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HAIMA INFORMATION SYSTEM TO SUPPORT OPME MANAGEMENT IN A HEALTH UNIT

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Abstract: Orthotics, prosthetics and special materials are part of a broad category of supplies, with a wide range of products used in medical, dental and physiotherapy procedures, as well as in the diagnosis, treatment, rehabilitation and monitoring of patients. The management of these materials permeates a large part of the hospital's processes, from scheduling the procedure to accounting for the information, including logistics, consumption and billing. This flow contributes to their characteristics in terms of care and marketing being considered complex, as it involves patients, doctors, healthcare professionals, manufacturers, suppliers and managers. This context gives rise to the need to develop strategies to improve the management of the use of orthoses, prostheses and special materials. In order to solve these problems, an information system was developed as a strategy to contribute to the management of these supplies in a health unit that has difficulty managing its supplies. The aim of this work is to design and develop an information system to support the management of orthoses, prostheses and special materials. The development process was based on a structure defined in three phases in an interactive and cyclical way. In the first, called planning and design, the literature was reviewed, the current workflow operating in the hospital was familiarized, a new workflow was defined and requirements were obtained. In the second phase, the requirements, design and implementation were analyzed. The third and final phase was preliminary validation and delivery of the system. The architecture of the system developed includes medical requests on a specific digital form and directing the materials requested in accordance with the Management System for the Table of Procedures, Medicines and OPME of the Unified Health System and current legislation. This work resulted in improvements related to communication flow, process standardization, the production of management indicators, device traceability, greater control over workflow and cost reduction. In conclusion, the Haima system was validated and proved to be viable and capable of meeting the proposed requirements, with no failures during the simulation process.
Keywords: Hospital Management, Health Technology, Nursing, OPME, Biomedical Engineering.

INTRODUCTION

The epidemiological profile consists of a detailed analysis that describes the distribution and determinants of health states or events in specific populations. It is used to inform the formulation of health policies and intervention strategies (PEREIRA, 2015). This same process has led to notable changes in hospital management, both in terms of redefining its role in the healthcare system and in its internal reorganization of work. Thus, each hospital has its own model in place, seeking excellence in highly complex procedures, technology, a high level of reliability and quality, aiming for total patient care, with the challenge of ensuring financial balance (DEUS; MELO, 2015). Today, these hospitals are considered complex organizations, with specialized professionals who carry out various activities at different levels of care.

Healthcare workers use a variety of high-tech materials, which has contributed to rising costs. The management of these materials, along with human and financial resources, are the foundation of the hospital, the former being considered the most complex when compared to other segments. This is due to the fact that expenditure on materials represents around 25% of current budgets (MORAES; RABIN; VIÉGAS, 2018). Among the materials used, orthoses, prostheses and special materials (OPME) are of great economic importance in the accounts of these institutions (BRASIL, 2015).

OPME are part of a broad category of materials, with an extremely diverse universe of products used to perform medical, dental and physiotherapy procedures. These procedures contribute to the diagnosis, treatment, rehabilitation or monitoring of patients (BRASIL, 2015; RIBEIRO, SOLER, REIS, 2024). In general, they are characterized by a high degree of diversity and technological distinction, and are responsible for major advances in health care for the population worldwide, being directly related to the evolution of surgical procedures (ALENCAR, 2016).

This fact is currently evident in the different medical specialties that have complex OPME and advanced technologies which, combined with the emergence of endovascular surgery and percutaneous interventions, have made it possible to replace conventional surgeries with innovative treatments and improved prognosis and quality of life (CAMARGO, 2017). However, despite the gain in healthcare provision, the use of the various OPME has an impact on healthcare, as they are considered high-cost products (ALENCAR, 2016). Given this context, the management of these material resources has been a cause for concern, especially in public sector health organizations, since, due to restricted budgets, they need more control over consumption and costs so as not to deprive employees and patients of the necessary material (GARCIA *et al*., 2012).

In practice, it can be seen that the public sector has a tendency to blame the lack of medical supplies or stock problems on a lack of financial resources. But it's not just the lack of financial resources that causes problems in the supply of medical and hospital materials; poor stock control can also play a large part in this process, causing waste and misuse (RAIMUNDO; DIAS; GUERRA, 2015). Another difficulty faced is the lack of standardization of models (i.e. processes). As a consequence, this leads to rework, wasted time, materials and labor, directly affecting costs and the final quality of care (SILVA *et. al.*, 2018). In addition, in public institutions, the barriers of legislation, the high turnover of managers, the absence of various OPME in the SUS Table of Procedures, Medicines and OPM (SIGTAP/SUS), and insufficient payment to cover expenses for the procedures performed, make OPME management even more difficult and generate a financial deficit for the institution (REIS, 2017; CAMARGO, 2017).

OPME management is present in a large part of hospital processes, from scheduling the procedure to accounting for the information, including logistics, consumption and billing. This flow contributes to its characteristics in terms of care and marketing being considered complex, as it involves people, processes, information systems and suppliers (MORAES; RABIN; VIÉGAS, 2018). Managing OPME involves efficiently and economically planning, executing and controlling the flow of materials, from their specifications to their delivery (GARCIA *et al*., 2012). This process becomes important because it is evident that when failures occur at any point, the cost of the operation remains active. This is due to the human, technological and logistical resources that remain in place, plus the costs of operating room idleness, inadequate preparation and deprivation of the material needed by the patient (GARCIA *et al*., 2012; MORAES; RABIN; VIÉGAS, 2018).

In view of this, there is a need to develop strategies aimed at improving the management of the use of OPME, in order to improve the control of financial expenditure, bring everyone involved closer together and streamline the flow of communication. This promotes greater control in the process of ordering, dispensing and traceability and generates more accurate information on the use of these devices (SILVA; LIMA, 2015).

Some of the recent developments observed in healthcare provision are new business models aimed at improving workflow planning throughout the hospital, using information technology, operations management and advanced data analysis techniques (CAÑAMARES *et al*., 2014). The reorganization reflects the concerns of Brazil's national reality, in which annual spending on OPME is U$5.00 billion (ITO, 2015). This figure has a tendency to continue to increase costs in the coming years, as the use of these inputs is predominant in the hospital sectors with the greatest expansion, especially: operating rooms, hemodynamics, diagnostic imaging and intensive care units (MORAES; RABIN; VIÉGAS, 2018). As a result, there is expected to be an even greater direct impact on the cost equation for government revenues and supplementary healthcare operators (JÚNIOR, 2018).

The use of information and communication technologies has made it possible to improve hospital management routines and reduce costs, with increased control of situations that are decisive both for the survival of patients and for the economic and financial health of the institution itself (PINOCHET, LOPES E SILVA, 2014). This allows for an increase in the volume and complexity of information exchange between the partners and actors involved in supply management. It also allows sharing information in real time, which increases visibility in the extended supply chain (KEMBRO, J., NASLUND, D., OLHAGER, J., 2017).

In view of this, one solution found in the organization and administration of OPME is information technology. It contributes to patient safety, workflow efficiency and decision support (MARÇULA, 2013).

METHODOLOGY

The study is an applied or technological methodological research, as it aims to develop and create a new product (FREITAS JUNIOR et al, 2014), an information system for practical application, aimed at supporting OPME management, with the aim of innovating and improving workflow. This tool is intended to connect all the professionals involved in requesting and using OPME, with the aim of improving management. It was designed to achieve greater control over the use of these supplies and the scheduling of procedures, standardization of work processes, optimization of time and material resources, greater security in the flow of communication and the production of management indicators.

The system was developed in partnership with a team of professionals from the programming school of the Health Innovation Laboratory (LAIS/UFRN). It was called HAIMA, which means blood in Greek, and this name was chosen to represent the sector it was designed for (hemodynamics - blood movement) and the purpose of the system, since blood in the human body has a well-established flow.

Based on models proposed by software engineering, an agile development process was used, based on Scrum, which is a dynamic working arrangement for project management based on interactive and incremental practices that seek to provide more value to the business (CRUZ; 2013). In this model, development takes place in cycles of iterations (sprints) to which increments are applied - delivery of a Minimum Viable Product (MVP) at the end of each cycle, in order to add value to the final product, as it meets the needs of the system's users (DA SILVA; LOVATO, 2016).

Thus, the system development process was carried out at the LAIS/UFRN Programming School with 15-day Sprints, during which a set of activities were carried out and/or

implemented. Each day of a Sprint, the team held a brief meeting, called the Daily Scrum, with the aim of disseminating knowledge about what had been done the previous day, identifying impediments and prioritizing the work for the day ahead. At the end of a Sprint, the team presents the implemented features in a Sprint Review. The team then planned the next Sprint. Thus began the cycle of new activities.

