Adoption of Information Systems in Breast Cancer Screening, by Radiology Technicians

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***Abstract*— Breast cancer screening is part of the National Program for Oncological Diseases (PNDO) of the General Directorate of Health (DGS) in the National Health Service (SNS). At the moment, this is carried out by several entities, which makes this service heterogeneous and decentralized of IT solutions and Health Information Systems (SIS) at the national level [33].**

The SIS aims to promote the quality and continuity of care provided, and as such, health organizations must follow the new standards of demand to respond to current challenges. They are the key to improving the effectiveness, efficiency and quality of healthcare.

The evaluation of IS by users allows for understanding and improving the system, and consequently supporting decision-making for improvement in the future. Radiology technicians play a key role in this program, they are responsible for performing mammograms and deal with IS on a daily basis.

In this sense, and given the relevance of the use of SIS, the present study analyzed the adoption of these tools by radiology technicians in breast cancer screening, using the DeLone & McLean SI assessment model.

The initial phase focused on a systematic review of the literature on the IS in Breast Cancer Screening. In the second phase, the questionnaire was used to understand and analyze the research questions, where the data obtained were subject to descriptive statistical analysis.

It was possible to verify that the "System Usage", "Individual/Organizational Impact" and the "Image Archive" were the aspects with the greatest satisfaction. "Inter-institutional information sharing", "Alert Devices/Mechanisms", "Intra-institutional sharing" and "Technical Support" were the least satisfactory.

Keywords— Information Systems, Breast Cancer Screening, DeLone & McLean IS Assessment Model, Radiology Technician.

I. Introduction

According to the SNS, the main objectives of IS in Health are to improve accessibility, efficiency, quality and continuity of care, and increase the satisfaction of professionals and citizens. [1]

With the evolution of healthcare systems, health organizations have invested a lot in technologies and IS. It is a fact that all IS investments must be "systematically" evaluated [17].

According to Lapão, health organizations need an "information and knowledge management model" aligned with a management strategy that aims to support their work processes, being essential to know the needs and expectations of customers [11] [34]. However, there are no systematic IS assessment processes and there is some "professional dissatisfaction" [34].

The IS assessment processes, based on the extent of acceptance of use by their users, improve the efficiency of the service provided, as well as make the service to the user more efficient [16] [17].

The evaluation of IS can be done based on multiple paradigms or visions, being crucial for the success of any IT profitability strategy [4].

In Breast Cancer Screening, it is the radiology technicians, users, who deal with the IS on a daily basis. The evaluation of acceptance and satisfaction by users of the SIS is of fundamental character, in order to contribute to its improvement.

This study aims to contribute with knowledge regarding the adoption and satisfaction of IS by radiology professionals, and to contribute to the identification of failures and, consequently, allowing the acquisition of corrective measures and strategies in work procedures, both in the provision of care to the patient, as well as in organizational and management processes.

A. Research Objectives

- Identify the IS used by radiology technicians in Breast Cancer Screening,
- Identify the level of IS satisfaction by radiology technicians, in the Breast Cancer Screening,
- Analyze how the quality of services, system quality and information quality of the IS are considered in the Breast Cancer Screening, by radiology technicians,
- Assess the individual and organizational impact of the IS, from the perspective of radiology technicians,
- Analyze how the use of IS is considered by radiology technicians.

II. Theoretical Framework

A. Breast cancer screening

In 1999, the Portuguese League Against Cancer (LPCC) created the National Breast Cancer Screening Program (PNRCM) with the integration of Regional Centers [6].

Subsequently, with the creation of the National Program for Oncological Diseases (PNDO) of the General Directorate of Health (DGS), organized population-based cancer screenings were once again integrated as one of the priorities, with one of the strategic objectives of the program being the expansion of the geographic coverage [7].

According to the LPCC [6], the Breast Cancer Screening Program consists of performing a mammogram in women with a traceable age between 50 and 69 (this age range varies according to the incidence rate for each region). It uses mobile units that move every 2 years to each municipality and is also made up of fixed units. Invitation letters are sent to clients to have a mammogram (voluntarily and free of charge). This radiological examination is read independently by two radiologists who, in the event of disagreement, are read for a

third time by a third radiologist. The patient is recalled for an assessment consultation, if doubts persist. In case of suspicion of malignancy, they are referred to hospital institutions (integrated in the Hospital Referral Network - RRH), where a final diagnosis is carried out, and where ~~if~~ an oncological situation is confirmed, proper follow-up procedures are carried out.

1) Breast cancer

According to the World Health Organization, in 2020 the most common type of cancer was breast cancer, and the second most frequent worldwide [36]. In Portugal, with a female population of 5 million, around 7,000 cases of breast cancer were diagnosed in 2020 and 1,800 women died from this disease [6].

Breast cancer can also occur in men, but it is extremely uncommon. In Portugal, about 1% of all breast cancers are in men [37].

For an early diagnosis, clinical examination and mammography are the most recommended means. [6]

2) TSDT- Radiology Technicians

According to Decree-Law n.º 111/2017 [8], Radiology Technicians are Senior Technicians of Diagnosis and Therapeutics (TSDT), in the area of radiology. They have specialized training at a higher level, providing health care within the scope of Diagnosis and Therapeutics by Image.

They are the professionals who support and perform the techniques in Breast Cancer Screening, namely, in carrying out screening exams (mammograms) and supporting exams in gauging consultations.

3) Mammography

It is a diagnostic test that studies breast tissue through ionizing radiation-

B. Information Systems

According to Laudon & Laudon [9], an information system is a "set of interrelated components that collect (or retrieve), process, store and distribute information designed to support decision making, coordination and control in an organization".

