improvements to the process. During interviews, close attention was paid to capturing the responses given word-for-word. Finally, the imprecise language used by interviewees to describe their needs was translated into more concrete statements that represent functional attributes or features for the redesign project. The interview questions, some example responses, and corresponding interpreted needs statements are given in Table 4.2. In total, 57 unique need statements were identified.

Table 4.2 - Examples of responses collected during and needs statements interpreted from interviews

Question	Response	Interpreted Need
1. What do you need to communicate with doctors/secretaries for?	To take care of non-urgent tasks (e.g., scheduling patient appointments, exams, transportation, etc.)	Provides a way to communicate follow-up tasks
2. What do you like about the current process through which you communicate with doctors/secretaries?	The information is all condensed in one place	Facilitates ease-of-use (e.g., information condensed all in one place/time)
	The ability to indicate priorities for tasks	Allows follow-up tasks to be prioritized

3. What do you dislike about the current process through which you communicate with doctors/secretaries?	Things get lost and there is no second security copy	Minimizes the chances of communications getting lost
		Provides a security (back-up) in case communication gets lost
	Each doctor lists tasks in their own way	Standardizes the format doctors use to communicate tasks to secretaries
	Have to interrupt patient appointments to follow-up on something	Minimizes interruptions to patient appointments to clarify something
4. What do you suggest to improve the process through which you communicate with doctors/secretaries?	Abolish paper communication/computerize	Enables sharing communications electronically
	Eliminate multiple forms of communication	Limits the forms of communication (to just one)

During these interviews, another problem that could be overcome by the project team was detected: the way in which information regarding the service's contacts was presented to patients. In each patient's first appointment, they are given a sheet with the contacts of the secretaries and the health team, and this information is unclear and poorly organized. Thus, the redesign of this particular sheet also became an objective of the project.

To derive additional meaning from the need statements derived from interviews, they were organized into groups with common themes using an affinity diagram, as shown in Figure 4.1. The groups that emerged from this sorting process, 18 total, were then given names that reflected the category of each group. Categories included communication (purpose and method), scheduling, and task prioritization, just to name a few.