The development process was based on a structure defined in three phases in an interactive and cyclical way, combining the activities of planning and design, development and evaluation respectively. In this way, all team members took on specific tasks during each interaction. Figure 1 outlines the methodological procedure.

The literature review looked for articles of current relevance on the characteristics of OPME management in healthcare institutions, seeking to assess the current state of the art and identify benefits, difficulties and challenges. The research was based on articles published on the CAPES journal portal, in the PubMed, LILACS, SCOPUS and Google Scholar databases. The selected articles were subjected to filter refinement. An inclusion criterion was adopted which included scientific articles published between 2003 and 2018 on the subject, available in Portuguese, English and Spanish. We also searched the Brazilian Ministry of Health for the same period on the same subject.

In order to focus on more specific terms, the "filter my results" feature was used in each database, by topic. Considering the major objective of this research, a set of terms was selected which, in the opinion of the authors of this work, are the most appropriate to encompass the largest number of articles of interest and relevance to the proposed topic. Thus, the keywords indexed in the health sciences descriptors (DeCS) were crossed: hospital administration, prostheses and implants, hospital resource management, hospital materials administration, information system. Totaling around 1,200 articles. The same descriptors were also used in English, according to the database. The search was carried out on the website in January 2019.

After cross-referencing the descriptors, and pre-selecting these studies by reading the titles and abstracts when necessary, 58 publications were selected. The articles were read in full in order to identify whether they met the inclusion criteria for this review. The configuration of the methodology for this review is shown in Figure 2.

After the pre-selection stages, 33 articles were excluded, resulting in a final sample of 25 articles. Of this total, the highest number of publications occurred in 2018 (5 articles). With regard to the languages of the articles, 5 were in English, 19 in Portuguese and 1 in Spanish. With regard to the databases, 4 articles were found in PubMed, in the years 2016 and 2018; in Google Scholar, 20 articles were selected, published between the years 2003 and 2018; and in Scopus 1 article, referring to the year 2016. A summary of the main articles found in the literature is shown in Table 1.

Familiarization with the work process of the use of OPME was carried out by observing the work routine of the professionals involved in management of these materials. From this stage, it was possible to observe that the work process involves doctors, nurses/scheduling, pharmacy/stock control and the manager, but occurs in a non-standardized way and without the requirement of a standard workflow involving the work of these various professionals.

Based on the researchers' work experience, coupled with a critical view of the work process and knowledge of current legislation, critical problems were identified in the process with regard to the absence of a prior request for OPME or manual and incomplete com-

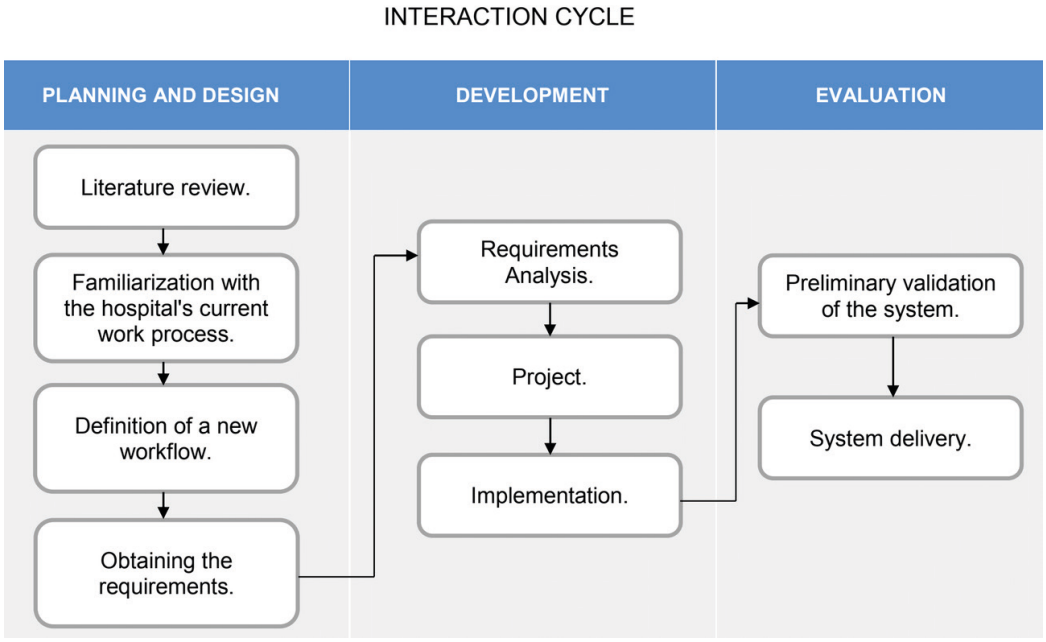

Figure 1 - HAIMA development process.

Source: Prepared by the author (2020)

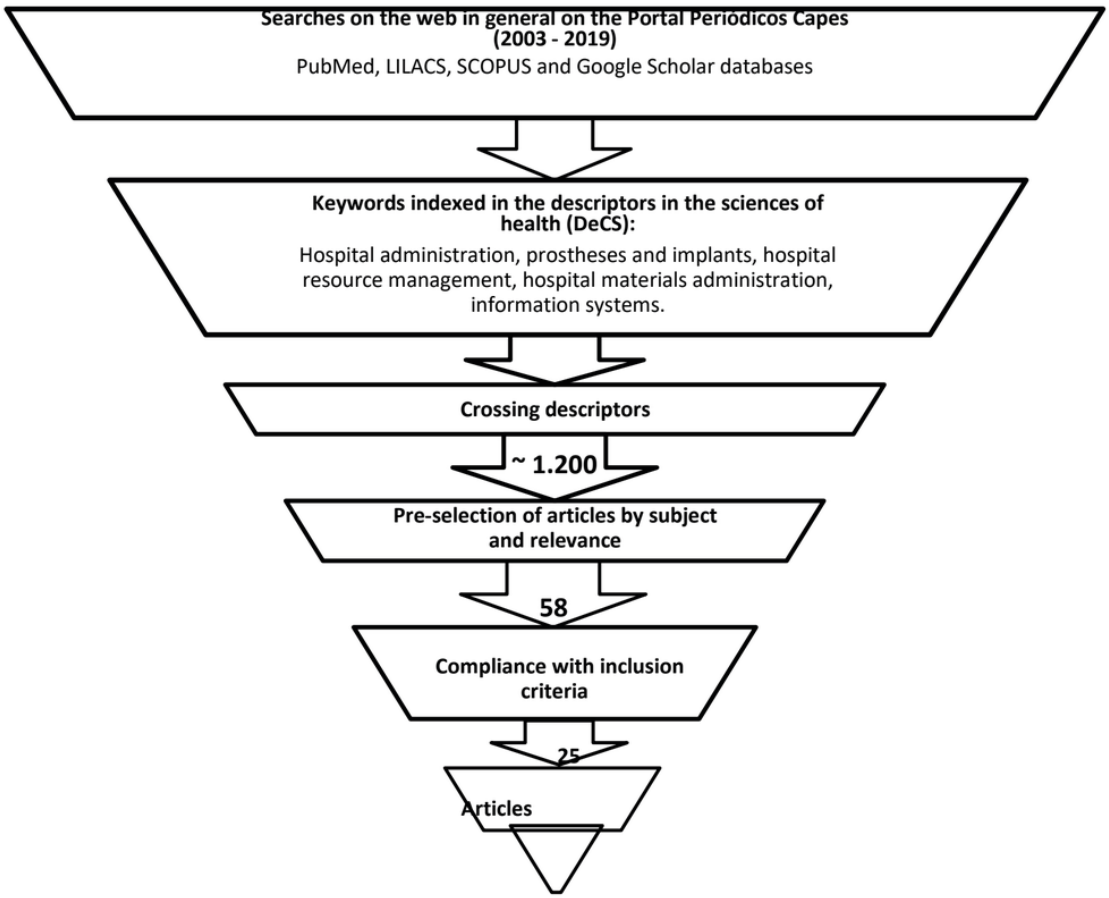

Figure 2 - Stages of the methodology used to search for articles in the specific area.

Source: Prepared by the author, 2020.