1) Health Information Systems (SIS)

In the 1990s, the SIS began to integrate information related to the provision of health care, to manage the resources used in the provision of care and support management decisions [10].

Lapão [11] refers to the importance of using IS in health units, so that information management is carried out in an optimized way, providing data that guarantees the improvement of the management processes of health units.

a) Hospital Information Systems (HIS)

It is an information system designed to manage all aspects of a hospital's functioning, such as medical, administrative, financial, legal and operational matters.

One of the main goals of the HIS is to serve as a central medical archive. In this way, allowing the records to be integrated and stored in a database, with information on the means of diagnosis and therapy, hospitalizations, consultations and other data specific to each patient. [38]

HIS also integrates internal and external communication between the team and healthcare providers. It integrates other systems, such as RIS and PACS.

b) Radiology Information Systems (RIS)

It is the system that allows the clinical or hospital team to maintain control over all exams performed on all patients, in an organized and standardized way. It is a solution created so that information is always available [12].

c) Picture, Archive and Communications System (PACS)

It is a diagnostic image communication and file system, which allows storing images and facilitating communication in the imaging service [13].

DICOM, Digital Imaging and Communications in Medicine, is a universal standard for digital medical imaging.

d) HIS, RIS and PACS integration

An integration and articulation of the HIS, RIS and PACS Information Systems is essential to ensure the success of these systems. For the implementation of the PACS system, the proper integration must coexist.

The functionality of this integration allows a correct diagnosis of the image. A clinician needs to have an integrated view of all patient information, that is, he consults images through the PACS that are associated with data stored by the RIS regarding patients identified by the HIS. Some companies in the SIS area have created HIS/RIS/PACS interoperability solutions. The company Glintt has designed resources for the integration of RIS with HIS [39]. The BYME company also presents resources within the scope of Interoperability with the IS ecosystems of a given entity [45].

e) SIRCM-SI of Breast Cancer Screening

It was developed and managed by the LPCC, which provides information regarding the monitoring of breast cancer screening to ARSs. It consists of managing a database of users eligible to participate in the aforementioned program and recording information regarding their participation, from the status of participation to the characterization and results of the radiological examinations performed.

This application is used in the breast cancer screening program in all Health Regions of the Continent, except for the Algarve [43].

There is a collaboration protocol between the LPCC and the Organized Screening for Breast Cancer in the Azores (ROCMA), for the use of the SIRCM, for the purposes of operational, organizational support, monitoring and evaluation of the program in the ROCMA [44].

f) SiiMA Screenings

SiiMA is an IS for the management of Population Screening Programs that allows the implementation of the functional screening circuit, from the invitation for the exam to the treatment and follow-up. This platform features modules for various cancer screenings. The processes provided by the system follow the guidelines described in the European lines for the implementation of Screening Programs [14].

Although SiiMA Rastreios supports the entire screening circuit, there is no breast cancer screening entity that has this system in its entirety. However, this system is used in a complete way in the Screening of Cervical Cancer, Cervical Cancer, Diabetic Retinopathy and Children's Visual Health.

This system only has partial participation in the LPCC of the North Region, where it maintains the flow of information between the ARS North and the LPCC of the North region.

g) Synapse

SI created by Fujifilm that consists of a medical informatics platform for the management of diagnostic images, advanced visualization, workflow in the imaging service and shared informatics architecture. It allows real-time information management as well as diagnostic and clinical workflow [40]. Synapse Clinical Workflow Manager (CWM) allows the healthcare entity to manage the entire workflow related to the imaging service. It can work as a standalone solution, but it also allows for easy integration with PACS.

h) Medicine One®

It is an integrated clinical management solution, focused on the user and designed to respond to the different needs of national Health Units. It manages all the clinical and administrative information of users, in order to promote good collaboration between professionals through integrated work workflows, improving processes and supporting clinical practice. [45].

In the Azores Region, the entire network of primary care units and the COA are managed by Medicine One.

C. Assessment of Information Systems

The evaluation of IS has several dimensions and can be based on multiple paradigms or visions. However, it is decisive for the success of any strategy to monetize information technologies [15].

This assessment is characterized by referring to qualitative or quantitative aspects, or approaches focused on more subjective aspects, such as user satisfaction and acceptance or changes in organizational cultures. It can be said that there are three dimensions that can be decisive in IS evaluation: users, technical operability (hardware/software) and strategic potential [16].

The evaluation processes of the IS, based on the dimension of acceptance and satisfaction of use by its users, improve the efficiency of the service provided, make the service to the user more efficient, and consequently allow the provision of quality health services [17].

1) The DeLone & McLean IS Assessment Model

The DeLone & McLean model is one of the most used frameworks to assess the effectiveness of IS. This approach was developed to provide project teams with a means to measure IS performance and find success factors [18].

The authors presented an interactive model with six integrated measures of IS success. Later, they updated the model based on a literature review, where they sought to validate, challenge or propose improvements [19]. The following dimensions are identified: "System Quality", "Information Quality", "Service Quality", "System Use" ("Intent to Use", "Use") and "Net Benefits" ("Individual Impacts" and "Organizational Impacts"). Fig.1 illustrates the dimensions of the SI assessment and their relationships through arrows [1].