Resolving Gaps in Healthcare Using Design for Six Sigma

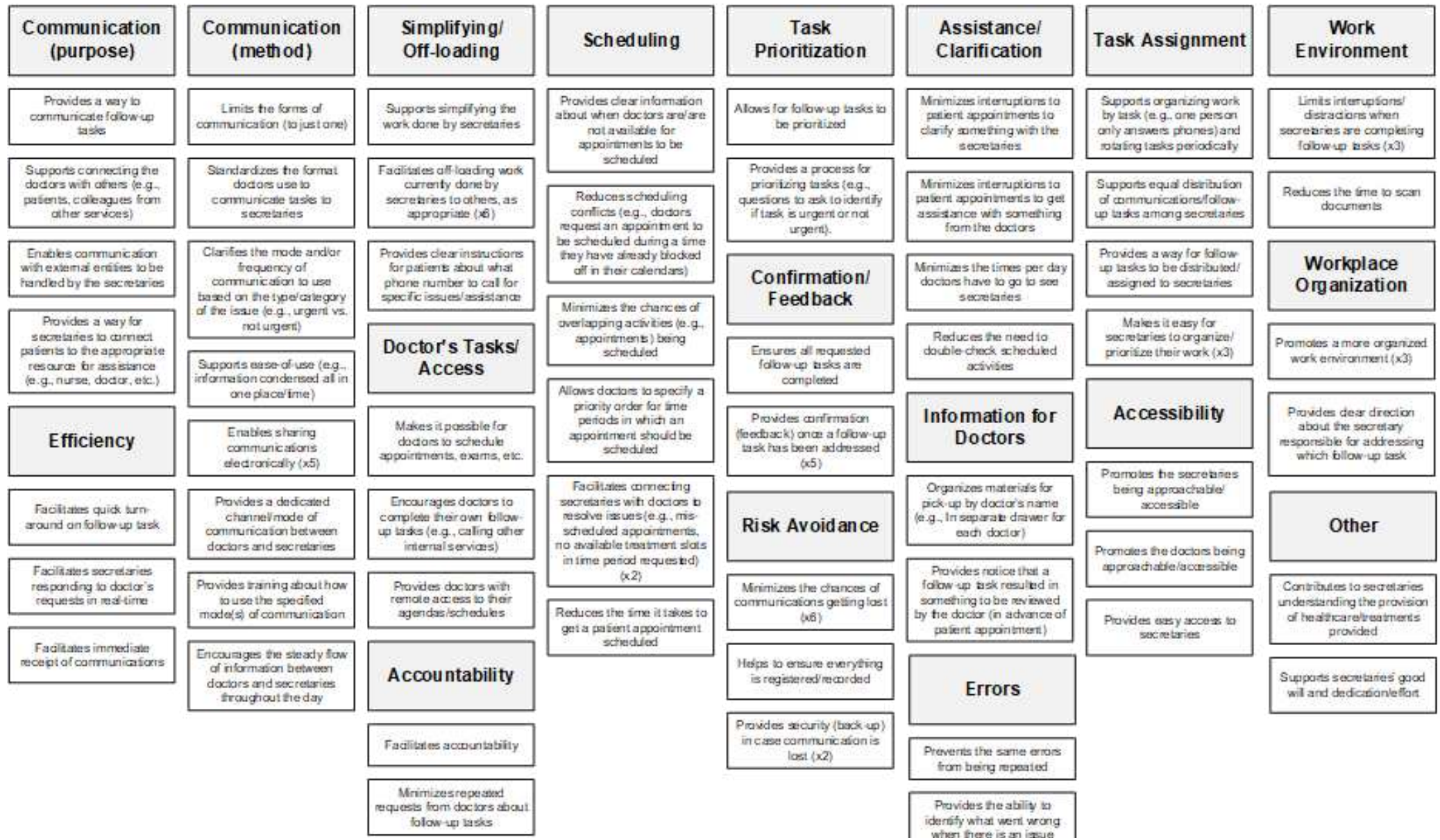


Figure 4.1 - Organization of needs statements into descriptive categories

Given the difficulty of redesigning a process to effectively fulfill a large number of needs, the project team individually identified which needs they felt were most important to the redesign project based on both their knowledge of the department and the number of times needs statements were mentioned in interviews (shown in Figure 4.1 as “x6” when mentioned six times, for example). Through a discussion regarding their individual selections, the project team came to a consensus regarding a sub-set of 20 critical needs. Next, a survey was created to further prioritize these 20 needs. As shown in Table 4.3, this survey asked respondents to indicate how important the needs (specified as features of the process through which doctors and secretaries communicate follow-up tasks) were to them using a Likert scale, in which a score of 1 represented that the feature was undesirable, and 5 indicated that the feature was critical. All doctors and half of the secretaries completed this survey.

Table 4.3 - Needs Priorization Survey

Instructions: Please indicate how important the features of the process through which doctors and secretaries communicate follow-up tasks listed below are to you, using the following scale:	
1. Feature is undesirable. I would not consider a system with this feature. 2. Feature is not important, but I would not mind having it. 3. Feature would be nice to have, but is not necessary. 4. Feature is highly desirable, but I would consider a system without it. 5. Feature is critical. I would not consider a system without this feature.	
Rating	Feature The process through which doctors and secretaries communicate follow-up tasks:
_____	1. Enables sharing information electronically
_____	2. Facilitates immediate receipt of communications
_____	3. Standardizes the format doctors use to communicate information to secretaries
_____	4. Facilitates off-loading tasks currently done by secretaries to others, as appropriate
_____	5. Provides confirmation (feedback) once a follow-up task has been addressed
_____	6. Minimizes interruptions to patient appointments to clarify or check on something
_____	7. Provides a dedicated channel/mode of communication between doctors and secretaries
_____	8. Provides clear direction for doctors about the secretary that is responsible for addressing a given task
_____	9. Provides a way for doctors to prioritize tasks they ask the secretaries to complete
_____	10. Minimizes the chances of overlapping activities (e.g., appointments) being scheduled
_____	11. Organizes materials for pick-up by doctor's name (e.g., in separate drawers for each doctor)
_____	12. Limits interruptions/distractions when secretaries are completing follow-up tasks

	13.	Encourages the steady flow of information between doctors and secretaries throughout the day
	14.	Provides clear instructions for patients about what phone number to call for specific issues/assistance
	15.	Minimizes repeated requests from doctors about follow-up tasks
	16.	Ensures all requested follow-up tasks are completed
	17.	Provides a way for follow-up tasks to be distributed/assigned to secretaries
	18.	Minimizes the chances of communications getting lost
	19.	Provides notice that a follow-up task resulted in something to be reviewed by the doctor (in advance of patient appointment)
	20.	Makes it easy for secretaries to organize/prioritize their work

4.2.3 Analyze phase

To specify more clearly what the redesigned process should do, the work in this phase of the project focused on identifying the most important needs. Simple descriptive statistics were used to analyze the results from the needs prioritization survey. Figure 4.2 shows the percentage of responses for each category of the rating scale specified in the survey. Using a threshold of 60% or more of respondents identifying a need/feature as critical (rating 5), the project team identified the top-rated needs for the process through which doctors and secretaries communicate follow-up tasks. As shown in the left-column of Table 4.4, the top-rated needs included 3) standardizing the format of communications, 6) minimizing patient appointment interruptions, 14) providing clear instructions for patients to obtain assistance, 15) minimizing repeated request from doctors, 18) minimizing lost communications, and 20) facilitating the organization/prioritization of secretaries' work.