Articles	Fragments of the article that demonstrate its main contributions from the perspective of OPME management
ISLAM, POLY E LI (2018)	According to this author, information systems for managing OPME fall under the heading of auxiliary information systems. These systems have gained a lot of attention in recent years, particularly for reducing clinical errors, such as medication errors and diagnostic errors, and for supporting healthcare professionals by offering up-to-date information. They promise to improve the workflow and efficiency of care, thus increasing the overall quality of healthcare.
MIRALDO (2016)	They presented the implementation of a process management system, known as "workflow", in a healthcare provider to control the release of elective hospitalization procedures using OPME. The results showed that the system contributed to efficient control of requests for elective hospitalizations and control of OPME-type materials, resulting in an increase in responses to requests of around 18%. It has also made it possible to create indicators that allow managers to monitor the operation in real time, and has enabled historical reports to be issued and documents in the process to be retrieved quickly.
MARQUEZ-PEIRO(2016)	It described the introduction of the Sanitary Products Surveillance System, SIVIPS, in a pharmacy service for the management of medical devices in terms of use and incident control. It concluded that the introduction of the SIVIPS tool has improved the traceability of prostheses and implants, facilitated the collection of data on the types of prostheses most consumed and the main suppliers, and improved the recording and monitoring of incidents related to health products, which is basic information for future decisions on the acquisition of certain brands of products or suppliers of health products.
MEI AND LU (2016)	They developed a system to manage the traceability of medical devices. In this study, the authors evaluated the system as good at managing traceability and unifying processes.
LORENZETTI; GELBCKE; VANDRESEN, 2016	He developed management software for inpatient units that covered various management modes, including materials. In this study, there are no details about this module, but the author's results show that, after being used for a year, there were benefits in materials management, and the technology was positively evaluated by the nursing team and the external evaluation committee.
PINOCHET, L. H. C.; LOPES, A. S.; SILVA, J.S, 2014.	It discusses the new emerging trends in Information Technology that are bringing direct and indirect benefits to Health Management. With regard to the management of stock control of materials and medicines, the authors emphasize that the use of computerized processes makes it possible to reduce costs by reducing rework, reducing or eliminating theft of materials/medicines, providing a source for generating hospital indicators and supporting the decision-making and strategic process of administrative management.

Table 1 - Summary of the main articles found in the literature.

pletion of the same, the absence of a standardized workflow, the scheduling of the procedure without the manager's knowledge and without the prior reservation of the material, in addition to the lack of control over the use of materials, since the materials are not used based on the SIGTAP/SUS table and there is no written justification in cases where the use of materials exceeds the limit.

To help describe the sequence of activities related to OPME management, a workflow was designed, based on familiarization with the existing work process, current legislation and the Ministry of Health's OPME management best practices manual.

At this stage, it was decided that the four groups of professionals already identified in the current process (doctors, nurses/scheduling, pharmacy/stock control and manager) are fundamental to management and need to act in an integrated and standardized way in all OPME requests and exchange quality information for management efficiency. A workflow involving these professionals was therefore developed using the BPMN (*Business Process Model and Notation*) notation, using the Draw.io *software*, which is a free tool used specifically for process mapping, in which it is possible to notate and model processes, making it possible to draw and detail the tasks. The workflow is shown in Figure 3.

Within the design presented, the organized sequence of standard activities carried out by each professional is specified, with their interconnections, to enable improvement in the OPME management process, particularly in the sense of solving the critical problems found in the current work process identified. To this end, it was developed with a view to using the computerized system for requesting the

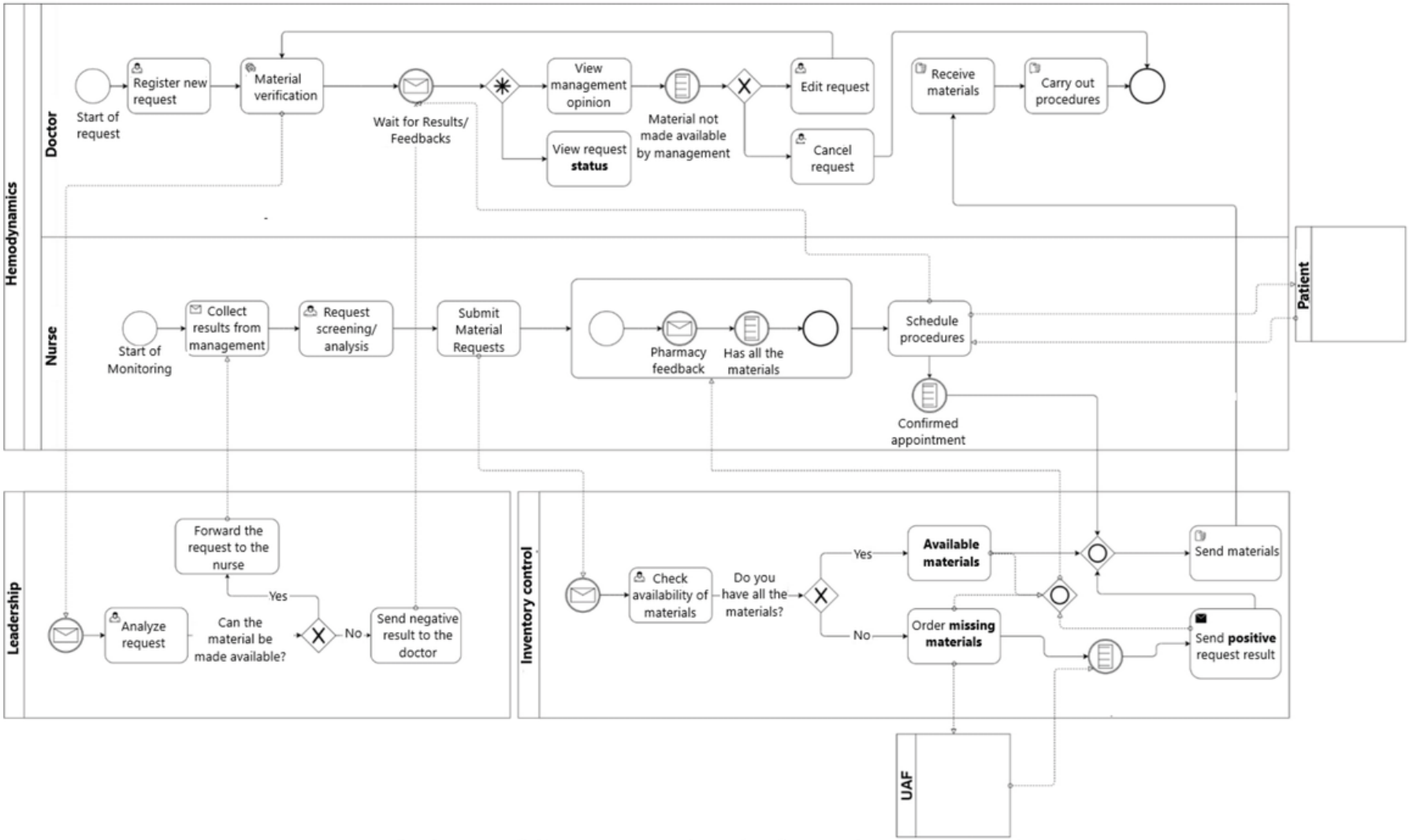

Figure 3 - Proposed OPME management workflowSource: Prepared by the author.

use of materials available in the hospital, geared towards specific procedures and patients.

The workflow begins with the medical request for the material, which, once registered, is forwarded to the manager for analysis and authorization for use. If the use of the material is not authorized by the manager, the requesting doctor is notified and can cancel or change the request, in the latter case restarting the flow. When the use of the material is authorized, the request goes to nursing/scheduling for a kind of triage. This function is characterized by taking requests to the pharmacy only when they are expected to be fulfilled within 15 days, so that the OPME can be reserved for the specific patient in the request. This sequence is necessary due to the reality of public hospitals, which have long waiting lines for procedures. When the request is sent to the pharmacy, it is informed of the availability of the material. In cases where they are available, nursing/scheduling is notified, followed by scheduling with contact with the patient, informing the professionals involved of the date and finalizing the flow by dispensing the material and carrying out the procedure. In cases where the material is not available, the pharmaceutical supply unit is notified of the need to purchase the material and awaits its arrival, which, when it happens, follows the flow for positive cases.

Several techniques were used to gather requirements, including initial contacts and on-site observation.

The initial contacts were aimed at identifying the objectives and restrictions of the system to be built. These contacts involved a nurse, a pharmacist and a doctor from the hemodynamics unit, the researcher and the LAIS/HUOL programming school team. The aim was to obtain relevant information about users' needs and possible problems with the process of controlling, requesting and using OPME.