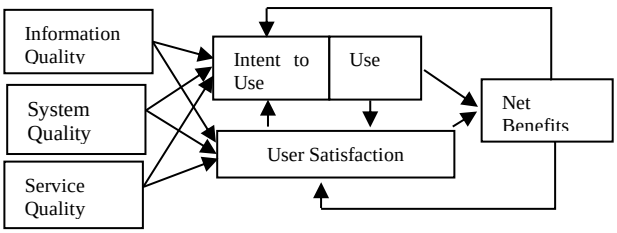


Fig. 1– Scheme adapted from the DeLone & McLean IS Assessment Model

"Information Quality" concerns the output characteristics of information systems and factors related to the content delivered to users [19]. The "System Quality" dimension can be measured using elements such as ease of use, responsiveness, flexibility and functionality, training opportunities and technical assistance [19]. The "Quality of Services" appears to add the essentially technical support provided to IS users, whether in the resolution of hardware or software problems [18].

The "Intention to Use" is more linked to the users' attitude towards the IS, while the "Use" refers to the degree and the way in which the users use all the IS capabilities [19]. According to VENKATESH [46] a strong relationship between "intention to use" and "use" was evidenced and that, to measure the use of the system, the frequency of use and the duration are not the most appropriate measures, but rather , the effects of "System Usage".

The "User Satisfaction" dimension shows the extent to which needs and expectations have been met.

The "Net Benefits" dimension results from the merger of the "Individual Impact" and "Organizational Impact" dimensions. The individual impact is related to how systems affect the quality of the work environment, decision making, work performance, work quality and work effectiveness. Organizational impact shows the extent to which the IS is contributing to the success and performance of the organization.

It is important to emphasize that the DeLone and McLean guides were successfully used in previous studies to examine the impact of IS in the health area, as is the case of the study by Campos [41], on the assessment of IS.

III. RESEARCH METHODS

A. Systematic Review of Literature

The three phases necessary to carry out an RSL are to plan, carry out and report [42], through the PRISMA guidelines [3] it is intended to investigate the existing conditions and characteristics of the IS in the Breast Cancer Screening in Portugal, as well as to investigate whether there is evaluation of these IS. Then, and through the methodology of investigation by inquiry, the instrument will be carried out where several variables to be studied will be selected.

1) Introduction

The subject of the present investigation arises in the convergence of academic and professional factors. From an academic point of view, the topic is based on a particular interest in the IS area. From a professional point of view, and as a radiology technician, the interest is due to the employment relationship at the Breast Cancer Screening Center in Madeira. As a user of an IS, I recognize the potential it brings in improving services, however with some difficulties and gaps that are part of everyday life.

SIS have been implemented in order to improve the quality of procedures and the clinical and management process [1]. The concern with the quality of services by health organizations is a reality. It is essential to assess the adoption of IS to understand whether they enhance the quality and performance of health professionals.

a) Research Questions

Q1: Are the ISs in breast cancer screening effective?
Q2: What are the characteristics of the IS in the Breast Cancer Screening?
Q3: What ISs are used in Breast Cancer Screening?
Q4: How is the IS assessed in the Breast Cancer Screening?

Q5: What is the satisfaction of the IS in the Breast Cancer Screening, by radiology technicians?

2) Methods

In order to collect as many studies as possible that can provide answers to research questions, a review protocol was created.

a) Protocol

An investigation was carried out in March 2021, in several databases using the following investigation expression: "information system*" AND "breast cancer screening"

b) Sources of information

Then, the research expression was applied to the summary of articles stored in several digital libraries, as shown in Table I:

TABLE I. INFORMATION SOURCES AND RESPECTIVE WEBSITES

Information sources	Website
Biblioteca B-on	https://www.b-on.pt/
PubMed	https://pubmed.ncbi.nlm.nih.gov/
ACM Digital Library	http://portal.acm.org/
AIS eLibrary	https://aisel.aisnet.org/
Host EBSCO	http://eds.b.ebscohost.com/
IEEE Xplore	http://ieeexplore.ieee.org/
ISI Web of Science	http://www.isiknowledge.com
Science @ Direct	http://www.sciencedirect.com
Scopus	http://www.scopus.com

There was contact with certain authors to have access to complete articles, and the acquisition of official documents from several institutions: LPCC North region, LPCC Center region, LPCC South region, ARS Algarve, Organized Screening for Breast Cancer in the Azores (ROCMA) and the Breast Cancer Screening Center of Madeira.

The date of the last Investigation was March 30, 2021. Then, the articles were selected based on the inclusion and exclusion criteria, as shown in the following Table II:

TABLE II. INCLUSION AND EXCLUSION CRITERIA

Inclusion	Exclusion
Scientific articles, conference articles and books	Duplicate titles
Studies in the area of information systems and breast cancer screening	Studies that do not link information systems and breast cancer screening
Articles in Portuguese, English, French and Spanish	Documents not available or incomplete

Thus, the first set of candidate documents was obtained, from which the summaries were read in order to determine their relevance for this work. Then, the documents were selected based on the reading of the full text, in order to obtain the final selection of studies to be reviewed.

3) Results

a) Selection of studies

The investigation expression was applied to the databases defined in the review protocol, and the documents to be selected were found. After applying the inclusion and exclusion criteria to the summary of each document, 33 documents were obtained, which were read in their entirety. Of these, 16 final studies were selected. (Fig. 2).

All official documents obtained by the entities (7 documents) presented the expression of investigation, as well as the inclusion criteria. These were read in their entirety and all were relevant to this study.

Considering that the number of valid RSL articles was very low (9 articles), the snowball strategy was performed, but no additional articles were identified.

