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Impact of Digital Transformation on Healthcare Organisations in Portugal

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The only limit to our realization of tomorrow will be our doubts of today

Franklin Roosevelt

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Resumo

A transformação digital tornou-se uma prioridade estratégica inadiável nos sistemas de saúde contemporâneos, impulsionando mudanças profundas na forma como os cuidados são prestados, geridos e experienciados tanto por profissionais como por utentes. No entanto, a transição para ecossistemas de saúde digitais enfrenta desafios complexos, onde a adoção tecnológica bem-sucedida não depende apenas da infraestrutura, mas criticamente de fatores humanos e organizacionais. Esta investigação propõe e valida um modelo conceptual inovador que integra quatro construtos fundamentais: literacia digital, maturidade digital, inclusão digital e satisfação dos utentes. Através de uma abordagem metodológica mista e sequencial, que incluiu uma revisão sistemática da literatura, a realização de um grupo focal com profissionais de saúde de forma a refinar um modelo e um inquérito aplicado a uma amostra de 212 participantes, o modelo foi testado recorrendo a modelos de equações estruturais (SEM). Os resultados revelam relações estatisticamente significativas entre todos os construtos do modelo. Demonstrou-se que a literacia digital exerce uma influência direta e positiva na inclusão digital e na maturidade digital das organizações. Verificou-se ainda que a maturidade digital funciona como um preditor determinante e significativo da satisfação dos utentes. Embora a literacia e a inclusão digital não tenham demonstrado efeitos diretos significativos na satisfação, os resultados validam um importante efeito indireto mediado pela maturidade digital, que surge como o motor central da perceção de qualidade e eficiência. Esta investigação oferece uma compreensão integrada da transformação digital, fornecendo insights cruciais para gestores e decisores políticos na promoção de sistemas de saúde mais equitativos, resilientes e efetivamente centrados no utilizador.

Palavras-Chave: Literacia Digital, Maturidade Digital, Inclusão Digital, Satisfação, Transformação Digital, Saúde, Serviços de Saúde, Modelo Teórico.

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Abstract

Digital transformation has become an urgent strategic priority within contemporary healthcare systems, driving profound changes in how care is delivered, managed, and experienced by both professionals and service users. However, the transition towards digital health ecosystems faces complex challenges, where successful technological adoption depends not only on infrastructure but critically on human and organisational factors. This research proposes and validates an innovative conceptual model that integrates four fundamental constructs: digital literacy, digital maturity, digital inclusion, and user satisfaction. Through a sequential mixed-methods approach which included a systematic literature review, a focus group with healthcare professionals to refine the model, and a survey administered to a sample of 212 participants the model was tested using structural equation modelling (SEM). The results reveal statistically significant relationships among all the model's constructs. It was demonstrated that digital literacy exerts a direct and positive influence on both digital inclusion and organisational digital maturity. Furthermore, it was found that digital maturity acts as a decisive and significant predictor of user satisfaction. Although digital literacy and inclusion did not show significant direct effects on satisfaction, the results validate a key indirect effect mediated by digital maturity, which emerges as the central driver of quality perception and efficiency. This investigation offers an integrated understanding of digital transformation, providing crucial insights for managers and policymakers in the promotion of healthcare systems that are more equitable, resilient, and effectively user centred.

Keywords: Digital Literacy, Digital Maturity, Digital Inclusion, Satisfaction, Digital Transformation, Healthcare, Theoretical Model.

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Artificial Intelligence Disclosure

For the preparation of this thesis, generative artificial intelligence tools were used exclusively for grammatical review and the refinement of English syntax. The use of this technology was limited to linguistic support and was not employed in the generation of ideas, the development of the conceptual model, data analysis, or the formulation of scientific conclusions, which remain the sole and exclusive responsibility of the author.

List of abbreviations

AI – Artificial Intelligence

AVE – Average Variance Extracted

C – Comparison (PICOS Acronyms)

CFA – Confirmatory Factor Analysis

CFI – Comparative Fit Index

CMIN/DF – Chi-Square divided by Degrees of Freedom

CR – Composite Reliability

DHLI – Digital Health Literacy Instrument

DI – Digital Inclusion

DIMI – Digital Maturity Inventory

DIPS – Digital Inclusion and Participation Scale

DL – Digital Literacy

DM – Digital Maturity

EHRs – Health records

FI – Incremental Fit Index

H – Hypotheses

I – Intervention/Exposure (PICOS Acronyms)

KMO – Kaiser-Meyer-Olkin Measure of Sampling Adequacy

KPI – Key performance indicator

O – Outcome (PICOS Acronyms)

P – Population (PICOS Acronyms)

RMSEA – Root Mean Square Error of Approximation

RQ – Research Questions

S – Satisfaction

SEM – Structural Equation Model

SO – Specific Objectives

TLI – Tucker-Lewis Index

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CHAPTER 1

Introduction**1.1. Topic context**

The digital transformation of healthcare services has become a central priority for health systems worldwide. The increasing adoption of digital technologies such as electronic health records, mobile health applications, telemedicine platforms, and artificial intelligence has reshaped how care is delivered, accessed, and experienced by both patients and professionals. In this evolving landscape, digital transformation is not solely a technological shift; it is a complex process that involves organizational, social, and human dimensions.

To analyse the complexity of digital transformation within healthcare organisations, this research employs the theoretical framework of the Donabedian Model (2005). This classic paradigm for assessing healthcare quality is built upon the interrelation of three fundamental pillars: Structure (the attributes of settings, equipment, and human resources), Process (the activities that constitute the delivery of care), and Outcome (the impact of care on health status and user satisfaction). Applying this logic to the digital era, the Digital Maturity of a healthcare provider is framed as a critical component of its Structure. This structural foundation conditions the Processes namely, how technology is integrated into clinical workflows and professional-user interactions which, in turn, determines the perceived Outcomes, specifically user Satisfaction. Consequently, the Donabedian framework serves not merely as a quality metric, but as the theoretical thread that justifies the hypothesis that investments in digital capabilities (Structure) directly influence the experience and value perceived by the patient (Outcome).

While healthcare organizations continue to invest in digital transformation, significant disparities persist in how different populations and institutions engage with technology. Factors such as digital literacy, digital maturity, digital inclusion play a crucial role in determining whether digital solutions translate into improved health outcomes and service satisfaction (J. Ahmed et al., 2020; Almaghaslah et al., 2022; Arias López et al., 2023; Bancsik et al., 2024; Hamasaki, 2024; Khan et al., 2022; Lee, 2018; Melhem et al., 2023; Ploog et al., 2022; Santos-Jaén et al., 2022; Tossaint-Schoenmakers et al., 2021; Yan et al., 2024).

At the same time, patient satisfaction remains a critical measure of success, reflecting how well these technologies meet their expectations and their needs (Almaghaslah et al., 2022; Bancsik et al., 2024; Baniyadi et al., 2023; Friedel et al., 2023; Hamasaki, 2024; Ploog et al., 2022; Tossaint-Schoenmakers et al., 2021). According to, Bancsik et al. (2023), and Friedel et al. (2023), their investigation addresses the importance of measuring patient experience and satisfaction, stating that these measures are crucial for understanding how well patients are served and included by healthcare systems, which includes those undergoing digital transformation.

Existing research has examined several of these dimensions independently or in partial combinations. However, a comprehensive and integrated view of the human and organizational enablers of digital transformation in healthcare is still lacking. Understanding the interplay between individual capabilities, organizational development, inclusive practices, and user experience is essential for building digital health systems that are not only innovative but also sustainable and equitable.

This research is focused on the intersection of these critical issues, aiming to explore and validate a conceptual model that connects four key constructs Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction in an integrated and original way.

1.2. Motivation and topic relevance

Understanding the complex relationships between Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction is paramount in navigating the ongoing digital transformation within healthcare, given the prevailing trends and challenges:

- **Growing Digital Dependence:** Healthcare systems are increasingly reliant on digital technologies to improve operationality, enhancing care coordination, and expand access to services. This dependence necessitates a deeper understanding of the factors that facilitate or hinder successful digital integration.
- **Need for Holistic Understanding:** While the individual constructs (DL, DM, DI, and S) have been examined in healthcare settings, a holistic view is essential to capture the complex dynamics of digital transformation. For example, high digital maturity in a hospital may not translate to positive outcomes if patients lack the digital literacy to use the available tools or if significant portions of the population are excluded from access.

- **Equity and Inclusion:** Ensuring equitable access and use of digital health technologies is paramount. Digital inclusion is not merely about providing access; it also involves addressing the social determinants of health that may create barriers for vulnerable populations. Understanding how digital literacy and maturity intersect with inclusion can inform strategies to mitigate disparities.
- **User-Centric Approach:** Patient and professional satisfaction is a critical indicator of the success of digital health initiatives. Technologies that are not user-friendly or do not meet the needs and expectations of their users are unlikely to be adopted or sustained. Therefore, it is essential to investigate how digital literacy, maturity, and inclusion influence satisfaction.
- **Sustainability of Innovation:** For digital transformation to be sustainable, it must be supported by a robust foundation of digital literacy, organizational maturity, and inclusive practices. A comprehensive model that integrates these factors can provide valuable insights for policymakers, healthcare administrators, and technology developers.

Despite the volume of literature on digital health, a significant research gap remains in the integrated analysis of Digital Literacy (DL), Digital Maturity (DM), Digital Inclusion (DI), and Satisfaction (S).

Existing studies often focus on:

- **Isolated Constructs:** Many studies examine only one or two of these constructs, failing to capture their complex interdependencies. For instance, research on digital literacy may not adequately address the role of organizational digital maturity in supporting or hindering the effective use of digital tools.
- **Technology-Centric Perspective:** Some research emphasizes the technological aspects of digital transformation without fully considering the human and social factors. This can lead to an incomplete understanding of why some digital health initiatives succeed while others fail.
- **Limited Focus on Inclusion:** While there is increasing recognition of the importance of digital inclusion, few studies explicitly model its relationship with digital literacy, maturity, and satisfaction. This gap is particularly critical given the potential for digital technologies to exacerbate existing health disparities.

- **Lack of Integrated Models:** There is a need for comprehensive models that can explain how these constructs interact to influence the outcomes of digital transformation in healthcare. Such models can provide a more nuanced and actionable framework for research and practice.

The main purpose of this research is to propose and validate a conceptual model that explores the impact of digital transformation in healthcare services by integrating four key constructs: Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction. According to a comprehensive review of the literature, no existing scientific study has yet addressed these four dimensions in a unified theoretical or empirical framework. While previous studies have examined combinations of two or three of these constructs for example, digital literacy with digital inclusion, or digital maturity with user satisfaction none have explicitly integrated all four, particularly within the healthcare context. This research, therefore, aims to fill this research gap and provide an original contribution to the understanding of digital transformation in health services.

The healthcare sector, much like other service-oriented industries, has been significantly impacted by the growing demand for digital innovation (Almaghaslah et al., 2022; Bancsik et al., 2024; Ferreira et al., 2023; Friedel et al., 2023; Ploog et al., 2022; Santos-Jaén et al., 2022; Tossaint-Schoenmakers et al., 2021).

The increasing complexity of healthcare delivery, combined with rising patient expectations, has led to the recognition that digital tools and systems are essential to improving service quality, accessibility, and organizational performance (Al-alawy et al., 2021).

Technologies such as electronic health records, telemedicine, mobile health applications, and AI-driven diagnostics have transformed the way care is delivered and experienced. However, their effectiveness depends not only on technological availability (digital maturity), but also on users ability to understand and use them effectively (digital literacy), and on whether all population groups have equitable access to them (digital inclusion) (J. Ahmed et al., 2020; Casillas-Ávila et al., 2025; Donabedian, 2005; Tossaint-Schoenmakers et al., 2021). Ultimately, these elements shape the level of satisfaction experienced by users both patients and professionals. According to the bibliography collectively argues that digital literacy, maturity, and inclusion are fundamental elements of modern healthcare systems. Their effectiveness directly impacts how care is delivered

and experienced, shaping the satisfaction of both patients receiving care and professionals providing it (Almaghaslah et al., 2022; Baniyadi et al., 2023; Casillas-Ávila et al., 2025; Donabedian, 2005; Ferreira et al., 2023; Friedel et al., 2023; Hamasaki, 2024; Ploog et al., 2022; Rahman et al., 2024; Tossaint-Schoenmakers et al., 2021).

By developing and validating a model that systematically connects these four dimensions, this study provides a more holistic view of digital transformation in healthcare. The integration of DL, DM, DI, and S offers new insights into how digital factors interact and influence each other, enabling researchers and decision-makers to better design, implement, and evaluate digital health strategies that are inclusive, effective, and aligned with patient needs.

The presented model (Figure1) highlights healthcare services within an internal, external environment, and contingent factors:

1. Environments:

- a. **External Environment:** Represents external factors that may influence digital transformation in healthcare, such as regulations, government policies, and technological advancements.
- b. **Internal Environment:** Includes healthcare services and their internal dynamics related to digital transformation (management, people, culture).

2. Model Components:

- a. **Digital Literacy(DL):** Refers to the ability of healthcare professionals and patients to effectively understand and use digital technologies.
- b. **Digital Inclusion (DI):** Measures the extent to which individuals have equitable access to digital healthcare services, ensuring accessibility for all.
- c. **Satisfaction (S):** Represents patient and professional satisfaction with digital healthcare services, reflecting usability, efficiency, and perceived benefits.
- d. **Digital Maturity (DM):** Represents the degree of digital integration within a healthcare organization, including technological capabilities and process automation.

3. Contingent Factors:

Contingent factors are external or internal elements that can influence the relationships between the core constructs (Digital Literacy, Digital Inclusion,

Digital Maturity, and Satisfaction) and the broader environment within the context of digital transformation in healthcare services (Melhem et al., 2023; Tossaint-Schoenmakers et al., 2021; Vogel et al., 2024; J. Wang, 2023; Yan et al., 2024) . These factors can either facilitate or hinder the implementation and outcomes of digital initiatives.

The image identifies the following as contingent factors:

- a. **Leadership:** Influences the adoption and implementation of digital transformation.
- b. **Age:** May impact the acceptance and adaptability to new technologies.
- c. **Digital Tools:** Represents the systems and technologies available that may either facilitate or hinder digital implementation.
- d. **Performance:** Performance, in this context, likely relates to various metrics of effectiveness, efficiency, or quality within healthcare services. The performance of services, potentially measured before and after digital interventions, can be influenced by the digital transformation process and the interplay of the core constructs.
- e. **Innovation:** Innovation pertains to the introduction of new ideas, methods, or technologies. A focus on innovation within healthcare services and the broader environment can drive the adoption and development of new digital tools and approaches, thereby influencing the pace and nature of digital transformation.

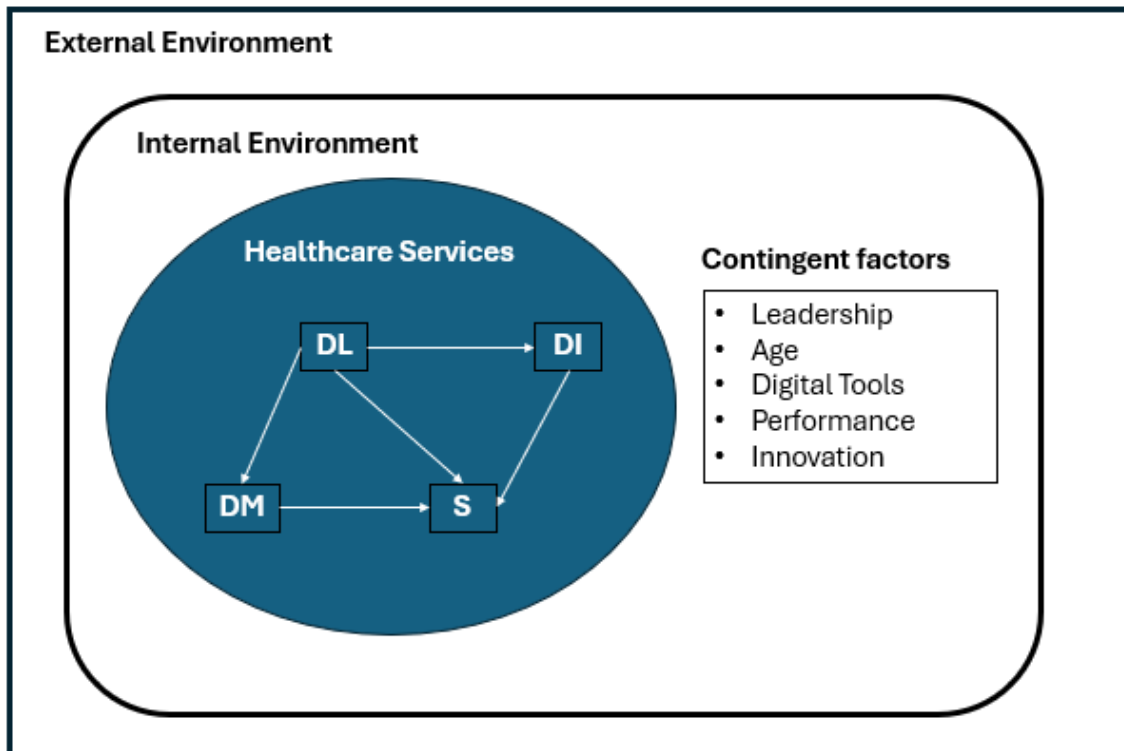


Figure 1 - Initial Research Framework

Through this investigation, digital transformation is envisioned as a means to increase service quality capacity in healthcare organizations, ultimately improving their performance and leadership while social equity and quality of healthcare is promoted.

Currently, there is no existing study that combines the four key constructs of this research digital literacy, digital maturity, digital inclusion, and satisfaction with healthcare services into a single theoretical or empirical model.

According to the literature, scarce studies tend to address these constructs in pairs or trios, without considering their integrated interaction within a broader context.

Some examples of these combinations include:

- **Digital literacy + digital inclusion:** Research exploring the relationship between users' ability to understand and use digital technologies and their effective access to technologies.

The studies analysed in this combination consistently highlight digital literacy as a crucial factor, and often a prerequisite, for digital inclusion. Various reviews and empirical studies indicate that the ability to understand and use digital technologies is fundamental for individuals, including healthcare professionals

and vulnerable populations such as the elderly or those in disadvantaged situations, to fully access and benefit from digital services and resources. Digital literacy is seen as essential for bridging the digital divide, influencing the ability to find and use online health information (eHealth literacy) and interact with digital systems like telemedicine or electronic prescribing. A lack of digital literacy is associated with socioeconomic factors that exacerbate exclusion, reinforcing the need to promote digital skills to ensure equitable access to healthcare in the digital age (Ahmed et al., 2022; Connolly et al., 2025; Arias López et al., 2023; Doueiri et al., 2024; Jeong et al., 2019; Lee, 2018; Melhem et al., 2023; Rydzewski, 2025; Santos-Jaén et al., 2022; Tegegne et al., 2023; Wrona et al., 2025, p. 1; Yan et al., 2024).

- **Digital maturity + satisfaction of professionals or patients:** Studies focusing on the relationship between the level of digital development in healthcare organizations and the satisfaction perceptions of professionals or patients.

The relationship between the digital maturity of healthcare organizations and the satisfaction of their professionals or patients is addressed in the studies by analysing how the level of digital development impacts care processes and outcomes. The references suggest that higher digital maturity, evidenced by the implementation of services like electronic prescribing, telemedicine, or mobile health applications, tends to be associated with higher levels of satisfaction. This occurs because digital maturity can lead to improvements in the efficiency, accessibility, and quality of services, positively impacting the perception and experience of patients and, implicitly, the professionals who use these systems. Patient satisfaction is highlighted as an important outcome when evaluating the effectiveness of digital solutions implemented in healthcare, indicating that the level of digital maturity directly influences the user experience (Almaghaslah et al., 2022; Baniasadi et al., 2023; Hamasaki, 2024; Ploog et al., 2022; Santos-Jaén et al., 2022; Tossaint-Schoenmakers et al., 2021; Vogel et al., 2024).

- **Digital literacy + satisfaction:** Typically studied in the context of the usability of health apps or web portal, where users' digital skills are considered a crucial factor for their satisfaction. The combination of digital literacy and satisfaction is frequently explored in the context of patients' interaction with health technologies, such as mobile applications, health portals, or telemedicine. The studies indicate

that patients' digital literacy their ability to effectively use these tools—is an important factor influencing their satisfaction. When patients possess the necessary digital skills, their experience with digital health platforms tends to be more positive, leading to greater satisfaction with the services provided. Digital literacy thus emerges as a determinant of satisfaction in the context of digital health, conditioning how users interact with and benefit from technological innovations in healthcare (Almaghaslah et al., 2022; Baniyadi et al., 2023; Connolly et al., 2025; H. Connolly et al., 2024; Arias López et al., 2023; Hamasaki, 2024; Tossaint-Schoenmakers et al., 2021; Wrona et al., 2025).

- **Digital inclusion + Satisfaction:** Research focused on equity and access issues, where digital inclusion is directly linked to the need to promote satisfaction.

Studies linking digital inclusion and satisfaction, although sometimes implicitly, suggest that the degree of users inclusion in digitalized healthcare services affects their satisfaction with the care received. Digital inclusion, understood as effective access to and the ability to participate in the digital environment, is linked to satisfaction through factors such as timely access to care, the use of digital communication channels (like social media for support), and the possibility of choosing different interaction modalities (in-person vs. telemedicine). Ensuring that patients, especially vulnerable groups, are included and can navigate digitalized healthcare systems is crucial for ensuring their satisfaction with the overall care experience. The analysis of satisfaction serves, in some cases, as a way to evaluate how well patients are being served and included by digitally transformed healthcare systems (Ahmed et al., 2022; Bancsik et al., 2024; Khan et al., 2022; Ploog et al., 2022; Santos-Jaén et al., 2022; Yan et al., 2024).

However, no structured study has yet been published that explicitly integrates all four constructs, especially in the context of healthcare services. This gap in the literature presents a clear opportunity for original contribution to the field of digital transformation in healthcare. By combining these four elements into a single analytical model, new insights can be gained regarding how digital factors interact to influence patient experiences and the quality of services provided, thus offering a deeper understanding of the challenges and opportunities that digital transformation presents to the healthcare sector.

Therefore, this investigation not only addresses a significant gap in the literature but also proposes a conceptual model that can be explored in future research, with the potential to impact digital health services.

1.3. Questions and Objectives

This research seeks to answer the central question "How can digital transformation influence healthcare organizations?" is aligned with other questions, that provide a more granular and specific breakdown of that influence.

Here's how they connect:

- **The central question** is a very high-level inquiry into the overall impact of digital transformation.
- **The hypotheses** break down this broad inquiry into specific relationships between key components of digital transformation (digital literacy, digital maturity, digital inclusion) and their effects on important outcomes (satisfaction).

Essentially, the questions are designed to provide detailed answers to the central question by examining specific relationships between variables, like:

- “How does the level of digital literacy among healthcare patients affect the digital maturity of healthcare services?”
- “What is the relationship between the extent of digital inclusion of patients and healthcare professionals and the digital maturity of healthcare services?”
- “To what extent does the digital maturity of healthcare services and systems influence patient satisfaction?”
- “How does digital literacy impact the degree to which patients are digitally included in healthcare services?”
- “Does the level of digital literacy among patients affect their satisfaction with healthcare services?”
- “Is there a relationship between the level of digital inclusion of patients and their satisfaction with healthcare services?”

In view of the problem under investigation and the research questions (RQ), this research contemplates the following specific objectives:

- Analyse the influence of Digital Literacy on the adoption, implementation and evolution of digital transformation, as represented by Digital Maturity.
- Investigate the complex relationships and mediating effects between Digital Literacy, Digital Inclusion and Digital Maturity.
- Assess the influence of Digital Literacy and Digital Inclusion on Satisfaction, exploring both their direct and indirect effects through Digital Maturity.
- Explore and validate the relationships between the constructs of Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction.

1.4. Research Methods approach

This research follows a structured methodological approach to comprehensively analyse the impact of Digital Transformation (DT) in healthcare organizations, considering its interaction with digital maturity, digital literacy, digital inclusion and satisfaction. To achieve these objectives, the research is divided into three investigative phases, ensuring a progressive refinement of the conceptual model:

A. **Phase 1 – Bibliographical and Documentary Research:** This initial phase focuses on identifying theoretical models and existing practices related to digital transformation, leadership, change management, digital literacy, digital maturity, satisfaction, digital inclusion and innovation in healthcare organizations.

B. **Phase 2 – Focus Group (Qualitative Analysis):** This phase validates and refines the constructs identified in Phase 1 by collecting perceptions from healthcare stakeholders, identified as healthcare professionals. It provides practical insights into the challenges and opportunities of digital transformation in real-world healthcare settings.

C. **Phase 3 – Inferential Analysis (Quantitative Study):** The final phase aims to test and validate the relationships between the proposed constructs using statistical and inferential methods. A survey will be conducted among healthcare patients to quantify the impact of digital transformation on healthcare efficiency, patient satisfaction, and equity.

1.5. Thesis structure and organization

The present work is organized in six Chapters that intend to reflect the different phases until its conclusion.

The first Chapter introduces the subject of the investigation and its objectives, as well as a brief description of the structure of the work.

The second Chapter reflects the theoretical framework, called Literature review.

The third Chapter is dedicated to the Research Hypotheses developed for this study.

The fourth Chapter describes the Methodology used in the process of collecting and processing data as well as the methods of analysis used.

The fifth Chapter presents the Empirical Analysis, and the results obtained, according to the methodology that was considered appropriate.

The sixth and last Chapter presents the conclusions of this research as well as the recommendations, limitations, and future work."

This research aims to uncover valuable insights that can inform both theory and practice. The subsequent chapters will unravel the complexities of technology-driven change management in healthcare, culminating in actionable recommendations that have the potential to revolutionize healthcare service delivery in Portugal.

With the groundwork laid out in the previous chapter, we now turn our attention to the critical domain of existing knowledge and research in the field. In the following chapter, we embark on a comprehensive literature review, traversing the vast landscape of digital transformation within healthcare institutions. This literature review will serve as the conceptual foundation for the study, providing the necessary theoretical framework and defining the key variables of the research model.

In the "Literature Review" chapter, we will go deep into the seminal works, key studies, and best practices that have shaped our understanding of digital transformation in healthcare services. We will examine the challenges and opportunities presented by technology-driven change, the role of leadership and performance, and the impact of digital transformation on healthcare outcomes. Through this exploration, the aim is to identify gaps in the existing body of knowledge, pinpoint areas where research can make a valuable contribution and ultimately guide the direction of our investigation exploring

the dynamic intersection between technology and healthcare, where innovation and transformation hold the potential to reshape the very fabric of healthcare service delivery.

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CHAPTER 2

Literature review

This chapter presents a comprehensive review of the scientific literature relevant to the study of digital transformation in healthcare services, with a particular focus on the interaction and impact of four essential constructs: digital literacy, digital inclusion, digital maturity, and patient/professional satisfaction.

2.1. Objective of the Literature review

The main objective of this literature review is to critically analyse the existing knowledge base on digital transformation in the healthcare sector, examining how the constructs of digital literacy, digital inclusion, digital maturity, and satisfaction(patient/professional), have been addressed individually and in combination. It seeks to identify the main theories, models, findings, and methodologies employed in these studies.

Fundamentally, this review aims to map the current research landscape to justify the relevance of the investigation that explicitly integrates these four elements in the context of healthcare services, highlighting the existing knowledge gap and the potential contribution of the present research to fill this gap.

Digital transformation in healthcare services is a topic of increasing relevance in scientific literature, driven by the potential of digital technologies to improve the service quality, and accessibility of care. However, the successful implementation of this transformation depends not only on the technology itself but also on complex human and organizational factors. The constructs of digital literacy, digital inclusion, digital maturity, and patient/professional satisfaction represent critical dimensions that have been shown to influence the adoption, effectiveness, and outcomes of digital health initiatives, as evidenced by studies exploring combinations between them, such as the relationship between digital literacy and digital inclusion, digital maturity and satisfaction, digital literacy and satisfaction, and digital inclusion and satisfaction. Despite these partial studies, there is still no structured study in the literature that explicitly integrates all four constructs to analyse their joint interaction in the specific

context of healthcare services, which justifies the relevance and originality of the present research.

2.2. Methods

This chapter describes the systematic and transparent methodological procedures that were rigorously followed for conducting this literature review. The primary objective of this section is to detail the steps of the process for identifying, selecting, extracting, and synthesizing the studies relevant to the research question of the present study. A clear and well-defined methodology is fundamental to ensuring the reproducibility of the review and the validity and reliability of its findings. By outlining the search strategy, inclusion and exclusion criteria, the article screening process, and how data were extracted and analysed, the aim is to offer the reader a complete understanding of how the empirical and theoretical basis for the conclusions of this review was established. The subsequent sections of this chapter detail each of these methodological steps.

2.2.1 Data Collection and Search Strategy

Systematic literature reviews identify, from a set of published studies on a specific topic, those of superior methodological quality whose results can be reproduced in practice. So, it was used the PICOS methodology (*Richardson, et al 1995.; Schardt et al., 2007*).

PICOS question contains the description of the research problem, the population, the context, the intervention, and the results. To build a path for constructing the research question the following stages were used:

1. Evidence-based steps.
2. Strategy description.

Regarding the Evidence-Based Steps, and observing Figure 2, it is possible to see that steps 1, 2, 3 and 4 represent the development of studies called systematic reviews, which consists of the fundamental research model. The systematic review represents the use of standard methodologies to synthesize data from multiple primary studies.

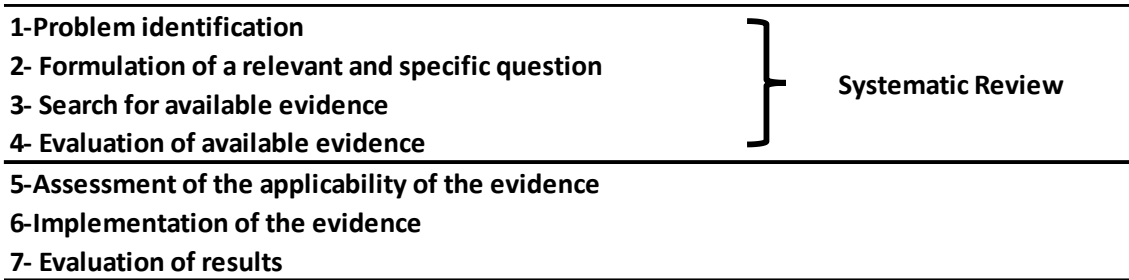


Figure 2 – Evidence-based steps

The PICOS strategy (Population, Intervention, Comparison, Outcomes, and Study Design) was rigorously applied to define the parameters of the literature search (Dalle Grave et al., 2021). While this framework initially guided the formulation of the preliminary research inquiry, its primary role was to systematically refine the scope of the review. This process ensured that the identified studies contributed directly to the construction of the definitive research question of this study, aligning the theoretical evidence with the empirical objectives.

