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SOFTWARE TO SUPPORT LOGISTIC DECISION IN THE PROCESS OF ORGAN ACQUISITION AND TRANSPLANTATION

SOFTWARE PARA APOIO À DECISÃO LOGÍSTICA NO PROCESSO DE CAPTAÇÃO E TRANSPLANTE DE ÓRGÃOS

SOFTWARE DE APOYO A LA DECISIÓN LOGÍSTICA EN EL PROCESO DE OBTENCIÓN Y TRASPLANTE DE ÓRGANOS

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Objective: to develop and evaluate a software to support the decision-making of transplant center professionals in the logistic definitions involved in the process of organ procurement and distribution for transplantation. Method: applied technological production study, supported by the Design Science Research Methodology method. Ten nurses from the Transplant Center of Santa Catarina participated in the usability evaluation stage. Data collection took place from 1 to 20 July 2021 through the System Usability Scale questionnaire. Results: the software used JavaScript language with ReactJS and PHP with Laravel, for the PostgreSQL database. The evaluation obtained a mean score of 98.25, and its usability is considered as best achievable. Conclusion: the software proved to be adequate and functional, with easy handling, gathering integrated and objective information. It represents a breakthrough in the area, proposing a technological innovation for the management and support to the logistic decisions involved in the process of organ procurement and transplantation.

Descriptors: Organ Transplantation. Decision Support Systems, Management. Nursing. Nursing Informatics. Health Sciences, Technology, and Innovation Management.

Objetivo: desenvolver e avaliar um software para apoio à tomada de decisão dos profissionais da central de transplantes nas definições logísticas envolvidas no processo de captação e distribuição de órgãos para transplante. Método: estudo de produção tecnológica aplicada, sustentado pelo método Design Science Research Methodology. Participaram da etapa de avaliação da usabilidade dez enfermeiros da Central de Transplantes de Santa Catarina. A coleta de dados ocorreu de 1 a 20 de julho de 2021 por meio do questionário System Usability Scale. Resultados: o software utilizou linguagem JavaScript com ReactJS e PHP com Laravel, para o banco de dados PostgreSQL. A avaliação obteve escore médio de 98,25, sendo sua usabilidade considerada como melhor alcançável. Conclusão: o

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software demonstrou ser adequado e funcional, com fácil manuseio, reunindo informações integradas e objetivas. Representa um avanço na área, propondo uma inovação tecnológica para a gestão e apoio às decisões logísticas envolvidas no processo de captação e transplante de órgãos.

Descritores: Transplante de Órgãos. Sistema de Apoio a Decisões Administrativas. Enfermagem. Informática em Enfermagem. Gestão de Ciência, Tecnologia e Inovação em Saúde.

Objetivo: desarrollar y evaluar un software para apoyar la toma de decisiones de los profesionales de la central de trasplantes en las definiciones logísticas implicadas en el proceso de captación y distribución de órganos para trasplante. Método: estudio de producción tecnológica aplicada, sustentado por el método Design Science Research Methodology. Participaron de la etapa de evaluación de la usabilidad diez enfermeros de la Central de Trasplantes de Santa Catarina. La recopilación de datos tuvo lugar del 1 al 20 de julio de 2021 a través de la encuesta System Usability Scale. Resultados: el software utilizó lenguaje JavaScript con ReactJS y PHP con Laravel, para la base de datos PostgreSQL. La evaluación obtuvo un puntaje medio de 98,25, siendo su usabilidad considerada como mejor alcanzable. Conclusión: el software ha demostrado ser adecuado y funcional, con fácil manejo, reuniendo información integrada y objetiva. Representa un avance en el área, proponiendo una innovación tecnológica para la gestión y apoyo a las decisiones logísticas involucradas en el proceso de captación y trasplante de órganos.

Descriptores: Trasplante de Órganos. Enfermería. Sistemas de Apoyo a Decisiones Administrativas. Informática Aplicada a la Enfermería. Gestión de Ciencia, Tecnología e Innovación en Salud.

Introduction

From the second half of the twentieth century, organ transplantation became a reality, allowing to replace organs that have lost their function by viable organs, ensuring the improvement of the quality of life of people in unrecoverable clinical conditions. After about 60 years, a combination of factors involving the deepening of studies, the improvement of surgeries, the development of drugs and compatibility tests have made transplantation a routine treatment of great importance to society, being considered a safe and effective technique[1].

Although Brazil is an example for having organized the largest public transplant system in the world, there are still problems and challenges that need to be overcome – from high rates of family refusal and disposal of organs to logistic and operational problems[2].

Brazilian data, published in 2016, showed that the number of organ refusals for logistical reasons increased 42.4%[3]. In 2017, in Brazil, 10,629 potential donors were notified, but only 3,415 of these donors had the donation effective[4]. Among the reasons for loss of donors, 1,683 were attributed to reasons related to logistic or operational difficulties. Still in 2021, a survey identified and evaluated the main risks, their impacts and relevance in the national donation and transplantation process, highlighting logistic problems as one of the weaknesses[5]. The supply chain of donations and transplants is directly influenced by the delicate combination of standardized processes, high levels of urgency, uncertainty and the highest degree of efficiency to be pursued[6].