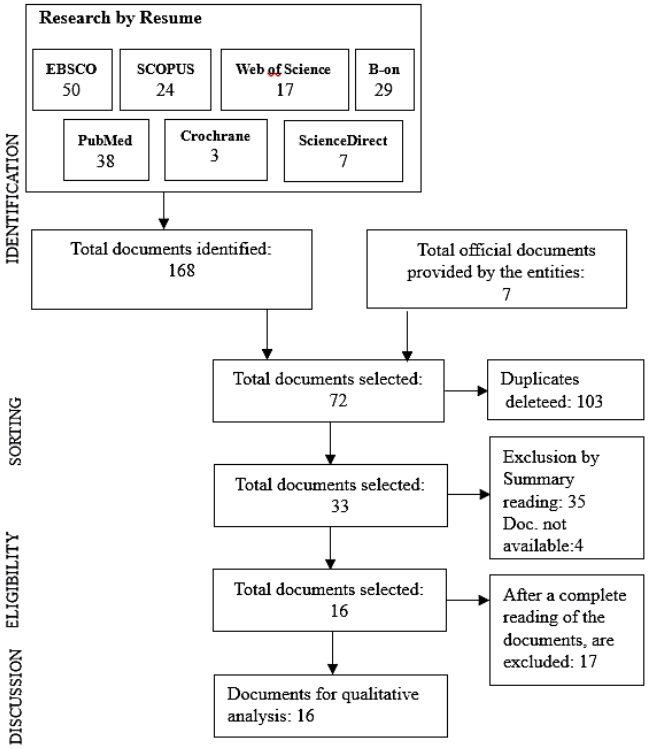
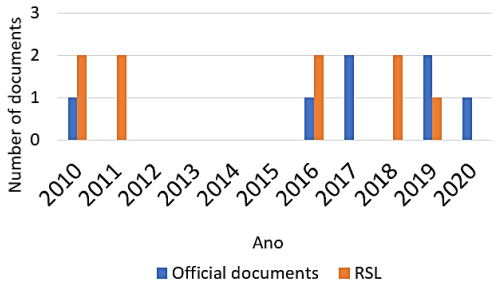


Fig.2- Information flow in the document selection process

b) Characteristics of the studies

All selected RSL documents are newspaper articles. Most of the selected studies are from Science Direct (4) and Web of Science (4), PubMed presents only 1 result. These documents were also found in the Ebsco database. In Graphic 1 it is possible to observe the distribution of documents according to the year of publication.



Graph. 1- Number of documents with respective sources, resulting from RSL

4) Discussion

a) Summary of evidence:

BREAST CACER SCREENING IN PORTUGAL

According to the proposal of the National Program for Oncological Diseases of the DGS, population-based cancer screening carried out in the SNS must comply with technical criteria, uniform at national level, namely in terms of recruitment and selection methods [32]. With registration in a computer application dedicated to the program, of national scope, on the invitations, exclusions, adhesions, results of the primary tests, subsequent referral of the user and times in which the interventions were carried out.

It is incumbent upon the Shared Services of the Ministry of Health, E.P.E., to make the necessary adaptations to the computer applications that make this registration possible, which must allow the reporting of statistical data for the management of the program, as well as articulating with the National Cancer Registry. The DGS, together with the Regional Health Administrations, should produce an annual report on the evaluation and monitoring of population-based cancer screening [32].

In 2017, the standardization of a single national computer solution began, to overcome difficulties in recruiting users and monitoring the screening program [28]. This work has been developed through the joint work of ACSS, ARS and SPMS. The integration of this multitrack platform with RON will be the final step to complete the monitoring of the data along the entire track circuit. In the Azores, the own platforms were maintained which, already developed, correspond to the essential requirements [27].

Another difficulty encountered is the outdated list of users, which causes insufficiencies in the calls, with a negative impact on the participation rate [28].

In Portugal, it is recognized that there is a heterogeneity at the technical level of screening programs at regional level. Despite efforts to harmonize data collection, it is necessary to invest in IS that allow the collection of data to be aggregated in national terms, with well-defined indicators and identical criteria for all regions, promoting improved monitoring and periodic evaluation of these screenings, namely breast cancer screening [27].

Over the years, breast cancer screening in Portugal has evolved significantly, with an expansion of geographic coverage, an increase in the number of users screened and an improvement in adherence rates [33]. By 2021, 100% geographic coverage for breast cancer screening is achieved [6][28].

Any screening program is dependent on a sequence of interventions that range from the identification of the target population to therapy, through the processes of summoning the defined population or diagnosis. The effectiveness of such a program depends on all the links in this chain. Organized screening programs, with all elements of that chain properly instituted, proved to be more effective than opportunistic screenings (unorganized and unmonitored) [33].

In the Autonomous Region of the Azores (RAA), the entity responsible for implementing, carrying out and monitoring population-based cancer screening is the Azores Oncology Center (COA). The monitoring of the program is carried out through the SIRCM application, in partnership with the LPCC [33].

In the Autonomous Region of Madeira (RAM), the entity responsible for carrying it out is SESARAM E.P.E. (Health Service of the Autonomous Region of Madeira), units under the Regional Health Department that ensure the provision of health throughout the autonomous region. Screening is performed through the Breast Cancer Screening Center. Women who are registered in the Health Centers of RAM are invited, according to their residence [33] [30].

In the Northern Regional Health Administration (ARSN), the entity performing breast cancer screening is LPCC. The monitoring and evaluation of the program is carried out in the LPCC's own system, returning the results obtained to the ARS. These are integrated into the multi-screening platform (SiiMA Rastreios) that supports all population-based screening programs at ARS Norte and it is from these that family doctors access the results of women enrolled in their lists of users who have been screened [31].