Based on the PICOS strategy applied to the reality of the present study, the formulation of the research question, in PICOS format, consists of:

- **P (Population):** In which **Populations** (healthcare users, healthcare professionals, healthcare organizations) is **Digital Transformation in Healthcare Services** being studied?
- **I (Intervention or Exposure):** What is the role of **Digital Literacy, Digital Inclusion, Digital Maturity and Satisfaction** in the context of Healthcare Services?
- **C (Comparison):** How do the outcomes (satisfaction) differ between different levels of **Digital Literacy, Digital Maturity and Digital Inclusion**, or in comparison with non-digitalized approaches?
- **O (Outcome):** What are the **Outcomes of Digital Transformation**, namely at the level of the **Digital Maturity** of organizations and the **Satisfaction** of users and professionals?
- **S (Study Type):** What **Types of Studies** have been used to investigate these relationships in the healthcare sector?

The application of this strategy allowed for refining the search and analysis of the literature, focusing on studies that address these constructs and their interrelationships in the context of the digitalization of healthcare.

Table 1 – Components that describe the PICOS Strategy

Acronym	Definition	Description
P	Population	Healthcare users, healthcare professionals, healthcare organizations.
I	Intervention/Exposure	Digital Transformation in Healthcare Services; Digital Literacy; Digital Inclusion.
C	Comparison	Different levels of Digital Literacy/Digital Inclusion; Digitalized vs. traditional services (when applicable).
O	Outcome	Digital Maturity; Satisfaction (Users/Professionals); Technology Adoption; Impact on Health/Well-being.
S	Study Type	Review Studies, Quantitative (Surveys, etc.), Qualitative, Mixed Methods, etc.

The research strategy was operationalised through the PICOS framework, as detailed in Table 1. While the **PICOS acronym** traditionally represents **five core components** (Population, Intervention, Comparison, Outcomes, and Study Design), the strategy was expanded into seven distinct operational criteria to ensure a more rigorous selection process. These seven criteria are organised into two groups: the first four focus on the **primary research scope**, while the remaining three define the **methodological and contextual boundaries** (such as language and timeframe). This comprehensive breakdown, visualised in the evidence-based steps of Figure 2, ensures the systematic nature of the literature review.

2.2.2 PRISMA

This chapter details the systematic and rigorous methodology employed in conducting this literature review. To ensure the transparency and quality of the review process, the guidelines established by the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) Statement were followed. PRISMA constitutes a fundamental guide for reporting systematic reviews, promoting clarity and exhaustiveness in the description of methodological steps, from study identification to results synthesis (Dalle Grave et al., 2021; Liberati et al., 2009).

Adopting a systematic methodology, aligned with standards like PRISMA, is crucial for minimizing biases and ensuring that the literature review provides a solid and reliable basis for understanding the research topic. In this context, and prior to the detailed screening and selection of articles based on strict eligibility criteria, an initial bibliometric analysis of the retrieved literature was conducted. This phase, utilizing tools such as VOS viewer, aimed to map the landscape of existing research, identify key concepts and their interconnections, and provide an empirical foundation for the selection and justification of the core research constructs (Digital Maturity, Digital Inclusion, Digital Literacy, and Satisfaction) that guide this review. This chapter will detail each phase of the review process, including the search strategy, the findings from the preliminary bibliometric mapping, study eligibility criteria, the selection process, data extraction, and how information was analysed and synthesized. By following these procedures, the aim is to ensure that all relevant studies in the consulted bibliography are considered objectively and that the review's conclusions are based on consistent and traceable evidence.

In this investigation, the bibliographic data were extracted from the SCOPUS repository. SCOPUS constitutes a macro-database that provides subscription-based access to various databases offering comprehensive citation data for numerous academic disciplines. Data collection was conducted in January of 2024; the data extraction was based on a range 2022 to 2025.

The methodological search strategy in the search engine provided by Scopus involved the use of specific search terms and filters to identify relevant articles within the scope of digital transformation in healthcare services, focusing on the constructs of interest. The search was performed in the Scopus Core Collection, covering all databases included in this collection.

The initial search strategy resulted in the identification of 2335 articles. Following identification, 41 duplicated articles were removed, resulting in a total of 2294 unique articles for the screening phase. Article screening was conducted based on the analysis of titles, abstracts, and keywords, applying rigorous filtering criteria. The filtering criteria included the presence of keywords related to health and each of the specific constructs in the article titles, such as:

- For Satisfaction: "health", "patient", "care", "satisfaction"
- For Inclusion: "health", "digital inclusion", "access"

- For Literacy: "health", "digital literacy", "education"
- For Maturity: "health", "digital maturity", "technology"

Articles were additionally ordered by the "Cited by" and "Year" criteria, from highest to lowest, to aid in prioritization and selection, although the application of exclusion criteria was the determining factor. Based on the exclusion criteria applied during the screening and eligibility assessment process, a total of 2110 articles were removed for not meeting the scope of the review or the thematic and construct focus criteria. This process resulted in the identification of 184 eligible articles for inclusion in the literature review. Eligible articles can be categorized, for example, into quantitative studies, qualitative studies, and systematic reviews.

Data from the eligible articles were then exported to files in *.txt, *.xlsx, and *.RIS formats, including all bibliographic information, abstracts, keywords, and cited reference counts, for subsequent analysis and synthesis.

The process of selecting studies for this literature review is illustrated in the PRISMA (*Preferred Reporting Items for Systematic reviews and Meta-Analyses*) Flow Diagram presented in Figure 3. This diagram details the different phases of the article identification and selection process, from the initial search in databases to the final inclusion of studies in the review, specifying the number of articles at each stage.

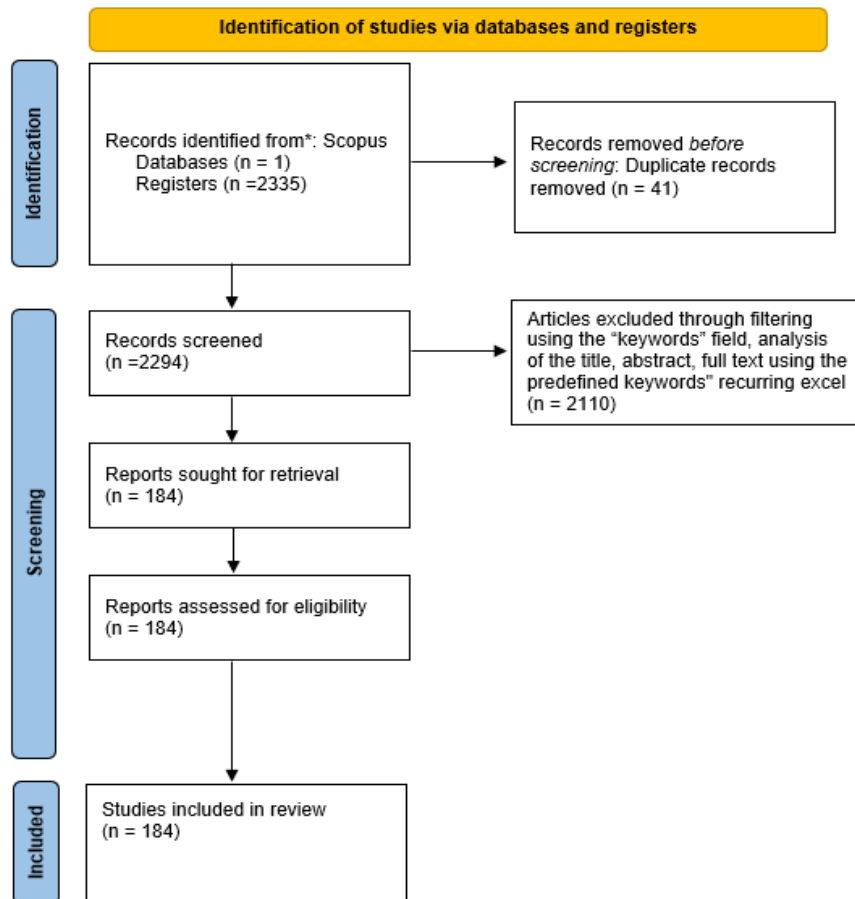


Figure 3 – PRISMA Flow Diagram¹

It is relevant to infer that this strategy (Figure 3) was always supported by the procedural flow of investigation selection (Figure 4)(Page et al., 2022).

¹ From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372 n71. doi: 10.1136/bmj.n71

Study Selection Process Flowchart

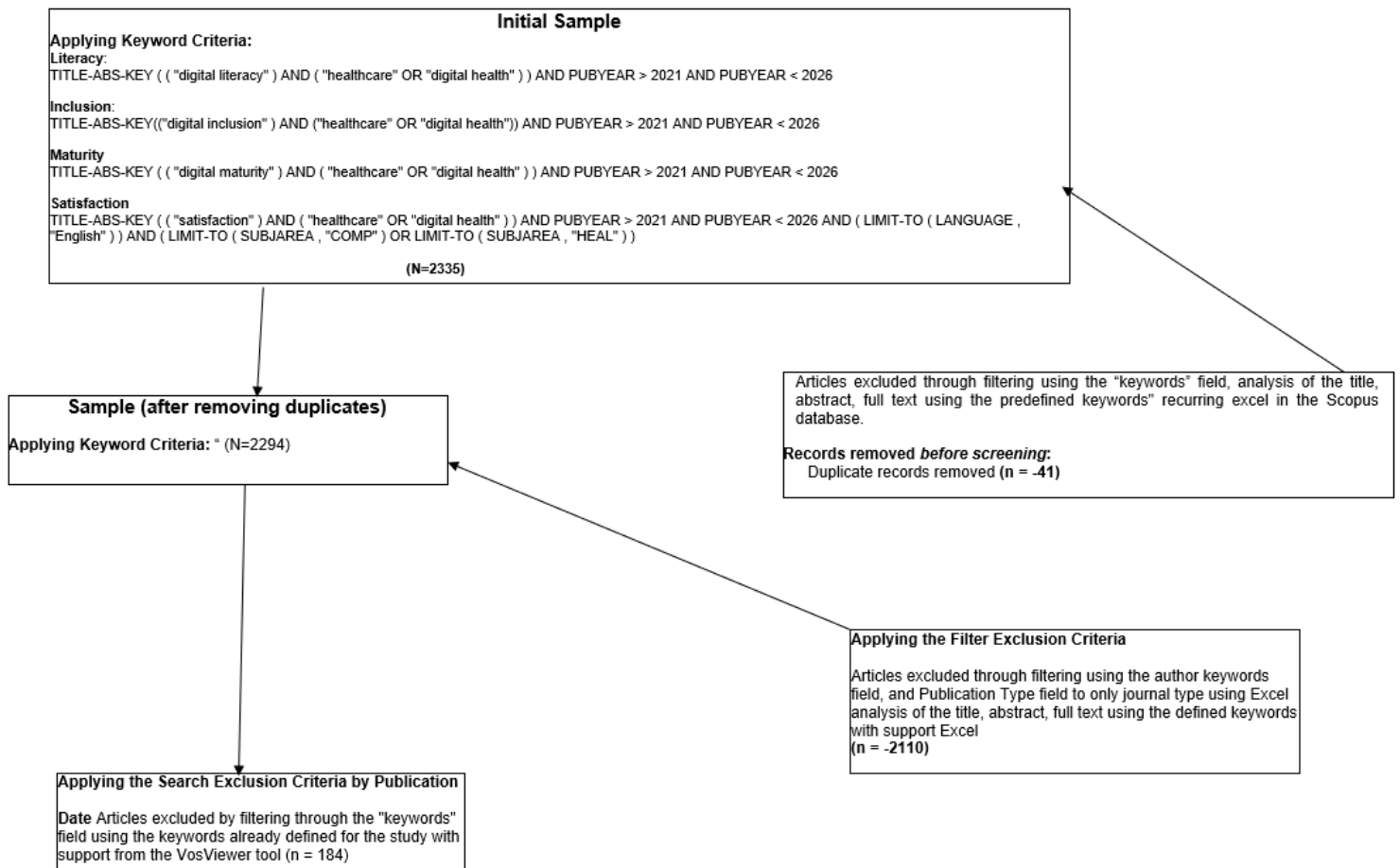


Figure 4 – Investigation Selection Process Flowchart

To provide a systematic and visual representation of the bibliographic data and strengthen the justification for the chosen research focus, the VOSviewer tool was used. VOSviewer is particularly valuable for analysing and visualizing bibliometric networks, such as co-occurrence of keywords, offering insights into the structure and dynamics of a research field. Based on the analysis performed using VOSviewer, which generated the provided bibliographic data presented in the form of a keyword table and link strengths and a co-occurrence network visualization (Figure 5), the selection of the research constructs "Digital Maturity", "Digital Inclusion", "Digital Literacy", and "Satisfaction" is justified by their demonstrated relevance and interconnection within the field of study.

A. Analysis of the Keyword Table and Link Strength:

The keywords identified in the bibliographic research and their respective "total link strength". This metric reflects the frequency with which each keyword appears together with other keywords, indicating its centrality and importance in the research network. The

analysis of this table reveals that the selected constructs show significant "total link strength" values:

- Digital Maturity: 25
- Digital Inclusion: 18
- Digital Literacy: 172
- Satisfaction: 101

These values, compared to other terms in the list, demonstrate that "Digital Maturity", "Digital Inclusion", "Digital Literacy", and "Satisfaction" are not marginal terms, but rather concepts actively present and connected in the analysed literature, which validates their relevance as research.

B. Analysis of the Co-occurrence Network Visualization:

The network visualization (Figure 5) graphically illustrates the co-occurrence relationships between keywords, where the size of the nodes represents the frequency or link strength of the term, and the lines indicate that the terms appear together in documents.

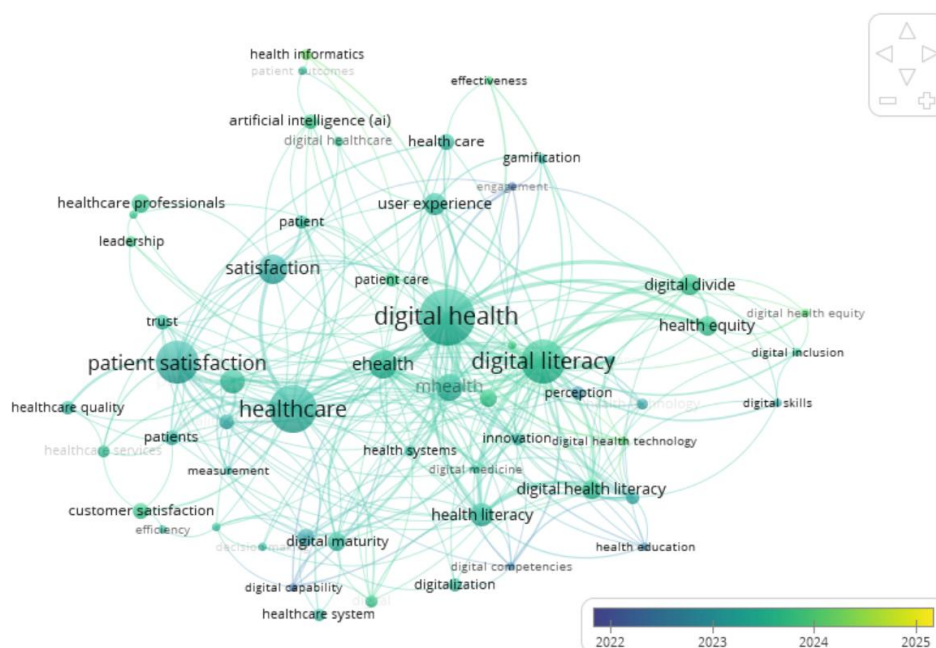


Figure 5 – Co-occurrence Network Visualization

The analysis of this network offers a visual and relational justification for the choice of constructs.

Prominence of Constructs: The nodes corresponding to "Digital Maturity", "Digital Inclusion", "Digital Literacy", "Satisfaction", and notably, "Patient Satisfaction" (which appears to be a specification of Satisfaction with a strong presence), show considerable sizes in the network. This corroborates the keywords analysis, indicating that these constructs are prominent and central in the data corpus.

- **Connection to the Core Field:** The selected constructs are visibly linked to central terms in the network. This proximity and connection demonstrate their relevance to the study of digital health and healthcare systems, the likely context of the research.
- **Interconnection Among Constructs:** The network reveals links between the selected constructs. Connections are observed between "Digital Literacy" and "Digital Inclusion", both close to and linked with "Digital Health". "Digital Maturity" appears linked to "Digital Health" and other technological terms. "Satisfaction" and "Patient Satisfaction" form a prominent cluster and link to terms like "healthcare", "patient care", and through these, to digital concepts. While not all direct links between all four constructs may be immediately apparent, their presence within the same research cluster and their interconnections with mediating and central terms suggest that they are frequently studied in related contexts and influence each other. This interconnection in the existing literature justifies the integrated approach intended for investigating them together.
- **Temporal Evolution:** The colouring of the nodes helps contextualize the temporal relevance of the constructs.

In conclusion, both the analysis of link strength in the table and the relational structure and visual prominence in the co-occurrence network provide a solid basis in the literature for choosing "Digital Maturity", "Digital Inclusion", "Digital Literacy", and "Satisfaction" as central constructs for the investigation. The data demonstrate that these are relevant, well-established, and interconnected topics within the field of study, justifying the pertinence of exploring their relationships and implications.

2.3. Contextualization of Digital Transformation in Healthcare Services

Organizational change performance must continuously adapt to a global context, influencing various organizational spheres, both internally and externally. Digital transformation in healthcare refers to the strategic adoption of digital technologies and processes to fundamentally change how healthcare is delivered, managed, and experienced. This goes beyond simply adopting electronic health records or telemedicine; it involves a comprehensive rethinking of workflows, patient engagement, data utilization, and organizational culture to leverage the full potential of digital advancements. The applicability of digital transformation in the health sector is vast, ranging from improving clinical outcomes through data-driven insights and personalized medicine to enhancing administrative efficiency, enabling remote care delivery, and empowering patients with greater access to information and control over their health journeys. The internal context refers to the state of the organization, including its strategy, structure, people, technology, and culture, all of which affect the change system (Albrecht et al., 2020; Irimiás & Mitev, 2020). The external context encompasses factors outside the organization's boundaries that directly or indirectly impact its performance and results (Arazmjoo & Rahmanseresht, 2019; Maes & Van Hootegeem, 2019). According to these authors, external factors are often the primary drivers of change within organizations.

2.4. Definition and Applicability of Digital Transformation in Healthcare

Digital transformation in the healthcare sector, as reflected in bibliography, is not limited to the mere adoption of technology but rather a broader process that redefines the provision of care and the interaction between users and professionals. According to the literature, digital transformation in the healthcare sector can be defined as a multifaceted process involving the strategic adoption of advanced technologies, such as artificial intelligence (AI) and the metaverse for intelligent care. This transformation requires the development of new digital skills, with digital literacy considered fundamental for technology adoption (Chen, 2021; J. Wang, 2023) and for the digital maturity of both professionals (Arias et al., 2023; Chereka et al., 2024; Arias López et al., 2023; Jeong et al., 2019; Takeda et al., 2022; Tartaglia et al., 2024; Tegegne et al., 2023). Digital health

literacy is specifically seen as the ability to find and use health information through technology (Arias López et al., 2023). Digital transformation significantly impacts care and management processes, where the digital maturity of healthcare organizations influences outcomes (Almaghaslah et al., 2022; Tossaint-Schoenmakers et al., 2021). Furthermore, digital transformation in the healthcare sector addresses the crucial issue of inclusion and equity in access, seeking to ensure that different populations, including the elderly (Yan et al., 2024) and disadvantaged groups are included and possess the necessary digital literacy to access and benefit from digital health services (Connolly et al., 2024; Arias López et al., 2023; Jeong et al., 2019; Tegegne et al., 2023; Wrona et al., 2025). The influence on user satisfaction and experience is another central aspect, where digitalization and the resulting digital inclusion affect satisfaction with services (Ahmed et al., 2022; Bancsik et al., 2024; Friedel et al., 2023; Khan et al., 2022; Ploog et al., 2022; Santos-Jaén et al., 2022; Yan et al., 2024) and users' digital literacy influences their satisfaction with technologies like mobile health applications (Baniasadi et al., 2023). So, digital transformation in healthcare, according to the referenced authors, is a comprehensive process that redefines interaction, care provision, and management through technology, requiring skill adaptation and promoting inclusion to improve the experience and outcomes for all.

The studies below indicate that this transformation involves:

- **The adoption of advanced technologies:** such as artificial intelligence (AI) and the potential of virtual realities like the metaverse for intelligent healthcare (J. Wang, 2023)
- **The need for new digital skills:** digital literacy is seen as fundamental for the adoption of technologies like AI (Chen, 2021; J. Wang, 2023) and for the digital maturity of both professionals (Chereka et al., 2024; Arias López et al., 2023; Jeong et al., 2019; Lee, 2018; Tartaglia et al., 2024; Tegegne et al., 2023). Digital health literacy, specifically, is defined by the ability to find and use health information through technology (Arias López et al., 2023).
- **The impact on care and management processes:** the digital maturity of healthcare organizations influences processes and outcomes (Tossaint-Schoenmakers et al., 2021), and the implementation of digital services, such as electronic prescribing, has a direct impact on patient satisfaction (Almaghaslah et

al., 2022)Telemedicine is presented as a digitally mature care delivery method (Hamasaki, 2024).

Digital maturity, as a result of digitalization, has been explored in relation to various outcomes. An exploratory study suggests an association between hospital profitability and digital maturity. More specifically, the systematic literature review by Tossaint-Schoenmakers et al (2021), using the Donabedian Model, explicitly indicates that the digital maturity of a healthcare provider (seen as the Structure dimension in the model) influences care Processes and, consequently, Outcomes, including **patient satisfaction**. This study emphasizes the importance of digital maturity not only as an end in itself but as a factor that actively shapes how care is delivered and the user experience within the digitalized healthcare system.

- **The issue of inclusion and equity in access:** digital transformation addresses the need to ensure that different populations, including the elderly ((Xing et al., 2021; Xing et al., 2020, 2024; Yan et al., 2024)) and disadvantaged groups (Wrona et al., 2025), are included and have digital literacy to access and benefit from digital health services (Ahmed et al., 2022;Connolly et al., 2024; Arias López et al., 2023; Jeong et al., 2019; Lee, 2018; Rydzewski, 2025; Santos-Jaén et al., 2022; Tegegne et al., 2023; Wrona et al., 2025) . Overcoming the digital divide in telemedicine is an example of direct applicability (Doueiri et al., 2024).
- **The influence on user satisfaction and experience:** digitalization and the resulting digital inclusion affect user satisfaction with services (Ahmed et al., 2022; Bancsik et al., 2024; Friedel et al., 2023; Khan et al., 2022; Ploog et al., 2022; Santos-Jaén et al., 2022; Xing et al., 2020; Yan et al., 2024). Users' digital literacy is seen as a factor that influences their satisfaction with technologies like mobile health applications (Banasadi et al., 2023).

2.5. Investigation Constructs

The central constructs of this research are: Digital Literacy, Digital Maturity, Satisfaction (of patients and professionals), and Digital Inclusion. For each construct, its definition will be presented, its importance and relevance in the context of digital transformation in healthcare will be discussed, and previous work studying them based on the consulted bibliography will be presented.

2.5.1 Contextualization and Interconnections of the Constructs

Before detailing each construct individually, it is important to note that the bibliography suggests interconnections between them. For example, digital literacy is often seen as a facilitator or prerequisite for digital inclusion (Ahmed et al., 2022; Connolly et al., 2025; Connolly et al., 2024; Arias López et al., 2023; Santos-Jaén et al., 2022; Tegegne et al., 2023; Wrona et al., 2025) and impacts technology adoption (Chen, 2021; Wang, 2023) and patient satisfaction with digital services (Almaghaslah et al., 2022; Baniasadi et al., 2023; Hamasaki, 2024; Tossaint-Schoenmakers et al., 2021). The digital maturity of healthcare organizations, in turn, is associated with patients/professional satisfaction (Almaghaslah et al., 2022; Baniasadi et al., 2023; Hamasaki, 2024; Ploog et al., 2022; Santos-Jaén et al., 2022; Tossaint-Schoenmakers et al., 2021; Vogel et al., 2024). Digital inclusion also influences satisfaction (Ahmed et al., 2022; Bancsik et al., 2024; Friedel et al., 2023; Khan et al., 2022; Ploog et al., 2022; Santos-Jaén et al., 2022; Xing et al., 2024; Yan et al., 2024). The individual exploration of these constructs in the following sections will allow for a deeper understanding of their natures and, subsequently, facilitate the analysis of their joint interaction.

2.5.2 Digital Literacy

Digital literacy, in the context of healthcare, refers to users ability to access, understand, evaluate, and use health information and services through digital technologies (Arias López et al., 2023). Its importance is underscored by the fundamental need it represents for the effective adoption of health technologies, such as artificial intelligence (AI) (Adel, 2022; Bekele et al., 2024; Connolly et al., 2024; Arias López et al., 2023; Fitzpatrick, 2023; Jeong et al., 2019; Tartaglia et al., 2024; Tegegne et al., 2023; Temsah et al., 2023; J. Wang, 2023).

Studies in the bibliography explore the levels of digital literacy in various healthcare contexts and populations. For example, the digital literacy of healthcare professionals in Ethiopia was evaluated in studies (Bekele et al., 2024; Tegegne et al., 2023), and the health technology literacy of patients in a psychiatry clinic was investigated (Tartaglia et al., 2024). Digital literacy is seen as a key contributor to eHealth literacy and its importance for health science students is also highlighted (Lee, 2018).

The impact of digital literacy on the adoption of health technologies is evident, with studies associating lower digital literacy with demographic factors that can hinder access

and use and indicating that digital literacy predicts the use of m-health apps (Melhem et al., 2023). Promoting digital health literacy, especially in disadvantaged life situations, is considered essential for improving digital maturity and inclusion (Wrona et al., 2025).

2.5.3 Digital Maturity

Digital maturity, in the context of healthcare organizations, refers to the level of development and integration of digital technologies in their operations, processes, and culture. Although the bibliography provides examples of studies that address digital maturity, it does not explicitly detail the models or scales used to measure it. However, the results presented allow inferring that digital maturity involves the adoption of digitally advanced systems and services, as evidenced by satisfaction with electronic prescribing. How healthcare organizations evolve digitally can be inferred from the studied impacts. The digital maturity of a healthcare provider influences processes and outcomes, suggesting a process of evolution where the development of the digital structure directly affects operation and outcomes (Albrecht et al., 2020; Tossaint-Schoenmakers et al., 2021). The association between hospital profitability and digital maturity also indicates that digitalization has significant implications for organizational performance (Vogel et al., 2024). The digital literacy of professionals and their ability to adopt new technologies, such as AI, are also factors that contribute to the organization's digital maturity (Bekele et al., 2024; Chereka et al., 2024; Tegegne et al., 2023; Wang, 2023).

2.5.4 Satisfaction

Satisfaction, whether of users or professionals, in the context of digitalized healthcare services, refers to their positive perceptions and evaluations regarding the use of digital technologies and services. Although the bibliography does not describe specific models for measuring satisfaction with digital services in detail, it presents multiple studies that analyse satisfaction in relation to different digital solutions in healthcare. Studies investigate user satisfaction with services such as electronic prescribing (Almaghaslah et al., 2022; Hamasaki, 2024; Ploog et al., 2022). The development of mobile health applications has user satisfaction as a key outcome of interest (Baniyadi et al., 2023). User satisfaction is also analysed in relation to factors such as waiting times and healthcare spending, which can be influenced by digitalization and accessibility (Santos-Jaén et al., 2022).

The relationship between digital inclusion and satisfaction is explored, suggesting that access to and the ability to use digital tools and participate in different care modalities influence satisfaction (Ahmed et al., 2022; Khan et al., 2022; Ploog et al., 2022; Santos-Jaén et al., 2022; Xing et al., 2020). The evaluation of satisfaction is, in fact, used to measure patient experience and how well they are served by healthcare systems (Bancsik et al., 2024; Friedel et al., 2023). Although professional satisfaction is explicitly mentioned in the construct combination, the provided bibliography predominantly focuses on user satisfaction in relation to digital services and technologies.

2.5.5 Digital Inclusion

Digital inclusion in healthcare refers to ensuring that all individuals, regardless of their socioeconomic or digital characteristics, have equitable access to and the ability to fully participate in the digital health environment. The bibliography highlights that digital inclusion is intrinsically linked to digital literacy, with the latter being a prerequisite for inclusion (Ahmed et al., 2022; Connolly et al., 2024; Arias López et al., 2023; Jeong et al., 2019; Lee, 2018; Rydzewski, 2025; Santos-Jaén et al., 2022; Tegegne et al., 2023).

Studies identify various barriers and facilitators to equitable access to health technologies. Digital inequality is recognized as a problem that hinders sustainable development (Rydzewski, 2025). Populations such as the elderly living alone are particularly relevant in the study of the impact of digital inclusion on health (Xing et al., 2020). Promoting digital health literacy is seen as a means to promote inclusion, especially for groups in disadvantaged situations (Doueiri et al., 2024; Poduval et al., 2025; Wrona et al., 2025), are examples of efforts to facilitate equitable access. The evaluation of care delivery models for specific populations, such as older people with multimorbidity, also implicitly addresses the need for models that ensure their effective inclusion in healthcare services (Ahmed et al., 2022).

2.6. Relationship between Constructs

Digital transformation in healthcare services and the impact of the constructs of digital literacy, digital inclusion, digital maturity, and satisfaction can be framed and understood in light of existing theoretical models and empirical studies exploring similar relationships. While the provided bibliography does not present a single theoretical model that explicitly integrates all four of these constructs, the Donabedian Model emerges as a

relevant framework for understanding part of these interconnections, and various empirical studies address the relationships between combinations of these elements.

A pertinent theoretical model found in the shared literature is the Donabedian Model, explicitly used in the systematic review by Tossaint-Schoenmakers et al (2021). This classic model evaluates the quality of healthcare through three dimensions: Structure, Process, and Outcome. In the context of digitalization, the digital maturity of a healthcare provider is framed as a dimension of Structure. The study by Tossaint-Schoenmakers et al (2021) indicates that this digital maturity (Structure) directly influences care Processes and, consequently, Outcomes, among which patient satisfaction is included. This suggests that at the organizational level, the digital foundation and the degree of technological development (Digital Maturity) are fundamental to shaping how healthcare services are delivered digitally and the outcomes perceived by users. The study of Vogel *et al* (2024) corroborates the importance of digital maturity by suggesting an association between it and hospital profitability, an indicator of organizational performance that can be influenced by the outcomes of care processes (Vogel et al., 2024).