The complexity of managing the logistic aspects involved in organ procurement for transplants lies in the need for alignment between several factors such as: time, geographic location of the donor and the transplanter center, climatic conditions, conditions of the donor and/or recipient, availability of transportation, demand for funding, availability of collection teams and hospital structure. The specific condition of each of these factors is usually defined at the time of family authorization, requiring from the professional who will perform the logistics a detailed analysis for decision-making[1,7-8].

When there is a donor, the team of the Transplant Center (TCE) triggers actions to enable the procurement and distribution of organs. At this stage, some aspects are fundamental, such as the definition of the organs to be acquired, the surgeons who will make the explant, the

necessary materials and the availability of the room and surgical team, as well as the means of transport. The management of these resources that are involved in the removal/delivery of organs for transplantation, in a given place and time, can be defined as the logistics involved in organ procurement[1,8]. In Santa Catarina (SC), the large number of information to be consulted for such logistics is distributed in different physical files (folders with forms, contacts, information from cities, hospitals, airports, among others), making data consultation laborious and slow. This fact sometimes makes the organization of organ procurement complex. In addition, the high amount of information available in a dispersed manner tends to hinder the training of new professionals to work in the area.

In Brazil, a systematic literature review verified the indicators used to monitor and control the process of organ donation and transplantation, revealing the lack of standardization of efficiency indicators, being the focus predominantly on the stage of donation, gaps in measurement at other points in the process. There is a lack of data in key stages, as well as in the distribution of organs. The logistic indicators are little used, not evaluating, for example, the proportion of organs lost by delays in this stage of the process. Further analysis could reveal points of inefficiency in organ distribution logistics and signal the need for staff training, investments in transport infrastructure and adoption of standardized practices for organ storage[9].

A report prepared by a non-governmental organization in 2015 describes the logistics process involved in organ donation and transplantation as slow and obsolete, considering it random, disorderly and without organized support logistics[10]. The importance of logistic planning applied to health is unquestionable, being essential for the definition of the lives of many people. The performance of this stage is related, in many occasions, to the continuity of life or not, since the outcome of transplantation is directly related to the execution and the time of the phases relevant to logistics. Thus, the development of new studies that can improve the logistic organization becomes relevant, prudent and fundamental, seeking greater quality and safety in the process of organ donation and transplantation[11].

The various processes involved in organ donation and transplantation have significant potential for improvements resulting from innovations. A systematic literature review on innovations in organ donation and transplantation services, conducted in 2018, showed that innovations in the area have a clinical focus, highlighting the scarcity of debates on the management of the innovation process. In the innovations described, the use of resources and knowledge of the medical area and not of management tools predominates. Focusing on aspects of the management of the innovation process will allow to use knowledge and organizational skills to create value and competitive advantages for the institution involved with organ donation and transplantation services[12].

In view of the possibilities and trends presented by the combination of technological resources combined with logistic decisions, the creation of a logistic software for organ procurement and transplants will contribute to greater efficiency and process security, improving the use of resources. By gathering the geographic and structural data of institutions, teams, means of transportation and technical aspects related to donation/transplantation in a single platform, it will be possible to streamline access to data, facilitating the flow of information, enabling decision-making to organize logistics safely and effectively.

Thus, the objective of this study was to develop and evaluate a software to support the decision-making of transplant center professionals in the logistic definitions involved in the process of organ procurement and distribution for transplantation.

Method

It is a study of applied technological production. For the construction of technological research,

the Design Science Research Methodology (DSRM) method was chosen. Technological research focuses on the solution of specific problems, highlighting the development of an artifact, which will not always be something material, and may be an artificial project or intervention on a system[13].

The development of this study was guided by the six steps recommended by the DSRM methodology:

Step 1 – Identification of the problem and justification of the research, which will guide the construction of the artifact, aiming at the solution[13]. For this, a survey of studies that identified problems in the process of organ donation and transplantation in Brazil/world was conducted, through the research platforms Latin American and Caribbean Health Sciences Literature (LILACS), PubMed, Scopus, Web of Science, Health Sciences Scientific Electronic Library Online (SciELO) and academic Google. The analysis revealed that the logistics involved in the process of organ donation requires improvements, since this step still presents problems that cause loss of organs. The unification and centralization of data in a single software will allow to streamline decision-making. Moreover, there are few studies on this specific step of the process, generating a gap that needs to be better explored and understood.

Step 2 – Definition of the objectives to solve the problem[13]. In this step, the purpose of the study established was to develop and evaluate a software to support professional decision-making in the logistic definitions involved in the process of organ procurement and distribution for transplantation in the state of Santa Catarina.