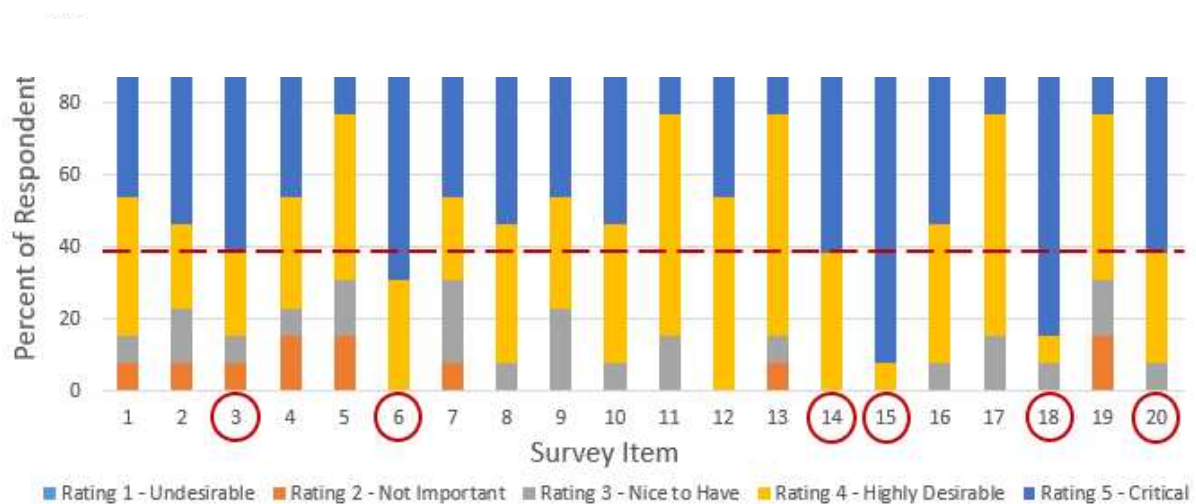


Figure 4.2 - Results obtained from the needs prioritization survey

To further guide the redesign project, and ultimately provide a way to measure how well the redesigned process addresses the top-rated needs, metrics were created for each need. Metrics

included items such as 1) the process through which doctors and secretaries communicate is easy to use (subjective), 2) number of patient appointment interruptions (average count per week), and 3) registers/logs all follow-up task requests (binary). The project team documented the relationship between the needs and metrics in the matrix shown in Table 4.4 where a dot represents the metrics that address each need. To effectively measure how well the redesigned process addresses the top-rated needs, each need is addressed by at least two metrics.

Table 4.4 - Relation between needs and metrics.

		Metrics											
		Process through which doctors and secretaries communicate is easy to use	Process through which doctors and secretaries communicate is effective	Number of ways/mechanisms doctors use to communicate with secretaries	Number of times patient appointments with doctors are interrupted	Provides patients with phone numbers to call for specific types of assistance	Information about what phone number to call for specific types of assistance is clear	Information about what phone number to call for specific types of assistance is easy to find	Estimated frequency of repeated requests from doctors about tasks they asked the secretaries to complete	Number of issues reported in log sheet due to lost information/incomplete tasks	Provides a way to register/log all requested tasks	Provides a way for secretaries to organize/prioritize their work	Process through which secretaries organize/prioritize their work is easy to use
Top-rated Users' Needs													
3	Standardizes the format doctors use to communicate information to secretaries	•		•									
6	Minimizes interruptions to patient appointments to clarify or check on something		•		•								
14	Provides clear instructions for patients about what phone number to call for specific issues/assistance.					•	•	•					
15	Minimizes repeated requests from doctors about tasks they asked the secretaries to complete		•	•					•				
18	Minimizes the chances of information getting lost (e.g., ensures all task requests are registered/logged, provides a back-up copy, etc.)	•	•	•						•	•		
20	Makes it easy for secretaries to organize/prioritize their work		•	•							•	•	•

The metrics were then used to establish a baseline measure of the current process performance. Several of the subjective metrics (1-2, 8, and 12) were measured through a survey using a Likert scale. A 5-point strongly agree (5) to strongly disagree (1) scale was used for all survey items except for metric 8 – estimated frequency of repeated requests from doctors about follow-up tasks, which utilized a 5-point frequency scale (always, very often, sometimes, rarely, never). All doctors and half of the secretaries participated in this survey. For the communication

process, the median score was 3-neutral for ease-of-use and 2-disagree for effectiveness. Ease-of-use for the process secretaries use to organize/prioritize their work received a median score of 2-disagree. The median score for metric 8 was 2 – rarely. A survey was also used to measure metrics 6 and 7. However, because a requirement of this project was not to have direct contact with patients, a sample of 7 people representative of the Oncology Department’s patient population completed this survey. Regarding information about what phone number patients should call for specific issues/assistance, the median was 2 for clear/easy to understand and 3 for easy to find.

All of the binary metrics (2, 5, 10, and 11) were measured through yes/no questions based on observations of the current process. For metric number 2, that was measured with a 5-point scale is also here measured. When measuring if the current communication process provides a way to keep record of the tasks and to prioritize the secretaries work (metric 10 and 11, respectively) the answer is “no” to both. About providing patients with phone numbers for specific assistance (metric 5), the staff answer was “yes” which is a positive feature of the current process, so the project team wants to ensure that it is kept in the redesigned process.