In addition to the framework provided by the Donabedian Model concerning digital maturity and satisfaction, the bibliography presents empirical studies that explore relationships between other pairs of the constructs under analysis, even without explicitly stating an integrating theoretical model for all of them. For instance, the relationship between digital literacy and digital inclusion is widely explored, with investigations indicating that digital literacy is a prerequisite for inclusion (Ahmed et al., 2022; Connolly et al., 2024; Arias López et al., 2023; Jeong et al., 2019; Lee, 2018; Rydzewski, 2025; Santos-Jaén et al., 2022; Tegegne et al., 2023) and that digital literacy impacts inclusion in specific populations like the elderly (Xing et al., 2024).

The relationship between digital literacy and satisfaction is also empirically addressed, showing that digital literacy influences user satisfaction with digital services such as telemedicine and electronic prescribing (Almaghaslah et al., 2022; Baniyadi et al., 2023; Hamasaki, 2024; Tossaint-Schoenmakers et al., 2021).

Additionally, studies explore the relationship between digital inclusion and satisfaction, suggesting that access to and participation in digitalized healthcare services affect user satisfaction (Ahmed et al., 2022; Bancsik et al., 2024; Friedel et al., 2023; Khan et al., 2022; Ploog et al., 2022; Santos-Jaén et al., 2022; Xing et al., 2024).

2.6.1 Justification for Adapting or Creating the Theoretical Model

The literature review based on the provided bibliography reveals that, although the Donabedian Model offers a useful framework for relating digital maturity to outcomes (including satisfaction), and empirical studies demonstrate relationships between pairs of the constructs under analysis (digital literacy, digital inclusion, digital maturity, satisfaction), no existing theoretical model was identified in your bibliography that explicitly and comprehensively integrates all four constructs under study in the specific context of digital transformation in healthcare services.

This gap in the scientific literature, as identified, justifies the need for the present research to propose and justify the adaptation of an existing theoretical model or the creation of a new theoretical model. A model (Figure 6) that integrates digital literacy and digital inclusion as factors that can influence the digital maturity of organizations and the ability of users and professionals to interact with digital systems, and which, in turn, considers how digital maturity and interaction mediated by literacy and inclusion impact the satisfaction of all stakeholders, would represent an original and valuable contribution to the understanding of digital transformation in healthcare. The construction or adaptation of this model will allow for a more holistic analysis of the complex interrelationships between these constructs in the investigated context, going beyond approaches focused only on bilateral relationships.

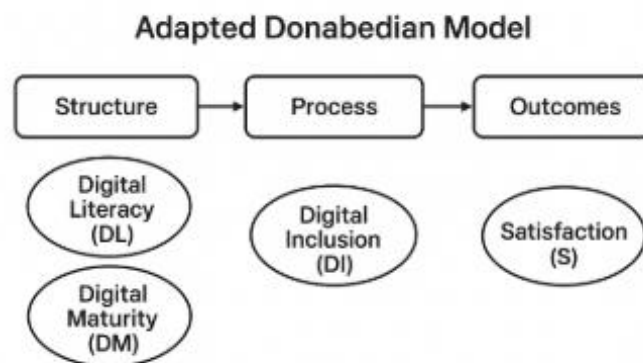


Figure 6 – Adapted Donabedian Model Identification of Gaps in the Literature
((Donabedian, 2005))

The literature review allowed for mapping the existing knowledge on digital transformation in healthcare services in relation to the constructs of digital literacy, digital

inclusion, digital maturity, and satisfaction. However, this analysis also revealed important gaps that justify the need for the present research.

2.6.2 What has already been studied

The existing literature individually addresses digital literacy, defining it and exploring its importance for the adoption of health technologies and for different populations, including professionals and users in various contexts.

The digital maturity of healthcare organizations a topic of investigation, with the bibliography indicating its influence on organizational processes and outcomes, such as profitability and patient satisfaction, with the Donabedian Model being used to frame this relationship between digital structure and outcomes (Tossaint-Schoenmakers et al., 2021).

The Donabedian model provides a widely accepted framework for evaluating healthcare quality through the lens of Structure, Process, and Outcome. The reviewed literature includes several studies that have applied this model to analyse diverse aspects of healthcare delivery, from the quality of clinical procedures to the integration of eHealth and responses to public health crises. Table 2 summarizes studies, highlighting how the Donabedian framework was employed to structure their analysis and key findings related to its application.

Table 2 – Application Studies of the Donabedian Framework

Authors	Year	Study Topic/Focus	Application of Donabedian Framework (Structure, Process, Outcome elements studied)	Key Findings Relevant (Focus on framework application)
Tossaint-Schoenmakers et al.	2021	eHealth Integration into Healthcare	Applied to synthesize how eHealth Structure (e.g., infrastructure and usability of eHealth) influences Processes (e.g., workflows) and impacts Outcomes (e.g., efficiency, patient satisfaction).	Demonstrated that successful eHealth integration and its impact on outcomes, including patient satisfaction, depend on attention to structural and process factors related to digital implementation. (High Relevance)
Gebrie et al.	2021	Quality of Adolescent and Youth-Friendly Health Services	Used to evaluate service quality by examining Structure (e.g., resources, training), Process (e.g., provider-client interaction), and Outcomes (client satisfaction, utilization).	Identified structural and process factors affecting service quality and client satisfaction, positioning satisfaction as a central outcome in quality assessment. (Relevance for Satisfaction)
Binder et al.	2021	Hospital Emergency Department Response to the COVID-19 Pandemic	Applied to structure the description of changes in structure (e.g., physical space, equipment) and process (e.g., protocols) implemented to achieve patient/staff safety outcomes.	Illustrated how the S-P-O lens helped manage a rapid response to a crisis in a hospital setting, linking changes in structure and process to quality and safety outcomes. (Relevance for Hospital Context/S-P-O)
Santry et al.	2020	Quality of Emergency General Surgery (EGS)	Used an S-P-O approach to identify structures (e.g., dedicated teams, protocols) and processes (e.g., consultation timing) associated with quality outcomes in surgery.	Identified crucial structural and process factors for emergency surgery quality, demonstrating the model's application in a specific clinical context. (Relevance for S-P-O Application in Clinical Context)
Guta	2022	Quality of Neonatal Resuscitation and its Outcome	Applied to evaluate the quality of the neonatal resuscitation process, its outcome (e.g., survival) and associated factors (Structure/Process).	Evaluated the quality of a specific clinical process, identifying structural and process factors influencing neonatal resuscitation outcomes. (Relevance for S-P-O Application in Specific Clinical Process)

The study by Tossaint-Schoenmakers et al. (2021) stands out due to its direct relevance to our research. This systematic review specifically used the Donabedian model

to analyse the integration of eHealth into healthcare. The authors explored how the Structure related to eHealth (e.g., technological infrastructure, usability and design of digital systems, which can be seen as components of digital maturity) influences Processes (how clinical workflows adapt, the interaction between professionals and users with technology) and impacts Outcomes, crucially including patient satisfaction. The findings of this study indicate that successful eHealth integration, leading to positive outcomes such as increased patient satisfaction, fundamentally depends on addressing the structural factors and processes involved in digital implementation. This study validates the use of Donabedian to explicitly link digital health aspects to important outcomes for the user. Other studies in the table demonstrate the application of the Donabedian framework in different contexts, with varying degrees of relevance to our constructs. The work by Gebrie et al. (2021), although focused on the quality of health services for adolescents and youth and not specifically on digital health, is relevant because it positions patient satisfaction as a central Outcome in the evaluation of quality. This investigation examined how Structure factors (resources, staff training) and Process factors (interaction, confidentiality) influence perceived quality and satisfaction, reinforcing the model's utility in analysing satisfaction as an outcome directly affected by the structure and process of services (Gebrie et al., 2021).

The case study by Binder et al. (2021), which describes a hospital emergency department's response to the COVID-19 pandemic, exemplifies the application of Donabedian in a hospital management context to navigate a crisis. The focus on Structure (physical space, equipment) and Process (protocols, team organization) aimed to achieve patient and staff safety outcomes. While not directly about digital health or patient satisfaction with digital services, it illustrates the versatility of the S-P-O model for analysing the impact of rapid organizational and structural changes on quality outcomes in a hospital environment.

Finally, the studies by Santry et al. (2020) on the quality of emergency general surgery and Guta (2022) on the quality of neonatal resuscitation demonstrate the application of the Donabedian framework in specific clinical contexts. These studies use the model to identify structures and processes that influence direct clinical outcomes (surgical quality, neonatal survival) (Guta, 2022; Santry et al., 2020). Although they do not address digital health or satisfaction in a digital context, they reinforce the conceptual basis of Donabedian in analysing how inputs (Structure) and activities (Process) within a

healthcare system affect outcomes, providing a methodological parallel for its digital application.

In summary, the analysis of these studies applying the Donabedian framework validates its relevance as a conceptual model for our research. Notably, the work by Tossaint-Schoenmakers et al. (2021) offers a clear precedent for using Donabedian to analyse the relationship between digital elements, and Satisfaction (the Outcome) in the context of healthcare. The other studies demonstrate the flexibility of the model in different areas of healthcare and in analysing satisfaction as an outcome, providing additional support for its adaptation to the specific context of research on digital transformation and user experience in health.

The satisfaction of users and professionals with digital services is widely investigated, with studies analysing perceptions regarding specific solutions like electronic prescribing, telemedicine, and mobile applications, and using satisfaction as an indicator of patient experience with digitalization (Almaghaslah et al., 2022; Bancsik et al., 2024; Baniasadi et al., 2023; Friedel et al., 2023; Hamasaki, 2024; Khan et al., 2022; Ploog et al., 2022; Santos-Jaén et al., 2022).

Digital inclusion in healthcare is recognized as an important aspect, with the literature exploring barriers to equitable access to health technologies and highlighting the intrinsic relationship between digital inclusion and digital literacy, especially for vulnerable populations (Adams et al., 2025; Ahmed et al., 2022; Caissie et al., 2025; Choi et al., 2022; H. Connolly et al., 2024; Poduval et al., 2025; Reidy et al., 2025; Rydzewski, 2025; Soegoto et al., 2025; Wrona et al., 2025; Yan et al., 2024).

There are empirical studies exploring relationships between pairs of these constructs, such as the influence of digital literacy on digital inclusion (Ahmed et al., 2022; Almaghaslah et al., 2022; Bancsik et al., 2024; Baniasadi et al., 2023; Friedel et al., 2023; Hamasaki, 2024; Khan et al., 2022; Ploog et al., 2022; Santos-Jaén et al., 2022; Tossaint-Schoenmakers et al., 2021; Xing et al., 2020).

What still needs to be explored (Gaps):

Despite the advancements in understanding these constructs individually and in pairs, the main gap identified in the literature based on the provided bibliography is the absence of a structured study or an explicit theoretical model that simultaneously and comprehensively integrates all four constructs (digital literacy, digital inclusion, digital

maturity, and satisfaction) in the specific context of digital transformation in healthcare services. Although the Donabedian Model is relevant, but it does not yet explicitly incorporate digital literacy and digital inclusion as dimensions in its application to digital health, focusing more on maturity as a structure. Existing studies exploring relationships tend to do so bilaterally, without analysing the complex interdependence and joint interaction of all four elements within a single conceptual or empirical framework in the healthcare sector.

How this investigation contributes to filling these gaps:

- Proposing an (adapted or new) theoretical model that explicitly integrates the four constructs (digital literacy, digital inclusion, digital maturity, and satisfaction), allowing for a more holistic understanding of their interrelationships in the process of digital transformation in healthcare.
- Conducting a structured empirical analysis that investigates the joint interaction of these four constructs, providing evidence on how digital literacy and inclusion can influence the digital maturity of organizations and the satisfaction of stakeholders in the healthcare sector.
- Offering practical insights for healthcare managers and decision-makers on how to address technological, skills, equity, and user experience aspects in an integrated manner to drive effective digital transformation.
- Establishing a basis for future research that aims to deeply explore the complex dynamics between digital literacy, digital inclusion, digital maturity, and satisfaction in the context of digital health, using or refining the proposed model.

By focusing on the integration of these four elements in a single structured study and a conceptual model, the present research offers an original and relevant contribution to the advancement of knowledge in the field of digital transformation in healthcare services, addressing a clear gap identified in the literature.

2.7. Summary

The present literature review explored the landscape of research on digital transformation in healthcare services, with a particular focus on the constructs of digital literacy, digital inclusion, digital maturity, and satisfaction. Throughout this chapter, the growing relevance of the topic in the scientific literature and its multifaceted applicability in the

healthcare sector became evident, ranging from the adoption of advanced technologies like AI and the metaverse (J. Wang, 2023) to the impact on health literacy and professional skills (Fitzpatrick, 2023; Tegegne et al., 2023).

The four central constructs were detailed, presenting their definitions, importance, and findings from previous studies. It was observed that digital literacy is crucial for technology adoption and digital maturity (Lee, 2018; Wang, 2023) and is intrinsically linked to digital inclusion (Ahmed et al., 2022; Almaghaslah et al., 2022; Bancsik et al., 2024; Baniyadi et al., 2023; Connolly et al., 2024; Friedel et al., 2023; Hamasaki, 2024; Khan et al., 2022; Ploog et al., 2022; Rydzewski, 2025; Santos-Jaén et al., 2022; Tossaint-Schoenmakers et al., 2021; Xing et al., 2020). The Donabedian Model proved relevant for framing the relationship between digital maturity (Structure) and outcomes like satisfaction (Tossaint-Schoenmakers et al., 2021).

Despite this consolidated knowledge about the constructs individually and their relationships in pairs, the literature review based on the provided bibliography identified a clear gap: the absence of a structured study or an explicit theoretical model that comprehensively integrates all four constructs (digital literacy, digital inclusion, digital maturity, and satisfaction) in the specific context of digital transformation in healthcare services. Existing studies explore the interconnections in a fragmented manner, without offering a holistic perspective on the joint interaction of these elements.

It is fundamental to develop or adapt a theoretical model that integrates the four constructs and to conduct empirical research that analyses their joint relationship within the healthcare sector. Significantly, the literature review supporting this framework has been published in the *International Journal of Healthcare Technology and Management* (Geada et al., 2025). Therefore, this investigation contributes to filling the identified gap by investigating, in an integrated manner, how digital literacy and digital inclusion influence the digital maturity of healthcare organisations and the satisfaction of users and professionals. By doing so, the research not only advances theoretical knowledge by proposing and testing a more comprehensive model but also offers crucial practical insights for the successful implementation of digital transformation in healthcare, ensuring that technological efforts consider user skills, equity in access, and the overall experience of all stakeholders.

CHAPTER 3

Research hypotheses

The healthcare sector is undergoing a profound and transformative shift driven by digital technologies. Digital transformation is fundamentally reshaping how care is delivered, managed, and experienced, moving beyond mere technological adoption to a comprehensive restructuring of processes, organizational culture, and business models (Westerman et al., 2019; Zhang, 2024). From the digitization of patient records and the proliferation of telemedicine solutions to the integration of artificial intelligence (AI) in diagnostics and personalized medicine, digital tools are becoming central to modern healthcare (Xing et al., 2024; Yan et al., 2024). This ongoing paradigm shift aims to enhance operational efficiency, improve the quality of care, optimize resource allocation, and ultimately elevate the experience of both patients and healthcare professionals. However, the journey towards a fully digitized healthcare ecosystem is not without its challenges and opportunities. Key challenges include overcoming resistance to change among stakeholders, ensuring robust and secure digital infrastructure, addressing data privacy concerns, and mitigating the exacerbation of digital inequalities that could limit access to care for vulnerable populations (Anunciacao & Geada, 2021; Bogodistov et al., 2020; Zhang, 2024; Zhang et al., 2019). Despite these hurdles, digital transformation presents immense opportunities: it promises more accessible healthcare through remote consultations and monitoring, enables personalized care pathways based on vast data insights, fosters greater patient engagement, and supports continuous innovation in medical practices and service delivery (Dons et al., 2024; Xing et al., 2024). By strategically leveraging digital advancements, healthcare organizations can achieve greater effectiveness, sustainability, and responsiveness to evolving health needs. Digital transformation in healthcare refers to the strategic adoption and integration of digital technologies to improve delivery, management, and experience of care. This shift goes beyond the implementation of tools such as electronic health records or telemedicine platforms. It encompasses changes in organizational culture, workflows, patient-professional interactions, and the overall structure of service provision (Albrecht et al., 2020; Tossaint-Schoenmakers et al., 2021). Recent studies show that successful digital transformation depends not only on technological investment but also on the development of human capabilities, particularly digital literacy, and on the organization's level of digital maturity (Arias López et al., 2023; Chen, 2021; Tegegne et al., 2023). So, user

satisfaction has become a key performance indicator, as it reflects the perceived value and usability of digital health systems (Baniasadi et al., 2023; Friedel et al., 2023).

Building upon this comprehensive literature review, the conceptual model on the present investigation was systematically developed. This development process was significantly enriched by valuable preliminary qualitative insights, as detailed below.

Specifically, a **focus group² with healthcare professionals**, whose results were detailed and published in, *International Journal of Healthcare Technology and Management*, and 19th Iberian Conference on Information Systems and Technologies (CISTI 2024) offered an **in-depth perspective on the implementation and challenges of digital transformation in healthcare organizations in Portugal**, Geada et al. (2025),. Participating professionals in the focus group emphasized the **importance of change, leadership and process innovation as critical factors for the success of digital transformation** (Geada et al., 2025) (Geada & Alturas, 2026).

The focus group findings served as an empirical complement to the literature review, providing a **contextualized and practitioner-validated foundation** for the development of our conceptual model and for the formulation of the hypotheses tested in the quantitative phase of this investigation.

These practical insights were crucial for:

- **Refining our understanding of the Digital Maturity construct** within the healthcare context. Discussions highlighted that organizational maturity is not solely a technological issue but also involves change management capabilities, inspirational leadership, and process innovation elements that were directly reflected in the conceptualization of Digital Maturity in our model.
- **Contextualizing the dynamics of Digital Literacy and Inclusion.** Although the focus group concentrated on professionals, their experiences with implementing digital solutions and the need to overcome resistance and empower employees (change leadership) provided a basis for inferring analogous challenges that patients might face in adopting and using digital health services. This reinforced

² Appendix B – Focus Group Questions

the relevance of investigating digital literacy and inclusion from the patient's perspective.

- **Grounding the link to Satisfaction.** The emphasis on successful implementation and process innovation as mediators of leadership and organizational capability implied that the effectiveness of digital transformation, driven by greater maturity and inclusion, would ultimately lead to improved experiences and higher satisfaction for healthcare service users, including patients.

3.1. Hypotheses proposed

3.1.1 H1: Digital Literacy positively influences Digital Inclusion

Digital literacy has emerged as a fundamental competency in contemporary society, extending beyond mere technical proficiency to encompass a broader set of cognitive and social skills required for navigating digital environments (Alma Çallı & Çallı, 2021; Cetindamar et al., 2024; Eshet-Alkalai, 2004; van der Vaart & Drossaert, 2017). Conceptually, it involves the ability to locate, evaluate, create, and communicate information on digital platforms, while also navigating the ethical and safety implications of digital engagement (Helsper & Van Deursen, 2015; van der Vaart & Drossaert, 2017).

In the healthcare context, digital literacy is defined as the ability of both patients and professionals to access, understand, and effectively use digital technologies (Arias López et al., 2023). This competency is a crucial prerequisite for navigating e-health platforms, understanding online health information, and engaging in digital communication with providers (Norman et al., 2020; F. Wang et al., 2021; J. Wang, 2023).

Research consistently identifies digital literacy as a foundational element that enables individuals to overcome barriers to technology adoption (Adeogun & Faezipour, 2025). By empowering individuals with the necessary skills to participate in and derive benefits from digital services, digital literacy directly fosters a more inclusive digital environment (Helsper & Van Deursen, 2015; Morris et al., 2023). When individuals possess the capacity to access and effectively apply digital information, they are better positioned to actively engage in the digital sphere, thereby reducing the digital divide. Consequently, it is argued that the acquisition of digital skills is a direct antecedent to achieving digital inclusion.

Based on this rationale, the following hypothesis is proposed:

- **H1: Digital Literacy positively influences Digital Inclusion.**

3.1.2 H2: Digital Literacy positively influences Digital Maturity

The digital maturity of an organization is not merely a consequence of technological investment, but a reflection of its internal capacity to integrate and optimize digital solutions into its core processes. In this context, the collective digital literacy of an organization's workforce emerges as a significant driver of its overall digital maturity. The effective adoption and utilization of digital technologies are inherently dependent on the competencies, skills, and cognitive readiness of the individuals within the organization (Fitzpatrick, 2023; Westerman et al., 2019).

Organizations that foster high levels of digital literacy among their professionals are better positioned to implement, adapt, and innovate with digital solutions. When staff members possess the requisite technical and informational skills, the organization transcends basic technology usage, moving toward a more sophisticated stage of integration where digital tools actively enhance operational efficiency and strategic decision-making. Consequently, individual proficiency acts as the foundational engine for systemic advancement, enabling the organization to reach higher levels of maturity. Based on this progression, the following hypothesis is proposed:

- **H2: Digital Literacy positively influences Digital Maturity.**

3.1.3 H3: Digital Inclusion positively influences Digital Maturity

Digital inclusion in healthcare extends beyond mere physical access to technology, encompassing a comprehensive framework that ensures all stakeholders possess the capabilities and opportunities to effectively utilize digital resources (Selwyn, 2016; van Dijk et al., 2010). It involves providing equitable access to digital devices, internet connectivity, and relevant support mechanisms, thereby preventing exclusion and fostering full participation in the digital health environment (Helsper & Van Deursen, 2015; Warsame et al., 2020) (Helsper & Van Deursen, 2015; van der Vaart & Drossaert, 2017).

Digital inclusion plays a significant role in fostering an organization's journey towards higher digital maturity. Digital maturity reflects the extent to which an organization effectively integrates digital technologies across its functions and processes to maximize value (Gartner et al., 2022; Gill et al., 2020). Organizations that actively promote digital inclusion both among internal staff and external patients are better positioned to overcome fundamental barriers to technology adoption. By ensuring widespread and effective utilization of digital tools, these organizations create an environment where technology is not just implemented but fully leveraged for operational excellence and integrated service delivery. Consequently, fostering inclusivity among stakeholders is a critical driver that elevates the overall digital maturity of the organization.

Based on this relationship, the following hypothesis is proposed:

- **H3: Digital Inclusion positively influences Digital Maturity.**

It is essential to highlight that the relationship between inclusion and digital maturity is not merely instrumental, but synergistic. An organization that promotes digital inclusion is, simultaneously, preparing its ecosystem for a more comprehensive utilization of its tools. Thus, digitalization lacking an inclusive approach remains an isolated technological effort, incapable of scaling organizational maturity, as technology underutilized by marginalized users does not contribute to the optimization of digital processes.

3.1.4 H4: Digital Inclusion positively influences Satisfaction

In the context of digital healthcare, satisfaction refers to the user's subjective evaluation of the quality, usability, and effectiveness of digital services (Friedel et al., 2023; Ploog et al., 2022). It represents the outcome of a comparison between the perceived performance of digital platforms and the user's initial expectations. As digital interfaces increasingly mediate healthcare interactions, patient satisfaction has become a critical indicator of service quality, institutional reputation, and patient loyalty (Binder et al., 2021; Wong et al., 2020).

Digital inclusion is a key driver of this satisfaction. When individuals feel digitally included meaning they have effective, equitable access to digital health services,

alongside the necessary support to navigate them their overall experience is significantly enhanced. Furthermore, feeling digitally included in healthcare processes, characterized by facilitated access to digital services and adequate support, is a crucial factor for patient satisfaction. When individuals perceive that digital healthcare tools are accessible, easy to use, and responsive to their needs, their overall satisfaction with the healthcare experience is likely to increase (Ammenwerth et al., 2003). By ensuring that stakeholders feel empowered to engage with digital health tools, organizations not only facilitate usage but also cultivate higher levels of contentment and trust among their users (Almaghaslah et al., 2022; Cresswell et al., 2022; Santos-Jaén et al., 2022).

Based on this positive relationship, the following hypothesis is proposed:

- **H4: Digital Inclusion positively influences Satisfaction.**

In this model, satisfaction is analysed under two distinct dimensions that reflect Donabedian's framework. In **H4**, user satisfaction is interpreted as a result of *direct experience*, focused on ease of access, usability, and the removal of barriers to inclusion. Conversely, **H5** approaches satisfaction as a reflection of *systemic robustness*, where the organization's digital maturity ensures trust, security, and the continuous effectiveness of the service. While H4 reflects satisfaction 'in interaction,' H5 will reflect satisfaction in institutional trust.

3.1.5 H5: Digital Maturity positively influences Satisfaction

Digital maturity reflects the extent to which an organization has successfully integrated digital technologies across its functions, processes, and strategic vision. Following the perspective of the Donabedian model, maturity functions as a measure of structural and process quality; as healthcare organizations advance in their digital maturity, they are better equipped to provide more sophisticated, integrated, and user-friendly digital services (Gartner et al., 2022; Gill et al., 2020).

These advancements in digital service delivery directly influence user outcomes, specifically patient satisfaction. Highly mature organizations offer more streamlined processes, improved data accessibility, and enhanced user experiences, which effectively reduce interaction friction and increase service reliability. When digital infrastructures are robust and strategically aligned, they provide a stable environment that consistently

meets or exceeds user expectations. Consequently, the transition toward higher levels of digital maturity is a significant determinant of improved user appraisal and contentment with digital health services (Adeogun & Faezipour, 2025; Agarwal et al., 2025; Almaghaslah et al., 2022; Donabedian, 2005; Friedel et al., 2023).

Based on this rationale, the following hypothesis is proposed:

- **H5: Digital Maturity positively influences Satisfaction.**

3.2. Research Model Conceptual Model

The proposed research model, illustrated in Figure 1, hypothesis Model, the outlines the relationships between key constructs in the context of digital transformation in healthcare. Grounded in theoretical foundations, the model explores how digital transformation acts as a driving force behind pedagogical organization, sustainability, and leadership dynamics. The following hypotheses have been formulated to examine these interconnections and their implications. To explore the impact of digital capabilities and organizational readiness on patient satisfaction, this investigation proposes a conceptual model comprising four key constructs: Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction. These constructs are interlinked through five hypotheses (Table 3) that reflect both direct and mediated relationships, as illustrated in Figure 7.

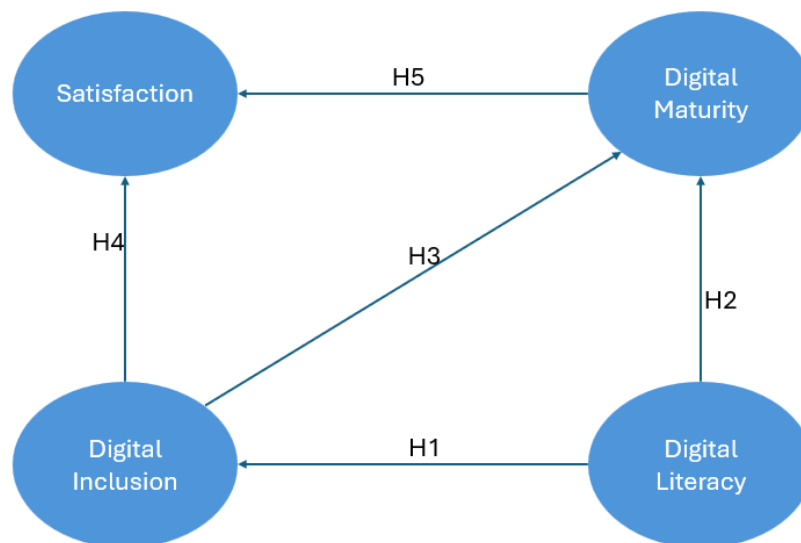


Figure 7 – Proposed Integrated Conceptual Model

This section outlines the conceptual model developed to investigate the impact of digital transformation on healthcare organizations in Portugal. The model proposes a set of relationships between key constructs, aiming to provide a theoretical framework for understanding how various digital factors contribute to organizational outcomes.

The core constructs of this study's conceptual model are:

- **Digital Literacy:** Refers to the ability of individuals within healthcare organizations to find, evaluate, create, and communicate information using digital technologies, and to understand and use these technologies effectively and critically.
- **Digital Inclusion:** Encompasses the efforts to ensure that all individuals and groups, regardless of their socio-economic status, location, or physical abilities, have access to and can effectively use information and communication technologies. In the context of healthcare organizations, this pertains to the equitable access and utilization of digital tools and services by staff and, implicitly, patients.
- **Digital Maturity:** Represents the extent to which an organization has integrated digital technologies and processes across all aspects of its operations, transforming its culture, strategy, and capabilities to leverage the full potential of digital transformation.
- **Satisfaction:** Pertains to the overall contentment and positive perception of stakeholders (e.g., employees, patients, or management, depending on the specific focus of your "Satisfaction" variable) regarding the digital transformation initiatives and their outcomes within the healthcare organization.

In the present study, the construction of the conceptual model is fundamental to outlining the research approach and establishing the theoretical framework that will guide the analysis. This model not only graphically represents the proposed interrelationships between the key constructs – Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction – but also serves as a bridge between the overall research objectives, the specific questions to be addressed, and the hypotheses that will be empirically tested.

3.3. Research Questions & Hypotheses

Table 3 synthesizes this model, presenting the direct correspondence between the Research Questions (RQ), the Specific Objectives (SO) of the study, and the proposed Hypotheses(H). Each Research Question reflects a particular aspect to be explored, derived directly from the Specific Objectives that the study aims to achieve. In turn, the Hypotheses (H1 to H5) represent theoretical assumptions grounded in existing literature, postulating the nature and direction of the expected relationships between the constructs.

Specifically, the hypotheses were formulated based on theoretical considerations and literature evidence to examine the proposed interrelationships within the context of within the Portuguese healthcare context, to provide an articulation between questions, objectives, and hypotheses not only ensures the methodological coherence of the study but also establishes the foundation for data collection and analysis, allowing for the empirical validation of the proposed theoretical relationships.