Step 3 – Creation of the artifact according to the desired functionality and architecture. Conceptually, a design research artifact can be any designed object, so that a research contribution is embedded in the design[13]. The artifact designed and developed was the software to support the logistic decisions involved in the process of organ procurement and transplantation.

Step 4 – Demonstration of the artifact solving the problem, through simulation, case study, experiment or other appropriate activity[13]. Therefore, the simulation of the use of the software was performed, through the insertion of fictitious data, and the software pointed out to the professional options for defining the logistics involved in the process of organ procurement and transplantation.

Step 5 – Observation and measurement of how the artifact met the solution of the problem, comparing the proposed objectives and the results resulting from the use of the artifact[13]. Initially, the software was presented to the nurses of the TCE-SC, allowing the manipulation of the tool by professionals. Then, the System Usability Scale (SUS) questionnaire was applied to evaluate the usability of the software.

Step 6 – It consists of the disclosure of the problem and presentation of the developed artifact[13], which, in this study, was the presentation of the final version of the software.

The study was developed in the Central State of Transplants of Santa Catarina, located in Florianópolis. The TCE-SC or *SC Transplantes* is an integral unit of the administrative structure of the State Health Department of Santa Catarina, responsible for centralizing and coordinating actions involving collection and transplantation in the state, management of the unique lists of organ and tissue recipients, as well as in the processes of procurement and distribution of organs and tissues. The TCE-SC is also responsible for formulating transplant policies at the state level[14].

The study participants were the nurses who perform the logistic activities of organ donation and transplantation processes in the TCE-SC. The inclusion criteria were: to be a nurse and to be working in the TCE-SC for at least three months at the time of data collection. Only the researcher and a nurse who absent from work due to maternity leave were excluded from the sample.

Data collection took place from 1 to 20 July 2021. In these 20 days, nurses from TCE-SC, who are the users of the target technology, were invited to explore and test the software's functionalities. Of the ten nurses who worked

in the Central during this period, all agreed to participate.

The usability of the software was evaluated through survey research, and the nurses received a questionnaire to assess issues related to learning ability; efficiency of use; memorization ability, error handling and user satisfaction regarding the software, using the System Usability Scale.

The SUS provides for the application of a questionnaire with ten questions, five of a positive character and five of a negative character, which allow to assess user satisfaction. This technique allows to obtain a value of the level of overall user satisfaction. The questions are qualified on a 5-ponit Likert scale, with one as completely in disagreement, and five as completely in agreement. Specific weights are established for the answers given to even and odd questions. A specific formula allow to find the total score of usability of the system or product. The results of the odd sentences (1, 3, 5, 7 and 9) are calculated by decreasing 1 of the chosen option. For even sentences (2, 4, 6, 8 and 10), the score will be equivalent to 5 minus the answer. After obtaining all the scores (maximum value of 40), the sum is multiplied by 2.5 and the usability result (0 to 100) will be obtained[15].

The research is part of a Professional Master's thesis in Health Informatics entitled *Contributions of a System to Support Logistic Decision in the Organ Procurement and Transplantation Process in the State of Santa Catarina*[16]. It was approved by the Research Ethics Committee (REC) of the Federal University of Santa Catarina, by Opinion n. 4.622.388, Certificate of Presentation of Ethical Assessment (CAAE) 44432621.1.0000.0121. Authorization was also requested to the TCE-SC to carry out the study. All participants received the Informed Consent Form (ICF) for reading and signing in two copies.

Results

The development of the software occurred through a partnership established between the researcher – a nurse in the transplant area – and a hired technician in the computer area, who established the navigation flowchart and the functionalities that the product should contemplate. Among the functional requirements listed, the software should: contain log in, register data; view, delete and edit registered data; search for information in the local database; support the choice between different options; generate reports on acquired organs and types of transport used; consult the map and generate PDF of logistics. As for the non-functional requirements, the software should: ensure that the return time is less than 5 seconds; have compatibility with the Internet Explorer and Firefox browsers; have user-friendly interface; be developed in JavaScript languages with ReactJS and PHP with Laravel; support Google Maps; and be in dashboard format.

The programming language chosen for the software was JavaScript with ReactJS and PHP with Laravel. JavaScript is a very consolidated language in the creation of websites, which allows to implement several items of high level of complexity in web pages, including maps, graphics and information able to self-update in standard time intervals. ReactJS is a JavaScript tool that was used to build a more efficient user interface. Laravel is a framework that allows to program quickly and in organized way, through a functional code, contributing to the development of safe and performative applications effectively.