Observation of the site was aimed at facilitating understanding by the professionals from the programming school of the work routine in the hemodynamics unit. It was possible to observe the care provided to users, as well as the nursing work carried out and its difficulties. From this experience, it was possible to see which requirements were important; how the Health Unit's existing information systems were used; what data was stored and what reports were issued; what data and reports were considered relevant or unnecessary; and what data, although relevant, was not included.

SYSTEM DEVELOPMENT

At this stage, a detailed study of the data obtained from the requirements survey was carried out, making it possible to determine the various properties of the system by defining the functional and non-functional requirements (appendix C).

Users were defined as the professionals characterized as fundamental in the management of OPME (doctors, nurses, pharmacy/stock control and manager).

After these definitions, a low-fidelity model (*wireframe*) was drawn up using the *Balsamiq® Mockups* tool *(BALSAMIQ WIREFRAMES, 2020)*. This model was evaluated by at least one healthcare professional from each area covered by the system, in order to check that the requirements were in line with the needs of OPME management. This stage was important to validate the system's functionalities, contributing to the smooth running of the development team's activities.

This model was developed with four modules. The first was created for the medical request for OPME, containing the procedures and materials in the SIGTAP/SUS table, with the option of adding materials not offered by SUS, with the respective justification. The second module was developed for the hospital's pharmacy/stock control, which indicates the

availability of OPME in stock, and reserves and dispenses these materials for the hemodynamics unit on the day scheduled for the surgical procedure. The third is the Manager module, which is designed to obtain authorization for OPME, and is responsible for analyzing the medical request for the material and justification. The fourth module was developed so that the nursing/scheduling team can control waiting lists for therapeutic procedures, information on scheduling dates and availability of materials. In addition to these modules, there is a profile for the system administrator, who can accept users, consult and delete profiles and register material specifications. Figure 4 shows the functionalities of the HAIMA software.

SUGGESTIONS FOR IMPLEMENTING THE SYSTEM

The *Unified Modeling* Language (UML) was used to model the system, enabling the development of artifacts to allow understanding of the application domain, documentation and subsequent maintenance of the system.

One of the artifacts is the system's use case diagram, which represents the ways in which the functionalities relate to each other and how they will be used by the user when using the system (Figure 5). In this diagram, users are represented by actors (stickman); use cases (actions) are represented by ellipses; and interactions between actors and use cases are represented by a continuous line.

The entity-relationship diagram (Figure 6), another artifact of the system, represents the static interactions and classes involved in the system, also allowing the hierarchies of the classes to be identified, represented by inheritance and aggregation. This diagram makes it possible to visualize the data that will be stored and manipulated by the system. In an attempt to improve its readability, the diagram is presented partially.

Next, we proceeded to model the database, a stage in which we organize the information that will be stored, consulted or data obtained from the SIGTAP/SUS table. At this stage, the *DB diagram* tool was used and the database management system adopted was *PostgreSQL*.

The *software* was developed for the *web* platform, with authentication and user access through the Sabiá platform, used to access the systems of the Federal University of Rio Grande do Norte. The programming languages used were HTML, CSS, *JavaScript*, PHP, *Ajax* and SQL. A convenient *framework* was developed for the PHP language, *Laravel*, to increase productivity and facilitate the flow of activities, while at the same time providing greater security for the application. Similarly, *jQuery* was also used. While Sass is a CSS preprocessor that allows you to minimize the writing of code, making it clearer and cleaner, *jQuery* is a JavaScript library used to improve the dynamics of CSS by promoting animations and interactions on the page.

GitLab was used to control the versioning of the files needed for the *web* application. The *Visual Studio Code* editor was chosen to write the code, due to its ease of use and large number of features. In addition, *Google Chrome* and *Firefox* were adopted as the mechanisms for monitoring development results, as they are among the most popular browsers.

The Haima system integrates the management of care and administrative processes involved in OPME management. The various users authorized to use it have access with a login and password and have restricted permission to the operations carried out by each professional. Figure 7 shows the initial screen of the software, the start of the Haima operation for all users.

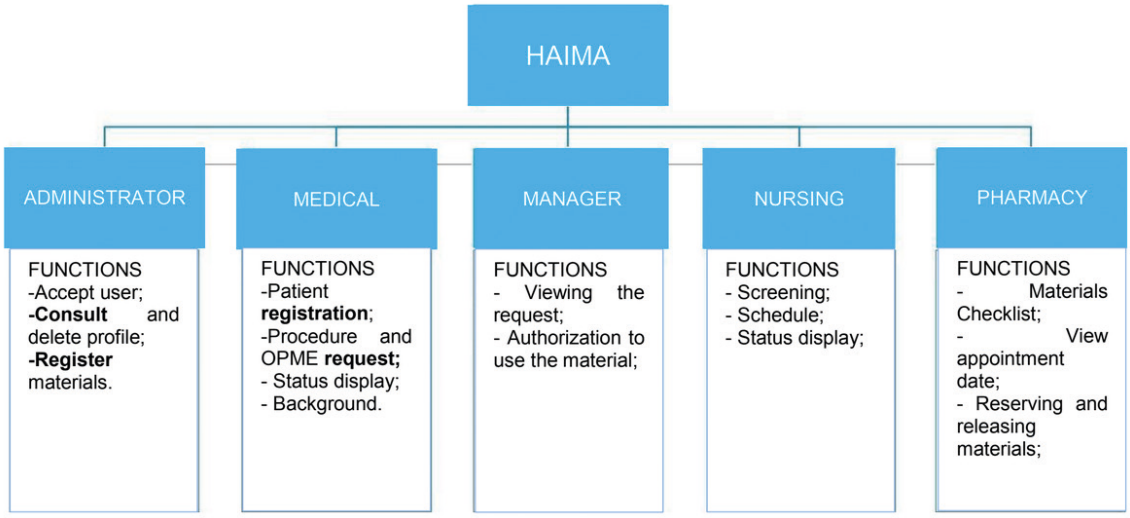

Figure 4 - HAIMA overview Source: Prepared by the author,2020.

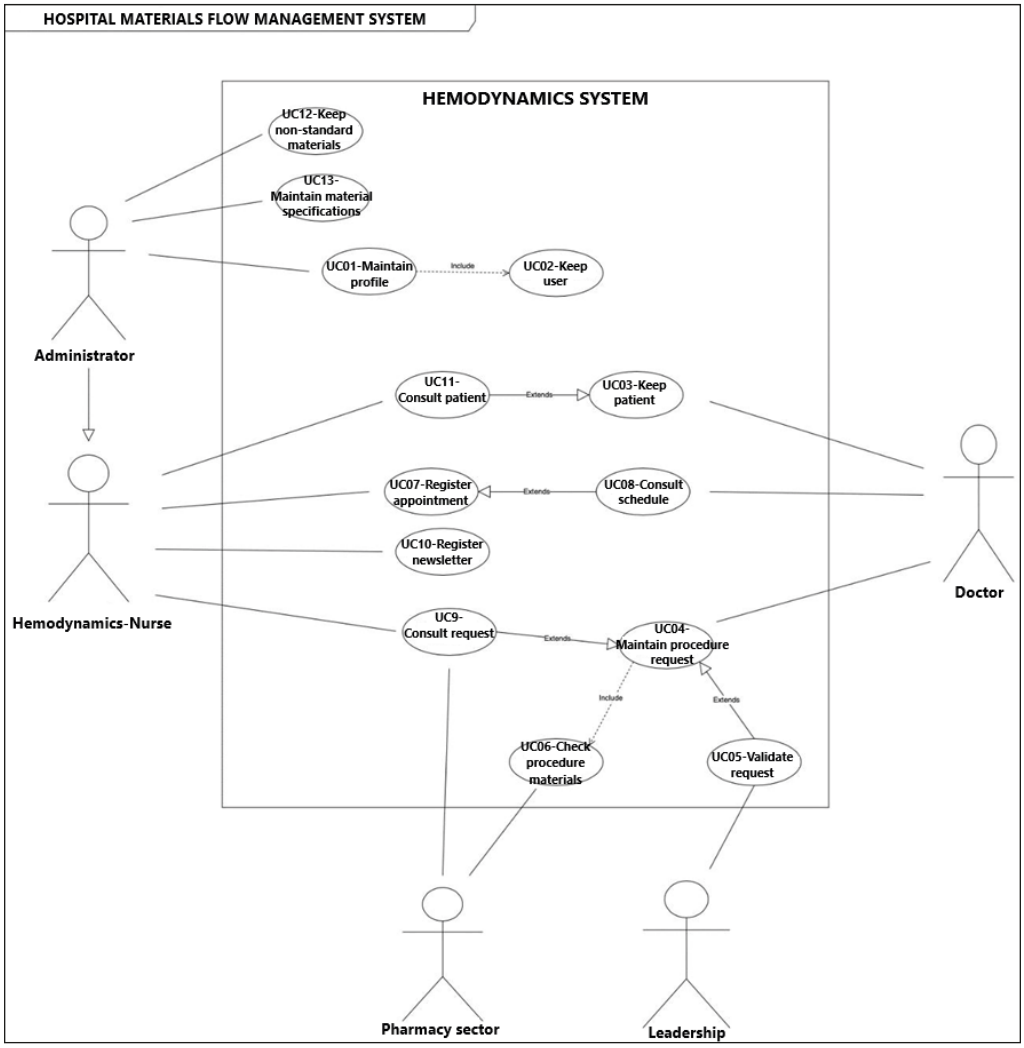

Figure 5 - Use case diagram Source: Prepared by the author, 2020

Figure 6 - Entity-relationship diagram Source: Prepared by the author, 2020

Figure 7 - Initial screen for accessing the Haima software Source: Prepared by the author, 2020.