In the Regional Health Administration of the Center (ARSC), the entity responsible for screening for breast cancer is LPCC. The monitoring and evaluation of the program is done through the SIRCM which monitors all LPCC screening activities [33].

In the Regional Health Administration of Lisbon and Tagus Valley (ARSLVT), the entity performing breast cancer screening is LPCC. The monitoring and evaluation of the program is carried out by the SIRCM, which monitors all LPCC screening activities, assigned to ARSLVT [29].

In the Alentejo Regional Health Administration (ARS-Alentejo), the entity responsible for breast cancer screening is LPCC. The monitoring and evaluation of the program is carried out in partnership with the LPCC [33].

At the Regional Health Administration of the Algarve (ARS-Algarve), the Breast Cancer Screening Program in the Algarve is promoted by ARSA, and results from a partnership protocol between the Regional Health Administration of the Algarve I.P., the Oncological Association of the Algarve (AOA) and the Centro Hospitalar do Algarve. The increase in human resources at the Coordinating Nucleus (in the area of information technology) led to the creation of a base software for this program, which is already implemented [29].

In breast cancer screening, there is still no entity that has a specific SI in its entirety. However, ARS LVTA is yet to start screening with the *SiiMa Rastreios* Platform [33], and RAM is in the negotiation phase for its acquisition [14].

Interoperability in Breast Cancer Screening

The Shared Services of the Ministry of Health (SPMS) are developing interoperability work on the IS of screenings in partnership with the IT services of the 5 ARS and with the coordination of the PNDO. Essential aspects are being resolved [33]:

1. Integration with the National User Registry (RNU), as the guarantee of elimination of deaths and correction of addresses, minimizing the number of returned letters;
2. Integration with the base SI (SClinico)
3. Automatic availability of screening results also in SClinico.

Also within the scope of the IS, the process was initiated for the centralization and unification of the tracking computer solutions, in order to reduce constraints in the articulation of the various IT platforms, making them more user-friendly.

In order to achieve the objectives, procedural work is required that involves the entire hierarchical chain, namely the human, financial and logistical resources that allow resources to be allocated to these programs in a sustainable and transparent manner. Currently, it should be noted that existing SIS such as HIS, RIS and PACS do not allow efficient management of medical information due to their complexity and heterogeneity [26].

The existence of an IS that supports all screening activity is essential, as well as interoperability with the IS of primary health care and hospital care (SClinico). Since the National Cancer Registry has already been created, the conditions are created for the development of interfaces by the SPMS [33], in order to allow the assessment of the impact of screening in terms of incidence, survival and mortality.

IS in the Screening of Breast Cancer in the Republic of Servia

In the Republic of Serbia, the organized breast screening program has been carried out since 2012 and the SI includes: organization of information and education, identification of

the target population, scheduling of examinations, carrying out screening, organizing mammogram readings, archiving mammograms, referral of patients for additional diagnostic tests, referral of patients for treatment, storage of records, data collection and reporting of results [20].

A medical IS module, MEDIS.NET, was implemented for the creation of a screening list, which allows the analysis of risk factors that affect the occurrence of breast cancer and the signaling of women at high risk. After analyzing the risk factors and determining the degree of high risk, data collected when the user consults with her family doctor in primary health care, the next two steps are the invitation to the examination and the examination [20]. The system is actively used in 23 healthcare institutions in the Republic of Serbia.

IS IN BREAST CANCER SCREENING IN THE CZECH REPUBLIC REPUBLIC

According to Majek [21], in order to obtain the projected benefits and minimize the negative outcomes, the breast cancer screening program in the Czech Republic must be implemented with an organized, population-based approach, with quality assurance at all appropriate levels, and in accordance with the European Guidelines for Quality Assurance in the Screening and Diagnosis of Breast Cancer. The policy of a screening effort must be documented in official law or regulation to qualify as a screening program. Six characteristics of an organized screening program are stated: a policy that specifies the target population, screening method and interval; a team responsible for supervising the screening centers; a decision and responsibility structure for health management; a quality assurance system using relevant data; and monitoring the occurrence of cancer in the target population.

Annually, screening program data is consolidated from local databases at screening centers and subsequently stored in a secure central database. Official results that describe the performance tracking and monitoring process are published annually. Feedback to screening centers is provided through annual reports with performance indicators.

IS IN THE SCREENING OF BREAST CANCER IN BRAZIL

According to Passman [22], before the implementation of the specific IS for breast cancer screening in Brazil, the SISMAMA, a training plan was made for users and strategies for acceptance of professionals, in the imaging and laboratory services. SISMAMA has two modules: a module for service providers, which is used in imaging services and laboratories, to record the diagnostic tests performed; and a second module for program coordinators and managers.

For mammograms, SISMAMA generates a standardized report, which includes a BI-RADS (Breast Imaging-Reporting and Data System) category. The management module allows the supervision of actions, monitoring of users with a "positive" result and the organization of a care network that promotes a sequence of referrals.

SISMAMA can generate management reports, such as quality control reports on mammography services and on breast biopsies provided by public and private facilities. Health managers can consult the clinical indications and quantity of mammograms and biopsies performed, assess the technical quality of services and the content of radiology and pathology reports, as well as measure waiting times [22].

Health professionals and health managers can ask their questions with the system team, by email. There is a biannual training offered to employees. The system includes downloadable technical and management manuals and web-based discussion forums for technical support to users, healthcare professionals and administrators [22].

IS IN THE SCREENING OF BREAST CANCER IN OTHER COUTRIES

The organized breast cancer screening program in Denmark, Italy, Spain and Sweden has policies specifying age groups, screening intervals and detection methods, as well as quality assurance systems [21].