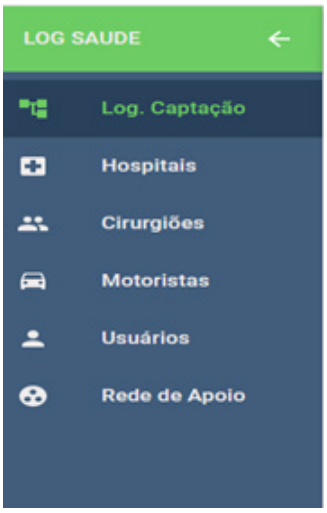
The object-relational database manager chosen was the PostgreSQL Database Server, used for secure information storage, having the ability to support considerable workloads and be able to process large volumes of information. The Google Maps Application Programming Interface (API) was also used to obtain the exact location – latitude and longitude – of the places of interest (hospitals, transplanter).

On the homepage of the software is the login screen, where access occurs by entering e-mail and password, in order to ensure the integrity and security of information, allowing only duly registered professionals to use the product.

After login, the software will allow the access to the main menu, available in the left corner of the screen during the entire browsing period. In

the main menu, shown in Figure 1, the following icons can be chosen: Log. Procurement, Hospitals, Surgeons, Drivers, Users, Support Network. Each of the buttons directs the user to a respective screen, which allows to register, delete or edit data, perform appointments, as well as help the user in decision-making during the definition of logistics for organ procurement and transplantation.

Figure 1 – Main menu. Florianópolis, Santa Catarina, Brazil – 2021

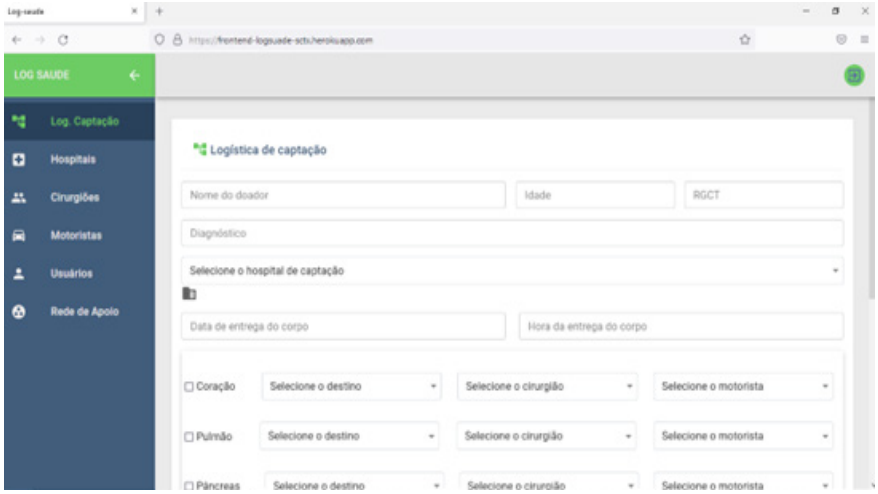


Source: created by the authors.

On the first icon of the main menu, Log. Procurement, the user will enter the data related to the donation and procurement of organs: name of the donor, age, General Registry of the Transplant Center (GRTC), diagnosis, hospital of procurement, date and time of delivery of the body.

Next, the user will select: organs to be acquired, destination of the organ (institution, city or state of the transplant), surgeon, driver. The definition of professionals (doctors and drivers) will follow the work scale, respecting their availability; the destination of the organ will be defined according to the technical and legal criteria of allocation.

Figure 2 – Screen with procurement logistics data. Florianópolis, Santa Catarina, Brazil – 2021

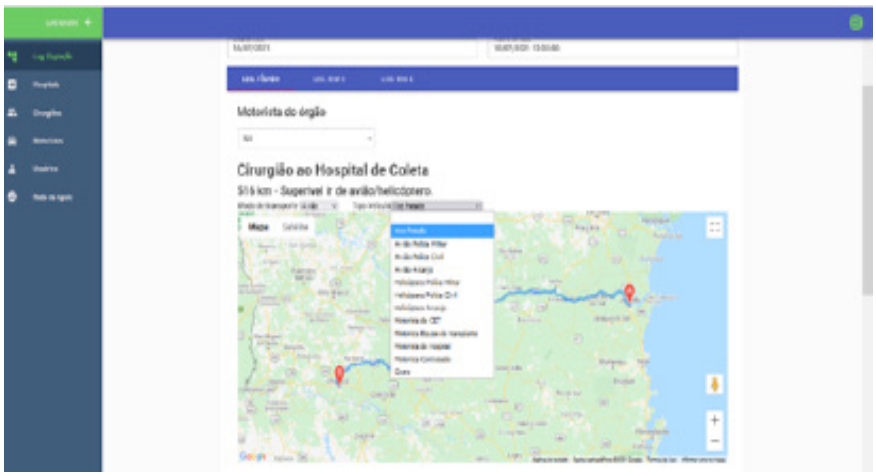


Source: created by the authors.

Just below the selected Hospital of Procurement, there is a link (highlighted in Figure 2) that allows to consult specific institution data in a new window, in order to facilitate consultation in case of doubt or clarification about the characteristics of the place or team.