A discrete list is used to measure the “number of formats used to communicate” currently counting with 3 forms: e-mail, via Lync and on a paper. Lastly, a Quantitative type of metric is used to measure metric 9 that goes by “number of issues logged” counted per week. To collect data for this last metric, it was handed to the doctors and secretaries a log sheet template (see appendix A) that they have to fill in when realizing something is not correctly scheduled, marking with an “x” when applicable sentences like “Patient arrives, but has no scheduled appointment”, or “Patient exams not scanned, as requested” and completing this log with a brief description about what was done to solve the situation. Also, the “number of patient appointment interruptions” (metric 4) was counted with an average count per week, with medical staff pointing to a piece of paper placed in each room every time they were interrupted, by a member of the secretaries.

The following table (table 4.5) represents all the metrics, the units of measure and the baseline measures. This will provide a useful point of comparison in the Verify phase to determine if/how much the redesigned process improves performance.

Table 4.5 - Baseline Metrics

No.	Metric	Units	Baseline
1	Process is easy to use	5-point scale	3
2	Process is effective (e.g., request specifies required info.)	5-point scale	2
		Yes/No	No
3	Methods used to communicate	Count	3
4	Number of patient appointment interruptions	Avg. Count/wk.	10.25
5	Provides patients with phone number for specific assistance	Yes/No	Yes
6	Phone information is clear/easy to understand	5-point scale	2
7	Phone information is easy to find	5-point scale	3
8	Estimated frequency of repeated requests about tasks	5-point scale	2
9	Number of issues logged (i.e., lost info./incomplete tasks)	Avg. Count/wk.	2.5
10	Provides way to register/log all requested tasks	Yes/No	No
11	Provides way for secretaries to organize/prioritize their work	Yes/No	No
12	Way secretaries organize/prioritize their work is easy to use	5-point scale	2

4.2.4 Design phase

This phase is divided into two sub-phases: the redesign of the communication process between doctors and secretaries, and the redesign of the contact sheet given to patients at their first appointment.

To develop ideas for how to address the top-rated needs, the answers given to question 4 of the interviews initially conducted *"What do you suggest to improve the process through which you communicate with doctors/secretaries?"* were taken into account, and some ideas arose from those answers. In addition, brainstorming and benchmarking were also used to generate more ideas. The brainstorming sessions counted with the presence of the project team, most of the medical team, and 3 secretaries. In the first brainstorming session, the project team began by thinking about how things are done and about small to big improvements the communication process could suffer in order to change. After this first approach to designs, brainstorming sessions with doctors and secretaries were conducted to better understand what seems feasible to them, and the features that they most mentioned, for later have it into consideration. To close the brainstorming stage, a meeting was held with the hospital's IT department to understand what information systems existed that could satisfy the needs of the service, which were presented to them.

To gather more ideas, benchmarking was performed with a private healthcare institution. The goal was to examine how they manage internal communications. From this the

project team learned that this hospital has a design made specifically for their needs, so the problems that the HFF's oncology department felt, they did not. The project team can conclude from this that it is really important to understand what the needs of each service are, because this private hospital considers its system efficient because it is tailor made, so it meets all their requirements.

All the work developed so far resulted in seven ideas for a new internal communication process. The first idea was for doctors to verbally communicate follow-up tasks to secretaries, meaning that, each doctor, in the end of their workday goes to the secretaries and tells them what tasks they needed them to complete. The second idea would be to keep the same system that currently exists but create a template for it so that it is easier for the secretaries to read. Another hypothesis would be to create this template but use it in an online format, since there are already shared folders that the service uses, the idea would be to have a template in excel format (which would make it totally customizable) in which at the end of the day each doctor would enter their follow-up tasks, making it much harder for it to get lost as it is the first alternative in digital format. The fourth option is an online form that the doctors fill-out describing each task, and daily, form entries are downloaded to a spreadsheet by the secretaries. Another solution that came up was to have doctors create a "task" describing each follow-up task in Google Tasks and assign it to a secretary. Secretaries then would mark tasks as "complete" once they have been addressed. Taking advantage of something that everyone knows and uses, another form of communicate tasks could be by Lync (internal chat app) that would be as simple as sending a message with the intended errand. For the last idea, in the meeting with the IT department, a system was brought forward that already existed in the hospital that is called CRM (customer relationship management). In this system, doctors begin to fill-out an online page (that belongs to the intranet) with the information they need to pass, describing each follow-up task, and the secretaries are notified of new entries and can mark tasks as "complete" once they have been addressed, and doctors can later see which secretary completed the task. The best part of this system is that it is highly customizable, which makes it possible to choose all the fields that one wants to be present in this system, in a way that best suits the service.

After all these ideas were clearly structured, these were presented to the doctors and secretaries in separate meetings. Secretaries already use the CRM to place transport requests for patients who need it, but at doctors' meeting, special emphasis was given to the presentation of the CRM because this tool was not familiar to them, so it is important to explain the

functionalities it has and how it works. Both groups provided feedback regarding the initial design ideas.

To understand which design the project should go forward with, a prioritization matrix was developed where eight doctors and three secretaries were asked to rate how well each of the seven ideas met different characteristics on a scale of Excellent (9 points), Somewhat (3 points) and Poor (1 point). Each value presented (except for the subtotal and total) was calculated by the median of all responses for each of the criteria, for each design, separated by doctors and secretaries. In the following table (Table 4.6) it is possible to see the synthesis of this information, divided by design and into doctors (D) and secretaries (S).