Participation rates in successful organized programs approach the European Guidelines target of 70% (such as Spain, UK, Denmark), or even exceed them, as is the case in Finland.

However, the call may also not achieve the stated objective, as is the case with the decentralized call in Hungary and the no-nomination call in Luxembourg. Therefore, it is necessary to plan, implement and monitor the invitation process [21]. In Spain, the fact that screening programs operate in a network has generated a high degree of consensus on methodology and IS, which in turn allows joint assessment and comparison of results [23]. In England [24] and Morocco [25], the IS has been improved in order to rigorously standardize practice and improve performance.

It is advisable to promote the highest possible level of organization, with strict monitoring of performance indicators [21].

b) Limitations

In terms of RSL, it is evident that there is a large gap, with regard to the little information available on the IS in breast cancer screening in Portugal, as well as the lack of studies on evaluations of the IS in breast cancer screening.

Due to this situation, it was necessary to seek official information from the competent authorities.

Studies were identified by searching electronic databases. Some articles resulting from the RSL were not available

c) Conclusions

The SNS is served by multiple IS that, independently, ensure data collection, monitoring, interaction and organization of access to health care in different specific areas [27], however, it appears that in breast cancer screening, there is heterogeneity and decentralization of IT solutions and IS [33].

Failures in the efficiency of the system are identified, namely in the integration with RNU, in the integration with the basic information systems (SClinico) and in the automatic availability of the tracking results also in SClinico.

There is a need to implement an integrated population screening management platform, at the national level, for operational support and, consequently, to standardize screening circuits and the technological platform for all ARS [33].

In this investigation, no information was found on the assessment of IS in breast cancer screening. It can be concluded that the lack of evaluation of information systems in breast cancer screening by radiology technicians (users) is a very relevant research problem in the area of information systems. The success of IS in health is dependent on the level of acceptance and satisfaction on the part of the professionals who use them.

In Portugal, in breast cancer screening, there is no entity that has a completely appropriate IS, which makes the circuit from start to finish. However, in some entities, the appropriate and specific IS acquisition process is being completed for this organized screening.

B. *Investigation Methodology by Survey*

This phase consisted in the elaboration of a questionnaire adapted from the DeLone and McLean model, in order to achieve the objectives of this investigation, and in order to overcome the gaps and limitations identified in the SLR.

1) Design of the Survey

To carry out this methodology, a set of steps [5] were followed, as shown in Fig. 3

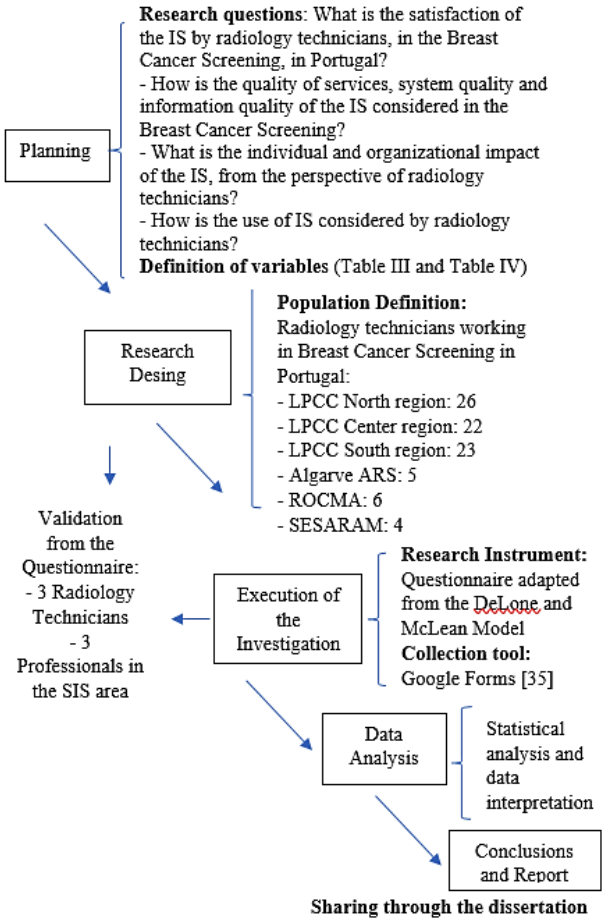


Fig.3 - Phases of the survey research methodology

The period considered for data collection was from November 2021 to March 2022. The questionnaire was sent to the person in charge/coordinator of each entity where breast cancer screening is carried out, being responsible for sending the questionnaires by email to the radiology technicians. The population corresponded to all radiology technicians (86) who work in breast cancer screening in Portugal (Fig. 3).

The data obtained were later compiled into a database for their treatment and descriptive statistical analysis.

The 22 questions/statements about IS satisfaction were organized into six dimensions adapted from the DeLone and McLean model. The answers were operationalized around a 5-point Likert scale. The last section of the survey corresponded to the "Suggestions" for improving the IS in use

In Table III we present the sociodemographic and complementary variables, and in Table IV the variables on the dimensions under study.

The period considered for data collection was from November 2021 to March 2022. The questionnaire was sent to the person in charge/coordinator of each entity where breast cancer screening is carried out, being responsible for sending the questionnaires by email to the radiology technicians.

The data obtained were later compiled into a database for their treatment and descriptive statistical analysis.