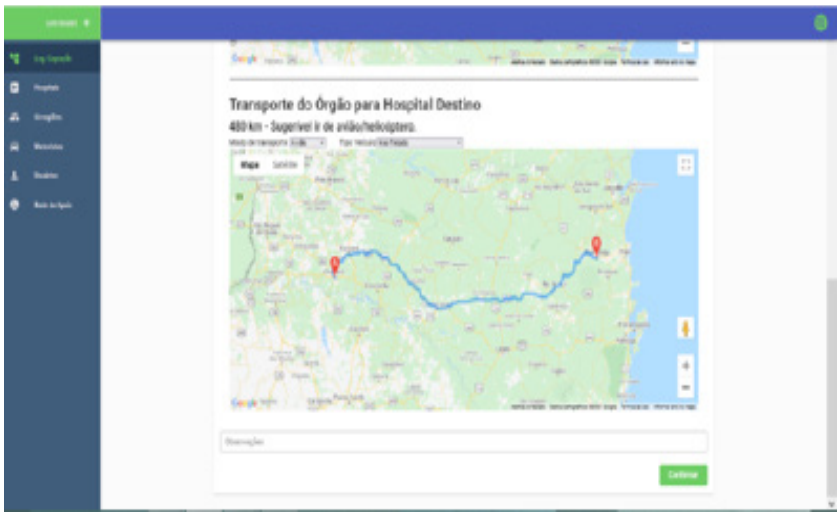
The software will assist the user in making a logistic decision, presenting maps with the distances to be traveled, both for the trip of the procurement team to the hospital where the donor is, as well as the distance for delivery of organs in transplant centers after procurement, as shown in Figures 3 and 4.

Figure 3 – Screen with data from the procurement logistics – travel from the surgeon to the hospital of procurement. Florianópolis, Santa Catarina, Brazil – 2021



Source: created by the authors.

Figure 4 – Screen with procurement logistics data – transfer of the organ to the transplant hospital. Florianópolis, Santa Catarina, Brazil – 2021



Source: created by the authors.

The software will indicate the displacement mileage between the selected points:

* Start = city of the surgeon to the city of the hospital where the collection will take place.

* Return = city from hospital of procurement to the city of destination of the organ.

The software will make the suggestion of the modality of air or land transport, according to the distance and organs to be acquired, respecting the following rules: up to 200 km, preferably terrestrial; more than 200 km, preferably aerial; heart and lung, preferably aerial.

The software will also make the suggestion of beginning of the surgery time, having as reference the time defined by the family for the delivery of the body. The rule for calculating the start of the procurement will be: 2 selected organs = body delivery time (x h) – 3h = start time; 3 selected organs = body delivery time (x h) – 4h = start time; 4 or + selected organs = body delivery time (x h) – 5h = start time.

Despite the recommendations of the software on means of transport and time of beginning of the procurement, the user will have autonomy to make choices different from those pointed out, with the possibility of changing the recommended data. Certain situations require the need to adapt the rules to the context presented. In some cases, the definition of the beginning of procurement will be influenced not only by the number of organs, but also by the hospital structure, demand for procurements in the state and/or availability of the procurement team.

Regarding the definition of transport, for reasons related to meteorology, in some cases, there will be impediment of the use of air transport, causing the user to have to opt for land transport, even at distances greater than 200 km. Another point that interferes with the type of transport is the existence of airport or landing strip near the hospital of procurement/transplantation, a fact that should be considered by the specialist who will be acting in the definition of logistics.

After the suggestions of the software and according to the analysis and choices of the user, a logistic report will be generated, with donor identification data (hospital, GRTC, explant date, date and time of delivery of the body), procurement data, field of observations and orientations.

The logistic report can be accessed in PDF format for referral to those involved in the stage of organ procurement and transplantation (nurses, surgeons and drivers).

In the Hospitals icon, health institutions with potential for organ donation and transplantation should be registered in the software with the following information:

Identification data: Name / Address (latitude/longitude) / Telephone (General, Intensive Care Unit (ICU), Emergency, Surgical Center (SC) / institutional e-mail;

Staff: Professionals of the Hospital Transplantation Commissions (HTC);

Field for free text: to record some particularity of the place.

Still in the hospital register, just below the data, it is possible to view the data of the support network of the city where the institution is located. In the Support Network, data related to cities that have donor and transplanter hospitals will be registered. The registration screen of the municipality will request data related to the institutions that are involved and/or support the TCE in carrying out logistics, such as Regional Health, Civil Police, Military Police, Highway Police and Airports, according to the specificities of each location. In addition, there will be a field for free text to record other information that may be relevant to the place.

In the icon Surgeons, as well as in the icon Drivers, doctors who perform organ procurement and professionals who assist in transporting organs, respectively, will be registered, with the following data: doctor's name, CPF / ID / CRM (doctors), address, e-mail, telephone.

In the icon Users, e-mail addresses and passwords will be registered to perform the login in the software.