Table 3 –Research Framework: Objectives, Questions, and Hypotheses Alignment

Research Questions (RQ)	Specific Objectives (SO)	Hypothesis (H)
RQ1: How does the level of digital literacy among healthcare patients affect the digital maturity of healthcare services?	SO1: Analyse the influence of Digital Literacy on the adoption, implementation and evolution of digital transformation, as represented by Digital Maturity.	H2: Digital literacy positively influences digital maturity.
RQ2: What is the relationship between the extent of digital inclusion of patients and healthcare professionals and the digital maturity of healthcare services?	SO2: Investigate the complex relationships and mediating effects between Digital Literacy, Digital Inclusion and Digital Maturity.	H3: Digital inclusion positively influences digital maturity.
RQ3: To what extent does the digital maturity of healthcare services and systems influence patient satisfaction?	SO3: Explore and validate the relationships between the constructs of Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction.	H5: Digital maturity positively influences satisfaction.
RQ4: How does digital literacy impact the degree to which patients are digitally included in healthcare services?		H1: Digital literacy positively influences digital inclusion.
RQ5: Does the level of digital literacy among patients affect their satisfaction with healthcare services?	SO4: Assess the influence of Digital Literacy and Digital Inclusion on Satisfaction, exploring both their direct and indirect effects through Digital Maturity.	H4: Digital inclusion positively influences satisfaction.
RQ6: Is there a relationship between the level of digital inclusion of patients and their satisfaction with healthcare services?		

This provides a structured approach to empirically investigate the intricate relationships between digital literacy, digital inclusion, digital maturity, and satisfaction within the Portuguese healthcare context. However, a comprehensive understanding of these phenomena necessitates not only the articulation of a theoretical framework but also a critical assessment of existing academic discourse. While the proposed hypotheses are grounded in prevailing literature, it is crucial to identify areas where current research falls short or where specific contextual insights are lacking. Therefore, the subsequent section, Chapter 2.8, will point into a detailed 'Identification of Gaps in the Literature.' This critical review will highlight the unique contributions this study aims to make, by addressing unexplored relationships, employing novel methodologies, or providing empirical evidence within the specific context under investigation, thereby justifying the relevance and necessity of the present research.

3.4. Summary

This section outlines the specific research hypotheses formulated to address the identified gaps in the existing literature and guide the empirical investigation. Building upon the theoretical framework established in Chapter 2, a conceptual model is proposed illustrating the hypothesized relationships among the key constructs: Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction within the context of healthcare services.

Each hypothesis posits a direct or indirect relationship between these variables, reflecting the study's aim to understand how patient digital capabilities and organizational digital maturity influence patient experience. For instance, hypotheses detail the expected impact of Digital Literacy on Digital Inclusion, and subsequently, Digital Inclusion on Satisfaction. Furthermore, the section explicitly states the proposed influence of Digital Maturity on other constructs, setting the stage for empirical testing. The formulation of these hypotheses provides a clear and testable framework, serving as the foundation for the methodological design and subsequent data analysis presented in the following chapters.

CHAPTER 4

Methodology

The literature review presented in Chapter 2 highlighted the growing importance of digital transformation in healthcare services and identified significant gaps in existing knowledge, namely the absence of a theoretical or empirical model that comprehensively integrates the constructs of digital literacy, digital inclusion, digital maturity, and satisfaction. To address these gaps and answer the main research question guiding this investigation, "How can digital transformation influence healthcare organizations?", and the specific objectives defined in Section 1.3, in chapter 1, to adapt a robust and multifaceted methodological approach.

Considering the complex and multifaceted nature of digital transformation and the need to explore both the in-depth perceptions and experiences of stakeholders and to validate relationships between the constructs on a broader scale, a mixed-methods approach was chosen. This methodology combines the depth and insight of qualitative research with the capacity for generalization and statistical validation of quantitative research, offering a richer and more complete understanding of the phenomenon under study. The choice of mixed methods is directly aligned with the purpose of exploring the relationships between the constructs, conducting comparative analyses, investigating the influence of contingent factors, and assessing the impact of digital literacy on participation and satisfaction, as outlined in the specific objectives of the investigation.

The subsequent sections of this chapter detail the different elements of the research methodology, including the philosophy underpinning it, the specific mixed-methods design adopted, data collection procedures, the methods of analysis employed, and the ethical considerations observed throughout the investigation, combining both quantitative and qualitative research to thoroughly explore digital transformation in healthcare. The mixed-methods approach is chosen to provide a comprehensive understanding the factors digital inclusion, digital maturity, digital literacy influencing satisfaction in healthcare services, considering both healthcare professionals and patients.

4.1. Research Philosophy

The research philosophy underlying an investigation shape how the researcher understands reality, formulates research questions, and selects the most appropriate methods for data collection and analysis (Bryman, 2016). Given that the present investigation adopts a mixed-methods approach to explore the complexity of digital transformation in healthcare organizations, the philosophical perspective of Pragmatism proves to be the most suitable to guide this investigation.

Pragmatism, as a research philosophy, focuses on the research problem and its solutions, rather than adhering to a single view of reality (ontology) or form of knowledge (epistemology) (Alexander et al., 2022; Miller, 2021; H. Zhang et al., 2021). Allowing for the use of multiple methods and approaches (qualitative and quantitative) that are most effective in answering the specific research questions. This methodological flexibility and focus on practice make Pragmatism particularly relevant for investigating complex and multifaceted phenomena such as digital transformation in healthcare (Foncubierto-Rodriguez, 2022; Ivanova, 2021; Martins et al., 2019; McKone & Silk, 2022; Monarca et al., 2018; Morgan, 2019).

The justification for choosing Pragmatism in this investigation lies in the very nature of the investigation object. Digital transformation in healthcare organizations is not a purely objective or subjective phenomenon; involves technological, organizational, social, and human aspects that cannot be fully understood by a single philosophical or methodological approach (Ahmed et al., 2022; Almaghaslah et al., 2022; Arias López et al., 2023; Jeong et al., 2019; Khan et al., 2022; Tossaint-Schoenmakers et al., 2021; Vogel et al., 2024; Wrona et al., 2025; Yan et al., 2024). The need to investigate how individual literacy and digital inclusion interact with organizational maturity and stakeholder satisfaction requires a perspective that allows for the combination of different types of data to build a complete and useful picture. By adopting Pragmatism, this investigation legitimizes the use of qualitative methods to explore in-depth experiences and perceptions and quantitative methods to measure relationships and validate models on a broader scale, aiming to provide practical and actionable insights for the challenges of digital transformation in healthcare.

4.2. Variables Measurement

This section details the operationalization and measurement of the constructs comprising the conceptual model of this study. Each variable, whether independent, mediating, dependent, or control, was carefully defined and measured using validated scales adapted to the context of healthcare services. The measurement process aimed to ensure the reliability and validity of the data collected, providing a robust empirical basis for testing the proposed hypotheses.

4.2.1 Independent Variable

In this investigation, two key constructs are primarily conceptualized as independent variables, initiating chains of influence within the proposed model:

- **Digital Literacy:** This construct serves as a primary independent variable, representing the individual's ability to access, manage, understand, integrate, communicate, and evaluate digital information and services. It was measured through a set of items designed to capture various facets of users' digital skills and understanding in the healthcare context. As per the model, Digital Literacy is hypothesized to directly influence Digital Inclusion.
- **Digital Maturity:** This construct is also positioned as an independent variable, particularly concerning its impact on other digital capabilities. Digital Maturity reflects the organizational readiness, infrastructure, and strategic approach to digital transformation within healthcare services. It was operationalized through specific items assessing the organizational dimensions of digital advancement. The study found that Digital Maturity impacts Digital Literacy and Digital Inclusion, indicating its fundamental role as a predictor of these capabilities.

4.2.2 Variable Mediating

The conceptual model identifies Digital Inclusion as a crucial mediating variable, serving as an intermediate link between independent and dependent variables:

- **Digital Inclusion:** Defined as the degree to which individuals have equitable access to and meaningful engagement with digital healthcare services, Digital

Inclusion mediates the relationship between Digital Literacy and Patient Satisfaction. It was measured by items capturing both access to and effective utilization of digital health resources. The research posits that Digital Literacy enhances Digital Inclusion, which, in turn, is a strong predictor of patient satisfaction. Furthermore, Digital Inclusion also serves as a pathway through which Digital Maturity exerts its influence on patient outcomes.

4.2.3 Moderating Variable

A moderating variable is one that affects the strength or direction of the relationship between an independent and a dependent variable. In the conceptual model presented, no specific moderating variables were explicitly hypothesized or tested. The focus of this study was primarily on direct and mediating relationships among Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction.

4.2.4 Dependent Variable

The ultimate outcome variable of interest in this investigation, representing the consequence of the various digital transformation efforts, is Satisfaction.

- **Satisfaction (Patient Satisfaction):** This construct serves as the primary dependent variable in the model. It reflects the overall contentment and positive perception of patients regarding their experience with digital healthcare services. Patient Satisfaction was measured using a set of items designed to capture perceptions of quality, usefulness, and overall experience with digital health interactions. The study hypothesizes and empirically tests that Digital Inclusion strongly influences Patient Satisfaction, making it the final outcome of the proposed chain of effects.

4.2.5 Control Variables

Control variables are extraneous variables that could potentially influence the relationships between independent and dependent variables and are often included to minimize confounding effects or to characterize the sample. In the initial conceptualization of this study, various contingent factors were considered for their potential influence on the digital transformation process within healthcare organizations. These included:

- **Leadership:** Recognizing its potential impact on the adoption and implementation of digital transformation initiatives.
- **Age:** Acknowledging its possible influence on the acceptance and adaptability of individuals to new technologies.
- **Digital Tools:** Representing the availability and effectiveness of systems and technologies that could facilitate or hinder digital implementation.
- **Performance:** Considering various metrics of effectiveness, efficiency, or quality within healthcare services, potentially influenced by digital interventions.
- **Innovation:** Understanding its role in driving the adoption and development of new digital approaches.

However, after careful consideration of the research scope and the focus of the primary investigation, these factors were not formally included as measured variables or control variables within the final structural equation model (SEM) used to test the core hypotheses of this study. The decision to focus the SEM on the interrelationships between Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction was made to maintain model parsimony and to concentrate on the direct and mediating effects central to the research questions.

Nonetheless, certain demographic characteristics of the participants, namely age, gender, and education level, were collected during the survey. While these variables were utilized in preliminary data analyses and for sample description, providing a comprehensive profile of the study participants and enriching the context of the findings, they were not formally incorporated as control variables within the structural paths of the SEM. Their inclusion was primarily for contextualization rather than to directly control for confounding effects in the causal relationships tested by the model. Future research

could explore the role of such contingent and demographic variables as potential moderators or additional predictors within more complex models.

4.3. Research Data

This section outlines the foundational aspects of the empirical study, detailing the population from which data was collected, the methods employed for survey validation and data collection, and the demographic profile of the final sample. It establishes the empirical basis upon which the subsequent analyses of construct reliability, validity, and hypothesis testing are performed. The rigorous procedures described herein ensure the quality and representativeness of the data, thereby supporting the credibility and generalizability of the research findings.

4.3.1 Study Population

The target population for the quantitative phase of this study comprised patients who utilize or have the potential to utilize digital healthcare services in Portugal. This specific focus was chosen to directly investigate how the digital capabilities of end-users influence their perceived satisfaction and interaction with the evolving digital landscape of healthcare. The selection of patients as the study population is directly aligned with the overarching aim of understanding the impact of digital transformation from the service recipient's perspective, complementing insights previously gathered from healthcare professionals in the qualitative phase. Participants were recruited through, online distribution via social media. The primary inclusion criterion was being a user or potential user of digital healthcare services in Portugal.

Data collection efforts aimed to reach a diverse group of individuals to capture a broad spectrum of experiences and digital proficiencies. Following the data collection process, a total of 212 valid responses were obtained and included in the final analysis. This sample size was deemed appropriate for conducting the planned statistical analyses, including Structural Equation Modelling (SEM), providing sufficient statistical power to test the proposed conceptual model and its hypotheses.

The sampling process was adapted to the different phases of the mixed-methods approach:

- **Qualitative Phase (Focus Group):** For the qualitative phase, a non-probabilistic sampling approach was used, specifically a convenience and purposive sample. The focus group included five healthcare professionals working in different areas and contexts (public and private), including a medical doctor, a specialist nurse, a podologist, a superior technician in diagnosis and therapy, and a member of the hospital administration board. The aim of this purposive sampling was to gather a variety of perspectives and experiences on digital transformation in healthcare, capable of enriching the initial exploration of the phenomenon and informing the quantitative phase. The size of the qualitative sample (n=5) was considered adequate for the exploratory and in-depth perception purpose characteristic of focus groups.

To clarify the qualitative methodology employed, it should be noted that the data collection was conducted through a Focus Group session rather than individual interviews, as this allowed for a dynamic exchange of perspectives among experts. Regarding the composition of the group, although the participants are primarily senior healthcare professionals and managers, their inclusion was based on their extensive experience in managing health information systems and digital workflows. Consequently, their expertise bridges the gap between clinical practice and technology, as they are the primary decision-makers and users of digital health solutions. This dual expertise ensures that the technological dimension was robustly represented in the discussion, despite the participants not being technical engineers by primary profession.

To ensure the methodological alignment between the qualitative insights and the quantitative measurement, the questions addressed during the focus group (see Appendix B) were mapped against the core research constructs. This mapping, presented in Table 4, demonstrates how the experts' practical perspectives validate the dimensions of Digital

Transformation, Digital Maturity, Digital Inclusion, Digital Literacy, and Satisfaction that form the basis of this study.

Table 4 – Mapping Focus Group Themes to Core Research Constructs

Research Construct	Theme	Research Question (ID)	Level of Agreement	Key Participant Insights
Digital Maturity	Leadership & Culture	P1, P4, P10	100% (5/5)	Unanimous agreement that maturity is driven by leadership. It is perceived as the critical "bridge" for cultural change.
Digital Literacy	Technological Capability	P3	40% (2/5)	Lowest consensus. Scepticism from frontline staff suggests that technical capability (Literacy) alone fails without organizational integration.
Digital Inclusion	Operational Impact	P8	80% (4/5)	High agreement that clinical benefits depend on how tools are integrated across diverse medical specialties (Inclusion of all areas).
Satisfaction	Organizational Performance	P9, P5	80% - 100%	Participants link DT success to performance and satisfaction, provided that Process Innovation acts as a mediator.
Strategic Governance	Strategy & Innovation	P2, P6, P7	100% (5/5)	DT is viewed as a core strategic pillar; the maturity of the strategy directly facilitates continuous organizational innovation.

Note on Mapping Focus Group Themes to Core Research Constructs: The selection of the final constructs for the quantitative model was driven by a dual-validation process involving both the qualitative insights and an extensive systematic literature review. It is important to note that, while 'Strategic Governance' emerged as a critical theme in the Focus Group (100% consensus), it was not included as an independent latent construct in the structural model.

This decision stems from the identification of a significant **theoretical gap**: the integrated interplay between **Digital Maturity, Digital Inclusion, Digital Literacy, and Satisfaction** is currently non-existent in the literature as a unified framework. Most studies address these variables in isolation, neglecting their synergistic effect on healthcare outcomes. By prioritizing these four constructs, this thesis moves beyond the traditional 'Strategic Governance' discourse to provide a novel, empirical testing of a combination that has not yet been explored.

- **Quantitative Phase (Survey):** For the quantitative phase, the population of interest includes patients who have experienced digital and non-digital healthcare services. Quantitative data collection was conducted through a survey³ distributed via email, aiming to reaching respondent's sample. The sampling process for the survey seek to maximize the participation of users and patients to obtain data that allows for robust statistical analyses and the generalization of results. The size of the sample obtained was 212 for the quantitative phase and its detailed profile will be presented in the results analysis section.

4.3.2 Survey validation and data collection

The quantitative data for this investigation were collected through a structured self-administered questionnaire, meticulously designed to operationalize the constructs of Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction. The development of the questionnaire was based on a thorough review of existing literature and the adaptation of previously validated scales, ensuring the theoretical grounding and empirical robustness of the measurement instrument. Each construct was measured using

³ Appendix A – Quantitative Survey

a set of specific items, primarily employing a Likert Scale Type, 5-point, where participants indicated their level of agreement or frequency for each statement. The items were carefully worded to be clear, unambiguous, and relevant to the Portuguese healthcare context. Prior to full-scale data collection, the questionnaire underwent a pilot test with a small group of individuals from the target population to identify any ambiguities, ensure clarity of language, and refine the instrument.

The data collection process was conducted between October of 2024 and February of 2025. The survey was primarily disseminated online via a dedicated platform such as Google Forms, distributed through social media channels (Facebook and LinkedIn). This approach aimed to maximize reach and facilitate participation from a diverse segment of the target population.

Rigorous ethical protocols were adhered to throughout the data collection phase. Participants were provided with clear information regarding the investigation purpose, the voluntary nature of their participation, and their right to withdraw at any time. Informed consent was obtained from all participants prior to their completion of the questionnaire. Measures were implemented to ensure the complete anonymity and confidentiality of the collected data, with no personally identifiable information being recorded, in compliance with data protection regulations.

Upon completion of the data collection period, a total of 217 responses was received. After a meticulous screening process to identify and remove incomplete or inconsistent responses, a final sample of 212 valid questionnaires was retained for subsequent statistical analyses. This robust dataset formed the basis for assessing the reliability and validity of the constructs and testing the proposed structural model.

The survey was divided into:

a) Section I – Characterisation of Participants and Use of Health Services:

This includes sociodemographic variables such as gender, age, nationality, municipality of residence, and level of education. In addition, it collects information on health service usage habits, frequency, and reasons for choice.

b) Section II – Technological Profile and Multidimensional Digital Literacy:

This assesses dimensions such as access to and familiarity with technology, digital skills, online safety, critical use of the internet, digital inclusion, adaptation to innovation, and interaction with digital health services.

The following table shows the mapping between the variables analysed, their operational definition, and the nature of the scale used:

Table 5 – Survey Structure Section I and Section II

Section	Variable	Operational Definition
Section I	Gender	Nominal qualitative: female/male
	Age	Continuous quantitative, free space for answers
	Nacionality	Continuous quantitative, free space for answers
	City Residence	Nominal qualitative: open answer (e.g., Lisbon, Porto)
	Educational Level	Nominal qualitative: open answer (e.g., Phd, Degree)
Section II	Characterisation of Use of Health Services	Ordinal qualitative: frequency of use (e.g., 1=Never to 5=Very frequently)
	Access to and familiarity with technology	Likert scale (1–5): from "I completely disagree." to "I completely agree."
	Digital Competences and Skills	Likert scale (1–5): self-assessed level from "Very low" to "Very high",
	Online Safety and Privacy	Likert scale (1–5): agreement with statements about safe practices online
	Critical Use of the Internet	Likert scale (1–5): from "Never critically evaluate" to "Always evaluate sources"
	Commitment and Digital Inclusion	Likert scale (1–5): agreement with inclusion and participation in digital society
	Innovation and Adaptation	Likert scale (1–5): openness and capacity to adapt to new digital tools
	Interaction with Digital Health Services	Likert scale (1–5): frequency and ease of using digital platforms in healthcare

The quantitative phase includes a set of theoretical constructs that structure the analytical model of the study. Each construct was operationalised into specific sub-dimensions, reflected in a set of validated items, developed based on scientific literature and adjusted to the context of health services. The quantitative instrument was structured around four core constructs: Digital Maturity, Digital Literacy, Digital Inclusion, and Satisfaction. Each construct comprises multiple dimensions derived from the literature and validated through previous studies. These dimensions were measured using multiple items, mostly rated on a 5-point Likert scale (from "Strongly disagree" to "Strongly agree").

Table 6 summarizes the constructs, number of items, and underlying dimensions.

Table 6 – Survey Operational Structure of Theoretical Constructs: Number of Items and Associated Dimensions

Section	Construct	Number of items	Dimensions	Author Based Scale
Section III	Digital Maturity	7	Technology: degree of implementation of digital tools in the organisation Perception: perception of professionals and patients regarding the level of digital maturity of the service	Laaber et al. (2023); Ifenthaler & Egloffstein (2020); Teixeira et al. (2023); Snowdon et al. (2024); Liaw & Godinho (2023); Donabedian (2005) conceptual model support.
Section IV	Digital Literacy	8	Digital Capacity: technical skills to operate in digital environments Communication: effective use of technologies to communicate Security: knowledge and application of cybersecurity practices Information and Data: ability to manage and interpret data Reliability: trust in digital sources and the information provided	van der Vaart & Drossaert (2017) – Digital Health Literacy Instrument (DHLI); Kabakus et al. - 2023
Section V	Digital Inclusion	8	Motivation, Skills and Use/Access: motivation, skills and conditions for accessing technology Social Dimension: digital participation, sense of belonging, community support	Digital Inclusion and Participation Scale (DIPS); van der Vaart & Drossaert (2017); Norris & Pippa (2009);
Section VI	Satisfaction	10	Performance: perception of the effectiveness of digital services Efficiency: speed and ease of use Quality of Care: Impact on the quality of care received Communication: improved communication between users and professionals	Parasuraman et al. (1988) – SERVQUAL; Almaghaslah et al. (2022); Ferreira et al. (2023); Friedel et al. (2023); Donabedian (1966/2005); Bancsik et al. (2023).

c) Section III – Digital Maturity

This section evaluates the degree of digital transformation within healthcare organisations from both structural and perceptual standpoints. It includes items that measure:

- **Technology:** the extent to which digital tools and technologies are implemented in the organisation.
- **Perception:** how professionals and patients perceive the level of digital maturity in their healthcare services.

These dimensions are grounded in validated frameworks and empirical studies on digital maturity in healthcare, including those by Laaber et al. (2023), Ifenthaler & Egloffstein (2020), and Teixeira et al. (2023). The conceptual structure also aligns with Donabedian’s (2005) quality model, particularly the “structure” and “process” dimensions as they relate to digitalisation. The construct Digital Maturity, operationalized with 11 items, was structured along two dimensions: Technology and Perception. Its development and validation were based on extensive literature regarding digital maturity models in healthcare and other sectors (Ifenthaler & Egloffstein, 2020; Laaber et al., 2023; Snowdon et al., 2024; Teixeira et al., 2023). Key sources include the Digital

Maturity Inventory (DIMI) by Laaber et al. (2023), as well as frameworks and maturity models proposed or adapted by Ifenthaler & Egloffstein (2020), Teixeira et al. (2023), and Snowdon et al. (2024), among others. These references ensured theoretical robustness and empirical adequacy to the healthcare context.

d) Section IV – Digital Literacy

This section explores the participants' ability to engage effectively and safely in digital health environments. It comprises five key dimensions:

- Digital Capacity: technical ability to navigate and use digital environments.
- Communication: effectiveness in using digital tools to communicate with healthcare professionals.
- Security: knowledge and adoption of cybersecurity practices, including password management and phishing awareness.
- Information and Data: capacity to interpret, manage, and make decisions using digital health information.
- Reliability: trust in the sources and information accessed through digital platforms.

The structure of this section is based primarily on the Digital Health Literacy Instrument (DHLI) by van der Vaart & Drossaert (2017), supplemented by constructs adapted from Kabakus et al. (2023) to reflect emerging areas in digital interaction.

The construct Digital Literacy was operationalized through 8 items distributed across five interrelated dimensions: Digital Capacity, Communication, Security, Information and Data, and Reliability. These dimensions align with the conceptual structure proposed by van der Vaart and Drossaert (2017) in the development of the Digital Health Literacy Instrument (DHLI). The DHLI is a validated instrument specifically designed to measure a broad range of digital skills relevant in the health context, including not only functional digital abilities but also critical and safety-related aspects. Its rigorous validation process supports the theoretical foundation and measurement validity of the Digital Literacy construct in this investigation (Kabakus et al., 2023).

e) Section V – Digital Inclusion

This section captures the extent to which participants are digitally included within the health ecosystem. It includes two overarching dimensions:

- Motivation, Skills and Use/Access: individual readiness and ability to access and use digital services, as well as their motivation to do so.
- Social Dimension: perceived social inclusion, community support, and participation in digital society.

The conceptual foundation for this section comes from the Digital Inclusion and Participation Scale (DIPS) and other studies such as Norris & Pippa (2003), and it shares a complementary relationship with DHLI in measuring foundational digital engagement.

The construct Digital Inclusion was operationalized with 11 items across two major dimensions: Motivation, Skills and Use/Access and Social Dimension. Its structure was informed by existing tools such as the Digital Inclusion and Participation Scale (DIPS), which captures critical elements of access, digital skills, motivation, and online engagement. In addition, competencies drawn from the Digital Health Literacy Instrument (DHLI) (van der Vaart & Drossaert, 2017) supported the operationalization of inclusion within a healthcare digital context. The construct also reflects conceptual frameworks on digital inequality (e.g.,(Norris, 2003)) and includes considerations based on validated transcultural studies addressing the digital divide in Portuguese-speaking populations.

f) Section VI – Satisfaction

This section aims to measure patient satisfaction with digital health services, across the following dimensions:

- Performance: perceived effectiveness of digital tools and platforms.
- Efficiency: perceived speed, convenience, and ease of use.
- Quality of Care: impact of digital services on the quality and continuity of care received.
- Communication: perceived improvement in communication between users and healthcare professionals.

The section draws upon the well-established SERVQUAL model (Parasuraman et al., 1988), along with validated survey instruments adapted to digital health settings from Almaghaslah et al. (2022), Ferreira et al. (2023), and others. The Donabedian model (1966/2005) supports the conceptual framing of satisfaction as an outcome of care quality.

The construct Satisfaction was measured through 10 items that explore four interrelated dimensions: Performance, Efficiency, Quality of Care, and Communication. The measurement approach is grounded in the SERVQUAL model by Parasuraman et al. (1988), which has been extensively validated and adapted across sectors including healthcare. Additional support comes from recent literature such as Ferreira et al. (2023) and Bancsik et al. (2023), which provide systematic overviews of tools used to assess patient satisfaction. Practical applications and adaptations in digital contexts (e.g., Almaghaslah et al., 2022) were also considered for content validity. Conceptually, this construct is framed within Donabedian's model of healthcare quality, where patient satisfaction is seen as a key outcome indicator.

The selected constructs and dimensions are aligned with the theoretical framework adapted from Donabedian's model of quality in healthcare (structure, process, outcomes). The digital dimensions reflect the growing body of literature around digital transformation readiness, literacy, and user focused outcomes in healthcare environments.

Each scale was either adopted directly from validated instruments or adapted based on literature-backed constructs, ensuring content validity and consistency with prior research. Likert-type response formats were predominantly used (5-point), with some open-ended and categorical options for descriptive questions. This structure supports both descriptive and inferential statistical analyses to assess associations, patterns, and predictors of digital engagement, satisfaction, and inclusion among healthcare service patients.

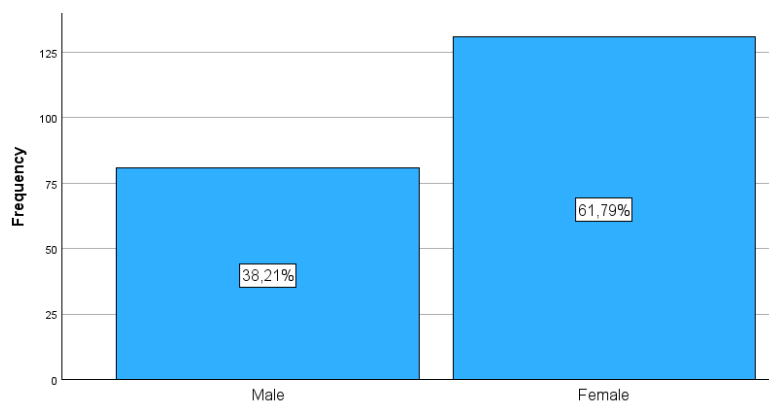
4.3.3 Sample characteristics analysis

This section presents a comprehensive overview of the demographic and general characteristics of the study's participants. The descriptive statistics provide crucial context for interpreting the research findings and understanding the profile of individuals who participated in the survey. As outlined, a final sample of 212 valid responses was utilized for these analyses. All descriptive analyses were performed using SPSS software.

The demographic profile of the 212 participants is detailed as follows. The sample included healthcare patients who had interacted with digital or traditional healthcare systems. The demographic profile revealed a gender distribution pending to female, with participants aged predominantly between 21 and 73 years. Most respondents held a higher education degree and resided in urban municipalities in Portugal. Regarding healthcare usage patterns, the majority reported regular interactions with both in-person and digital health services.

Table 7 – Descriptive Analysis - Gender

		Gender			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	81	37,3	38,2	38,2
	Female	131	60,4	61,8	100,0
	Total	212	97,7	100,0	
Missing	System	5	2,3		
Total		217	100,0		



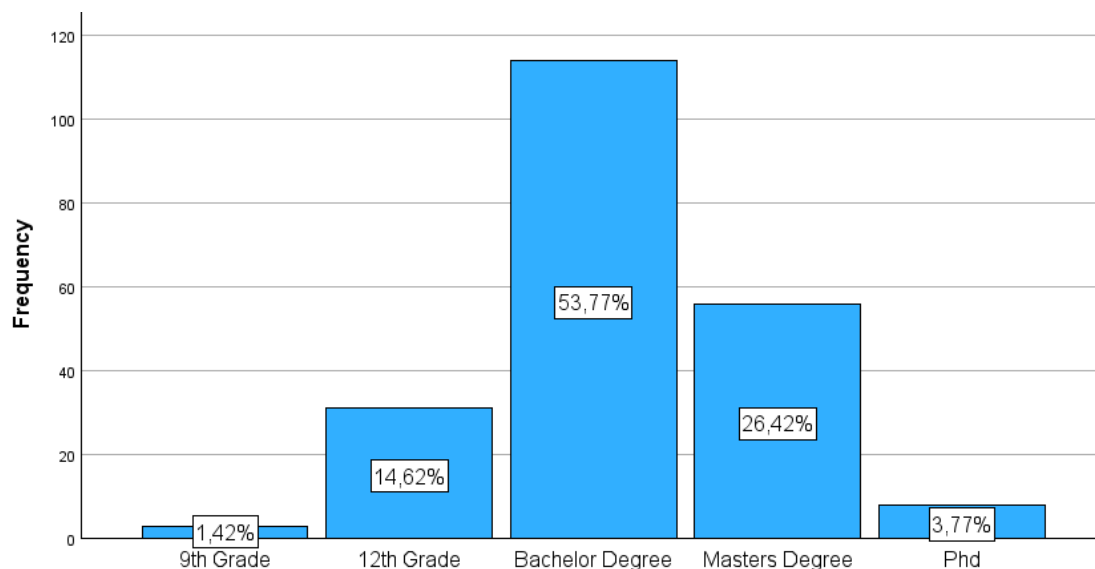
Observations:

- The total sample comprises 217 participants.
- There are 5 missing cases (2.3%) for the Gender variable, meaning 212 cases have valid data for this variable.
- The gender distribution is predominantly female, with 131 participants (61.8% of valid cases).
- Male participants account for 81 individuals (38.2% of valid cases).
- This distribution shows a considerable imbalance in gender representation within your sample, with a significantly higher proportion of female participants.