The first module of the software, where the workflow begins, is aimed at the medical professional. It was developed with the aim of allowing the creation of a request with complete identification data on the patient, the procedure and the necessary materials, with the basic specifications that allow the material to be correctly separated and dispensed by the pharmacy and in accordance with SIGTAP/SUS compatibility, allowing it to be adapted to current legislation.

Once you have accessed Haima, in the doctor's module, you can choose to register a new request or keep track of the requests you have made. The screen representing this function is shown in Figure 8.

When the "New request" option is chosen, the system displays the patient registration screen shown in Figure 9. The user minimally fills in the mandatory fields (name, CPF and contact telephone number) and then the system validates the data entered.

Once the new patient's details have been confirmed, the registration is complete and the procedure can be requested. In order to contribute to a better user experience, the procedures to be requested are already present in the *software,* according to the SIGTAP/SUS table, and are selected through a quick search, as shown in Figure 10.

After selecting and adding the procedures, the OPME request screen opens. The group of materials contained in SIGTAP/SUS for each procedure is already listed on this screen, and the medical professional can choose the materials they wish to request by simply checking and identifying the specifications (size and quantity) for each one. In addition, it is possible to request materials other than those listed in SIGTAP/SUS, with the appropriate justification, which becomes a mandatory field in these cases. The medical professional also has the option of requesting non-standardized material for the institution by filling in their own document, saved in the *software*. Figure 11 shows the medical request screen for the procedure with the respective OPME.

The request is finalized when the registration is confirmed, where it is possible to check the information entered into the *software*. The final screen for the medical request for OPME is shown in Figure 12. This request is forwarded to the nursing/scheduling module, when all the materials requested are contained in SIGTAP/SUS, or to the management module, otherwise.

This first module allows for adjustments to the legislation by following the Ministry of Health's good practice guidelines, including: the request for OPME on a specific form, which must include the patient's identification data, medical record number, date and name of the planned procedure, listing the necessary OPME (compatible with SIGTAP/SUS), the appropriate quantity and sizes (BRASIL, 2016).

The second module, called Manager, was developed for the analysis and authorization of OPME requests not provided for in SIGTAP/SUS. This option was provided because some of the procedures contained in SIGTAP/SUS are out of date and do not reflect the real need for materials for the patient's treatment. In this case, the request is forwarded to be evaluated by the technical manager of the unit, as to its indication and therapeutic evidence, in order to decide whether to authorize its use and/or acquisition. This module has a single screen where you can open past requests and

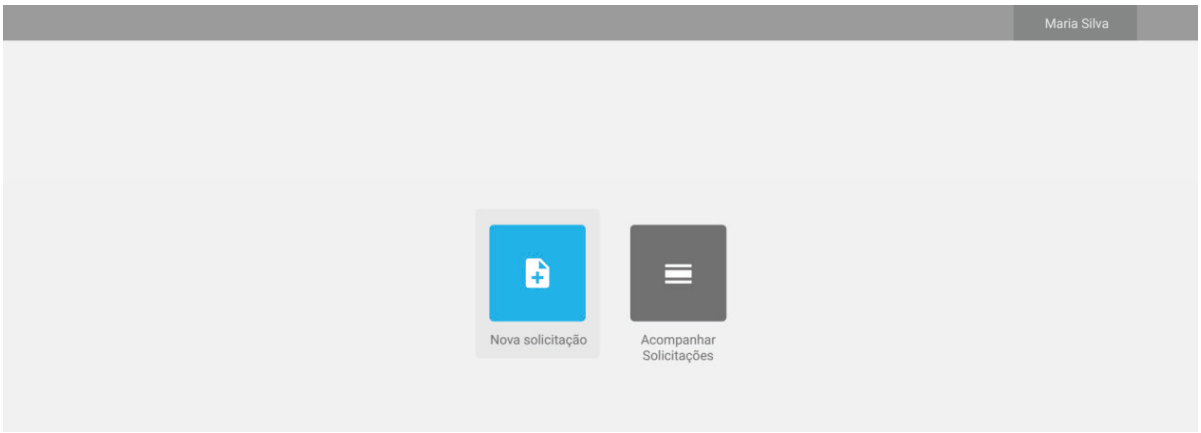

Figure 8 - Screen for registering or following up a request Source: Prepared by the author, 2020.

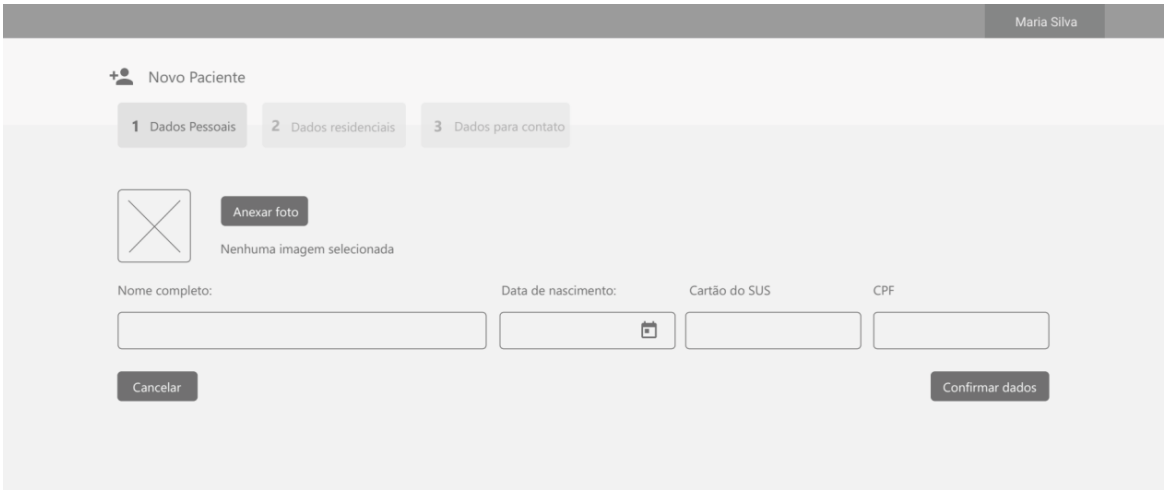

Figure 9 - Patient registration screen.

Source: Prepared by the author, 2020.

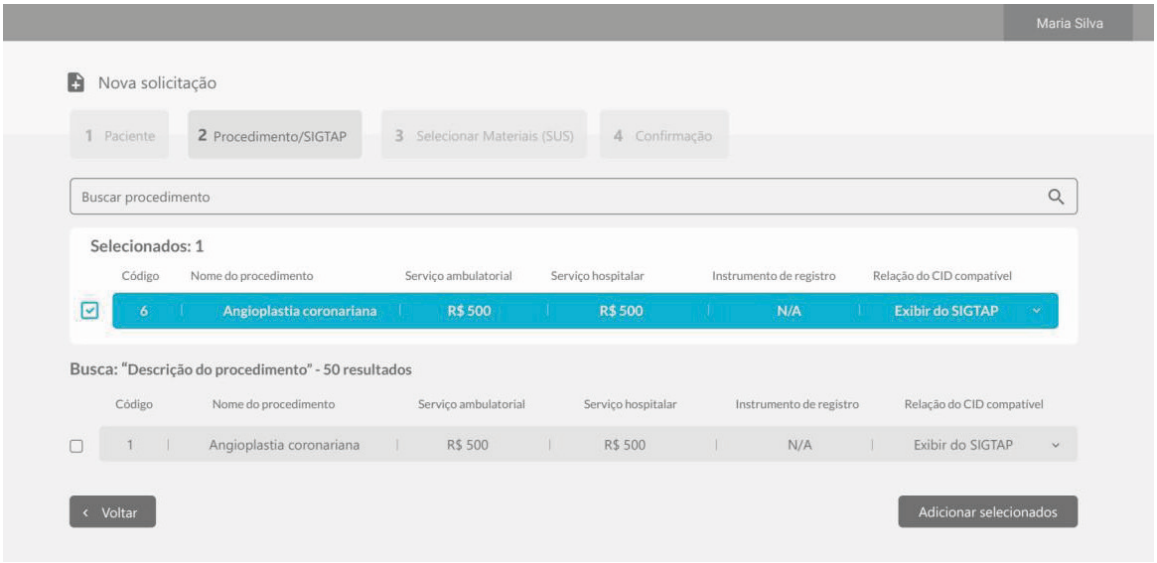

Figure 10 - Procedure request screen.