After the development, the software was used and had its usability evaluated by the nurses responsible for the logistic decisions related to the procurement and transplantation of organs in Santa Catarina, identified by codes N1 to N10, and also the calculation of the SUS score per participant and the final calculation (Chart

1). The data were organized using the Excel program and analyzed descriptively.

Chart 1 – System Usability Scale calculation per participant. Florianópolis, Santa Catarina, Brazil – 2021

Code	**Total Value System Usability Scale**
N-1	37
N-2	40
N-3	40
N-4	40
N-5	37
N-6	39
N-7	40
N-8	40
N-9	40
N-10	40
Total	393/10 = 39.3
Final System Usability Scale Calculation = 39.3 x 2.5 = 98.25	

Source: created by the authors.

Discussion

Information systems that facilitate access to data in an organized and standardized way emerge as technological resources capable of assisting the work process of health professionals, supporting decision-making, improving quality and reducing clinical and managerial record time[17].

Exploring technologies and their associations with professional practice provides the emergence of innovations that can contribute to a quick, clear and objective decision-making, facilitating action and minimizing the risk of errors[17]. Information and communication technologies in nursing are a foundation for the implementation of quality, using creative potential to favor the increase and participation in health management, thus providing a favorable climate for good performance at work[18].

In 2017, a computerized scale was developed to actively search for potential organ donors in intensive care units, enabling the sharing of information among the various professionals who work in the process in an agile way. In addition, the tool enabled the evaluation of information retrospectively, allowing to visualize the occurrence of underreporting and the ability to generate brain death in the institution evaluated. Thus, the computerized scale of active search for potential organ donors emerges as an instrument to organize the process of identification and maintenance of potential donors, favoring the notification of all patients in brain death (BD), reducing avoidable losses and increasing the quantity and quality of organs available for transplantation[19].

Seeking to optimize organ donation and transplantation in Brazil, a mobile application was developed in 2019. The *e-DOADOR* offers the synthesis of the main scientific and legal information on the process of organ donation and maintenance of the potential donor, presenting the content in a didactic, synthetic and clear way to users. Through the evaluation of the functionality of the application, it was possible to identify that there was improvement of the professionals and students involved in the study, with the potential to also optimize organ donation rates in Brazil[20].

Another example of technological development focused on the area of organ donation and transplantation is the nursing decision support system for brain death protocol

(*SADEnf-ME*). In the form of application for mobile device, the tool aims to facilitate the access of nurses to relevant and primordial information in the area of organ donation and transplantation, supporting the recognition of clinical signs of brain death, monitoring the diagnosis and maintenance of potential organ donors. The *SADEnf-ME* has shown potential to support the nurse's care practice and decision-making before and during the implementation of the BD protocol, and also to assist in the maintenance of the potential donor[21].

As well as the software to support the logistic decision in the process of organ procurement and transplantation, the authors' works[19-21] highlight the use of information and communication technologies (ICT) as support for professional activities in organ donation, procurement and transplantation. However, although acting on the same theme as previous studies[19-21], the focus of this research is directed to a very specific area, the logistic management by TCE, considering aspects such as the geographical location of services, installed capacity, available and competent human resources, means of transportation, time to be spent, among others. In this context, little explored so far, no researches with similar proposals were identified.

With the potential to organize, standardize and make available information related to the logistic stage of organ procurement and transplantation in the same tool, the software demonstrates ability to support the decision of the management of organ procurement, contemplating complex factors, as the definitions of transport. These characteristics corroborate the article on patient safety in the process of donation and transplantation and emphasize the need for standardization of processes to enhance safe and qualified decision-making in order to strengthen management interventions. Well-conducted and documented steps of the explant, packaging and transport of organs are related to greater safety in transplantation[22].

The software developed was designed to be functional, aiming at aesthetic simplicity with the amount of content required. In this way, the navigation happens through menus that organize the data in a standardized and intuitive way, not requiring previous training for its use. The intention is that any professional familiar with the logistic stage for organ procurement and transplantation can use the software without any operational or utilization restriction. Thus, it is expected to facilitate the professional performance in the logistic stages involved in the process of organ procurement and transplantation, reducing possible losses and generating reports capable of sustaining future management plans.

Usability consists of a set of attributes related to the effort required to use a system, determining whether the product meets the needs of users and is fit for use[23]. The evaluation of usability from the System Usability Scale generates a final score that can vary from 0 (unusable) to 100 (highly usable), and the mean of 68 points positively validates a software[15]. After the analysis and calculation of the score, the technological tools evaluated through the SUS generate a classification of the usability of the software, according to the score achieved, which may be: worse achievable (0 to 25 points); poor (26 to 39 points); acceptable (40 to 52 points); good (53 to 74 points); excellent (75 to 85 points) and best achievable (86 to 100 points)[24].