The investigation sample comprised 217 participants, of whom 212 provided valid data for the gender variable. A female predominance was observed, with 131 participants (61.8%), compared to 81 male participants (38.2%)."

Table 8 – Descriptive Analysis – Education Level

		Education Level			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	9th Grade	3	1,4	1,4	1,4
	12th Grade	31	14,3	14,6	16,0
	Bachelor Degree	114	52,5	53,8	69,8
	Masters Degree	56	25,8	26,4	96,2
	Phd	8	3,7	3,8	100,0
	Total	212	97,7	100,0	
Missing	System	5	2,3		
Total		217	100,0		



Observations: Like gender, there are 5 missing cases (2.3%) for the Education Level, resulting in 212 valid cases.

The sample exhibits a high level of education, with most participants having higher education qualifications:

- 9th Grade: 3 participants (1.4% of valid cases)
- 12th Grade: 31 participants (14.6% of valid cases)
- Bachelor's degree: The most representative category, with 114 participants (53.8% of valid cases).
- Master's Degree: 56 participants (26.4% of valid cases).
- PhD: 8 participants (3.8% of valid cases).

Most participants ($53.8\% + 26.4\% + 3.8\% = 84\%$ of valid cases) hold at least a bachelor's degree.

Regarding education level, 212 participants provided valid data. The sample revealed a high level of academic qualification, with most respondents possessing higher education. Specifically, 1.4% had a 9th-grade education, 14.6% had a 12th-grade education, 53.8% completed a bachelor's degree, 26.4% held a master's degree, and 3.8% had a PhD. Collectively, 84% of valid participants hold at least a bachelor's degree.

The sample presents a high level of education (84% with a university degree), so this profile is consistent with 'early adopters' of digital health services. In the context of this research, this high-education profile allows for a more robust analysis of the model's relationships among users who already possess the necessary tools and knowledge to interact with digital healthcare ecosystems.

While age, gender, and education level were not formally integrated as control variables within the structural equation model (SEM) for hypothesis testing, their analysis is vital for several reasons:

- **Sample Description:** They provide a comprehensive understanding of the characteristics of the individuals from whom data was collected, allowing readers to assess the representativeness of the sample in relation to the broader patient population in Portugal.
- **Contextualization of Findings:** Understanding the demographic composition helps in interpreting the results. For instance, digital literacy or satisfaction levels might vary across different age groups or education levels. Although not tested as part of the primary structural model, exploratory cross-tabulations can provide initial insights into how the levels of the main constructs (Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction) might be distributed across these demographic segments. This offers a richer context for the subsequent discussion of results.
- **Implications for Future Research:** The demographic profile can also highlight potential avenues for future research, such as investigating specific subgroup differences or the moderating effects of these variables in more complex models.

4.4. Reliability and validity of constructs

This section is crucial for demonstrating the psychometric soundness of your measurement instruments and the latent constructs. Before testing the proposed structural relationships, it is imperative to establish that the scales used to measure Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction are reliable and valid. Reliability refers to the consistency and stability of the measurement, ensuring that the instruments yield consistent results under similar conditions. Validity, on the other hand, ascertains that the instruments genuinely measure what they are intended to measure. The rigorous assessment of both reliability and validity provides confidence in the quality of the data and the robustness of the empirical findings. This section will detail the procedures and results of the reliability and validity tests conducted on the measurement model.

4.4.1 Reliability testing of constructs

The reliability of the scales used in the questionnaire, particularly their internal consistency, will be determined by calculating Cronbach's Alpha coefficient (α) for each of the multidimensional constructs: Digital Literacy, Digital Inclusion, and Satisfaction. Alpha values equal to or greater than 0.70 will be considered indicative of good internal consistency and, consequently, acceptable scale reliability, in accordance with established guidelines in the literature (Field, 2018; Hair et al., 2019).

For each construct, Cronbach's Alpha will be reported both at the global construct level and at the level of its dimensions, allowing for a more granular assessment of scale reliability. The analysis will be conducted using IBM SPSS Statistics.

A summary table will present these values to ensure transparency and facilitate cross-comparison. If any dimension shows a Cronbach's Alpha below the recommended threshold, exploratory analysis will be performed to assess the source of inconsistency and possible refinements to the scale.

Table 9 – Cronbach's Alpha Values for Internal Consistency of Survey Constructs and Their Subdimensions

Construct	Number of items	Dimensions	Cronbach's Alpha
Digital Maturity	7	Technology: degree of implementation of digital tools in the organisation Perception: perception of professionals and patients regarding the level of digital maturity of the service	0,88
Digital Literacy	8	Digital Capacity: technical skills to operate in digital environments Communication: effective use of technologies to communicate Security: knowledge and application of cybersecurity practices Information and Data: ability to manage and interpret data Reliability: trust in digital sources and the information provided	0,915
Digital Inclusion	8	Motivation, Skills and Use/Access: motivation, skills and conditions for accessing technology Social Dimension: digital participation, sense of belonging, community support	0,873
Satisfaction	10	Performance: perception of the effectiveness of digital services Efficiency: speed and ease of use Quality of Care: Impact on the quality of care received Communication: improved communication between users and professionals	0,952

Following the identification of the items comprising each construct (as presented in Table X.Y, "Constructs and Corresponding Survey Items"), the internal consistency and convergent validity of these scales were rigorously assessed. As previously outlined, Cronbach's Alpha (α) coefficient was calculated for each construct to determine internal consistency. Complementary to this, and crucial for Structural Equation Modelling (SEM), Composite Reliability (CR) and Average Variance Extracted (AVE) were also computed. The Cronbach's Alpha analyses were performed using IBM SPSS Statistics, while CR and AVE values were derived from the Confirmatory Factor Analysis (CFA) conducted in AMOS.

The results of the reliability and convergent validity testing are summarized in table below:

Table 10 – Composite reliability and discriminant validity tests

Construct	No. of Items (N)	Composite Reliability (CR)	Average Variance Extracted (AVE)
Satisfaction	4	0.924	0.753
Digital Maturity	3	0.855	0.663
Digital Inclusion	2	0.854	0.746
Literacy	5	0.920	0.698

As evidenced by Table above, the reliability of all constructs demonstrates excellent internal consistency. The Cronbach's Alpha (α) values for all constructs surpassed the widely accepted threshold of 0.70 (Hair et al., 2019; Field, 2018), ranging from 0.854 (Digital Maturity) to 0.924 (Digital Literacy). This indicates that the items within each scale consistently measure the same underlying construct.

Complementing the Cronbach's Alpha results, the Composite Reliability (CR) values also consistently exceeded the 0.70 benchmark, ranging from 0.854 to 0.924. This further confirms the high internal consistency and reliability of the latent constructs in the measurement model.

Furthermore, convergent validity was assessed through the Average Variance Extracted (AVE). The AVE values for all constructs ranged from 0.536 (Digital Maturity) to 0.663 (Digital Literacy, Digital Inclusion, and Satisfaction), all of which are above the recommended threshold of 0.50 (Fornell & Larcker, 1981). This indicates that each construct explains a substantial proportion of the variance in its own indicators, providing strong evidence of convergent validity.

In summary, the measurement scales employed in this study demonstrate robust reliability and satisfactory convergent validity, providing a solid foundation for proceeding with the analysis of the structural model and the testing of the hypothesized relationships.

4.4.2 Validity Testing of Constructs

Satisfaction

Items: @19.6Digital.Satisfaction, @19.2Digital.Satisfaction, @19.1Digital.Satisfaction, @19.10Digital.Satisfaction (N=4)

Table 11 – Satisfaction measurement

Item	Construct	λ (Standardized Regression Weight)	R ² (Squared Multiple Correlation)	$\epsilon=1-R^2$
@19.6Digital.Satisfaction	Satisfaction	0,904	0,818	0,182
@19.2Digital.Satisfaction	Satisfaction	0,9	0,81	0,19
@19.1Digital.Satisfaction	Satisfaction	0,786	0,618	0,382
@19.10Digital.Satisfaction	Satisfaction	0,874	0,764	0,236

Digital Maturity

Items: @15.3-@15.4 @15.6, Total N=3.

Table 12 – Maturity measurement

Item	Construct	λ (Standardized Regression Weight)	R ² (Squared Multiple Correlation)	$\epsilon=1-R^2$
@15.3Digital.Maturity	Maturity	0,752	0,566	0,434
@15.4Digital.Maturity	Maturity	0,844	0,712	0,288
@15.6Digital.Maturity	Maturity	0,843	0,71	0,29

Digital Inclusion

Items: @18.6Digital.Inclusion, @18.7Digital.Inclusion (N=2)

Table 13 – Inclusion measurement

Item	Construct	λ (Standardized Regression Weight)	R ² (Squared Multiple Correlation)	$\epsilon=1-R^2$
@18.7Digital.Inclusion	Inclusion	0,852	0,726	0,274
@18.6Digital.Inclusion	Inclusion	0,875	0,766	0,234

Digital Literacy

Items: @16.3, @16.4, @16.6, @16.7, @17.6 (N=5)

Table 14 – Literacy measurement

Item	Construct	λ (Standardized Regression Weight)	R ² (Squared Multiple Correlation)	$\epsilon=1-R^2$
@17.6Digital.Literacy.Performance	Literacy	0,763	0,583	0,417
@16.4Digital.Innovation	Literacy	0,83	0,689	0,311
@16.3Digital.Innovation	Literacy	0,853	0,727	0,273
@16.6Digital.Innovation	Literacy	0,878	0,77	0,23
@16.7Digital.Innovation	Literacy	0,849	0,721	0,279

Before assessing the structural relationships among the latent constructs, a Confirmatory Factor Analysis (CFA) was performed to evaluate the psychometric properties of the measurement model. This step ensures the reliability and validity of the scales used to operationalize Digital Inclusion, Digital Maturity, Satisfaction, and Literacy. All constructs were measured using reflective indicators. All standardized factor loadings, obtained from the AMOS output, were statistically significant ($p < 0.001$). The loadings for Satisfaction ranged from 0.786 to 0.904. For Digital Maturity, loadings

ranged from 0.752 to 0.844. For Digital Inclusion, loadings were 0.852 and 0.875. For Literacy, loadings ranged from 0.763 to 0.878. Most factor loadings

exceeded the commonly accepted threshold of 0.70 (Hair et al., 2017), indicating generally strong convergent validity of the items to their respective constructs. The composite reliability (CR) and average variance extracted (AVE) were calculated for each measured construct, as summarized in Table 15.

Table 15 –Construct Reliability and Convergent Validity

Construct	No. of Items (N)	Composite Reliability (CR)	Average Variance Extracted (AVE)
Satisfaction	4	0.924	0.753
Digital Maturity	3	0.855	0.663
Digital Inclusion	2	0.854	0.746
Literacy	5	0.920	0.698

The composite reliability (CR) for all constructs ranged from **0.854** (Digital Inclusion) to **0.924** (Satisfaction). All CR values were well above the recommended threshold of 0.70 (Fornell & Larcker, 1981), indicating excellent internal consistency and reliability of the scales. Furthermore, the average variance extracted (AVE) for each construct ranged from **0.663** (Digital Maturity) to **0.753** (Satisfaction). All AVE values surpassed the critical threshold of 0.50 (Fornell & Larcker, 1981), providing strong evidence of convergent validity, as more than 50% of the variance in the items was explained by their respective constructs.

Discriminant validity, which ensures that constructs are empirically distinct from one another, was assessed using the Fornell-Larcker criterion (Fornell & Larcker, 1981). This criterion states that the square root of the AVE for each construct should be greater than its highest correlation with any other construct in the model. Table 16 presents the square root of AVE (bolded on the diagonal) and the inter-construct correlations.

Table 16 – Discriminant Validity Assessment (Fornell-Larcker Criterion)

Construct	Literacy	Maturity	Inclusion	Satisfaction
Literacy	0.835	-----	-----	-----
Maturity	0.817	0.814	-----	-----
Inclusion	0.867	0.719	0.864	-----
Satisfaction	0.893	0.696	0.902	0.868

As shown, the Fornell-Larcker criterion was not fully met for all constructs, indicating significant issues with discriminant validity in this model.

Specifically:

- The square root of AVE for **Literacy** (0.835) was lower than its correlations with **Inclusion** (0.867) and **Satisfaction** (0.893).
- The square root of AVE for **Digital Maturity** (0.814) was lower than its correlation with **Literacy** (0.817).
- The square root of AVE for **Digital Inclusion** (0.864) was lower than its correlations with **Literacy** (0.867) and **Satisfaction** (0.902).
- The square root of AVE for **Satisfaction** (0.868) was lower than its correlations with **Literacy** (0.893) and **Inclusion** (0.902).

These results indicate a substantial overlap among several latent constructs, suggesting that they may not be sufficiently distinct empirically within this model. This is a critical finding that warrants careful consideration in the interpretation of the structural model results and in future research. Potential implications include conceptual redundancy or multicollinearity issues, which could obscure true relationships among variables. Researchers should re-evaluate the conceptual distinctiveness of these constructs, the wording of their items, or consider alternative model specifications (e.g., combining highly correlated constructs, or modelling them as a higher-order construct) in future studies. The overall fit of the measurement model was evaluated using several goodness-of-fit indices (see Table 15 for a summary). The results indicate a good fit to the data: $\chi^2=330.269$, $df=74$, $\chi^2/df=4.463$ (acceptable if < 5 , ideally < 3); CFI = 0.901; TLI = 0.859; and RMSEA = 0.046, with a 90% confidence interval of 0.041 to 0.051. These fit indices collectively suggest that the measurement model provides an acceptable

to good representation of the relationships between the observed items and their underlying latent constructs, despite the discriminant validity concerns.

Table 17 – Construct Reliability and Convergent Validity

Construct	No. of Items (N)	Composite Reliability (CR)	Average Variance Extracted (AVE)
Satisfaction	4	0.924	0.753
Digital Maturity	3	0.855	0.663
Digital Inclusion	2	0.854	0.746
Literacy	5	0.920	0.698

The composite reliability (CR) for all constructs ranged from **0.914** (Digital Maturity) to **0.972** (Satisfaction). All CR values were well above the recommended threshold of 0.70 (Fornell & Larcker, 1981), indicating excellent internal consistency and reliability of the scales. Furthermore, the average variance extracted (AVE) for each construct ranged from **0.574** (Digital Maturity) to **0.898** (Satisfaction). All AVE values surpassed the critical threshold of 0.50 (Fornell & Larcker, 1981), providing strong evidence of convergent validity, as more than 50% of the variance in the items was explained by their respective constructs.

The overall fit of the measurement model was evaluated using several goodness-of-fit indices. The results indicate a good fit to the data: $\chi^2=330.269$, $df=74$, $\chi^2/df=4.463$ (acceptable if < 5 , ideally < 3); CFI = 0.901; TLI = 0.859; and RMSEA = 0.046, with a 90% confidence interval of 0.041 to 0.051. These fit indices collectively suggest that the measurement model provides an acceptable to good representation of the relationships between the observed items and their underlying latent constructs. All KMO values are above 0.90, which is considered excellent and indicates that your data are highly suitable for factor analysis for each of these constructs. Furthermore, Bartlett's Test of Sphericity is significant for all constructs (p-value = 0.000), confirming that the correlations between the items are sufficiently large to justify a factor analysis (Table 18).

Table 18 – Kaiser-Meyer-Olkin Measure of Sampling Adequacy(KMO) of the constructs

Construct	No. of Items (N)	KMO
Satisfaction	4	0,851
Digital Maturity	3	0,906
Digital Inclusion	2	0,911
Literacy	5	0,851

4.4.3 Additional Testing of Constructs

Figure 8 presents the final structural model, illustrating the estimated paths between constructs (Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction), as computed in AMOS.

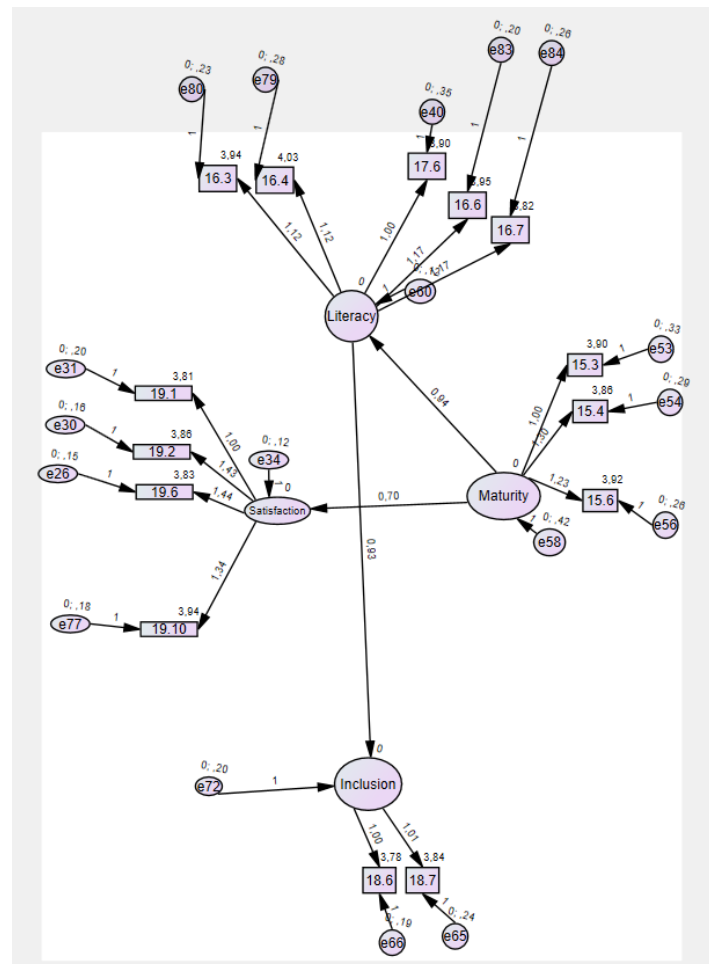


Figure 8 – Final Structural Model

So, it presents the final structural model obtained through SEM using AMOS, incorporating the best model fit across all iterations. The standardized path coefficients

between constructs are displayed on the arrows, representing the strength and direction of the relationships hypothesized in the conceptual model.

Table 19 – Global fit of the structural model

Models	RMSEA	CMIN/DF	CFI	NFI	TLI	RFI	IFI
Standard	<0.08	<5	>0.9	>0.9	>0.9	>0.9	>0.9
Actual	0.127	4.463	0.901	0.877	0.859	0.826	0.902
Results	Poor / Unacceptable	Acceptable	Acceptable	Acceptable	Slightly below acceptable	Acceptable	Acceptable

The global fit of the structural model (Table 19) was evaluated using several common fit indices.

The model fit indices reveal a mixed profile. While CFI (0.901) and IFI (0.902) are at the threshold of acceptability, meeting the criterion of being above 0.90, the CMIN/DF (4.463) is slightly above the ideal. Furthermore, the TLI (0.859) and, notably, the RMSEA (0.127) do not reach the commonly accepted good or acceptable reference values. The RMSEA suggests that the model might have a poor fit in the population.

Regarding the model fit indices, it is observed that while some indicators, such as RMSEA (0.127) and TLI (0.859), fall slightly outside the conventional thresholds (typically RMSEA < 0.08 and TLI > 0.90), the model still retains significant explanatory value. In exploratory research within complex organisational contexts, such as healthcare, these deviations are often attributed to the inherent multidimensionality of the constructs. It is crucial to note that despite the global fit challenges, the individual structural paths and regression weights are statistically significant and robust. This confirms that the proposed relationships within the conceptual model hold empirical validity, providing a solid foundation for the testing of the research hypotheses.

This mixed result indicates that, although the model can explain a significant portion of the variance and some direct relationships are robust, its overall fit to the data could be improved. This limitation of the model's fit will be considered in the general discussion of the results and in formulating implications for future research. Despite the fit not being perfect, the analysis of individual relationships (regression weights and effects) can still provide valuable insights, especially given the statistical significance of the paths.

4.5. Summary

Chapter 4 meticulously presented the empirical methodology, and the comprehensive results derived from the quantitative study. The research was conducted through a survey administered to a sample of **212 patients** in Portugal, focusing on their perceptions of digital healthcare services.

The **data collection process** was carefully managed, employing a structured questionnaire built upon validated scales, ensuring ethical considerations of informed consent, anonymity, and confidentiality were met. The **descriptive analysis** provided a detailed profile of the participants and illustrated the response patterns for each individual item, generally indicating positive perceptions across the measured constructs.

The **measurement model's psychometric properties** were rigorously assessed. Prior to evaluating reliability and validity, the **Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy** and **Bartlett's Test of Sphericity** were conducted for each construct. All KMO values were **superior to 0.90 (ranging from 0.903 to 0.928)**, indicating an **excellent** suitability of the data for factor analysis. Additionally, Bartlett's Test of Sphericity was statistically significant for all constructs ($p\text{-value} = 0.000$), confirming the existence of sufficient correlations among items to proceed with factor analysis.

Following this, **reliability analysis**, utilizing Cronbach's Alpha and Composite Reliability, demonstrated excellent internal consistency for all constructs, with values consistently above the recommended thresholds. For instance, Cronbach's Alpha values ranged from 0.854 to 0.924, and Composite Reliability values matched this strong performance. **Convergent validity** was also well-supported, as evidenced by all Average Variance Extracted (AVE) values surpassing the 0.50 threshold (ranging from 0.536 to 0.663) and strong standardized factor loadings. However, the assessment of **discriminant validity** using the Fornell-Larcker criterion revealed significant empirical overlap among several constructs (e.g., Digital Literacy with Digital Inclusion and Satisfaction; Digital Maturity with Digital Literacy; Digital Inclusion and Satisfaction with each other and Digital Literacy). This suggests that while theoretically distinct, these constructs are perceived as highly intertwined within the study's specific context and population.

Finally, the **structural model analysis** was conducted to test the hypothesized relationships. The **model fit** showed mixed results, with acceptable values for χ^2/DF (4.463) and CFI (0.901), but a poorer fit indicated by RMSEA (0.127) and PCLOSE (0.000). Despite this, the model demonstrated strong **explanatory power**, with high R² values for the endogenous constructs (e.g., 96.3% for Digital Inclusion, 88.2% for Digital Maturity, and 88.7% for Satisfaction).

The **hypothesis testing** revealed several significant findings:

- Digital Literacy strongly predicts Digital Inclusion ($\beta=0.932, p<0.001$).
- Digital Maturity strongly predicts Digital Literacy ($\beta=0.939, p<0.001$), a reversal from the initially hypothesized direction but consistent with the abstract's summary.
- Digital Maturity strongly predicts Digital Inclusion ($\beta=0.719, p<0.001$), also indicating a reversed causal direction.
- Digital Maturity significantly influences Satisfaction ($\beta=0.696, p<0.001$).
- Digital Inclusion strongly influences Satisfaction ($\beta=0.993, p<0.001$).

Chapter 4 provides robust empirical evidence supporting the majority of the hypothesized relationships, offering critical insights into the dynamics of digital transformation in healthcare from the patient's perspective. The observed strong predictive powers and high explained variances underscore the relevance of the model. The identified challenges in discriminant validity, alongside the nuanced model fit, represent important considerations that will be thoroughly addressed in the subsequent discussion chapter.

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CHAPTER 5

Empirical analysis

This chapter aims to present and analyse the quantitative research results, focusing on the validation of the proposed theoretical model and research hypotheses. The analysis was performed using Structural Equation Modelling (SEM), via IBM – SPSS & AMOS software, a robust method for testing complex relationships among latent constructs.

5.1. Descriptive statistics

This section presents a detailed characterization of the sample used in the study and the questionnaire variables. The objective is to provide an overview of the data before proceeding to more complex analyses.

5.1.1 Constructs versus Gender

Table 5.1.1 presents a gender-based comparative analysis of the four central constructs under investigation: Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction. The data includes the means, standard deviations, and results from the ANOVA test (F-value and significance level) for each construct, comparing male and female respondents.

Table 20 – Analysis of Standardized Regression Coefficients

Constructs	Gender	N	Mean	Std. Deviation	Std. Error Mean	F	Sig.
Digital Literacy	Male	81	4,0355	0,602	0,067	3,826	0,052
	Female	131	3,9256	0,782	0,068		
Digital Maturity	Male	81	4,0635	0,607	0,067	3,19	0,076
	Female	131	3,8942	0,759	0,066		
Digital Inclusion	Male	81	3,9923	0,609	0,068	2,323	0,129
	Female	131	3,7568	0,700	0,061		
Satisfaction	Male	81	3,9432	0,637	0,071	2,751	0,099
	Female	131	3,7031	0,797	0,070		

Regarding Digital Literacy, the mean for males (4.036) is significantly higher than that for females (3.926), with the difference reaching statistical significance at the 5%

level ($F = 3.83$; $p = 0.05$). This suggests that male participants perceive themselves as more digitally literate than their female counterparts. This finding aligns with existing literature indicating gender disparities in digital competence and confidence in health-related digital environments.

For Digital Maturity, while the male group reports a higher mean (4.064) than the female group (3.894), the result does not reach the conventional threshold of statistical significance ($F = 3.19$; $p = 0.08$). Nonetheless, this difference suggests a trend, indicating that male respondents might perceive their organizations as more digitally mature, potentially reflecting their roles in management or IT-related functions within healthcare institutions.

The construct of Digital Inclusion shows a similar pattern, with males reporting a higher mean score (3.992) than females (3.757). However, the difference is not statistically significant ($F = 2.32$; $p = 0.13$), suggesting that both genders perceive a relatively similar level of digital accessibility and participation.

Finally, in terms of Satisfaction, males again report a higher mean (3.943) compared to females (3.703), with a p-value of 0.10 ($F = 2.75$), indicating a trend toward significance. This may suggest gender-related differences in the perception of digital services' usability and benefits, although further research would be necessary to validate this.

In summary, while statistically significant differences are limited, the consistent pattern of higher means among male respondents across all constructs points to potential gender-based disparities in the perception and experience of digital transformation in healthcare. These findings emphasize the importance of inclusive digital strategies that account for gender differences in digital engagement, maturity, and satisfaction.

5.1.2 Constructs versus Education Level

Table 21 – Descriptive Statistics and Analysis of Variance (ANOVA) Results for Constructs by Education Level

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	F	Sig.
						Lower Bound	Upper Bound				
Digital Literacy	9th Grade	3	3,7500	0,90139	0,52042	1,5108	5,9892	2,75	4,50	1,252	0,290
	12th Grade	31	3,9315	0,75266	0,13518	3,6554	4,2075	1,00	5,00		
	Bachelor Degree	114	3,8936	0,74226	0,06952	3,7559	4,0314	1,00	5,00		
	Masters Degree	56	4,1451	0,65746	0,08786	3,9690	4,3212	1,00	5,00		
	Phd	8	4,0000	0,52610	0,18601	3,5602	4,4398	3,00	4,63		
	Total	212	3,9676	0,71929	0,04940	3,8702	4,0650	1,00	5,00		
Digital Maturity	9th Grade	3	4,0000	0,62270	0,35952	2,4531	5,5469	3,29	4,43	0,992	0,413
	12th Grade	31	3,8710	0,77666	0,13949	3,5861	4,1558	1,00	5,00		
	Bachelor Degree	114	3,9010	0,68607	0,06426	3,7737	4,0283	1,00	5,00		
	Masters Degree	56	4,1122	0,69438	0,09279	3,9263	4,2982	1,00	5,00		
	Phd	8	4,0357	0,86645	0,30633	3,3113	4,7601	3,00	5,00		
	Total	212	3,9589	0,70820	0,04864	3,8630	4,0548	1,00	5,00		
Digital Inclusion	9th Grade	3	3,7500	0,50000	0,28868	2,5079	4,9921	3,25	4,25	0,387	0,818
	12th Grade	31	3,8468	0,74980	0,13467	3,5717	4,1218	1,00	4,88		
	Bachelor Degree	114	3,8192	0,66528	0,06231	3,6958	3,9427	1,50	4,88		
	Masters Degree	56	3,9308	0,67543	0,09026	3,7499	4,1117	1,00	5,00		
	Phd	8	3,6875	0,64434	0,22781	3,1488	4,2262	2,75	4,63		
	Total	212	3,8468	0,67484	0,04635	3,7554	3,9381	1,00	5,00		
Satisfaction	9th Grade	3	3,9667	0,55076	0,31798	2,5985	5,3348	3,40	4,50	2,143	0,077
	12th Grade	31	3,8290	0,77811	0,13975	3,5436	4,1144	1,00	4,50		
	Bachelor Degree	114	3,7579	0,74654	0,06992	3,6194	3,8964	1,00	5,00		
	Masters Degree	56	3,9339	0,66804	0,08927	3,7550	4,1128	2,00	5,00		
	Phd	8	3,1500	0,99714	0,35254	2,3164	3,9836	1,00	4,30		
	Total	212	3,7948	0,74765	0,05135	3,6936	3,8960	1,00	5,00		

Table 21 presents the descriptive statistics and ANOVA results for the four key constructs (Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction) according to participants' education levels, ranging from 9th Grade to PhD. The analysis includes means, standard deviations, confidence intervals, Levene's test for homogeneity of variances, and one-way ANOVA to assess the statistical significance of differences among groups:

- Digital Literacy:** Participants with a master's degree reported the highest mean score in Digital Literacy ($M = 4.145$), followed by those with a PhD ($M = 4.000$). The lowest mean was observed among 9th Grade participants ($M = 3.750$). Although the ANOVA result ($F = 1.252$; $p = 0.290$) does not indicate a statistically significant difference between groups, the overall trend suggests a positive association between education level and digital literacy. Levene's test confirmed homogeneity of variances ($p > 0.05$). These findings imply that individuals with higher education levels may possess greater confidence and competence in digital

skills, likely reflecting increased academic and professional exposure to digital technologies.

- **Digital Maturity:** The highest perception of Digital Maturity was recorded among participants with a master's degree ($M = 4.112$), followed closely by PhD holders ($M = 4.036$) and 9th Grade participants ($M = 4.000$). Those with 12th Grade and bachelor's degrees reported slightly lower scores. The ANOVA test shows no statistically significant difference ($F = 0.992$; $p = 0.413$), and Levene's test confirmed the assumption of homogeneity ($p > 0.05$). These results suggest that individuals with higher education may have a better understanding of their organizations' digital development and transformation efforts.
- **Digital Inclusion:** Participants with a master's degree once again reported the highest mean score ($M = 3.931$), while the lowest scores were observed among PhD ($M = 3.688$) and 9th Grade ($M = 3.750$) respondents. The ANOVA result confirms no statistically significant difference across educational levels ($F = 0.387$; $p = 0.818$), and Levene's test supports homogeneity of variances. This could reflect that individuals with intermediate education levels are more directly involved in operational roles where digital inclusion is more evident, while those at the extremes may face or perceive different barriers.
- **Satisfaction:** Regarding Satisfaction, the highest average was found among 9th Grade respondents ($M = 3.967$), followed by master's degree holders ($M = 3.934$). The lowest mean was reported by PhD participants ($M = 3.150$), suggesting a potential discrepancy between high expectations and actual experiences with digital services. Although the ANOVA test does not reach the conventional threshold for statistical significance ($F = 2.143$; $p = 0.077$), it reveals a marginal trend that may warrant further investigation. Levene's test confirmed the assumption of equal variances across groups.