Source: Prepared by the author, 2020.

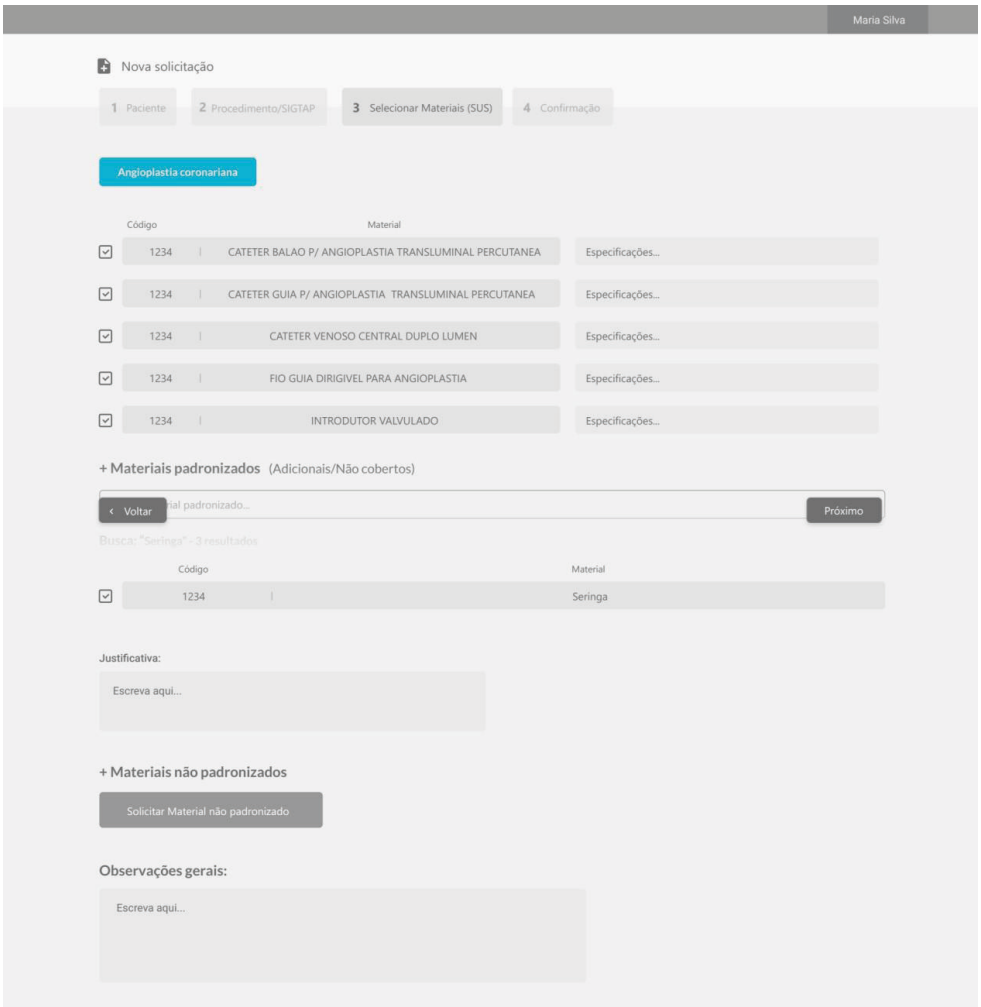

Figure 11 - OPME request screen Source: Prepared by the author, 2020.

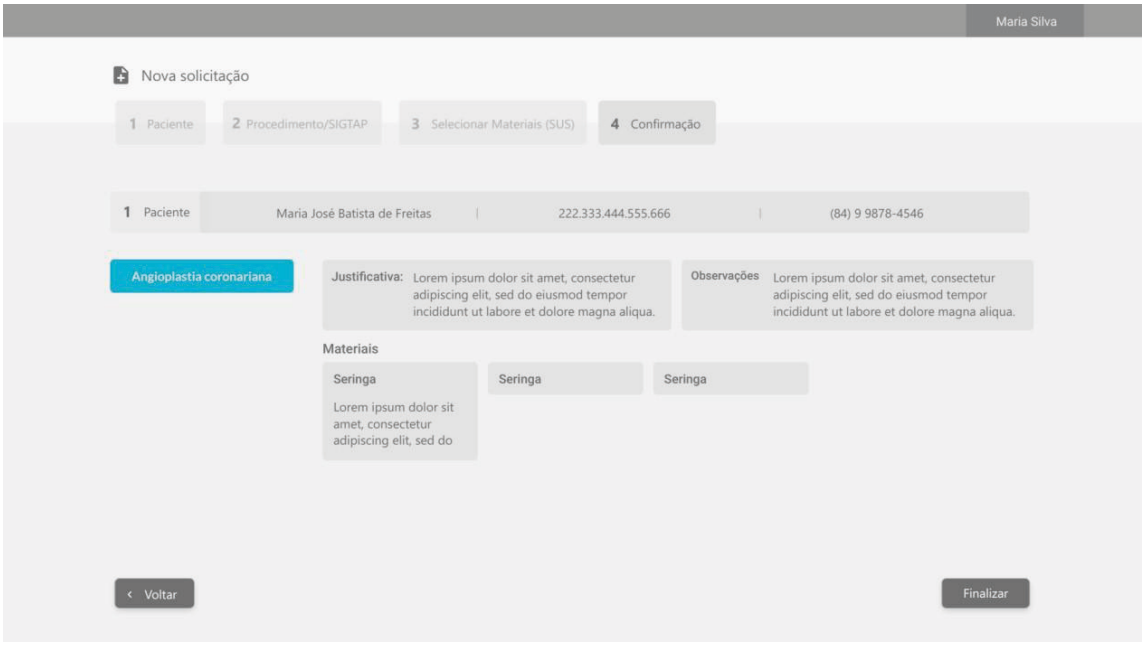

Figure 12 - OPME request final screen. Source: Prepared by the author, 2020.

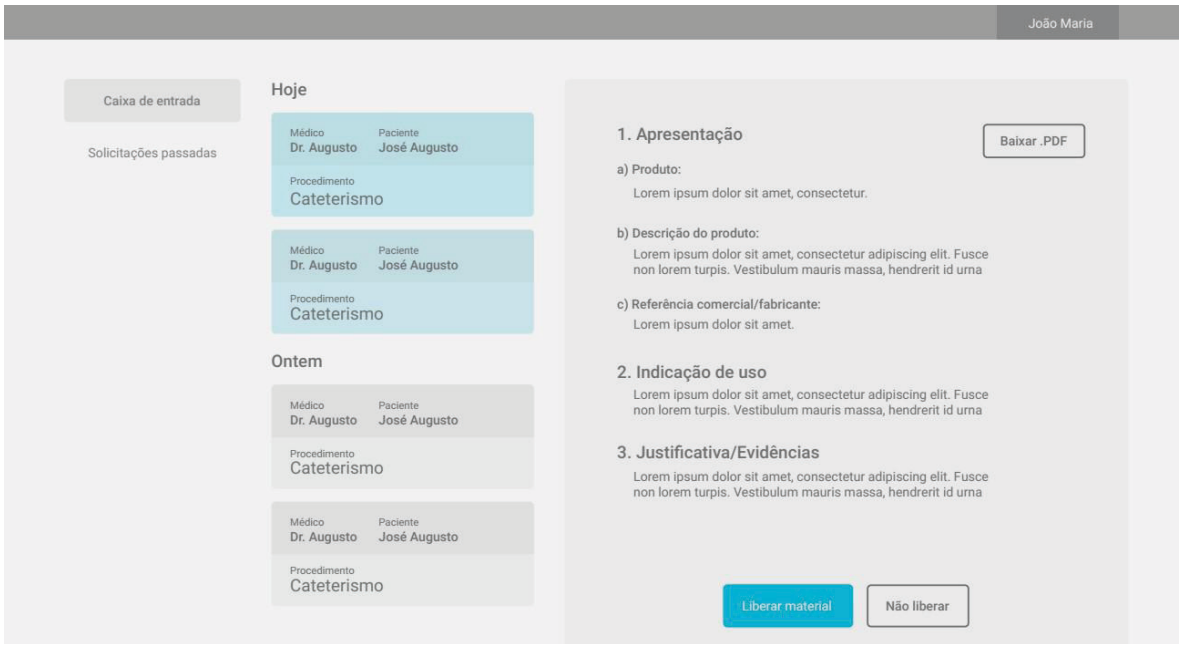

Figure 13 - Manager module screen. Source: Prepared by the author, 2020.