TABLE III. SOCIODEMOGRAPHIC AND COMPLEMENT VARIABLES

Sex
age group
Academic qualifications
Professional category
Place where you work
Professional practice time
Time of experience with the IS
Training in IS implementation
Sufficient/insufficient training
Continuous training of IS

TABLE IV. VARIABLES OF THE DIMENSIONS UNDER STUDY

Dimensions	**Variable**
Information Quality	Devices / Alert Mechanisms
System Quality	- Interface - Information Security and Protection - Processing Speed - Ease of Use - Equipment/Quantity of Hardware - Image Archive
Quality of Services	- Training - Technical support
System Usage (Use/Use Intent)	
Net Benefits	- Individual/Organizational Impact - Intrainstitutional information Sharing - Interinstitutional Information Sharing
User Satisfaction	

IV. PRESENTATION AND DISCUSSION OF SURVEY RESULTS

A. *Sample characterization*

The intention of the present study was to survey all radiology technicians who work in breast cancer screening at national level. This objective was not achieved since the LPCC North Region and the LPCC Region Centro did not authorize the carrying out of the surveys, "for reasons arising from the reorganization of services by COVID-19". The participation of four entities was authorized: LPCC from the Southern Region, the Algarve Region, Azores and Madeira. Taking into account the participation of these entities, with a total of 24 professionals, the sample under study represents 27.9% of the population.

The study had the participation, mostly of female individuals (95.8%), aged between 20 and 59 years, with the age group of 30 - 39 years being the most representative, with 50% of the sample. In terms of educational qualifications, it was found that 95.8% of the respondents had a degree. With regard to the professional category, the highest percentage of respondents, 95.7%, were at the base of their careers. The sample represented mostly respondents from the LPCC of the Southern Region (Lisbon, Vale do Tejo and Alentejo) with 50% of the sample, the Algarve region with 21%, the Region of Madeira with 17% and the Region of Azores with 12%. Regarding the length of time that radiology technicians have worked in the service, most of the sample reported "between 10 and 15 years" (29.2%) and "between 1 and 3 years" (25%). The vast majority (79.2%) had experience in the use of IS "over 24 months". In terms of the IS used, as far as we were able to determine through the RSL, in Portugal there is not a single IS implemented for breast cancer screening, which runs the screening circuit from start to finish. This fact was confirmed by the respondents' answers, where they identified several IS used. The data were confirmed and completed through the entities concerned. (Table V).

TABLE V. IS USED IN THE REGIONS OF THE ENTITIES UNDER STUDY

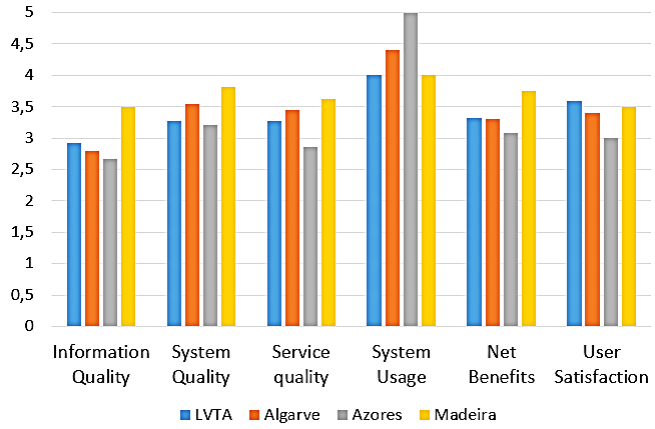
Region	Pop.	Sample	IS used
Region of Lisbon, Vale do Tejo and Alentejo	23	12	RIS, PACS, SIRCM
Algarve region	5	5	RIS, PACS, Synapse
Autonomous Region of the Azores	6	3	PACS, SIRCM, ByMe solution that is interconnected with Medicine One.
Autonomous Region of Madeira	4	4	RIS, PACS, Glintt Solution (makes RIS-HIS link)

Regarding training in the implementation of the IS in use, less than half of the sample (45.8%) had previous training, with 37.5% of these technicians reporting that training was sufficient. 62% of the total sample mentioned that they do not undergo continuous IS training.

B. *User Satisfaction taking into account the Dimensions Studied*

Descriptive analysis calculations were performed ignoring nulls (744 responses, only 8 are blank, 1%).

It is possible to mention that in terms of the dimensions of this sample, the highest average of satisfaction was "System Usage", followed by "User Satisfaction" and "System Quality". The dimension with the lowest satisfaction was "Information Quality" and "Net Benefits" (Graph 2)

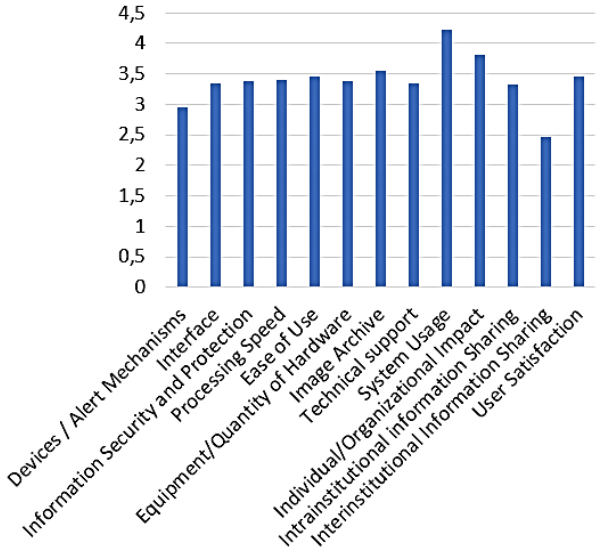


Graph. 2 - Average satisfaction of each dimension under study in the Breast Cancer Screening

Graphic 3 shows the variables analyzed in this study, and it is possible to verify that "System Usage", "Individual/Organizational Impact" and "Image File" were the variables with the greatest satisfaction. The "Inter-institutional Information Sharing", "Devices/Alert Mechanisms", "Intra-institutional Information Sharing" and "Technical Support" were the least satisfactory.