Table 4.6 - Priorization matrix

Criteria	Option													
	1		2		3		4		5		6		7	
	D	S	D	S	D	S	D	S	D	S	D	S	D	S
Easy to use	Δ	o	o	o	o	Δ	o	o	o	o	•	•	o	o
Effective	•	o	o	o	o	Δ	o	o	o	o	o	o	•	o
Minimizes patient appts. interruptions	Δ	Δ	o	o	•	Δ	•	o	•	o	Δ	o	•	o
Minimizes repeated taks requests	Δ	Δ	o	o	•	Δ	•	o	•	o	Δ	Δ	•	o
Minimizes information getting lost	Δ	Δ	o	o	•	Δ	•	o	•	o	Δ	Δ	•	o
Makes it easy for secretaries to organize/prioritize work	Δ	Δ	o	o	o	Δ	•	o	•	o	Δ	o	•	o
Subtotal	14	10	18	18	36	6	42	18	42	18	16	20	48	18
Total	24		36		42		60		60		36		66	

9 points - • ; 3 points - o ; 1 point - Δ D: doctors S: secretaries

As can be seen by the Grand Total shown in the table 4.6, the design that scored highest was the CRM (7), so that will be the one that goes forward. Before presenting a prototype to the staff service, the project team worked on different iterations, and together concluded to move forward with following image (Figure 4.3) to present to the doctors and secretaries:

The image shows a web form for a CRM system, specifically for doctors. The form is enclosed in a black border. It contains the following fields from top to bottom: a text input for 'Patient's Name*' with a red asterisk; a text input for 'No of Process*' with a red asterisk; a dropdown menu for 'Type*' with a red asterisk and a downward arrow; a date input for 'Date' with a calendar icon; a time input for 'Hour' with a clock icon; a dropdown menu for 'Urgency*' with a red asterisk and a downward arrow; a checkbox for 'Notify the patient*' with a red asterisk; and a large text area for 'Notes'.

Figure 4.3 - CRM (Doctors view)

*Mandatory

Type: Consultations, Transport, Exams, Treatment, Digitalizations, Contacts, Other

Urgency: Medium, High, Low

Notify the patient: Yes, No

When showing this version to both doctors and secretaries, some changing suggestions were made, such as: when inserting the patient's case number, the patient's name automatically appears; insert due dates for each of the urgencies present; the doctors being able to see each other's notes, being possible to secretaries to sort tasks by different fields, etc.

Later, another meeting with the IT department happened to clarify some doubts that arose about the functioning of the program, and also to ask about the possibility of adding these new features that had been requested by doctors. With everything aligned with the IT department, they started to develop a demo to later be tested by the service to see if it meets the needs or if it needs to be modified. When fully developed, tests with doctors, secretaries and the secretaries manager took place in order to ensure that every detail was according to their expectations and with everything approved and defined, the training sessions carried out, one for the doctors and another for the secretaries, since their focus is different. In these sessions, all the functionalities of the program were exemplified to the staff, from how to log in to the

system, to creating a new task, to adding all the details available in a task, to filtering tasks by doctor, by state, etc., to attaching documents to tasks.

In the next image (Figure 4.4) it is possible to see the fields that need to be filled in order to create a new task. First, the name of the patient is filled in by clicking on the arrow on the right side of the field, which contains the database of all patients, and the field for the process number is filled in automatically. For the Type of tasks, one can choose among the options previously defined together with the staff, that are considered the most frequent ones, always having the option of "others" (see appendix B). As this system is used by more departments in the hospital, in the Service field the doctors always select Oncology. In the Status field, by default and when the task is created it will always be "to be started", and later the secretaries will change it to either "in progress" or "concluded". Notifying the patient is a yes or no selection, and the Urgency can be defined as high, low or medium. There is also an optional field where any kind of observation can be added. When the task is completed, an overview appears so that doctors can verify that the information is all correct (see appendix C), thus completing the process of creating a new task.

The screenshot shows a web application interface for creating a new task. The top navigation bar includes 'Entrada', 'Tarefas', and 'Utilizadores'. The main form is titled 'Criar' and contains the following fields:

- Usuário:** A text input field with a search icon on the right.
- Nº Processo:** A text input field.
- Tipo Tarefa:** A dropdown menu.
- Serviço:** A dropdown menu.
- Estado:** A dropdown menu with 'Por Iniciar' selected.
- Notificar o Doente?:** A dropdown menu with 'Não' selected.
- Data de início:** A date and time picker showing '14-11-2022' and '23:00'.
- Data Limite:** A date and time picker showing '23:00'.
- Prioridade/Urgência:** A dropdown menu with 'Alta' selected.
- Descrição:** A large text area for notes.

At the bottom of the form are buttons for 'Guardar', 'Cancelar', and 'Fechar e criar novo'. The footer includes logos for HFF, QA, and SugarCRM, and text indicating it is produced in SuiteCRM and based on SugarCRM.