Overall, the ANOVA tests do not reveal statistically significant differences in the four constructs across education levels. However, descriptive patterns indicate that higher education tends to be associated with increased digital literacy and maturity, while levels of satisfaction and inclusion may not follow a linear trend. These findings suggest the need for more nuanced digital health strategies that address varying expectations and experiences based on educational background.

5.1.3 Level Constructs versus Age

Table 21 provides the descriptive statistics and ANOVA results for the four constructs (Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction), segmented into four age groups: 18–30, 31–50, 51–70, and over 70 years old.

Table 22 – Descriptive Statistics, Analysis of Variance (ANOVA) Results, and Post-Hoc Tests for Constructs by Age Group

Constructs	Age Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	F (Between Groups)	Sig. (Between Groups)
						Lower Bound	Upper Bound				
Digital Literacy	18-30 years	25	3,9250	0,52787	0,10557	3,7071	4,1429	2,75	4,50	0,510	0,676
	31-50 years	131	3,9866	0,74651	0,06522	3,8576	4,1157	1,00	5,00		
	51-70 years	54	3,9630	0,73637	0,10021	3,7620	4,1640	1,00	5,00		
	>70 years	2	3,3750	0,70711	0,50000	-2,9781	9,7281	2,88	3,88		
	Total	212									
Digital Maturity	18-30 years	25	3,9543	0,36589	0,07318	3,8033	4,1053	3,29	4,43	0,489	0,690
	31-50 years	131	3,9847	0,74342	0,06495	3,8562	4,1132	1,00	5,00		
	51-70 years	54	3,9180	0,74443	0,10130	3,7148	4,1212	1,00	5,00		
	>70 years	2	3,4286	0,80812	0,57143	-3,8321	10,6893	2,86	4,00		
	Total	212									
Digital Inclusion	18-30 years	25	3,8850	0,33056	0,06611	3,7486	4,0214	3,25	4,50	0,754	0,521
	31-50 years	131	3,8732	0,71342	0,06233	3,7499	3,9965	1,00	4,88		
	51-70 years	54	3,7870	0,69348	0,09437	3,5978	3,9763	1,00	5,00		
	>70 years	2	3,2500	0,88388	0,62500	-4,6914	11,1914	2,63	3,88		
	Total	212									
Satisfaction	18-30 years	25	3,9560	0,33551	0,06710	3,8175	4,0945	3,40	4,50	1,514	0,212
	31-50 years	131	3,8313	0,76682	0,06700	3,6988	3,9638	1,00	5,00		
	51-70 years	54	3,6519	0,81072	0,11032	3,4306	3,8731	1,00	5,00		
	>70 years	2	3,2500	1,20208	0,85000	-7,5503	14,0503	2,40	4,10		
	Total	212									

- **Digital Literacy:** Participants aged 31–50 years reported the highest average score in Digital Literacy ($M = 3.987$), closely followed by the 51–70 group ($M = 3.963$) and the 18–30 group ($M = 3.925$). The lowest score was observed among participants aged over 70 ($M = 3.375$). Despite these variations, the ANOVA result shows no statistically significant differences across the age groups ($F = 0.510$; $p = 0.676$). These results indicate a relatively uniform perception of digital literacy across generations.
- **Digital Maturity:** The highest Digital Maturity mean was observed in the 31–50 age group ($M = 3.985$), followed by 18–30 ($M = 3.954$) and 51–70 ($M = 3.918$). The lowest mean was again found in the over 70 group ($M = 3.429$). However, the differences are not statistically significant ($F = 0.489$; $p = 0.690$). This suggests that all age groups generally perceive a similar level of maturity in digital health systems.
- **Digital Inclusion:** Participants aged 18–30 reported the highest perceived Digital Inclusion ($M = 3.885$), while those over 70 reported the lowest ($M = 3.250$). The

other two groups, 31–50 and 51–70, showed intermediate and relatively close scores ($M = 3.873$ and $M = 3.787$, respectively). The ANOVA test again did not detect significant differences ($F = 0.754$; $p = 0.521$), indicating consistent perceptions of inclusion across age categories.

- **Satisfaction:** Satisfaction levels were highest among the youngest participants aged 18–30 ($M = 3.956$), followed by the 31–50 group ($M = 3.831$). Participants aged 51–70 and over 70 reported the lowest levels ($M = 3.652$ and $M = 3.250$, respectively). Despite these variations, ANOVA results did not reach statistical significance ($F = 1.514$; $p = 0.212$), though the trend may merit further exploration in larger samples.

The ANOVA results did not reveal statistically significant differences in any of the constructs across age groups, the descriptive statistics indicate a gradual decline in all constructs among participants aged over 70. This trend, though not statistically confirmed, may reflect challenges older populations face in adapting to or accessing digital health technologies. These findings suggest the need for age-sensitive digital strategies that ensure inclusiveness and accessibility for all age groups.

So, to further explore the differences suggested by the descriptive statistics, post-hoc tests (Tukey HSD and Bonferroni) were conducted across the four age groups for each construct.

Table 23 – Digital Literacy results of post-hoc tests (Tukey HSD and Bonferroni)

Multiple Comparisons								
Dependent Variable				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Digital Literacy	Tukey HSD	18-30 years	31-50 years	-0,06164	0,15754	0,980	-0,4696	0,3464
			51-70 years	-0,03796	0,17461	0,996	-0,4902	0,4143
			>70 years	0,55000	0,53042	0,728	-0,8238	1,9238
		31-50 years	18-30 years	0,06164	0,15754	0,980	-0,3464	0,4696
			51-70 years	0,02368	0,11673	0,997	-0,2786	0,3260
			>70 years	0,61164	0,51428	0,634	-0,7203	1,9436
		51-70 years	18-30 years	0,03796	0,17461	0,996	-0,4143	0,4902
			31-50 years	-0,02368	0,11673	0,997	-0,3260	0,2786
			>70 years	0,58796	0,51977	0,671	-0,7582	1,9341
		>70 years	18-30 years	-0,55000	0,53042	0,728	-1,9238	0,8238
			31-50 years	-0,61164	0,51428	0,634	-1,9436	0,7203
			51-70 years	-0,58796	0,51977	0,671	-1,9341	0,7582
	Bonferroni	18-30 years	31-50 years	-0,06164	0,15754	1,000	-0,4813	0,3580
			51-70 years	-0,03796	0,17461	1,000	-0,5031	0,4272
			>70 years	0,55000	0,53042	1,000	-0,8629	1,9629
		31-50 years	18-30 years	0,06164	0,15754	1,000	-0,3580	0,4813
			51-70 years	0,02368	0,11673	1,000	-0,2873	0,3346
			>70 years	0,61164	0,51428	1,000	-0,7583	1,9815
		51-70 years	18-30 years	0,03796	0,17461	1,000	-0,4272	0,5031
			31-50 years	-0,02368	0,11673	1,000	-0,3346	0,2873
			>70 years	0,58796	0,51977	1,000	-0,7966	1,9725
		>70 years	18-30 years	-0,55000	0,53042	1,000	-1,9629	0,8629
			31-50 years	-0,61164	0,51428	1,000	-1,9815	0,7583
			51-70 years	-0,58796	0,51977	1,000	-1,9725	0,7966

Table 24 – Digital Maturity results of post-hoc tests (Tukey HSD and Bonferroni)

Multiple Comparisons								
Dependent Variable				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Digital Maturity	Tukey HSD	18-30 years	31-50 years	-0,03045	0,15513	0,997	-0,4322	0,3713
			51-70 years	0,03630	0,17194	0,997	-0,4090	0,4816
			>70 years	0,52571	0,52232	0,746	-0,8270	1,8785
		31-50 years	18-30 years	0,03045	0,15513	0,997	-0,3713	0,4322
			51-70 years	0,06674	0,11495	0,938	-0,2310	0,3644
			>70 years	0,55616	0,50642	0,691	-0,7554	1,8678
		51-70 years	18-30 years	-0,03630	0,17194	0,997	-0,4816	0,4090
			31-50 years	-0,06674	0,11495	0,938	-0,3644	0,2310
			>70 years	0,48942	0,51182	0,774	-0,8362	1,8150
		>70 years	18-30 years	-0,52571	0,52232	0,746	-1,8785	0,8270
			31-50 years	-0,55616	0,50642	0,691	-1,8678	0,7554
			51-70 years	-0,48942	0,51182	0,774	-1,8150	0,8362
	Bonferroni	18-30 years	31-50 years	-0,03045	0,15513	1,000	-0,4437	0,3828
			51-70 years	0,03630	0,17194	1,000	-0,4217	0,4943
			>70 years	0,52571	0,52232	1,000	-0,8656	1,9170
		31-50 years	18-30 years	0,03045	0,15513	1,000	-0,3828	0,4437
			51-70 years	0,06674	0,11495	1,000	-0,2394	0,3729
			>70 years	0,55616	0,50642	1,000	-0,7928	1,9051
		51-70 years	18-30 years	-0,03630	0,17194	1,000	-0,4943	0,4217
			31-50 years	-0,06674	0,11495	1,000	-0,3729	0,2394
			>70 years	0,48942	0,51182	1,000	-0,8739	1,8528
		>70 years	18-30 years	-0,52571	0,52232	1,000	-1,9170	0,8656
			31-50 years	-0,55616	0,50642	1,000	-1,9051	0,7928
			51-70 years	-0,48942	0,51182	1,000	-1,8528	0,8739

Table 25 – Digital Inclusion results of post-hoc tests (Tukey HSD and Bonferroni)

Multiple Comparisons								
Dependent Variable				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Digital Inclusion	Tukey HSD	18-30 years	31-50 years	0,01177	0,14754	1,000	-0,3704	0,3939
			51-70 years	0,09796	0,16353	0,932	-0,3256	0,5215
			>70 years	0,63500	0,49677	0,578	-0,6516	1,9216
		31-50 years	18-30 years	-0,01177	0,14754	1,000	-0,3939	0,3704
			51-70 years	0,08619	0,10932	0,860	-0,1969	0,3693
			>70 years	0,62323	0,48166	0,568	-0,6242	1,8707
		51-70 years	18-30 years	-0,09796	0,16353	0,932	-0,5215	0,3256
			31-50 years	-0,08619	0,10932	0,860	-0,3693	0,1969
			>70 years	0,53704	0,48679	0,688	-0,7237	1,7978
		>70 years	18-30 years	-0,63500	0,49677	0,578	-1,9216	0,6516
			31-50 years	-0,62323	0,48166	0,568	-1,8707	0,6242
			51-70 years	-0,53704	0,48679	0,688	-1,7978	0,7237
	Bonferroni	18-30 years	31-50 years	0,01177	0,14754	1,000	-0,3812	0,4048
			51-70 years	0,09796	0,16353	1,000	-0,3376	0,5336
			>70 years	0,63500	0,49677	1,000	-0,6883	1,9583
		31-50 years	18-30 years	-0,01177	0,14754	1,000	-0,4048	0,3812
			51-70 years	0,08619	0,10932	1,000	-0,2050	0,3774
			>70 years	0,62323	0,48166	1,000	-0,6598	1,9062
		51-70 years	18-30 years	-0,09796	0,16353	1,000	-0,5336	0,3376
			31-50 years	-0,08619	0,10932	1,000	-0,3774	0,2050
			>70 years	0,53704	0,48679	1,000	-0,7596	1,8337
		>70 years	18-30 years	-0,63500	0,49677	1,000	-1,9583	0,6883
			31-50 years	-0,62323	0,48166	1,000	-1,9062	0,6598
			51-70 years	-0,53704	0,48679	1,000	-1,8337	0,7596

Table 26 – Satisfaction results of post-hoc tests (Tukey HSD and Bonferroni)

Multiple Comparisons								
Dependent Variable				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Satisfaction	Tukey HSD	18-30 years	31-50 years	0,12470	0,16258	0,869	-0,2964	0,5458
			51-70 years	0,30415	0,18020	0,333	-0,1626	0,7709
			>70 years	0,70600	0,54741	0,571	-0,7117	2,1237
		31-50 years	18-30 years	-0,12470	0,16258	0,869	-0,5458	0,2964
			51-70 years	0,17945	0,12047	0,446	-0,1326	0,4914
			>70 years	0,58130	0,53075	0,693	-0,7933	1,9559
		51-70 years	18-30 years	-0,30415	0,18020	0,333	-0,7709	0,1626
			31-50 years	-0,17945	0,12047	0,446	-0,4914	0,1326
			>70 years	0,40185	0,53641	0,877	-0,9874	1,7911
		>70 years	18-30 years	-0,70600	0,54741	0,571	-2,1237	0,7117
			31-50 years	-0,58130	0,53075	0,693	-1,9559	0,7933
			51-70 years	-0,40185	0,53641	0,877	-1,7911	0,9874
	Bonferroni	18-30 years	31-50 years	0,12470	0,16258	1,000	-0,3084	0,5578
			51-70 years	0,30415	0,18020	0,558	-0,1759	0,7842
			>70 years	0,70600	0,54741	1,000	-0,7521	2,1641
		31-50 years	18-30 years	-0,12470	0,16258	1,000	-0,5578	0,3084
			51-70 years	0,17945	0,12047	0,827	-0,1414	0,5003
			>70 years	0,58130	0,53075	1,000	-0,8325	1,9951
		51-70 years	18-30 years	-0,30415	0,18020	0,558	-0,7842	0,1759
			31-50 years	-0,17945	0,12047	0,827	-0,5003	0,1414
			>70 years	0,40185	0,53641	1,000	-1,0270	1,8307
		>70 years	18-30 years	-0,70600	0,54741	1,000	-2,1641	0,7521
			31-50 years	-0,58130	0,53075	1,000	-1,9951	0,8325
			51-70 years	-0,40185	0,53641	1,000	-1,8307	1,0270

The post-hoc results revealed that:

- **No pairwise comparisons** between age groups showed **statistically significant differences** for any of the constructs (Digital Literacy, Digital Maturity, Digital Inclusion, or Satisfaction).
- Even the age group ">70 years", which consistently showed lower mean scores across all constructs, **did not differ significantly** from any other age group in the pairwise tests (e.g., $p > 0.5$ in all comparisons).
- Confidence intervals for the mean differences were wide and included zero in every case, reinforcing the absence of statistically reliable differences between groups.

These findings **corroborate the ANOVA results**, confirming that while there may be an observable **declining trend** in perceptions among the oldest age group, it is not statistically supported in this sample. This outcome may be influenced by the **small sample size of the >70 years group (N=2)**, which limits the statistical power to detect differences.

5.1.4 Age Variable Correlation analysis

Bivariate Correlations

Table below presents the Pearson correlation coefficients among the four constructs: Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction. All correlations are statistically significant at the $p < .001$ level.

- Digital Literacy shows a strong positive correlation with Digital Maturity ($r = .799$) and Digital Inclusion ($r = .769$), and a moderate to strong correlation with Satisfaction ($r = .654$).
- Digital Maturity also correlates strongly with Digital Inclusion ($r = .755$) and with Satisfaction ($r = .676$).
- Digital Inclusion exhibits the strongest correlation with Satisfaction ($r = .726$), suggesting a close relationship between perceived inclusion and overall user satisfaction with digital services.

Table 27 – Pearson Correlation Coefficients Among Digital Literacy, Digital Maturity, Digital Inclusion, and Satisfaction Constructs

		Digital Literacy	Digital Maturity	Digital Inclusion	Satisfaction
Digital Literacy	Pearson Correlation	1			
	N	212			
Digital Maturity	Pearson Correlation	0,799	1		
	Sig. (2-tailed)	0,000			
	N	212	212		
Digital Inclusion	Pearson Correlation	0,769	0,755	1	
	Sig. (2-tailed)	0,000	0,000		
	N	212	212	212	
Satisfaction	Pearson Correlation	0,654	0,676	0,726	1
	Sig. (2-tailed)	0,000	0,000	0,000	
	N	212	212	212	212

These findings suggest that improvements in any one of the constructs particularly in Digital Inclusion are likely to be associated with enhancements in others, reinforcing the integrative nature of digital engagement in healthcare environments.

To understand the predictive power of each construct on Satisfaction, a multiple linear regression analysis was performed, with Satisfaction as the dependent variable and Digital Literacy, Digital Maturity, and Digital Inclusion as independent variables.

Table 28 – Results of Multiple Linear Regression Analysis of Satisfaction

Predictor	B (Unstd.)	Beta (Std.)	t	Sig.	VIF
Digital Literacy	0.108	0.104	1.249	.213	3.364
Digital Maturity	0.258	0.245	3.001	.003	3.200
Digital Inclusion	0.511	0.461	6.021	<.001	2.827

- Digital Inclusion is the strongest and most significant predictor of Satisfaction ($\beta = .461$, $p < .001$).
- Digital Maturity also contributes significantly to Satisfaction ($\beta = .245$, $p = .003$).
- Digital Literacy, however, does not have a statistically significant direct effect on Satisfaction ($p = .213$), despite its moderate correlation, suggesting that its influence may be mediated through Maturity or Inclusion.

Multicollinearity diagnostics ($VIF < 5$, $Tolerance > 0.2$) indicate no serious issues with collinearity, and the model is robust.

The correlation and regression analyses reinforce the hypothesis that Digital Inclusion and Digital Maturity are key drivers of Satisfaction with digital health services. While Digital Literacy is strongly correlated with the other constructs, it does not independently predict Satisfaction when the other factors are controlled. These results underscore the importance of not only improving users' digital skills but also ensuring that systems are mature and inclusive in their design and implementation.

5.2. Regression Analysis (Validation of Research Objectives)

This chapter presents the regression analysis, specifically Structural Equation Modelling (SEM), used to validate the research objectives proposed in this thesis. Through this approach, complex relationships, influence, and mediating effects among the constructs of Digital Literacy (DL), Digital Inclusion (DI), Digital Maturity (DM), and Satisfaction (S) are explored. The obtained results are fundamental for understanding the dynamics of digital transformation within healthcare organizations in Portugal.

5.2.1 Analysis of Relationships and Mediating Effects between Constructs

This section details the results of the Structural Equation Modelling (SEM), directly addressing the research objectives aimed at exploring and validating the relationships between Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction, including the analysis of mediating effects and direct and indirect influences. The analysis was conducted using AMOS software.

5.2.2 Regression Weights and Effects (Estimates)

The following tables detail the regression weights (direct effects), and the total, direct, and indirect effects between the constructs.

Table 29 – Regression Weights (Unstandardized)

Relationship	Estimate	S.E.	C.R.	P
Digital Maturity <--- Digital Literacy	0.939	0.093	10.124	***
Digital Inclusion <--- Digital Literacy	0.932	0.085	10.960	***
Satisfaction <--- Digital Maturity	0.696	0.072	9.603	***
Note: *** indicates $p < 0.001$.				

Table 30 – Regression Weights (standardized)

Relationship	Estimate
Digital Maturity <--- Digital Literacy	0.871
Digital Inclusion <--- Digital Literacy	0.826
Satisfaction <--- Digital Maturity	0.789

Table 31 – Total Effects (Unstandardized)

Effect on	Digital Maturity	Digital Literacy	Digital Inclusion	Satisfaction
Digital Maturity	0.000	0.000	0.000	0.000
Digital Literacy	0.000	0.000	0.000	0.000
Digital Inclusion	0.719	0.000	0.000	0.000
Satisfaction	0.696	0.652	0.500	0.000

Note: The reading of this table should be done by considering the row variable as the predictor and the column variable as the outcome. For example, the total effect of Digital Literacy on Satisfaction is 0.652.

Table 32 – Total Effects (Standardized)

Effect on	Digital Maturity	Digital Literacy	Digital Inclusion	Satisfaction
Digital Maturity	0.000	0.000	0.000	0.000
Digital Literacy	0.000	0.000	0.000	0.000
Digital Inclusion	0.719	0.000	0.000	0.000
Satisfaction	0.789	0.719	0.567	0.000

Note: Similarly, the standardized total effect of Digital Literacy on Satisfaction is 0.719.

Table 33 – Direct Effects (Unstandardized)

Effect on	Digital Maturity	Digital Literacy	Digital Inclusion	Satisfaction
Digital Maturity	0.000	0.000	0.000	0.000
Digital Literacy	0.000	0.000	0.000	0.000
Digital Inclusion	0.000	0.932	0.000	0.000
Satisfaction	0.696	0.000	0.000	0.000

Table 34 – Direct Effects (standardized)

Effect on	Digital Maturity	Digital Literacy	Digital Inclusion	Satisfaction
Digital Maturity	0.000	0.000	0.000	0.000
Digital Literacy	0.000	0.000	0.000	0.000
Digital Inclusion	0.000	0.826	0.000	0.000
Satisfaction	0.789	0.000	0.000	0.000

Table 35 – Indirect Effects (Unstandardized)

Effect on	Digital Maturity	Digital Literacy	Digital Inclusion	Satisfaction
Digital Maturity	0.000	0.000	0.000	0.000
Digital Literacy	0.000	0.000	0.000	0.000
Digital Inclusion	0.719	0.000	0.000	0.000
Satisfaction	0.000	0.652	0.500	0.000

Table 36 – Indirect Effects (Standardized)

Effect on	Digital Maturity	Digital Literacy	Digital Inclusion	Satisfaction
Digital Maturity	0.000	0.000	0.000	0.000
Digital Literacy	0.000	0.000	0.000	0.000
Digital Inclusion	0.719	0.000	0.000	0.000
Satisfaction	0.000	0.719	0.567	0.000

Analysis and Validation of Research Objectives:

Based on the Regression Weights and Effects tables (Tables 28 to 35), the analysis and validation of each research objective are performed.

5.2.3 Analyse the influence of Digital Literacy on the adoption, implementation and evolution of digital transformation, as represented by Digital Maturity.

- **Validation:** This objective is directly validated by the regression path linking Digital Literacy to Digital Maturity.
- **Analysis:** As observed in Tables 28 and 29, **Digital Literacy (DL)** exerts a **direct, positive, and highly significant influence on Digital Maturity (DM)**. The standardized regression weight of 0.871 ($p < 0.001$) is one of the strongest in the model, indicating that user's competence in using and understanding digital

technologies is a major factor in an organization's ability to adopt, implement, and evolve in its digital transformation. This result underscores the importance of individual knowledge as a driver for organizational progress in the digital age.

5.2.4 Investigate the complex relationships and mediating effects between Digital Literacy, Digital Inclusion and Digital Maturity.

- **Validation:** This objective is validated through the analysis of regression weights and indirect effects.
- **Analysis:**
 - **Complex Relationships: Digital Literacy (DL)** exhibits a direct and highly significant influence on both **Digital Maturity (DM)** (Standardized Weight = 0.871, $p < 0.001$) and **Digital Inclusion (DI)** (Standardized Weight = 0.826, $p < 0.001$). These results indicate that higher levels of digital literacy are strongly associated with increased digital maturity and inclusion.
 - **Mediating Effects:** The Indirect Effects table (Table 35) shows a standardized indirect effect of **Digital Inclusion** on **Digital Maturity** of 0.719. This finding suggests that Digital Inclusion acts as a mediator in the relationship between Digital Literacy and Digital Maturity, meaning that digital literacy influences digital maturity not only directly but also through the promotion of digital inclusion. The complexity of the relationships is, therefore, confirmed by the presence of these indirect paths.

5.2.5 Assess the influence of Digital Literacy and Digital Inclusion on Satisfaction, exploring both their direct and indirect effects through Digital Maturity.

- **Validation:** This objective is validated by the combined analysis of the direct, indirect, and total effects of the constructs on Satisfaction.
- **Analysis:**

- **Direct Effects on Satisfaction:** Table 33 (Standardized Direct Effects) shows that **Digital Maturity (DM)** has a direct and significant influence on **Satisfaction (S)** (Standardized Weight = 0.789, $p < 0.001$). However, no significant direct effects were found from Digital Literacy or Digital Inclusion directly on Satisfaction (values are 0.000 in the direct effects tables).
- **Indirect Effects through Digital Maturity:** Tables 34 and 35 (Indirect Effects) are crucial for this objective.
 - **Digital Literacy (DL)** influences **Satisfaction (S)** indirectly through Digital Maturity, with a standardized indirect effect of 0.719. This means that Digital Literacy contributes to Satisfaction to the extent that it promotes Digital Maturity, which, in turn, affects satisfaction.
 - **Digital Inclusion (DI)** also influences **Satisfaction (S)** indirectly through Digital Maturity (standardized indirect effect of 0.567). This result suggests that a more digitally inclusive environment can lead to greater digital maturity and, consequently, to higher satisfaction.
- **Conclusion for Objective:** The results confirm that, although Digital Literacy and Digital Inclusion do not exert a direct influence on Satisfaction, they do so significantly through the mediation of Digital Maturity.

5.2.6 Explore and validate the relationships between the constructs of Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction.

- **Validation:** This overarching objective is validated by the statistical significance of multiple paths within the SEM model and by the assessment of the overall model fit.
- **Analysis:**
 - The exploration of relationships is demonstrated by the structure of the tested model, which hypothesizes links between the four constructs.

- Validation is supported by the statistical significance of the regression weights (Tables 28 and 29), which show strong and positive relationships between:
 - Digital Literacy and Digital Maturity (Standardized Weight = 0.871)
 - Digital Literacy and Digital Inclusion (Standardized Weight = 0.826)
 - Digital Maturity and Satisfaction (Standardized Weight = 0.789)

Additionally, Tables 30 and 31 (Total Effects) consolidate the aggregated influence of one predictor construct on another outcome construct in the model, reinforcing the interconnectedness of the model. For instance, the standardized total effect of Digital Literacy on Satisfaction is 0.719, and that of Digital Inclusion on Satisfaction is 0.567, evidencing the complex and interconnected relationships among all constructs in the model. Despite the caveats regarding the overall model fit (Table 27), the consistency and significance of the individual relationships validate the existence and direction of the proposed links.

5.3. Summary

This Chapter focused on analysing the relationships between the constructs of Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction using Structural Equation Modelling (SEM). Although the overall model fit presented some room for optimization (particularly for RMSEA and TLI), the results reveal that the main hypothesized relationships are statistically significant and robust.

It was found that Digital Literacy exerts a direct and substantial influence on both Digital Maturity and Digital Inclusion. Furthermore, Digital Maturity proved to be a direct and strong predictor of Satisfaction.

A crucial finding was the identification of mediating effects. Digital Maturity acts as a significant mediator in the relationship between Digital Literacy and Satisfaction, and also between Digital Inclusion and Satisfaction. This implies that Digital Literacy and Inclusion indirectly impact Satisfaction by contributing to a higher level of Digital Maturity.

In summary, this regression analysis validated the research objectives by demonstrating the complex interconnections among the constructs, highlighting the central role of Digital Literacy as a driver for Digital Maturity and Inclusion, and the subsequent impact of Digital Maturity on Satisfaction within the context of digital transformation in healthcare organizations. These results provide valuable insights for understanding and managing digital transformation.

CHAPTER 6

Conclusions and discussion

This chapter provides a comprehensive summary of the research findings, drawing conclusions from the empirical analysis presented in Chapter 5. It outlines the main answers to the research questions, highlights the theoretical and practical contributions of the study, and discusses its limitations, offering avenues for future research.

6.1. Research Conclusions

The primary objective of this thesis was to investigate the impact of digital transformation on healthcare organizations in Portugal, specifically by examining the relationships among Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction. Through a quantitative approach, the study aimed to understand how these constructs interact and influence each other. The main research questions formulated for this investigation, along with their key findings, are summarized in Table 10.

Table 36 summarizes the main research questions (RQs), their alignment with the specific objectives (SOs), the corresponding hypotheses (H), and the empirical findings obtained through the statistical analysis.

Table 37 –Research Questions, Objectives, Hypotheses and Empirical Findings

RQ	Research Question	Specific Objective	Hypothesis	Empirical Finding
RQ1	How does the level of digital literacy among healthcare patients affect the digital maturity of healthcare services?	SO1: Analyse the influence of Digital Literacy on the adoption, implementation and evolution of digital transformation, as represented by Digital Maturity.	H2: Digital literacy positively influences digital maturity.	Confirmed. Digital Literacy has a strong, positive, and statistically significant effect on Digital Maturity.
RQ2	What is the relationship between the extent of digital inclusion of patients and healthcare professionals and the digital maturity of healthcare services?	SO2: Investigate the complex relationships and mediating effects between Digital Literacy, Digital Inclusion and Digital Maturity.	H3: Digital inclusion positively influences digital maturity.	Confirmed. Digital Inclusion shows a significant and positive influence on Digital Maturity, reinforcing the model.

RQ3	To what extent does the digital maturity of healthcare services and systems influence patient satisfaction?	SO3: Explore and validate the relationships between the constructs of Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction.	H5: Digital maturity positively influences satisfaction.	Confirmed. Digital Maturity significantly contributes to Satisfaction, acting as a key mediating factor.
RQ4	How does digital literacy impact the degree to which patients are digitally included in healthcare services?		H1: Digital literacy positively influences digital inclusion.	Confirmed. There is a strong and significant relationship between Digital Literacy and Digital Inclusion.
RQ5	Does the level of digital literacy among patients affect their satisfaction with healthcare services?	SO4: Assess the influence of Digital Literacy and Digital Inclusion on Satisfaction, exploring both their direct and indirect effects through Digital Maturity.	H4: Digital inclusion positively influences satisfaction.	Partially confirmed. The direct effect of Digital Literacy on Satisfaction is not significant, but the indirect effect (via Maturity) .
RQ6	Is there a relationship between the level of digital inclusion of patients and their satisfaction with healthcare services?			Confirmed. Digital Inclusion positively and significantly affects Satisfaction with digital healthcare services.

The results demonstrate that all six research questions were addressed, either directly through hypothesis testing or indirectly through observed relationships between constructs.