Analyzing the variables studied for each region, It can be said that in the LVTA region, "System Usage", "Individual/Organizational Impact" and "User Satisfaction" were the most satisfactory variables. As less satisfactory were the "Alert Devices/Mechanisms"; "Intra-institutional Information Sharing" which the same value as "Inter-institutional Information Sharing" and "Speed"; and finally the "Image file".

In the Algarve region, the following variables were the most satisfactory: "Equipment/ Quantity of Hardware" with equal value to "System Usage"; "Image file"; and "Speed" with equal value to "Individual/Organizational Impact". The



Graph 3- Average satisfaction of each variable under study in the Breast Cancer Screening

least satisfactory variables were: "Inter-institutional information Sharing", "Devices/Alert Mechanisms" and and "Intra-institutional information Sharing".

In the Azores, "System Usage", "Individual/Organizational Impact", "Intra-institutional Information Sharing" with the same value as "Image file" and "Speed", are the most satisfactory variables. As less satisfactory were "Inter-institutional Information Sharing", "Equipment/ Quantity of Hardware" with the same value as "Alert Devices/Mechanisms" and "Facility".

Finally, in Madeira, the most satisfactory variables were: "Individual/Organizational Impact" with the same value as "Ease", "Intra-institutional Information Sharing" and "System Usage". The variables "Inter-institutional Information Sharing", "Equipment", and "Devices/Alert Mechanisms" with equal value to "Speed", proved to be the least satisfactory.

C. *Suggestions given by Radiology Technicians*

It is possible to verify that there are indeed failures in sharing and updating information in breast cancer screening, namely in the updating of the list of users (for example in the elimination of users who have already had breast cancer or users who have died), the aspects mentioned by all entities; or sending the mammography report to the family doctor referred by users in the Azores and Madeira. The LVTA region, the Azores and Madeira also indicated that the updating of users' addresses should be improved.

Users in the LVTA region, Algarve, Azores and Madeira suggested the possibility of sending the mammography report by e-mail and not by letter. Users in the LVTA region and Madeira would also like the user to have the possibility to book their mammogram online. Users in the Azores also suggest that users receive an SMS the day before the exam to remind them of the mammogram appointment.

V. CONCLUSION

A. *Main Contributions*

With this work, it can be concluded that there is currently a need to improve SI in breast cancer screening. It was also possible to verify that there are no studies on the evaluation of IS in this area, in Portugal.

There is no entity that fully possesses an adequate and suitable health information system for breast cancer screening, from its beginnings with screening to follow-up/follow-up. However, each entity uses several SIS that interact with each other in order to operationalize and achieve the intended objective, in this case tracking the population.

In fact, the SIS revolutionized the health service and improved the service provided to the user [1], which can be seen with the high satisfaction in the "System Usage" and "Individual/Organizational Impact" variables.

However, and through this study, it is possible to conclude that in fact there are aspects that need to be improved in Breast Cancer Screening, such as "Inter-institutional Information Sharing" and "Alert Devices/Mechanisms". In addition to these variables, in the LVTA region, there are aspects to take into account, namely "Speed" and "Image file". In the Algarve region, the least satisfactory variables were the ones mentioned above, "Inter-Institutional Information Sharing", "Alert Devices/Mechanisms" and "Intra-institutional Information Sharing". In the Azores Region, users are, in general, the least satisfied, which also deserve attention in the "Equipment/ Quantity of Hardware" and "Ease" of using the IS. Finally, the Madeira region presented, in a global way, the best user satisfaction, however, some areas are highlighted as being unsatisfactory such as "Equipment/Quantity of Hardware" and "Speed".

It is important to mention that of the entire sample under study, less than half received training in the implementation of the IS and more than half of the sample stated that they did not have continuous training.

Through the "Suggestions" given by the radiology technicians, it can be seen that in fact there is a heterogeneity of IT solutions and IS. Failures are identified in the integration with RNU, in the integration with the base IS (SClinico) and in the automatic availability of the tracking results also in SClinico.

More than ten years ago, Lapão already mentioned that the lack of interoperability between the IS of the health units constituted an obstacle to the sharing of information [39], and today it continues to be one of the areas deserving attention.

This study is interesting, as it allows the detection of gaps that could be improved when implementing a specific IS for breast cancer screening. As well as helping ICT managers to adopt corrective strategies that enhance the acceptance and satisfaction of IS.

B. Limitations

One of the objectives of this study was the participation of radiology technicians who perform breast cancer screening at the national level. Unfortunately, this objective did not materialize, and there was great difficulty in finding a sufficient number of participants.

When analyzing the sample, a diversity of existing SIS was found, which differed from entity to entity. This implied an approach to results by the entity and not by IS itself.

Due to the size of the sample, it was not possible to perform statistical correlations of the data.

In order to carry out the field study, it was necessary to request authorization from the people in charge of all the entities involved in this study. This process took a long time, and the fact that the covid-19 pandemic also took place delayed data collection.

C. Future Research

In terms of future investigations, it is considered viable to develop a study, expanding the field of investigation to all breast cancer screening institutions, in order to obtain a larger sample than this study, and thus be possible to apply an inferential statistical analysis.

It is expected that user satisfaction will increase after the implementation of a specific information system for breast cancer screening. It would be interesting, after its implementation, to carry out a study on user satisfaction with the participation of all entities and make comparisons.

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