The evaluation of the software to support the logistic decision in the process of organ procurement and transplantation, by the users, through the application of the SUS questionnaire, obtained a mean score equal to 98.25, being its usability classification considered as positive or best achievable. A good result in the final product depends on a good evaluation in the essential points of indication of software quality contained in the SUS questionnaire. The usability scale covers a set of software aspects such as complexity, support need and interface. Systems with positive usability evaluations are related to ease of memorization, efficiency, ease of learning and minor inconsistencies. Usability is a fundamental aspect in the construction of information systems and websites, and the first

user experience is determinant for use and adherence to the system[25].

A factor that limited this research concerns the software test only in Santa Catarina. The use expansion, validation tests and usability evaluation of the software with a larger number of professionals are suggested.

The research has fully achieved the proposed objectives, and its results contribute to improvements in the process of organ procurement and transplantation, facilitating the role of the TCE nurse in logistic decisions, information management, optimizing the process, thus affecting positively activities in the area.

Conclusion

The creation of a software to support the logistic decision in the process of organ procurement and transplantation in the state of Santa Catarina reinforces the managerial practice of nurses, contributing to decision-making during logistics for organ procurement and distribution for transplantation. In addition to the development of the software, the study evaluated its usability, reaching a score of 98.25 by the System Usability Scale, which corresponds to the maximum level. The usability score shows that professionals consider the software appropriate, with accessible language, easy handling and understanding, functional, with well-integrated and objective information, potential of use in the practice of daily activities developed in the TCE-SC.

Due to the absence of similar proposals, the importance of conducting new research that presents the same focus of study and development is reinforced.

Collaborations:

1 – conception and planning of the project: Juliana Martins Costa, Betina Hörner Schlindwein Meirelles and Aline Lima Pestana Magalhães;

2 – analysis and interpretation of data: Juliana Martins Costa, Betina Hörner Schlindwein Meirelles and Aline Lima Pestana Magalhães;

3 – writing and/or critical review ítica: Juliana Martins Costa, Betina Hörner Schlindwein Meirelles and Aline Lima Pestana Magalhães;

4 – approval of the final version: Juliana Martins Costa, Betina Hörner Schlindwein Meirelles and Aline Lima Pestana Magalhães.

Competing interests

There are no competing interests.

References

1. Garcia CD, Pereira JD, Garcia VD, organizadores. Doação e transplante de órgãos e tecidos. São Paulo: Segmento Farma [Internet]. 2015 [cited 2019 Nov 7]. Available from: https://www.adote.org.br/assets/files/LivroDoacaOrgaosTecidos.pdf
2. Coelho GHF, Bonella AE. Doação de órgãos e tecidos humanos: a transplantação na Espanha e no Brasil. Rev Bioét. 2019;27(3):419-29. DOI: 10.1590/1983-80422019273325
3. O Globo. Sistema de Transplante desperdiçou quase mil órgãos em cinco anos [Internet]. Rio de Janeiro; 2016 [cited 2020 Feb 10]. Available from: https://oglobo.globo.com/brasil/sistema-de-transplante-desperdicou-quase-mil-orgaos-em-cinco-anos-19447655
4. Associação Brasileira de Transplantes de Órgãos. Dimensionamento dos transplantes no Brasil e em cada estado (2010-2017). RBT [Internet]. 2017 [cited 2023 Jul 10];23(4). Available from: https://bit.ly/2FWrocI
5. Almeida J, Araujo CAS, Roza BA, Siqueira MM, Rocha E. Análise de risco do processo de doação-transplante de órgãos no Brasil. Transplant Proc. 2021;53(2):607-11. DOI: 10.1016/j.transproceed.2021.01.018
6. Paganelli FP, Mantecchini LM, Peritore DP, Morabito VM, Rizzato LR, Costa AN. Network Model for Optimal Aircraft Location for Human Organ Transportation Activities. Transplant Proc. 2019;51(1):100-05. DOI: 10.1016/j.transproceed.2018.04.069
7. Koerich CL, Knihs NS, Magnus LM, Costa JM. O Enfermeiro no contexto da doação de órgãos e tecidos: da identificação do doador à distribuição dos órgãos e tecidos. Porto Alegre: Artmed Panamericana; 2018.

8. Oliveira PA, Oliveira TG. Logística no transplante renal no hospital das clínicas de Botucatu-SP. In: 7ª Jornada Científica e Tecnológica da FATEC de Botucatu. 2018. Botucatu, São Paulo. Anais JORNACITEC. 2018 [cited 2020 Nov 17]. Available from: http://www.jornacitec.fatecbt.edu.br/index.php/VIIJTC/VIIJTC/paper/view/1458

9. Siqueira MM, Araujo CA, Roza BA, Schirmer J. Indicadores de eficiência no processo de doação e transplante de órgãos: revisão sistemática da literatura. Rev Panam Salud Publica [Internet]. 2016 [cited 2019 Dec 10];40(2):90-97. Available from: https://www.scielosp.org/article/rpsp/2016.v40n2/90-97/