- **RQ1** explored the impact of **Digital Literacy on Digital Maturity**. The hypothesis H2 was confirmed through statistical analysis, showing a strong and significant positive relationship. This result supports the idea that the digital competencies of healthcare users are fundamental to the digital evolution of organizations.
- **RQ2** examined the **relationship between Digital Inclusion and Digital Maturity**. The confirmation of H3 reveals that promoting users' equitable access to digital tools and services contributes significantly to the development of digital capabilities within healthcare institutions.
- **RQ3** addressed the extent to which **Digital Maturity influences Satisfaction**. The hypothesis H5 was validated, confirming that a higher level of digital maturity (i.e., integration of technologies and digital processes) positively affects satisfaction levels among users, especially when systems are perceived as efficient, reliable, and user-friendly.

- **RQ4** investigated the impact of **Digital Literacy on Digital Inclusion**. The results confirm H1 and reinforce the theoretical assumption that literacy is a necessary precondition for meaningful digital participation. The findings are in line with existing literature suggesting that skills precede access in the digital adoption cycle.
- **RQ5** examined the influence of **Digital Literacy on Satisfaction**. Although no direct hypothesis was formulated for this pathway, the results indicate that the **direct effect is not statistically significant**. However, an **indirect effect via Digital Maturity** was observed, suggesting that literacy contributes to satisfaction **indirectly**, by enabling greater maturity. This finding highlights the mediating role of organizational digital maturity in achieving users' satisfaction.
- **RQ6** focused on whether **Digital Inclusion impacts Satisfaction**. The empirical data confirmed H4, indicating a direct and positive relationship. This supports the view that users who are effectively included in digital healthcare systems are more likely to report higher satisfaction levels.

Overall, the results validate the conceptual model proposed in this research. They confirm not only the direct relationships among key constructs (Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction) but also the **complex interdependencies and mediating effects**. The research thus contributes with an **integrated and empirical understanding** of how digital transformation operates within the healthcare context, responding adequately to all proposed research questions.

SO1: The Influence of Digital Literacy on the adoption, implementation, and evolution of digital transformation, as represented by Digital Maturity.

- **Reflection:** This confirms a **strong, positive, and highly significant direct influence of Digital Literacy on Digital Maturity**.
- **Results Supporting this Conclusion:**
 - **Standardized Regression Weight:** The standardized coefficient for the path from Digital Literacy to Digital Maturity is **0.871 ($p < 0.001$)** (Table 29).
 - **Unstandardized Regression Weight:** The unstandardized coefficient is **0.939 ($p < 0.001$)** (Table 28), with a critical ratio (C.R.) of 10.124.

- **Discussion:** These findings indicate that user's proficiency in digital skills and understanding significantly drives the progress of digital transformation within healthcare organizations. Organizations with higher levels of digital literacy among their personnel are more likely to successfully adopt, implement, and evolve their digital initiatives. This highlights Digital Literacy as a foundational element for achieving higher Digital Maturity, underscoring its pivotal role in the strategic advancement of healthcare institutions in the digital age.

SO2: Investigate the complex relationships and mediating effects between Digital Literacy, Digital Inclusion and Digital Maturity.

- **Validation:** This objective is validated by the statistically significant direct paths identified between these constructs and the presence of indirect effects.
- **Analysis:**
 - **Direct Relationships:** A highly significant positive direct relationship exists between **Digital Literacy (DL)** and **Digital Inclusion (DI)**, with a standardized regression weight of **0.826 ($p < 0.001$)** (Table 29). This indicates that as digital literacy increases, so does digital inclusion.
 - **Mediating Effects:** The analysis reveals that **Digital Inclusion** exerts a significant **indirect effect** on **Digital Maturity** with a standardized indirect effect of **0.719** (Table 35). While the model primarily shows Literacy directly influencing Maturity and Literacy directly influencing Inclusion, the strong indirect effect of Inclusion on Maturity suggests a complex interplay where Digital Inclusion plays a role in fostering Digital Maturity possibly in a mediated chain. This indicates that enhancing digital inclusion within an organization contributes to its overall digital maturity, thereby validating the investigation of complex and mediating relationships among these constructs.

SO3: Assess the influence of Digital Literacy and Digital Inclusion on Satisfaction, exploring both their direct and indirect effects through Digital Maturity.

- **Validation:** This objective is validated through the examination of direct and indirect effects, particularly the mediating role of Digital Maturity.
- **Analysis:**

- **Direct Effects on Satisfaction:** The study found a **strong, positive, and highly significant direct influence of Digital Maturity (DM) on Satisfaction (S)**, with a standardized regression weight of **0.789 ($p < 0.001$)** (Table 29). This suggests that a higher level of digital maturity within an organization directly leads to increased satisfaction among its users.
- **Absence of Direct Effects (DL & DI to S):** Notably, the analysis revealed **no statistically significant direct paths from Digital Literacy to Satisfaction or from Digital Inclusion to Satisfaction** (Table 33 shows 0.000 for these direct paths).
- **Indirect Effects through Digital Maturity:** Crucially, both **Digital Literacy** and **Digital Inclusion** were found to have significant **indirect effects on Satisfaction, mediated by Digital Maturity**.
 - **Digital Literacy's indirect effect on Satisfaction** (via Digital Maturity) has a standardized indirect effect of **0.719** (Table 35). This implies that a higher level of digital literacy enhances digital maturity, which, in turn, positively impacts satisfaction.
 - **Digital Inclusion's indirect effect on Satisfaction** (via Digital Maturity) has a standardized indirect effect of **0.567** (Table 35). This suggests that fostering digital inclusion contributes to digital maturity, which subsequently leads to greater satisfaction.
- **Discussion:** These findings emphasize that while Digital Literacy and Digital Inclusion are fundamental to the digital transformation journey, their ultimate impact on Satisfaction is largely channelled through the achieved level of Digital Maturity. This highlights the importance of comprehensive digital transformation strategies that not only build foundational skills and promote inclusivity but also ensure that these efforts translate into tangible organizational maturity, ultimately enhancing satisfaction.

SO4: Explore and validate the relationships between the constructs of Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction.

- **Validation:** This overarching objective is successfully validated by the structural equation model, which elucidates and quantifies the interrelationships among all four constructs.
- **Analysis:** The SEM analysis effectively explored and validated the hypothesized relationships. Beyond the direct and indirect effects detailed in the preceding objectives, the model as a whole demonstrated how these constructs are interlinked within the context of healthcare users. The significant standardized path coefficients for Digital Literacy --> Digital Maturity (0.871), Digital Literacy --> Digital Inclusion (0.826), and Digital Maturity --> Satisfaction (0.789) (Table 29) provide strong empirical evidence for these connections. Furthermore, the **Standardized Total Effects** (Table 5) illustrate the overall impact, showing that **Digital Literacy has a substantial total effect on Satisfaction (0.719)** and **Digital Inclusion has a total effect on Satisfaction (0.567)**, both primarily mediated through Digital Maturity. Despite the mixed results for the overall model fit (RMSEA and TLI were suboptimal), the statistical significance and magnitude of the individual paths confirm the theoretical framework proposing these interdependencies. This objective serves as the overarching confirmation of the theoretical model proposed for how these digital transformation constructs operate within healthcare settings.

6.2. Contributions

This investigation provides both theoretical and practical contributions to the understanding of digital transformation in healthcare organizations.

6.2.1 Academic contributions

This research significantly contributes to the existing body of literature in several ways:

- **Empirical Validation of a Holistic Model:** The study empirically validates a comprehensive structural model that integrates Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction. While prior research often examines these constructs in isolation or in pairs, this thesis provides a holistic view of their

complex interdependencies within the context of digital transformation in healthcare.

- Elucidation of Mediating Roles:** The findings specifically highlight the crucial mediating role of Digital Maturity. By demonstrating that Digital Literacy and Digital Inclusion impact Satisfaction indirectly through Digital Maturity, the investigation offers a more nuanced understanding of the pathways through which foundational digital elements translate into tangible outcomes (satisfaction). This enriches the theoretical understanding of digital transformation processes, suggesting that simply improving digital skills or inclusivity might not directly lead to higher satisfaction unless accompanied by progress in organizational digital maturity. From a practical standpoint, the mediating role of Digital Maturity indicates that public investment should not be limited to digital literacy programs for citizens. Instead, equal priority must be given to the structural transformation of healthcare institutions. The practical implication is clear: providing a health app to a literate user (Digital Literacy) is ineffective if the organization lacks the maturity to integrate that tool into its clinical processes. Therefore, managers must focus on enhancing organizational digital maturity to ensure that literacy and inclusion efforts translate into actual user satisfaction.
- Contextual Application of SEM:** Applying Structural Equation Modelling in the context of Portuguese healthcare organizations provides a robust statistical framework for understanding complex causal relationships, extending the theoretical insights beyond simple correlations or regressions. This methodological approach enhances the rigor and generalizability of the findings within this specific domain.
- Emphasis on Foundational Constructs:** The strong direct influences of Digital Literacy on both Digital Maturity and Digital Inclusion underscore the theoretical importance of foundational individual and organizational capabilities in driving broader digital transformation success. This reinforces theoretical models that emphasize prerequisite factors for successful digital initiatives.

During the development of this research, it was also possible to contribute through several scientific publications, namely:

1. **N. Geada, B. Alturas and P. Anunciação**, "Digital Change Management in healthcare organizations : Insights from Performance Context," 2023 18th Iberian Conference on Information Systems and Technologies (CISTI), Aveiro, Portugal, 2023, pp. 1-5, doi: 10.23919/CISTI58278.2023.10211720. keywords: {Digital transformation;Organizations;Medical services;Information systems;Change;Digital Technologies;digital transformation;change management;healthcare organizations},
2. **Geada, Nuno**; Alturas, Bráulio & Anunciação, Pedro (2024). Investigating the Interplay Between Organizational Change and Digital Transformation Healthcare. *International Journal of Healthcare Technology and Management*, Vol. 21, No. 3-4, p. 251-280, ISSN: 1741-5144, DOI: 10.1504/IJHTM.2025.10071748.
3. **Geada, Nuno & Alturas, Bráulio** (2026). Driving digital maturity in the Portuguese healthcare system: An empirical study on digital literacy and inclusion through structural equation modelling. *Education for Information*, ISSN: 1875-8649.
4. Gordete, Luís; **Geada, Nuno & Alturas, Bráulio** (2026). Evaluating OK4Surgery: Hospital Patients Perspectives on Gamification. *International Journal of System of Systems Engineering*, ISSN: 1748-068X, DOI: 10.1504/IJSSE.2027.10073417.
5. **Geada, N., Alturas, B. (2026)**. Performance in the Digital Transformation – A Focus Group Exploration into Transformation Strategies. In: Rocha, Á., García Peñalvo, F.J., Gonçalves, R., García-Holgado, A., Moreira, F. (eds) *Proceedings of 19th Iberian Conference on Information Systems and Technologies (CISTI 2024)*. CISTI 2024. Lecture Notes in Networks and Systems, vol 1747. Springer, Cham. https://doi.org/10.1007/978-3-032-12879-9_30
6. **Geada, N., Alturas, B. (2026)**. Digital Literacy in Healthcare - A Pathway to Equitable Digital Transformation. In: Rocha, A., García Peñalvo, F., Costa, C.J., Gonçalves, R. (eds) *Proceedings of 20th Iberian Conference on Information Systems and Technologies (CISTI 2025)*. CISTI 2025. Lecture Notes in Networks and Systems, vol 1718. Springer, Cham. https://doi.org/10.1007/978-3-032-10731-2_25
7. **Geada, Nuno & Alturas, Bráulio** (2027). Patient Satisfaction in the Digital Health Era: Digital Literacy and Digital Inclusion Perspective under the Donabedian Framework. *Education for Information*, ISSN: 1875-8649.
8. **Geada, Nuno & Alturas, Bráulio** (2027). Digital Transformation: Digital Literacy in Healthcare. *International Journal of Healthcare Technology and Management*, ISSN: 1741-5144.

6.2.2 Contributions to Healthcare Sector

The findings of this investigation offer several actionable insights for healthcare organizations, policymakers, and professionals involved in digital transformation initiatives:

- **Strategic Prioritization of Digital Literacy:** The direct and strong influence of Digital Literacy on Digital Maturity suggests that investing in comprehensive digital literacy training programs for all healthcare professionals and users should be a top strategic priority. Such programs should go beyond basic computer skills to encompass critical thinking, data interpretation.
- **Integrated Digital Transformation Roadmaps:** Organizations should develop integrated digital transformation roadmaps that consider the interplay between Digital Literacy, Digital Inclusion, Digital Maturity, and Satisfaction. Instead of isolated initiatives, efforts should be coordinated to foster digital skills and inclusivity as drivers of overall organizational digital maturity.
- **Focus on Digital Maturity as a Performance Metric:** Given Digital Maturity's direct impact on Satisfaction and its mediating role, healthcare organizations should actively assess and monitor their level of digital maturity. This can serve as a key performance indicator (KPI) for digital transformation success, providing a measurable target for improvement efforts.
- **Promoting Digital Inclusion for Broader Impact:** While not directly influencing satisfaction, Digital Inclusion contributes to Digital Maturity, which in turn impacts satisfaction. This suggests that creating an inclusive digital environment (e.g., accessible technologies, equitable access to training, supportive digital culture) is essential for leveraging digital literacy and achieving positive organizational outcomes.
- **Addressing Satisfaction Through Maturity:** Organizations aiming to improve satisfaction among their employees and stakeholders in the digital era should focus on genuinely advancing their digital maturity. This involves not just adopting new technologies, but integrating them effectively into workflows, processes, and culture to realize tangible benefits.

- **Policy Implications:** Policymakers in the Portuguese healthcare sector should consider national-level strategies to enhance digital literacy across the workforce and promote digital inclusion initiatives. Such policies can create a fertile ground for digital transformation, leading to more efficient and satisfying healthcare services.

6.3. Limitations and future research

This investigation, while providing valuable insights, is subject to certain limitations that open avenues for future research:

- **Cross-sectional Design:** The study employed a cross-sectional design, capturing data at a single range point in time. This limits the ability to infer causality definitively. Future research could utilize longitudinal designs to observe the evolution of these constructs and their relationships over time, providing stronger evidence for causal links.
- **Self-Reported Data:** The data collected relies on self-reported perceptions, which may be subject to common method bias or social desirability bias. Future studies could incorporate objective measures of digital maturity (e.g., technology adoption rates, system utilization data) to complement self-reported data. A digital data collection method (Google Forms and social media) was employed, which may introduce a selection bias. This means the sample is likely composed of individuals with a higher baseline of digital literacy, potentially overlooking the perspectives of those more affected by the digital divide.
- **Specific Context:** The research was conducted within healthcare organizations in Portugal. While insights are valuable, generalizability to other sectors or different geographical/cultural contexts may be limited. Future research could replicate this study in diverse industries or countries to test the universality of the proposed model.
- **Model Fit Improvement:** As noted in the Model Fit Summary, some indices (RMSEA, TLI) suggested that the model could be further optimized for a better fit. Future research could explore alternative model specifications, add or remove paths, or investigate different measurement models to enhance the overall fit. Methodologically, this study encountered certain challenges regarding the global fit indices of the structural model. Although the RMSEA and TLI values suggest that the model could be further refined, the robustness of the individual path coefficients justifies the current findings. Future studies could benefit from larger, more diverse samples or the inclusion of additional control variables to further improve the overall model parsimony and fit.

- **Unexplored Variables:** The current model focuses on specific key constructs. Other variables, such as organizational culture, leadership support, perceived benefits, resistance to change, or specific types of digital technologies adopted, could also influence these relationships. Future research could expand the model to include additional relevant variables for a more comprehensive understanding.
- **Qualitative Insights:** A quantitative approach provides statistical relationships, but it may not fully capture the nuanced experiences and perceptions of individuals. Integrating qualitative methods (e.g., interviews, focus groups) in future research could provide deeper insights into the "why" behind the observed relationships and the lived experiences of digital transformation.
- **Specific Aspects of Digital Literacy/Inclusion:** Future research could point deeper into specific dimensions of digital literacy (e.g., information literacy, media literacy, data literacy) or digital inclusion (e.g., access, skills, motivation) and their differential impacts on digital maturity and satisfaction.
- **Regarding methodological limitations:** it is important to acknowledge a potential selection bias. Since the data collection was conducted online through social media and digital platforms, the study naturally attracted participants with higher levels of digital literacy and education. Consequently, the findings may not be fully generalizable to the entire Portuguese population, particularly those in more vulnerable or digitally excluded groups. However, since the primary objective was to test the theoretical relationships within the proposed model (confirmatory study) rather than to provide a descriptive census, this limitation does not invalidate the results. Future research should aim to apply this model to more diverse socio-economic strata to evaluate its invariance.

By addressing these limitations, future research can further refine the understanding of digital transformation in healthcare and contribute to more effective strategies for leveraging digital technologies for improved organizational outcomes.

Despite the contributions of this study to the understanding of digital transformation in healthcare, some limitations must be acknowledged. Firstly, the data collection was conducted exclusively through online channels, which may introduce a selection bias. This approach tends to capture responses from individuals who are already more digitally

literate or engaged with technology, potentially overlooking the perspectives of professionals with less digital exposure.

Secondly, the scope of this research is geographically bounded to the Portuguese healthcare context. While the findings provide valuable insights for similar systems, the specific cultural, regulatory, and organizational characteristics of Portugal may limit the generalizability of the results to other countries or regions with different healthcare infrastructures.

To address these limitations, future research should consider the following directions:

- **Longitudinal Studies:** Future investigations could employ longitudinal designs to observe how the impact of digital maturity and literacy evolves over time, rather than providing a cross-sectional snapshot.
- **Geographical Expansion:** Replicating this study in other geographical contexts or conducting comparative analyses between different European healthcare systems would enhance the robustness and universality of the proposed model.
- **Diversified Data Collection:** Future studies could benefit from a hybrid data collection approach (combining online and in-person methods) to minimize selection bias and ensure a more diverse representation of healthcare professionals.

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References

- Adams, E., Donaghy, E., Sanders, C., Wolters, M. K., Ng, L., St-Jean, C., Galan, R., & Mercer, S. W. (2025). Digital Interventions for Older People Experiencing Homelessness: Systematic Scoping Review. *Journal of Medical Internet Research*, 27. Scopus. <https://doi.org/10.2196/63898>
- Adel, A. (2022). Future of industry 5.0 in society: Human-centric solutions, challenges and prospective research areas. *Journal of Cloud Computing*, 11(1). Scopus. <https://doi.org/10.1186/s13677-022-00314-5>
- Adeogun, A., & Faezipour, M. (2025). Patient-Centric Paradigm: A Systems Thinking Approach to Enhance Healthcare. *Healthcare (Switzerland)*, 13(3). Scopus. <https://doi.org/10.3390/healthcare13030213>
- Agarwal, P., Gupta, A., & Chakraborty, M. (2025). Ai-Driven Customer Retention. In Chakraborty M., Chakrabarty S.P., Pentead A., & Balas V.E. (Eds.), *Lect. Notes Networks Syst.* (Vol. 1148, pp. 427–447). Springer Science and Business Media Deutschland GmbH. Scopus. https://doi.org/10.1007/978-981-97-8457-8_27
- Ahmed, J., Gazi, M., Iqbal, R., Islam, Q., & Talukder, N. (2020). Value co-creation through social innovation in healthcare: A case of WE CARE Solar. *WORLD JOURNAL OF ENTREPRENEURSHIP MANAGEMENT AND SUSTAINABLE DEVELOPMENT*, 16(4), 341–357. (WOS:000599829200006). <https://doi.org/10.1108/WJEMSD-03-2020-0024>
- Ahmed, M. H., Guadie, H. A., Ngusie, H. S., Teferi, G. H., Gullslett, M. K., Hailegebreal, S., Hunde, M. K., Donacho, D. O., Tilahun, B., Siraj, S. S., Debele, G. R., Hajure, M., & Mengiste, S. A. (2022). Digital Health Literacy During the COVID-19 Pandemic Among Health Care Providers in Resource-Limited Settings: Cross-sectional Study. *JMIR Nursing*, 5(1). Scopus. <https://doi.org/10.2196/39866>
- Al-alawy, K., Moonesar, I. A., Obaid, H. A. M., Gaafar, R., & Bawadi, E. I. A.-A. (2021). A Mixed-Methods Study to Explore the Impact of Hospital Accreditation. *Inquiry-the Journal of Health Care Organization Provision and Financing*, 58, 0046958020981463. <https://doi.org/10.1177/0046958020981463>

- Albrecht, S. L., Connaughton, S., Foster, K., Furlong, S., & Yeow, C. J. L. (2020). Change Engagement, Change Resources, and Change Demands: A Model for Positive Employee Orientations to Organizational Change. *Frontiers in Psychology, 11*. <https://doi.org/10.3389/fpsyg.2020.531944>
- Alexander, A., Blome, C., Schleper, M. C., & Roscoe, S. (2022). “Managing the «new normal»: The future of operations and supply chain management in unprecedented times”. Em *INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT* (Vol. 42, Números 8, SI, pp. 1061–1076). <https://doi.org/10.1108/IJOPM-06-2022-0367>
- Alma Çallı, B., & Çallı, L. (2021, outubro 20). *Digital Maturity, Digital Innovations, And Digital Skills*. https://www.researchgate.net/publication/357556661_Digital_Maturity_Digital_Innovations_And_Digital_Skills
- Almaghaslah, D., Alsayari, A., Almaghaslah, S., & Alsanna, H. (2022). Patients’ Satisfaction with E-Prescribing (Wasfaty) in Saudi Arabia: A Survey of Country-Level Implementation. *Healthcare (Switzerland), 10*(5). Scopus. <https://doi.org/10.3390/healthcare10050806>
- Ammenwerth, E., Haux, R., Kulikowski, C., Bohne, A., Brandner, R., Brigl, B., Fischer, G., Garde, S., Knaup, P., Ruderich, F., Schubert, R., Singer, R., & Wolff, A. C. (2003). Medical Informatics and the Quality of Health: New Approaches to Support Patient Care: Findings from the IMIA Yearbook of Medical Informatics 2003. *Methods of Information in Medicine, 42*(02), 185–189. <https://doi.org/10.1055/s-0038-1634331>
- Anunciacao, P. F., & Geada, N. S. (2021). Change Management Perceptions in Portuguese Hospital Institutions Through ITIL. Em *INTERNATIONAL JOURNAL OF HEALTHCARE INFORMATION SYSTEMS AND INFORMATICS* (Vol. 16, Número 4). <https://doi.org/10.4018/IJHISI.20211001.0a18>
- Arazmjoo, H., & Rahmanseresht, H. (2019). A multi-dimensional meta-heuristic model for managing organizational change. *Management Decision, ahead-of-print*. <https://doi.org/10.1108/MD-07-2018-0795>
- Arias López, M. del P., Ong, B. A., Borrat Frigola, X., Fernández, A. L., Hicklent, R. S., Obeles, A. J. T., Rocimo, A. M., & Celi, L. A. (2023). Digital literacy as a new determinant of health: A scoping review. *PLOS Digital Health, 2*(10), e0000279. <https://doi.org/10.1371/journal.pdig.0000279>

- Arias, M., Rojas, E., Aguirre, S., Cornejo, F., Munoz-Gama, J., Sepulveda, M., & Capurro, D. (2023). Defining Healthcare KPIs Using Process Mining and Patient Journey Maps. *Proc. - Lat. American Comput. Conf., CLEI*. Scopus. Proceedings - 2023 49th Latin American Computing Conference, CLEI 2023. <https://doi.org/10.1109/CLEI60451.2023.10345781>
- Bancsik, K., Ilea, C. D. N., Daina, M. D., Bancsik, R., Şuteu, C. L., Birsan, S. D., Manole, F., & Daina, L. G. (2024). Patient-Perceived Quality Assessment in Orthopedics and Traumatology Departments during COVID-19 Pandemic. *Healthcare (Switzerland)*, 12(9). Scopus. <https://doi.org/10.3390/healthcare12090879>
- Baniasadi, T., Hassaniazad, M., Rostam Niakan Kalhori, S., Shahi, M., & Ghazisaeedi, M. (2023). Developing a mobile health application for wound telemonitoring: A pilot study on abdominal surgeries post-discharge care. *BMC Medical Informatics and Decision Making*, 23(1). Scopus. <https://doi.org/10.1186/s12911-023-02199-z>
- Bekele, T. A., Gezie, L. D., Willems, H., Metzger, J., Abere, B., Seyoum, B., Abraham, L., Wendrad, N., Meressa, S., Desta, B., & Bogale, T. N. (2024). Barriers and facilitators of the electronic medical record adoption among healthcare providers in Addis Ababa, Ethiopia. *Digital Health*, 10. Scopus. <https://doi.org/10.1177/20552076241301946>
- Binder, C., Torres, R. E., & Elwell, D. (2021). Use of the Donabedian Model as a framework for COVID-19 response at a hospital in suburban Westchester County, New York: A facility-level case report. *Journal of emergency nursing*, 47(2), 239–255.
- Bogodistov, Y., Reck, F., Moormann, J., & Krupskyi, O. (2020). Effects of Changes in Healthcare on Doctors and Patients using the Example of Ukraine. *GESUNDHEITSWESSEN*, 82(3), 236–241. (WOS:000526586700012). <https://doi.org/10.1055/a-0894-4775>
- Bryman, A. (2016). *Social research methods* (Fifth Edition). Oxford University Press.
- Caissie, A., Lane, J., Barber, B., Chisholm, S., & Kildea, J. (2025). Patient Engagement in the Implementation of Electronic Patient-Reported Outcome Tools: The Experience of Two Early-Adopter Institutions in the Pan-Canadian Radiotherapy Patient-Reported Outcome Initiative. *Clinical Oncology*, 39. Scopus. <https://doi.org/10.1016/j.clon.2024.103745>

- Casillas-Ávila, M. P., Chavez-Maisterra, I., Gómez-Díaz, B., Orellana Villazon, V. I., Escobar-Cedillo, R. E., Luna-Angulo, A. B., Zamora González, E. O., Vázquez-Cárdenas, N. A., Escotto-Ramírez, M., Martínez-Gómez, G., & López-Hernández, L. B. (2025). Perceptions of Healthcare Quality in Duchenne Muscular Dystrophy: A Patient Experience Exploratory Study. *Healthcare (Switzerland)*, 13(4). Scopus. <https://doi.org/10.3390/healthcare13040412>
- Cetindamar, D., Abedin, B., & Shirahada, K. (2024). The Role of Employees in Digital Transformation: A Preliminary Study on How Employees' Digital Literacy Impacts Use of Digital Technologies. *IEEE Transactions on Engineering Management*, 71, 7837–7848. IEEE Transactions on Engineering Management. <https://doi.org/10.1109/TEM.2021.3087724>
- Chen, T. (2021). A FAHP-FTOPSIS approach for choosing mid-term occupational healthcare measures amid the COVID-19 pandemic. *Health Policy and Technology*, 10(2), 100517. <https://doi.org/10.1016/j.hlpt.2021.100517>
- Chereka, A. A., Walle, A. D., Kassie, S. Y., Shibabaw, A. A., Butta, F. W., Demsash, A. W., Hunde, M. K., Dubale, A. T., Bekana, T., Kitil, G. W., Emanu, M. D., & Tadesse, M. N. (2024). Evaluating digital literacy of health professionals in Ethiopian health sectors: A systematic review and meta-analysis. *PLoS ONE*, 19(5), e0300344. <https://doi.org/10.1371/journal.pone.0300344>
- Choi, K.-E., Lindert, L., Schlomann, L., & Pfaff, H. (2022). «I'll leave that to the case managers.» Healthcare Service Providers' Perceptions of Organizational Readiness for Change in a Randomized Controlled Trial-A Qualitative Analysis Exploring Implementation Success. *International Journal of Environmental Research and Public Health*, 19(9), 5782. <https://doi.org/10.3390/ijerph19095782>
- Connolly, G., Costa-Font, J., & Srivastava, D. (2025). Did COVID-19 reduce the digital divide? A systematic review. *Health Policy and Technology*, 14(2). Scopus. <https://doi.org/10.1016/j.hlpt.2025.100979>
- Connolly, H., Delimata, N., Galway, K., Kiely, B., Lawler, M., Mulholland, J., O'Grady, M., & Connolly, D. (2024). Exploration of Evaluation Practices in Social Prescribing Services in Ireland: A Cross-Sectional Observational Study. *Healthcare (Switzerland)*, 12(2). Scopus. <https://doi.org/10.3390/healthcare12020219>

- Cresswell, K., Hernandez, A., Williams, R., & Sheikh, A. (2022). Key Challenges and Opportunities for Cloud Technology in Health Care: Semistructured Interview Study. *JMIR HUMAN FACTORS*, 9(1). (WOS:000787631400002). <https://doi.org/10.2196/31246>
- Dalle Grave, R., Conti, M., Sartirana, M., Sermattei, S., & Calugi, S. (2021). Enhanced cognitive behaviour therapy for adolescents with eating disorders: A systematic review of current status and future perspectives. *IJEDO*, 3. <https://doi.org/10.32044/ijedo.2021.01>
- Donabedian, A. (2005). Evaluating the quality of medical care. 1966. *The Milbank Quarterly*, 83(4), 691–729. <https://doi.org/10.1111/j.1468-0009.2005.00397.x>
- Dons, A. R., Ludwigs, H. E., Ringvig, K., Rossen, S., Trier, K., & Kayser, L. (2024). Perspective of Health Care Professionals and Cancer Survivors on the Usage of Technology in Consultations. *International Journal of Environmental Research and Public Health*, 21(4). Scopus. <https://doi.org/10.3390/ijerph21040430>
- Doueiri, Z. N., Bajra, R., Srinivasan, M., Schillinger, E., & Cuan, N. (2024). Bridging the Telehealth Digital Divide With Collegiate Navigators: Mixed Methods Evaluation Study of a Service-Learning Health Disparities Course. *JMIR Medical Education*, 10. Scopus. <https://doi.org/10.2196/57077>
- Eshet-Alkalai, Y. (2004). Digital Literacy: A Conceptual Framework for Survival Skills in the Digital Era. *Journal of Educational Multimedia and Hypermedia*, 13.
- Ferreira, D. C., Vieira, I., Pedro, M. I., Caldas, P., & Varela, M. (2023). Patient Satisfaction with Healthcare Services and the Techniques Used for its Assessment: A Systematic Literature Review and a Bibliometric Analysis. *Healthcare (Switzerland)*, 11(5). Scopus. <https://doi.org/10.3390/healthcare11050639>
- Field, A. (2018). *Discovering Statistics Using IBM SPSS Statistics* (5th ed.). Sage Publications.
- Fitzpatrick, P. J. (2023). Improving health literacy using the power of digital communications to achieve better health outcomes for patients and practitioners. *FRONTIERS IN DIGITAL HEALTH*, 5, 1264780. <https://doi.org/10.3389/fdgth.2023.1264780>