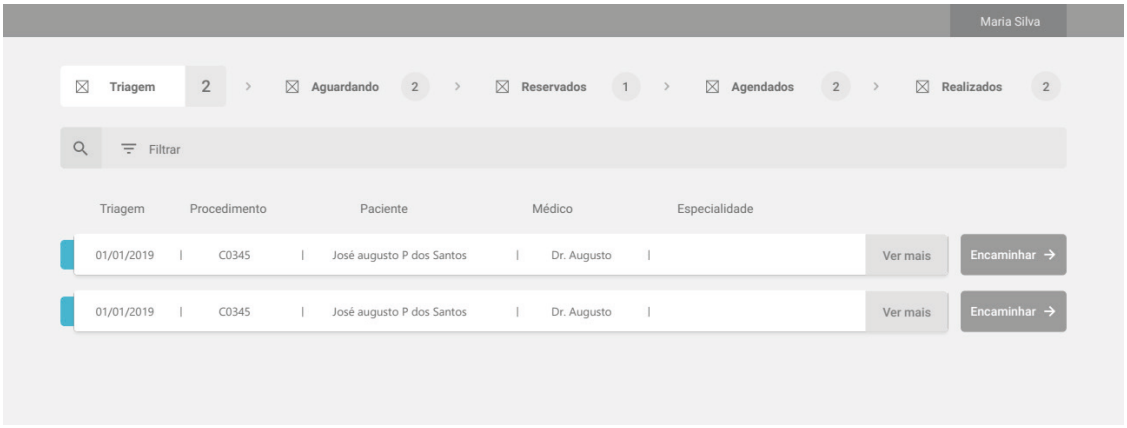

Figure 14 - Nursing module triage screen.

Source: Prepared by the author, 2020.

Figure 15 - Nursing module scheduling screen.

Source: Prepared by the author, 2020.

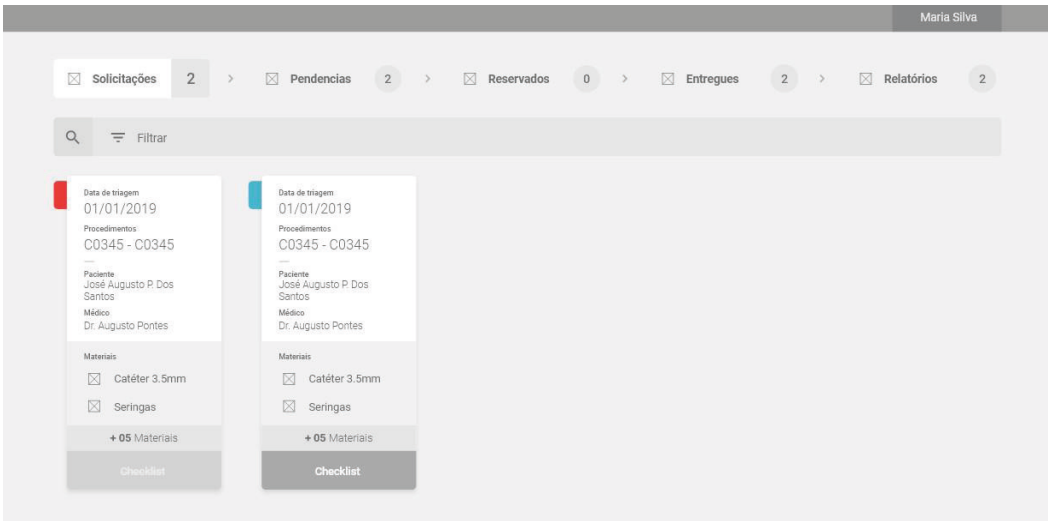

Figure 16 - New requests screen in the pharmacy/stock control module.

Source: Prepared by the author, 2020.

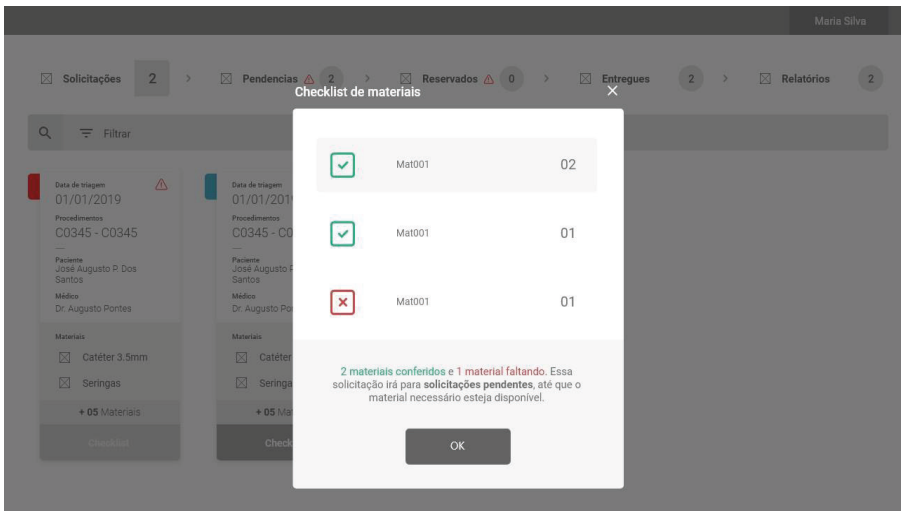

Figure 17 - Screen for confirming material in stock.

Source: Prepared by the author, 2020.

Figure 18 - Screen with history of procedures performed.

Source: Prepared by the author, 2020

evaluate new requests in the inbox, approving them or not, as shown in Figure 13.

In cases where the use of the material is not authorized by the manager, a notification with the response is sent to the requesting doctor, who can cancel or change the request, in the latter case restarting the flow. When the use of the material is authorized, the request goes to the nursing/scheduling module for the triage function. This function is characterized by a non-automatic forwarding from the *software*, carried out by the nursing/scheduling team, to the pharmacy of requests that are expected to be fulfilled within 15 days, as described in the workflow. The triage function, associated with the appointment registration, is developed in the nursing/scheduling module. This module has a screen where you can navigate according to the status of the request (awaiting triage, awaiting a response from the pharmacy, booked, scheduled and carried out). In triage status, when you click on forward, the request will be forwarded to the pharmacy, as shown in Figure 14.

In the reserved status, when you click on schedule, the date for scheduling the procedure will be entered. The screen for this function is shown in Figure 15.

The last module, called pharmacy/stock control, is responsible for responding to requests regarding the presence of materials and reserving them for the patient, ensuring that they are distributed correctly on the scheduled day. This module, like the nursing/scheduling module, has a screen where you can navigate according to the status of the request (new requests, pending materials, reserved and delivered materials). The screen for this module is shown in Figure 16.

On the screen above, clicking on check list opens a screen with the materials requested, allowing the user to list, via a simple check, the materials in stock or not, as shown in Figure 17.

After the procedure has been carried out, the nursing team registers the completion date, and the information is stored in the software database, as shown in Figure 18.

PRELIMINARY SYSTEM VALIDATION

For preliminary validation of the system, an OPME request was simulated in the system developed, with the established flow followed until the process was completed. The entire process was recorded on video.

The system proved to be viable and capable of meeting the proposed requirements, with no major failures during the OPME dispensation request process. The small preliminary corrections were carried out without major difficulties, as they are classic adaptations that occur during the implementation of the first versions of any academic or commercial software. After all, even large software companies and their major operating systems, such as Microsoft's Windows platform (UWP - Universal Windows Platform), are subject to corrections and changes year after year as new versions are released.