Figure 4.4 - Create a new task

When created by the doctors, the task is automatically available for the secretaries to consult, and they can organize the order in which they appear, as they find easier, being by priority, by state, by due date, etc. It is also possible to apply general filters to all the tasks, for example, if you only want to see the tasks of a specific doctor, filter by their name and the system will return only the tasks created by them. In the following image (Figure 4.5) this is

represented, and it is also into two separated boards where the top one is the one with pending tasks and the bottom one is the one with completed tasks.

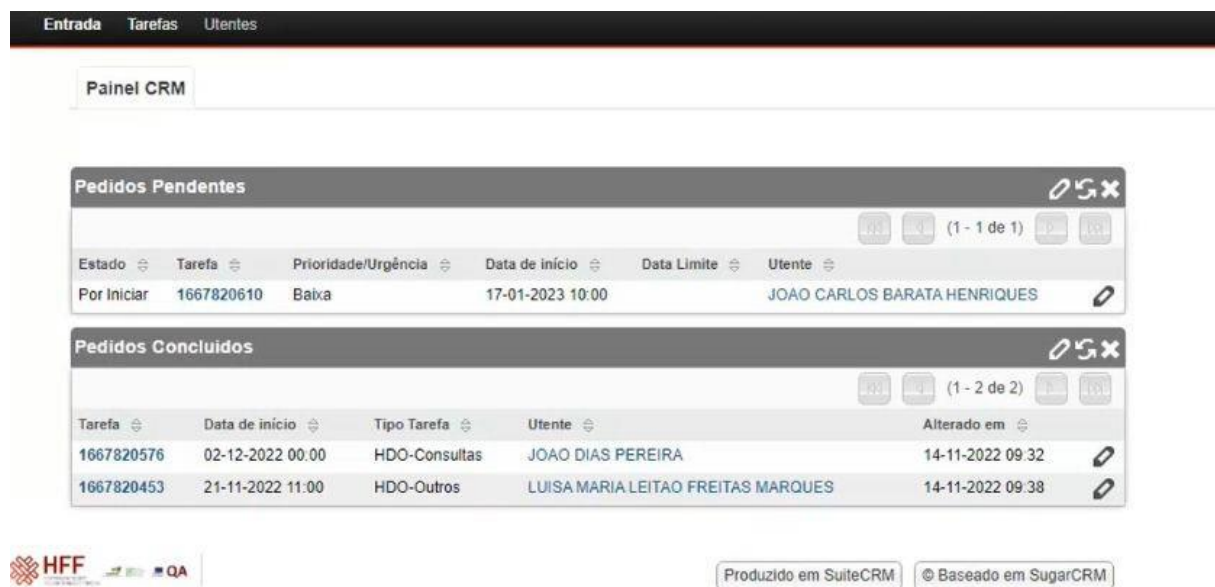


Figure 4.5 - Secretaries view of tasks

Contact sheet

Another problem identified by every doctor at the oncology department was the contact sheet they give to patients in their first consult, that includes the secretaries contacts, the email of the service and nurses cell phone numbers. All the doctors agreed that the information presented on this sheet was not clear enough and could lead to misinterpretation and confusion of the patients. In order to design a new contact sheet that better fits the service needs, questions about the topic were asked to the doctors on a meeting where they are all present, were a brainstorm session took place, so it was possible to collect everyone's ideas and understand what was important for them to be written on the sheet and what message they wanted to pass on to the patients.

As it is possible to see in Appendix D – that corresponds to the original contact sheet – all of the information is mixed, nothing is organized by theme, or schedule or follows a logic order. On the brainstorm session the doctors mentioned that they would like for the sheet to be divided into topics, either by schedule or type of problem the patient has. The first design delivered is divided by medical questions and non-medical questions. For the first part:

- The emergency phone number was added (112) - representing where to call for emergency topics;

- And a where to call/text in business days but also in holidays and at night, for non-emergent medical questions.

The second part of this sheet represents the contacts related to administrative assistance:

- Where it was emphasized that these contacts were only for appointment scheduling, declarations, prescriptions, and write-offs;
- Where it is made explicit that the preferred form of contact is email;
- Where it mentions what information patients should include when contacting the service;
- And the respective administrative phone contacts.

This version was presented to the doctors at a meeting, and it was not as they wanted to be yet, so they suggested minor adjustments that believed would be relevant to add and correct, so the final version of the contact sheet is the following (Figure 4.6)

**INFORMATION**

Oncology Service

In case of emergency – Call: 112

For administrative assistance (**Secretaries**) - appointment scheduling, declarations, prescriptions, and write-offs:

Preferential contact by e-mail: sec.hdoncologia@hff.min-saude.pt

To urgent situations: 214 348 424 | 214 345 603 | 214 348 422

For clinical matters (symptoms arising from the disease or ongoing treatment) please contact us as follows:

Business days (8am - 7pm): Call the secretaries. Alternatively, and only if it is not an emergency situation, by text message (SMS) - [REDACTED]

Nights (8pm-8am), **Weekends** and **Holidays** – Call: [REDACTED] nurses' phone)

Every time you contact us, please include the following patient information:

1. Clinical process number
2. Treatment type
3. Date of last treatment

Figure 4.6 - New Contact Sheet

4.2.5 Verify phase

In this last phase, the two new designs that were implemented were validated by gathering data to evaluate their performance. Once the CRM and the new contact sheet were in use for two weeks, data begun to be collected. This data was measured in the same way as in the Analyze phase, so that it could now be compared with the baseline measurements to see if the new designs were satisfying the needs for which they were redesigned. For needs 1, 2, 6, 7, 8 and 12, the project team handed again the same surveys to the hospital staff to collect the needed data, counting with the participation of nine doctors and three secretaries. Direct observation was used to collect data for metrics 3, 5, 10 and 11. Metrics 4 and 9 were once again measured through an average count per week, relying on data collected by the staff. In the next table (Table 4.7) the comparison of the baseline and verification measures are displayed.