10. Lima JAF, coordenador. Projeto Pulsar Vida: doação de órgãos e transplantes no Brasil: diagnóstico e diretrizes públicas [Internet]. Goiânia: AmarBrasil [Internet]. 2015 [cited 2019 Nov 11]. Available from: http://www.pulsarvida.org.br/wp-content/uploads/2015/10/cadernoPulsarVida_FINAL_VIEW.pdf

11. Cabral AS, Knihs NS, Magalhães ALP, Alvarez AG, Catarina AA, Martins SR, et al. Cultura de segurança no processo de doação de órgãos: revisão de literatura. Acta Paul Enferm. 2018;31(6):667-73. DOI: 10.1590/1982- 0194201800091

12. Siqueira MM. Inovações em serviços de doação e transplante de órgãos: revisão sistemática da literatura. RAHIS. 2018; 15(4):51-69. DOI: 10.21450/rahis.v15i4.5281

13. Freitas Junior V, Ceci F, Woszezenki CR, Gonçalves AL. *Design Science Research Methodology* enquanto estratégia metodológica para a pesquisa tecnológica. Espacios [Internet]. 2017 [cited 2019 Nov 15];38(6):25. Available from: https://www.revistaespacios.com/a17v38n06/a17v38n06p25.pdf

14. Santa Catarina. Secretaria do Estado da Saúde. SC Transplantes - TCE/SC [Internet]. Florianópolis; 2018 [cited 2019 Nov 17]. Available from: http://www.saude.sc.gov.br/index.php/resultado-busca/geral/6177-sc-transplantes

15. Martins AI, Rosa AF, Queirós A, Silva A, Rocha NP. European Portuguese Validation of the System Usability Scale. Procedia Comput Sci. 2015;67:293-300. DOI 10.1016/j.procs.2015.09.273

16. Costa JM. Contribuições de um sistema para apoio à decisão logística no processo de captação e transplante de órgãos no Estado de Santa Catarina [dissertação]. [Internet]. Florianópolis (SC): Centro de Ciências da Saúde, Universidade Federal de Santa Catarina; 2021 [cited 2023 Jul 19]. Available from: https://repositorio.ufsc.br/handle/123456789/231030

17. Pereira RA, Markus GWS, Dias AK, Couto GBF. Sistema de informação para o apoio à sistematização da assistência de enfermagem. Rev Multidebates [Internet]. 2021 [cited 2021 Sep 22];5(2):239-49. Available from: http://revista.faculdadeitop.edu.br/index.php/revista/article/view/296/337

18. Queiroz PES, Schulz RS, Barbosa JDV. Importância da tecnologia no processo de enfermagem para o tratamento de feridas crônicas. Rev Enf Contemp. 2017;6(2):158-66. DOI: 10.17267/2317-3378rec.v6i2.1182

19. Ludwig EFSB. Desenvolvimento e aplicação de escala informatizada para busca ativa de potenciais doadores de órgãos [dissertação]. Ribeirão Preto (SP): Escola de Enfermagem de Ribeirão Preto, Universidade de São Paulo; 2016. DOI: 10.11606/D.22.2017.tde-26012017-170218

20. Daniel RS. E-doador: construção de um aplicativo móvel para otimizar a doação de órgãos [dissertação]. [Internet]. Rio de Janeiro (RJ): Centro de Ciências Biológicas e da Saúde, Universidade Federal do Estado do Rio de Janeiro; 2019 [cited 2021 Sep 23]. Available from: https://docs.bvsalud.org/biblioref/2019/12/1026562/daniel-ribeiro-soares-de-souza.pdf

21. Garcia MC. Sadenf-me: Sistema de apoio à decisão de enfermagem para protocolo de morte encefálica [dissertação]. [Internet]. Florianópolis (SC): Centro de Ciências da Saúde, Universidade Federal de Santa Catarina; 2019 [cited 2021 Sep 23]. Available from: https://repositorio.ufsc.br/bitstream/handle/123456789/214781/PGIS0016-D.pdf?sequence=-1&isAllowed=y

22. Magalhães ALP, Lanzoni GMM, Knihs NS, Silva EL, Erdmann AL. Segurança do paciente no processo de doação e transplante de órgãos e tecidos. Cogitare Enferm. 2017;22(2):e45621. DOI: 10.5380/ce.v22i2.45621

23. Kortum P, Oswald FL. The Impact of Personality on the Subjective Assessment of Usability. Int J Hum Comput Interact. 2018;34(2):177-86. DOI 10.1080/10447318.2017.1336317

24. Bangor A, Kortum PT, Miller JT. An Empirical Evaluation of the System Usability Scale. Int J Hum Comput Interact. 2008;24(6):574-94. DOI: 10.1080/10447310802205776

25. Cavalcanti HGO, Bushastky M, Barros MBSC, Melo CMCS, Delgado Filho AJF. Avaliação da usabilidade de um aplicativo móvel para detecção precoce do câncer pediátrico. Rev Gaúcha Enferm. 2021;42:e20190384. DOI: 10.1590/1983-1447.2021.20190384

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