RESULTS AND DISCUSSION

The main focus of this study was the design and development of a *software program* for a public health institution to innovate and improve the management of OPME.

The *software* developed and implemented connects health professionals involved in the management of OPME and its architecture includes medical requests on a specific digital form, authorization for the use of the material by the manager, control of the waiting list and scheduling of therapeutic procedures, availability, reservation and dispensing of the material. Thus, the HAIMA *software*, developed in this study, is dedicated to the processes prior to the use of the OPME, unlike the software found in the literature, which focuses on spe-

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cific stages, dedicating itself to the processes prior to the use of the OPME mostly notification of use, incidents, traceability and auditing of devices.

An example of the studies found was developed by Marquez-Peiro *et al*. (2016) which described the introduction of the Health Products Surveillance System, SIVIPS, in a pharmacy service for the management of medical devices with regard to use and incident control. After one year of implementation, the system improved the traceability of prostheses and implants, facilitated the collection of data on the types of prostheses most consumed and the main suppliers, and improved the recording and monitoring of incidents related to health products, providing basic information for future decisions on the acquisition of certain brands of products or suppliers of health products. In another similar study, Mei and Lu (2016) developed a system to manage the traceability of medical devices. In this study, the authors evaluated the system as good at managing traceability and unifying processes.

In the literature, it was only possible to identify one study, carried out by Miraldo (2016), which presents the implementation of a process management system, called "*workflow*", in a health operator, which is similar to the Haima software in terms of the medical request and manager module, as it is aimed at controlling the release of elective hospitalization procedures using OPME. In this study, although it only covers the request and authorization of procedures and materials, it was already possible to see that the system contributed to the efficiency of controlling requests for elective hospitalizations and OPME-type materials, with results such as an 18% increase in productivity when responding to requests for procedures and hospitalizations. It also made it possible to create indicators that allowed managers to monitor the operation in real time, issue historical reports and quickly retrieve process documents. However, the Haima *Software* has the difference of also encompassing the various actions and interaction of the professionals involved in OPME management in the process that goes up to dispensing the material on the day the procedure is scheduled to take place, which allows for greater control in the work process, strengthening management. Therefore, the results of Miraldo's study (2016), despite the differences in the *software* architecture and reflecting the The reality of a private health institution suggests good prospects for the implementation of Haima software.

In addition, the Haima *software*, with its medical request and manager module, also makes it possible to comply with the Ministry of Health's OPME good practice manual, as it follows the guidelines contained therein, contributing to compliance with current legislation. In the literature researched, it was not possible to identify any studies associating the use of software for OPME management and compliance with legislation. This fact, present in the *software* developed, is necessary and has an impact on health care, because it is known that when it comes to quality, management must be in accordance with legislation, which must be adopted and followed within the management strategies adopted in health institutions (BRASIL, 2016). According to Cintra and Junior (2013), this provides users with quality and sustainable care, while preserving good relations with health professionals, based on ethics and transparency.

The pharmacy/stock control module of the Haima software ensures that the scheduling of procedures, currently carried out by the nurses at the study institution, is carried out after the material has been reserved in the name of the patient for whom it was requested. This function contributes to the safety of the surgical procedure, given the certainty of the presence of the material on the day sche-

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duled for the procedures, as well as allowing the pharmacy sector to predict future demand and have more control over the dispensing of materials, helping to minimize the occurrence of excesses and shortages of materials sent for surgery. The literature did not describe *software* that interacts with the requesting doctor, the scheduling sector and stock control in the management of OPME. However, with regard to the management and control of stock of materials and medicines, the benefits of computerized processes are well characterized. According to Pinochet, Lopes and Silva (2014), they make it possible to reduce costs by reducing rework, reducing or eliminating theft of materials/medicines, providing a source for generating hospital indicators and supporting the decision-making and strategic process of administrative management. Islam, Poly and Li (2018) characterize these systems as auxiliary information systems and point out that they have been gaining a lot of attention in recent years, particularly because they make it possible to reduce clinical errors, such as medication errors, diagnostic errors and to support health professionals by offering up--to-date information.

One of the main objectives of the Haima *software* is to interconnect and bring together the sectors involved from medical request to dispensation for the use of OPME, both assistance and administrative, as well as to qualify the information in the work process. The interaction between different authors has not been observed in *software* for the management and control of OPME reported in the literature. However, this requirement is considered to be important because, according to JUNIOR et al. (2013), the high cost and inefficient management of OPME is due to factors such as the lack of quality information between the players. This difficulty is also present among the health professionals working in the management of OPME in HUOL's hemodynamics unit and the *software* developed appears as a tool to favor the work process. According to Aguiar and Mendes (2016), information technologies and information systems are beneficial in terms of interaction between different sectors when they state that they act as a link between activities related to the care process and those related to the administrative process, since they have information and communication as the main tools for integrating production processes.

The Haima *software* was validated and evaluated by professionals involved in the management of OPME at HUOL. For them, the *software* innovates in the management of these materials and has helped to ensure that procedures are scheduled with the guarantee that essential previous processes have been complied with, ensuring the presence of all the necessary OPME in the operating room on the day of the procedure. It allows for greater safety in patient care and less unnecessary costs related to the suspension of procedures due to a lack of supplies. In addition, it contributes to the integration of the professionals involved, control of the process, more agile communication with less risk of failure, a reduction in the time it takes to carry out activities, an increase in productivity and the production of quality information.

However, although the software has been developed and is fit for use, the literature shows that implementing information systems in healthcare organizations poses a number of challenges. For Islam, Poly and Li (2018), healthcare has been particularly slow and lagging behind other areas. This is due to the complexity of issues such as interoperability, rationality technology, acceptability, managerial rationality, data security and data quality. These limitations can be attributed to technical, human and organizational factors. However, despite these findings, HUOL professionals were very interested and satisfied with the development and implementation of the *software*, which favors its effective use.

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In view of the above, despite the progress that is still needed in this area, it is clear that in order to efficiently manage the entire process involved in the use of OPME by healthcare institutions, it is essential to have information support for the logistics decision-making process, which occurs through information systems. Good management of OPME outweighs the benefits in hospital management when it achieves the objective of carrying out the procedure with the satisfaction of the client served (CINTRA; JUNIOR, 2013). The Haima software meets these requirements, making it an important tool for healthcare management.

Some limitations can be identified in this research when a critical analysis is carried out. The main limitation is the lack of wider validation of the system. This action was made impossible for a number of reasons: the difficulty of installing the software on the hospital's network, as it requires the authorization of managers, the short time for the work to be operational and, in particular, the occurrence of the pandemic (COVID-19), which diverted the focus of hospital management, as elective procedures, the main objective of using the system, were temporarily suspended to free up beds for patients with coronavirus.

However, it is important to emphasize that the implementation of HAIMA, although in its preliminary phase, has already been sufficient to verify its viability and real potential as an information system to support management decisions. The complete and robust study of current flows and the proposal of new customized flows to meet HUOL's more specific needs have contributed to this.

CONCLUSIONS

Thus, according to the literature review carried out in this work, also taking into account the reports in the literature on health information systems and based on the design and development of the Haima software, we can reach some conclusions.

- Health information systems have several benefits when applied to the management of OPME: improvements related to the flow of communication, standardization of processes, production of indicators for management, traceability of devices, greater control in the workflow and reduction of costs are benefits supported by the literature.
- The management of OPME permeates a large part of hospital processes, from requesting the material for the procedure to accounting for the information, including logistics, consumption and billing. This flow contributes to the fact that their care and marketing characteristics are considered complex, and the interaction between health professionals and the quality of information are fundamental to the management of these high-cost materials.
- Without the presence of the Haima system, there was manual and incomplete filling out, a lack of a standardized workflow, scheduling the procedure without the manager's knowledge and without previously booking the material, as well as a lack of control over the use of materials.
- The problems mentioned above jeopardize hospital billing, in breach of current legislation.
- An applicable workflow has been developed that allows the specific role of each professional to be defined, guiding the necessary interactions, something that until now has not been standardized in health units.

• The Haima software was designed, developed and implemented, and the results showed that it was feasible to implement.
• The results showed that, once it has been fully implemented, it will be possible to enjoy the following benefits associated with the results of this work: automation of the defined workflow; better-prepared requests for materials in accordance with the procedures and OPME available on SIGTAP/SUS and current legislation; electronic acknowledgement by the head of the requests and interconnection with the professionals involved, association with the list of waiting patients, information on the availability of the requested material and the scheduling date.
• In conclusion, the Haima system was validated and proved to be viable and capable of meeting the proposed requirements, with no failures during the simulation process in its use.

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