Table 4.7 - Comparison of the verification metrics with the baseline

No	Metric	Units	Baseline	Verify	Change
1	Process is easy to use	5-point scale	3	5	40% increase
2	Process is effective (e.g., request specifies required info.)	5-point scale	2	5	60% increase
		Yes/No	No	Yes	Positive
3	Methods used to communicate	Count	3	1	Positive
4	Number of patient appointment interruptions	Avg. Count/wk.	10.25	7	31% decrease
5	Provides patients with phone number for specific assistance	Yes/No	Yes	Yes	Positive
6	Phone information is clear/easy to understand	5-point scale	2	4	40% increase
7	Phone information is easy to find	5-point scale	3	3	No
8	Estimated frequency of repeated requests about tasks	5-point scale	2	4	40% increase
9	Number of issues logged (i.e., lost info./incomplete tasks)	Avg. Count/wk.	2.5	0	100% decrease
10	Provides way to register/log all requested tasks	Yes/No	No	Yes	Positive
11	Provides way for secretaries to organize/prioritize their work	Yes/No	No	Yes	Positive
12	Way secretaries organize/prioritize their work is easy to use	5-point scale	2	5	60% increase

Results

After collecting the verification data, it was compared to the baseline. Most of the 12 metrics presented changed significantly once the new designs were implemented. When looking at the ease of use of the new communication process (metric 1) it is possible to see a 40% increase (from 3 to 5), and this is correlated with the efficiency of the system (metric 2), which also

increased, but by 60% (from 2 to 5). When the new contact sheet was presented to the same inquiries as before, they noticed a significant improvement in the ease of interpreting the information presented (metric 6), which translated into a 40% increase (from 2 to 4). However, they still feel that the ease of finding this information anywhere other than this sheet is a 3 on a scale from 1 to 5. Given this, metric number 5 remained a "yes", that being the goal. The number of methods used to communicate (metric 3) went from 3 to 1, and this metric was extremely important to be changed because this way there is no information scattered in different places and the communication process is uniform. As for the secretaries' work, they now have a way to register all the requests made by the doctors (metric 10) and a way to prioritize their work (metric 11), and they also characterize this prioritization process as a 5, on a scale from 1 to 5, in terms of easy to use, having had an increase of 60% over the baseline (metric 12). The efficiency of the new communication process is also proven by the 40% decrease in the number of repeated requests (metric 8). Regarding of the number of issues logged (metric 9) that was a total of 0 records during the time data was collected. Since the process is now more efficient and well organized, this will reflect in the number of interruptions, that had a decrease of 31% per week.

4.3 Conclusions of the chapter

In this chapter, the Design for Six Sigma was applied together with the process mapping, SIPOC diagram, affinity diagrams and selection criteria tools that allowed for a more thorough examination and study of all processes, taking into account the aims and research question of this thesis project.

Together with brainstorming sessions, surveys, interviews, and direct and indirect process observation, the use of these instruments made it possible to pinpoint the areas that needed improvement. These areas for improvement were created with recommendations for action, which the Oncology service manager then approved. Using the DMADV approach, it was possible to identify doctors and secretaries' main needs and important features for a new communication process with all the people involved in the decision process.

After the implementations were made, the new designs results were analyzed through the defined metrics both in the communication process and in the new contact sheet.

Implementations that were made included: alteration of the communication process from manual paper-based to electronic communication; and the modification of an unclear contact sheet handed to patients to an easier to understand and straighter forward sheet.

In comparison with the baseline measures, it was possible to conclude that the first proposal has increased the efficiency and ease of use of the internal communication process, so that there are now fewer interruptions to patient appointments, less lost information since there is only one place where it is recorded and can be consulted at any time, which also leads to less repetition of follow-up tasks requests previously made.

The impact of the contact sheet is yet too soon to tell, and harder to measure its' real impact, since it is not possible to have direct contact with patients and understand their perception. However, it is clear for the project team that with the redesign of the sheet, the contact information is much clearer, given the fact that all 7 inquiries that view the old and new version of the sheet, agreed that now the information is much clearer and easy to understand.

5. CONCLUSION

The problem of communication in healthcare is not one of the most talked about topics due to all the other existing problems in the health services in Portugal, which are many, but the truth is that even though it is not a core activity, it tremendously affects the provision of medical care. The current case study illustrates a challenging collection process that required assistance because a paper-based communication process was carrying problems like the loss of information, never knowing if a task was concluded or not, not being able to keep record of previously asked tasks, and so on. So, it is possible to conclude that the main goal of this project is to turn this process more efficient and easier to use, which is in line with the research questions defined at the beginning.

A literature review was created to support the implementation solutions that were offered in order to accomplish this goal and be able to respond to the research question. In the literature review chapter, the Design for Six Sigma approach was presented as it meets the defined objectives of redesigning the Oncology Department's internal communication process deeply engaging with customers and develop a design based on their specific needs. The DMADV methodology was then established in order to improve the project as a whole and all the components required for its success.

In the case study chapter, it's presented a description of the hospital and the oncology service in more detail, as well as the number of staff members, the type of treatment that they perform and the capacity the service has. After describing the state-of-the-art, improvement opportunities were identified: the inefficient communication process between doctors and secretaries and an unclear contact sheet that was handed to patients. The suggestions for improvement were made in order to reduce or eliminate these inefficiencies: change the communication method to electronic instead of manual and redesign the contact sheet so it gets clearer and more understandable.

To answer the first established research question ““What” are the key design elements of a system for internal communication between HHF Oncology Department doctors and secretaries regarding follow-up tasks, etc.?” is now easier to answer, since, with the support of surveys, interviews, shadowing, informal conversations, and the collaboration of everyone involved, it was possible to identify these characteristics, which are: this system is electronic and not manual, the information is all stored in one place, there is a way to prioritize the tasks

that are most urgent, and there is information whether the task is in progress or already completed.

For the second research question ““How” should these elements function to achieve the ultimate goal of effectively addressing the needs of both HHF Oncology Department doctors and secretaries while minimizing negative impacts on patient care (e.g., lost requests, and appointment interruptions)?” it can be said that during the brainstorming sessions in the design phase several designs emerged that could satisfy many of the above mentioned requirements, but the development of the CRM, which had the advantage of being customizable, was the best way found to bring all these elements together into a single design that would be ideal for both doctors and secretaries and that in the end would help reduce the negative impact that the existing poor internal communication had on the patients in the oncology service.

To conclude, this study is an addition to the already existing studies in the literature, regarding healthcare, developed with the DFSS methodology that again proves to be effective in addressing the needs for which the process was redesigned

5.1 Limitations and Recommendations

During the months spent with both healthcare professionals (doctors and nurses) and the secretaries, months in which there were plenty of dialogues (formal and informal interviews), in which there was a significant amount of observation and shadowing, it was possible to get to know the oncology service very deeply in a broad sense. That said, it was possible to identify some problems that, even though not related directly to the case study, have a great impact on the daily life of these professionals.

To begin with, the nurses feel that there is not enough communication between them and the medical staff, and they say that their jobs would be much easier if they were more aware of what is going on in the Oncology Service. The recommendation that I leave for this problem is for the head nurse to go to the beginning of the meeting that doctors have every Monday, in order to have a fixed weekly communication point here, where both parties can report on the current state of their teams and also talk about any problems that may exist.

When it comes to the secretaries, there is a huge amount of work for these people. For this particular reason, the first suggestion would be to hire one more person to have a better distribution of work and less overload for each of the workers. I also recommend that the Oncology Service buy a new scanning machine because the one that is currently in use is

extremely slow, which makes their daily routine very difficult given the immense number of documents that need to be scanned every day.

A limitation that should not be neglected is that the conclusions drawn for the studies that use this approach are generally very particular conclusions that cannot be generalized to other organizations, and always have to be adapted for each specific project.

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Appendix C – Overview of created task (with name of the patient and process number censored)

Entrada

Tarefas

Ufentes

1668418076

☆

Editar

Visão geral

Outros

Estado: Por iniciar

Prioridade/Urgência: Alta

Serviço:

Data de início: 21-11-2022 00:00

Data Limite: 23-11-2022 11:00

Tarefa: 1668418076

Nº Processo:

Ufente:

Tipo Tarefa: HDO-Consultas

Descrição: Marcar consulta para dia 28/11

Produzido em SuliCRM

Baseado em SugarCRM

Imprimir esta página

Voltar ao topo

Criar

(1 de 3)

Appendix D – Original Contact Sheet (in Portuguese) (with phone number censored)

**HFF**
HOSPITAL PROFESSOR
DOUTOR FERNANDO FONSECA

INFORMAÇÃO

Hospital de Dia de Oncologia

Pode contactar-nos das seguintes formas:

Apoio Clínico

Por TM [REDACTED] - (das 20 às 8h) e fins de semana, contacto com enfermeiro/a.

Só por mensagem (SMS) [REDACTED] dias úteis (das 8 às 20h) contacto com enfermeiro/a.

Área Administrativa: das 8 às 19h dias úteis

214 348 424

214 345 603

214 348 422

Preferencialmente por correio electrónico: (P.S. verifique o e-mail)
sec.hdoncologia@hff.min-saude.pt

Nota: só para questões administrativas como marcação de consultas, declarações, receitas e baixas.

Atenção:

Quando efetuar um contacto, deve ter junto a si:

- Número de processo clínico;
- Tratamento que está a fazer;
- Data da realização do último tratamento.