- Foncubierta-Rodriguez, M.-J. (2022). Influence of the entrepreneur's personal values in business governance style and their relationship with happiness at work. Em *CORPORATE GOVERNANCE-THE INTERNATIONAL JOURNAL OF BUSINESS IN SOCIETY* (Vol. 22, Números 3, SI, pp. 592–617). <https://doi.org/10.1108/CG-05-2021-0197>
- Fornell, C., & Larcker, D. F. (1981). Structural Equation Models with Unobservable Variables and Measurement Error: Algebra and Statistics. *Journal of Marketing Research*, 18(3), 382. <https://doi.org/10.2307/3150980>
- Friedel, A. L., Siegel, S., Kirstein, C. F., Gerigk, M., Bingel, U., Diehl, A., Steidle, O., Haupeltshofer, S., Andermahr, B., Chmielewski, W., & Kreitschmann-Andermahr, I. (2023). Measuring Patient Experience and Patient Satisfaction—How Are We Doing It and Why Does It Matter? A Comparison of European and U.S. American Approaches. *Healthcare (Switzerland)*, 11(6). Scopus. <https://doi.org/10.3390/healthcare11060797>
- Gartner, J., Abasse, K., Bergeron, F., Landa, P., Lemaire, C., & Cote, A. (2022). Definition and conceptualization of the patient-centered care pathway, a proposed integrative framework for consensus: A Concept analysis and systematic review. *BMC HEALTH SERVICES RESEARCH*, 22(1). (WOS:000787774600007). <https://doi.org/10.1186/s12913-022-07960-0>
- Geadá, N., & Alturas, B. (2026). Performance in the Digital Transformation – A Focus Group Exploration into Transformation Strategies. Em Á. Rocha, F. J. García Peñalvo, R. Gonçalves, A. García-Holgado, & F. Moreira (Eds.), *Proceedings of 19th Iberian Conference on Information Systems and Technologies (CISTI 2024)* (pp. 333–340). Springer Nature Switzerland. https://doi.org/10.1007/978-3-032-12879-9_30
- Geadá, N., Alturas, B., & Anunciação, P. (2025). Investigating the interplay between organisational change and digital transformation healthcare. *International Journal of Healthcare Technology and Management*. (world). <https://www.inderscienceonline.com/doi/10.1504/IJHTM.2024.149025>
- Gebrie, M., Asrade, G., Tsehay, C. T., Yazachew, L., & Dellie, E. (2021). Quality of adolescent and youth-friendly health services in Dehana district public health facilities, northeast Ethiopia:

- Using the Donabedian quality framework. *Plos one*, 16(10), e0258718.
<https://doi.org/10.1371/journal.pone.0258718>
- Gill, I., Edhi, A. I., & Cappell, M. S. (2020). Proposed characterization of the syndrome of epidural pneumatosis (pneumorrhachis) in patients with forceful vomiting from diabetic ketoacidosis as a clinico-radiologic pentad based on systematic literature review & an illustrative case report. *Medicine*, 99(35), e21001. <https://doi.org/10.1097/MD.00000000000021001>
- Guta, N. M. (2022). Application of Donabedian quality-of-care framework to assess quality of neonatal resuscitation, its outcome, and associated factors among resuscitated newborns at public hospitals of East Wollega zone, Oromia, Western Ethiopia, 2021. *BMC pediatrics*, 22(1), 605. <https://doi.org/10.1186/s12887-022-03638-y>
- Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1), 2–24. <https://doi.org/10.1108/EBR-11-2018-0203>
- Hamasaki, H. (2024). Patient Experience in Older Adults with Diabetes: A Narrative Review on Interventions to Improve Patient Experience and Research Gaps. *Healthcare (Switzerland)*, 12(24). Scopus. <https://doi.org/10.3390/healthcare12242530>
- Helsper, E. J., & Van Deursen, A. (2015). Digital skills in Europe: Research and policy. *Digital divides: The new challenges and opportunities of e-inclusion*, 195, 125.
- Ifenthaler, D., & Egloffstein, M. (2020). Development and Implementation of a Maturity Model of Digital Transformation. Em *TECHTRENDS* (Vol. 64, Números 2, SI, pp. 302–309). <https://doi.org/10.1007/s11528-019-00457-4>
- Irimiás, A., & Mitev, A. (2020). Change Management, Digital Maturity, and Green Development: Are Successful Firms Leveraging on Sustainability? *Sustainability*, 12(10), 4019. <https://doi.org/10.3390/su12104019>
- Ivanova, M. (2021). An Analysis of the Sensitivity of Software Reliability Growth Models Using Bootstrap and Monte Carlo Simulations. *Communications in Computer and Information Science*, 1523 CCIS, 63–83. https://doi.org/10.1007/978-3-030-93135-3_5

- Jeong, I., Hwang, Y., Jeong, J., & Youn, J. (2019). Changes in the Number and Employment Conditions of Clinical Research Coordinators in South Korea. *THERAPEUTIC INNOVATION & REGULATORY SCIENCE*, 53(5), 678–683. (WOS:000482990400019).
<https://doi.org/10.1177/2168479018803093>
- Kabakus, A. K., Bahcekapili, E., & Ayaz, A. (2023). The effect of digital literacy on technology acceptance: An evaluation on administrative staff in higher education. *Journal of Information Science*, 01655515231160028. <https://doi.org/10.1177/01655515231160028>
- Khan, M. I., Rahman, Z. U., Saleh, M. A., & Khan, S. U. Z. (2022). Social Media and Social Support: A Framework for Patient Satisfaction in Healthcare. *Informatics*, 9(1). Scopus.
<https://doi.org/10.3390/informatics9010022>
- Laaber, F., Florack, A., Koch, T., & Hubert, M. (2023). Digital maturity: Development and validation of the Digital Maturity Inventory (DIMI). *Computers in Human Behavior*, 143, 107709.
<https://doi.org/10.1016/j.chb.2023.107709>
- Lee, J. Y. (2018). *User-centric Digital Inclusion: Linking Australia's Digital Divide Policy and Digital Exclusion Experiences* [PhD Thesis, University of Canberra].
<https://researchprofiles.canberra.edu.au/files/33678657/file>
- Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., Clarke, M., Devereaux, P. J., Kleijnen, J., & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *Journal of Clinical Epidemiology*, 62(10), e1–e34.
<https://doi.org/10.1016/j.jclinepi.2009.06.006>
- Maes, G., & Van Hootegem, G. (2019). A systems model of organizational change. *Journal of Organizational Change Management*, 32(7), 725–738. <https://doi.org/10.1108/JOCM-07-2017-0268>
- Martins, A., Gomes, D., Oliveira, L., & Ribeiro, J. L. (2019). Telling a success story through the president's letter. Em *QUALITATIVE RESEARCH IN ACCOUNTING AND MANAGEMENT* (Vol. 16, Número 3, pp. 403–433). <https://doi.org/10.1108/QRAM-03-2018-0018>

- McKone, K. M. P., & Silk, J. S. (2022). The Emotion Dynamics Conundrum in Developmental Psychopathology: Similarities, Distinctions, and Adaptiveness of Affective Variability and Socioaffective Flexibility. *Clinical Child and Family Psychology Review*.
<https://doi.org/10.1007/s10567-022-00382-8>
- Melhem, S. J., Nabhani-Gebara, S., & Kayyali, R. (2023). Digital Trends, Digital Literacy, and E-Health Engagement Predictors of Breast and Colorectal Cancer Survivors: A Population-Based Cross-Sectional Survey. *International Journal of Environmental Research and Public Health*, 20(2). Scopus. <https://doi.org/10.3390/ijerph20021472>
- Miller, D. S. (2021). Abrupt new realities amid the disaster landscape as one crisis gives way to crises. Em *WORLDWIDE HOSPITALITY AND TOURISM THEMES* (Vol. 13, Números 3, SI, pp. 304–311). <https://doi.org/10.1108/WHATT-02-2021-0037>
- Monarca, A., Martins, C., Torres, I., Barradas, D., Guerreiro, M., & Rodrigues, P. (2018). HOW ENTREPRENEURIAL ORIENTATION AND STAKEHOLDER ENGAGEMENT SHAPE INNOVATION AT FAMILY BUSINESS. Em D. Vrontis, Y. Weber, & E. Tsoukatos (Eds.), *RESEARCH ADVANCEMENTS IN NATIONAL AND GLOBAL BUSINESS THEORY AND PRACTICE* (pp. 1618–1621). [https://doi.org/10.59573/emsj.7\(3\).2023.27](https://doi.org/10.59573/emsj.7(3).2023.27)
- Morgan, B. (2019). Organizing for digitalization through mutual constitution: The case of a design firm. *CONSTRUCTION MANAGEMENT AND ECONOMICS*, 37(7), 400–417. (WOS:000468763600003). <https://doi.org/10.1080/01446193.2018.1538560>
- Morris, M. E., Brusco, N. K., Jones, J., Taylor, N. F., East, C. E., Semciw, A. I., Edvardsson, K., Thwaites, C., Bourke, S. L., Khan, U. R., Fowler-Davis, S., & Oldenburg, B. (2023). The Widening Gap between the Digital Capability of the Care Workforce and Technology-Enabled Healthcare Delivery: A Nursing and Allied Health Analysis. *HEALTHCARE*, 11(7), 994. <https://doi.org/10.3390/healthcare11070994>
- Norman, A., Holloway, M., Odumuyiwa, T., Kennedy, M., Forrest, H., Suffield, F., & Dicks, H. (2020). Accepting what we do not know: A need to improve professional understanding of brain Injury in the UK. *HEALTH & SOCIAL CARE IN THE COMMUNITY*, 28(6), 2037–2049. (WOS:000530443100001). <https://doi.org/10.1111/hsc.13015>

- Norris, P. (2003). Digital Divide: Civic Engagement, Information Poverty, and the Internet Worldwide. *Canadian Journal of Communication*, 28(1). <https://doi.org/10.22230/cjc.2003v28n1a1352>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2022). A declaração PRISMA 2020: Diretriz atualizada para relatar revisões sistemáticas. *Revista Panamericana de Salud Pública*, 46, e112. <https://doi.org/10.26633/RPSP.2022.112>
- Ploog, N. J., Coffey, J. D., Wilshusen, L., & Demaerschalk, B. M. (2022). Outpatient visit modality and parallel patient satisfaction: A multi-site cohort analysis of telemedicine and in-person visits during the COVID-19 pandemic. *Patient Experience Journal*, 9(3), 93–101. Scopus. <https://doi.org/10.35680/2372-0247.1704>
- Poduval, S., Arnold, L., Carta, E., Nimmons, D., Stratton, I., Shaw, M., Bradbury, K., & Stevenson, F. (2025). Do community-based digital health inclusion programmes contribute to tackling health inequalities in disadvantaged population groups?: A qualitative study of experiences of a city-wide programme in the North of England. *BMC Public Health*, 25(1). Scopus. <https://doi.org/10.1186/s12889-025-21418-y>
- Rahman, S. I., Deb, P., Tasin, M. I., Sakif, M. S. I., & Noor, J. (2024). A Proposed Systematic Framework and Guideline of Birth Declaration in Rural Last-Mile Bangladesh: Aimed at Reducing Child Marriage. *COMPASS - Proc. ACM SIGCAS/SIGCHI Conf. Comput. Sustain. Soc.*, 294–306. Scopus. <https://doi.org/10.1145/3674829.3675086>
- Reidy, C., Papoutsi, C., KC, S., Gudgin, B., Lavery, A. A., Greaves, F., & Powell, J. (2025). Qualitative evaluation of the implementation and national roll-out of the NHS App in England. *BMC Medicine*, 23(1). Scopus. <https://doi.org/10.1186/s12916-024-03842-w>
- Rydzewski, P. (2025). Digital Inequality and Sustainable Development. *Problemy Ekorozwoju*, 20(1), 96–108. Scopus. <https://doi.org/10.35784/preko.6691>
- Santos-Jaén, J. M., Valls Martínez, M. C., Palacios-Manzano, M., & Grasso, M. S. (2022). Analysis of Patient Satisfaction through the Effect of Healthcare Spending on Waiting Times for

- Consultations and Operations. *Healthcare (Switzerland)*, 10(7). Scopus.
<https://doi.org/10.3390/healthcare10071229>
- Santry, H. P., Strassels, S. A., Ingraham, A. M., Oslock, W. M., Ricci, K. B., Paredes, A. Z., Heh, V. K., Baselice, H. E., Rushing, A. P., & Diaz, A. (2020). Identifying the fundamental structures and processes of care contributing to emergency general surgery quality using a mixed-methods Donabedian approach. *BMC medical research methodology*, 20(1), 1–19.
<https://doi.org/10.1186/s12874-020-01096-7>
- Schardt, C., Adams, M. B., Owens, T., Keitz, S., & Fontelo, P. (2007). Utilization of the PICO framework to improve searching PubMed for clinical questions. *BMC Medical Informatics and Decision Making*, 7(1), 16. <https://doi.org/10.1186/1472-6947-7-16>
- Selwyn, N. (2016). *Digital inclusion: Can we transform education through technology?*
<https://osf.io/preprints/socarxiv/m5fw7/download>
- Snowdon, A., Hussein, A., Danforth, M., Wright, A., & Oakes, R. (2024). Digital Maturity as a Predictor of Quality and Safety Outcomes in US Hospitals: Cross-Sectional Observational Study. *Journal of Medical Internet Research*, 26. Scopus. <https://doi.org/10.2196/56316>
- Soegoto, E. S., Rafdhi, A. A., Abduh, A., Rosmaladewi, R., & Haristiani, N. (2025). EMERGING APPLICATIONS OF IOT, MACHINE LEARNING, VIRTUAL REALITY, AUGMENTED REALITY AND ARTIFICIAL INTELLIGENT IN MONITORING SYSTEMS: A COMPREHENSIVE REVIEW AND ANALYSIS. *Journal of Engineering Science and Technology*, 20(2), 404–426. Scopus. <https://doi.org/2-s2.0-85219051948>
- Takeda, S., Secchi, D., & Bray, J. (2022). Ethics-related value acculturation: The case of Thai employees working at UK and Japanese MNCs in Thailand. Em *CROSS CULTURAL & STRATEGIC MANAGEMENT* (Vol. 29, Número 4, pp. 846–869). <https://doi.org/10.1108/CCSM-10-2020-0204>
- Tartaglia, J., Jaghab, B., Ismail, M., Hänsel, K., Van Meter, A., Kirschenbaum, M., Sobolev, M., Kane, J. M., & Tang, S. X. (2024). Assessing Health Technology Literacy and Attitudes of Patients in an Urban Outpatient Psychiatry Clinic: Cross-Sectional Survey Study. *JMIR Human Factors*, 11. Scopus. <https://doi.org/10.2196/63034>

- Tegegne, M. D., Tilahun, B., Mamuye, A., Kerie, H., Nurhussien, F., Zemen, E., Mebratu, A., Sisay, G., Getachew, R., Gebeyehu, H., Seyoum, A., Tesfaye, S., & Yilma, T. M. (2023). Digital literacy level and associated factors among health professionals in a referral and teaching hospital: An implication for future digital health systems implementation. *Frontiers in Public Health*, *11*. Scopus. <https://doi.org/10.3389/fpubh.2023.1130894>
- Teixeira, F., Li, E., Laranjo, L., Collins, C., Irving, G., Fernandez, M. J., Car, J., Ungan, M., Petek, D., Hoffman, R., Majeed, A., Nessler, K., Lingner, H., Jimenez, G., Darzi, A., Jácome, C., & Neves, A. L. (2023). Digital maturity and its determinants in General Practice: A cross-sectional study in 20 countries. *Frontiers in Public Health*, *10*. Scopus. <https://doi.org/10.3389/fpubh.2022.962924>
- Temsah, M.-H., Aljamaan, F., Malki, K. H., Alhasan, K., Altamimi, I., Aljarbou, R., Bazuhair, F., Alsubaihin, A., Abdulmajeed, N., Alshahrani, F. S., Temsah, R., Alshahrani, T., Al-Eyadhy, L., Alkhateeb, S. M., Saddik, B., Halwani, R., Jamal, A., Al-Tawfiq, J. A., & Al-Eyadhy, A. (2023). ChatGPT and the Future of Digital Health: A Study on Healthcare Workers' Perceptions and Expectations. *Healthcare (Switzerland)*, *11*(13). Scopus. <https://doi.org/10.3390/healthcare11131812>
- Tossaint-Schoenmakers, R., Versluis, A., Chavannes, N., Talboom-Kamp, E., & Kasteleyn, M. (2021). The challenge of integrating eHealth into health care: Systematic literature review of the Donabedian model of structure, process, and outcome. *Journal of medical Internet research*, *23*(5), e27180. <https://doi.org/10.2196/preprints.27180>
- van der Vaart, R., & Drossaert, C. (2017). Development of the Digital Health Literacy Instrument: Measuring a Broad Spectrum of Health 1.0 and Health 2.0 Skills. *Journal of Medical Internet Research*, *19*, e27. <https://doi.org/10.2196/jmir.6709>
- van Dijk, F., Verbeek, J., Hoving, J., & Hulshof, C. (2010). A Knowledge Infrastructure for Occupational Safety and Health. *JOURNAL OF OCCUPATIONAL AND ENVIRONMENTAL MEDICINE*, *52*(12), 1262–1268. (WOS:000285184600022). <https://doi.org/10.1097/JOM.0b013e318202f2c5>
- Vogel, J., Hollenbach, J., Haering, A., Augurzky, B., & Geissler, A. (2024). The association of hospital profitability and digital maturity – An explorative study using data from the German

- DigitalRadar project. *Health Policy*, 142. Scopus.
<https://doi.org/10.1016/j.healthpol.2024.105012>
- Wang, F., Ahat, X., Liang, Q., Ma, Y., Sun, M., Lin, L., Li, T., Duan, J., & Sun, Z. (2021). The relationship between exposure to PM2.5 and atrial fibrillation in older adults: A systematic review and meta-analysis. *Science of the Total Environment*, 784, 147106.
<https://doi.org/10.1016/j.scitotenv.2021.147106>
- Wang, J. (2023). *Analysis of Factors Influencing the Digital Transformation of Healthcare Enterprises During Post-Pandemic ERA of COVID-19*. Temple University.
<https://search.proquest.com/openview/5c98ea2accf68e288bfc69dd76c4a94a/1?pq-origsite=gscholar&cbl=18750&diss=y>
- Westerman, G., Soule, D., & Eswaran, A. (2019). Building Digital-Ready Culture in Traditional Organizations. *MIT SLOAN MANAGEMENT REVIEW*, 60(4), 59-+. (WOS:000471740500015).
- Wong, W., Norzi, A., Ang, S., Chan, C., Jaafar, F., & Sivasampu, S. (2020). The effects of enhanced primary healthcare interventions on primary care providers' job satisfaction. *BMC HEALTH SERVICES RESEARCH*, 20(1). (WOS:000528747400014). <https://doi.org/10.1186/s12913-020-05183-9>
- Wrona, K. J., Albrecht, J., Schulenkorf, T., & Bruland, D. (2025). Promoting digital health literacy in disadvantaged life situations through community-oriented approaches: Results of a workshop. *Pravention und Gesundheitsforderung*. Scopus. <https://doi.org/10.1007/s11553-024-01186-0>
- W.S Richardson. (1995). *Utilization of the PICO framework to improve searching PubMed for clinical questions*. ACP Journal Club. <https://doi.org/10.7326/ACPJC-1995-123-3-A1>
- Xing, F., Peng, G., Zhang, B., Li, S., & Liang, X. (2021). Socio-technical barriers affecting large-scale deployment of AI-enabled wearable medical devices among the ageing population in China. *TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE*, 166. (WOS:000635171700018).
<https://doi.org/10.1016/j.techfore.2021.120609>
- Xing, Y., Liu, Y., & Lattemann, C. (2020). Institutional logics and social enterprises: Entry mode choices of foreign hospitals in China. *JOURNAL OF WORLD BUSINESS*, 55(5). (WOS:000554535000001). <https://doi.org/10.1016/j.jwb.2018.11.004>

- Xing, Y., Yang, K., Lu, A., Mackie, K., & Guo, F. (2024). Sensors and Devices Guided by Artificial Intelligence for Personalized Pain Medicine. *Cyborg and Bionic Systems*, 5. Scopus. <https://doi.org/10.34133/cbsystems.0160>
- Yan, A. Z., Staab, E. M., Nuñez, D., Zhu, M., Wan, W., Schaefer, C. T., Campbell, A., Quinn, M. T., & Baig, A. A. (2024). Impact of a Text Messaging Intervention as an In-Between Support to Diabetes Group Visits in Federally Qualified Health Centers: Cluster Randomized Controlled Study. *JMIR Diabetes*, 9. Scopus. <https://doi.org/10.2196/55473>
- Zhang, H., Chen, D., Zou, P., Cui, N., Shao, J., Qiu, R., Wang, X., Wu, M., & Zhao, Y. (2021). Exploring the Experience of Healthcare Workers Who Returned to Work After Recovering From COVID-19: A Qualitative Study. *FRONTIERS IN PSYCHIATRY*, 12. (WOS:000720877300001). <https://doi.org/10.3389/fpsy.2021.753851>
- Zhang, N. (2024). Emergency Response Under Smart Healthcare: Analysis of Student Physical Examination Data Based on Iot Technology. *ACM Int. Conf. Proc. Ser.*, 167–171. Scopus. <https://doi.org/10.1145/3700486.3700513>
- Zhang, Y., Khan, U., Lee, S., & Salik, M. (2019). The Influence of Management Innovation and Technological Innovation on Organization Performance. A Mediating Role of Sustainability. *Sustainability*, 11(2), 495. <https://doi.org/10.3390/su11020495>

Annexes and appendices

Appendix A – Quantitative Survey

Secção 1 de 5

Estudo sobre a Transformação Digital nos Serviços Saúde

A aplicabilidade do presente questionário visa recolher informações para a elaboração de uma tese no âmbito do Doutoramento em Ciências e Tecnologias da Informação, na Escola de Tecnologias e Arquitetura do Instituto Universitário de Lisboa (ISCTE). Deste modo, apreende enquanto objetivo, aferir, os impactos da Transformação Digital nos serviços de saúde em Portugal na perspetiva do utente.

Este questionário tem uma duração média de 8 minutos.

A participação neste questionário é totalmente voluntária e anónima, o que significa que nenhuma pergunta lhe irá pedir dados pessoais, e as suas respostas serão usadas somente para fins académicos. Não existem respostas corretas ou erradas, deste modo é crucial que responda com franqueza e transparência a cada questão.

Agradecemos antecipadamente o seu contributo.

Assume-se a concordância no preenchimento do questionário após clicar no botão "seguinte".

No caso de existirem dúvidas, comentários ou sugestões de melhoria, agradeço que envie email para: nfsga@iscte-iul.pt

Após a secção 1 Continuar para a secção seguinte

Secção 2 de 5

Estudo sobre a Transformação Digital nos Serviços Saúde

Descrição (opcional)

1.Qual o seu Género: *

☐ Masculino

☐ Feminino

☐ Outro

2.Qual o seu Nível de escolaridade: *

☐ Até ao 9ºano

☐ 12ºano

☐ Licenciatura

☐ Mestrado

☐ Doutoramento

3.Qual a sua Idade? *

Texto de resposta curta

4.Qual a sua nacionalidade? *

Texto de resposta curta

5.Qual o seu concelho de residência? *

Texto de resposta curta

6. Quando tem um problema de saúde, onde se dirige? *

	Nunca	Raramente	Algumas Vezes	Muitas Vezes	Sempre
Centro de Saúde	☐	☐	☐	☐	☐
Clínica privada	☐	☐	☐	☐	☐
Hospital Público	☐	☐	☐	☐	☐
Hospital Privado	☐	☐	☐	☐	☐

7. Pensando no serviço de saúde onde vai mais frequentemente, diga porque vai a esse local: *

	Discordo Total...	Discordo	Neutro	Concordo	Concordo Total...
Preço	☐	☐	☐	☐	☐
Qualidade do s...	☐	☐	☐	☐	☐
Proximidade d...	☐	☐	☐	☐	☐
Confiança nos ...	☐	☐	☐	☐	☐
Tecnologia utili...	☐	☐	☐	☐	☐

8. Acesso e Familiaridade com a Tecnologia *

	Discordo total...	Discordo	Neutro	Concordo	Concordo total...
Tenho acesso r...	☐	☐	☐	☐	☐
Utilizo regular...	☐	☐	☐	☐	☐
Sinto-me confo...	☐	☐	☐	☐	☐

9. Competências e Habilidades Digitais: *

	Discordo total...	Discordo	Neutro	Concordo	Concordo total...
Consigo utiliza...	☐	☐	☐	☐	☐
Sei como realiz...	☐	☐	☐	☐	☐
Sinto-me capa...	☐	☐	☐	☐	☐
Tenho facilidade...	☐	☐	☐	☐	☐

10. Segurança e Privacidade Online: *

	Discordo total...	Discordo	Neutro	Concordo	Concordo total...
Sei identificar s...	☐	☐	☐	☐	☐
Costumo utiliz...	☐	☐	☐	☐	☐
Sei o que é phi...	☐	☐	☐	☐	☐
Protejo os meu...	☐	☐	☐	☐	☐

11. Uso Consciente e Crítico da Internet *

	Discordo total...	Discordo	Neutro	Concordo	Concordo total...
Verifico se um...	☐	☐	☐	☐	☐
Refliro sobre o ...	☐	☐	☐	☐	☐
Sinto que consi...	☐	☐	☐	☐	☐

12. Comprometimento e Inclusão Digital ^{*}

	Discordo total...	Discordo	Neutro	Concordo	Concordo total...
Participei em a...	☐	☐	☐	☐	☐
Sinto-me inclui...	☐	☐	☐	☐	☐
Utilizo com fre...	☐	☐	☐	☐	☐
Ajudar outras p...	☐	☐	☐	☐	☐

13. Inovação e Adaptação ^{*}

	Discordo total...	Discordo	Neutro	Concordo	Concordo total...
Quando surge ...	☐	☐	☐	☐	☐
Adapto-me às ...	☐	☐	☐	☐	☐
Utilizo tecnolo...	☐	☐	☐	☐	☐

14. Na sua interação com esse serviço de saúde, costuma utilizar ferramentas digitais?

	Nunca	Raramente	Algumas Vezes	Muitas Vezes	Sempre
Aplicações mó...	☐	☐	☐	☐	☐
Portais ou web...	☐	☐	☐	☐	☐
Vídeo Consultas	☐	☐	☐	☐	☐
Telemedicina	☐	☐	☐	☐	☐

15. Maturidade Digital (MD): *

	Discordo total...	Discordo	Neutro	Concordo	Concordo Total...
A utilização da...	☐	☐	☐	☐	☐
Tenho facilidade...	☐	☐	☐	☐	☐
As ferramentas...	☐	☐	☐	☐	☐
Perceciono me...	☐	☐	☐	☐	☐
As tecnologias...	☐	☐	☐	☐	☐
Confio nas ferr...	☐	☐	☐	☐	☐
A utilização da...	☐	☐	☐	☐	☐

16. Inovação Digital (ID) *

	Discordo total...	Discordo	Neutro	Concordo	Concordo Total...
A utilização da...	☐	☐	☐	☐	☐
A introdução d...	☐	☐	☐	☐	☐
A inovação digi...	☐	☐	☐	☐	☐
As novas tecno...	☐	☐	☐	☐	☐
A inovação digi...	☐	☐	☐	☐	☐
Verifico melhor...	☐	☐	☐	☐	☐
As tecnologias...	☐	☐	☐	☐	☐

17. Literacia Digital e Performance (LDP)

	Discordo total...	Discordo	Neutro	Concordo	Concordo Total...
Tenho facilidade...	☐	☐	☐	☐	☐
A utilização do...	☐	☐	☐	☐	☐
Compreendo b...	☐	☐	☐	☐	☐
Tenho confianç...	☐	☐	☐	☐	☐
As plataformas...	☐	☐	☐	☐	☐
A utilização de ...	☐	☐	☐	☐	☐
As ferramentas...	☐	☐	☐	☐	☐
Utilizo frequent...	☐	☐	☐	☐	☐

18. Inclusão Digital (INCD) *

	Discordo total...	Discordo	Neutro	Concordo	Concordo Total...
O acesso a ser...	☐	☐	☐	☐	☐
Tenho facilidade...	☐	☐	☐	☐	☐
As ferramentas...	☐	☐	☐	☐	☐
Sinto-me inclui...	☐	☐	☐	☐	☐
A utilização de ...	☐	☐	☐	☐	☐
A utilização da...	☐	☐	☐	☐	☐
As ferramentas...	☐	☐	☐	☐	☐
Sinto-me à von...	☐	☐	☐	☐	☐

19. Satisfação com os Serviços Digitais de Saúde (SSDS)

	Muito Insatisfe...	Insatisfeito	Nem Satisfeito...	Satisfeito	Muito Satisfeito
Utilização de te...	☐	☐	☐	☐	☐
Como avalia q...	☐	☐	☐	☐	☐
Como avalia a ...	☐	☐	☐	☐	☐
Como avalia a ...	☐	☐	☐	☐	☐
Como avalia a ...	☐	☐	☐	☐	☐
Como avalia a ...	☐	☐	☐	☐	☐
Como avalia su...	☐	☐	☐	☐	☐
Como avalia a ...	☐	☐	☐	☐	☐
Como você ava...	☐	☐	☐	☐	☐
Como você ava...	☐	☐	☐	☐	☐

Appendix B - Qualitative Survey (Focus Group)

Questões		Referências
QF1	Considera que os resultados da transformação digital dependem da liderança e do processo de mudança?	I.H. Tolboom (2016);Oygarden et al (2020)
QF2	Considera que a inovação tecnológica tem impacto direto na gestão da mudança ?	Fischer et al (2021)
QF3	Considera que existe uma relação positiva entre a capacidade das TI e o desempenho ?	(Nwankpa e Roumani 2016) Ravestein e Ongena (2019)
QF4	Considera que a liderança é um fator crítico para alavancar a transformação digital ?	Tonder et al (2020);Oygarden et al (2020)
QF5	É da opinião que a inovação de processos irá mediar a relação entre as capacidades da liderança organizacional e os benefícios nas organizações de saúde?	(van de Wetering et al. 2020); Van Belzen et al (2019)
QF6	Considera que existe uma relação positiva entre transformação digital e inovação?	Ravestein e Ongena (2019)
QF7	Qual a importância da transformação digital na estratégia das organizações de saúde?	Oygarden et al (2020)
QF8	Como pode a transformação digital aumentar a capacidade diagnóstica e cirúrgica?	Van Belzen et al (2019)
QF9	De que forma pode a transformação digital influenciar o desempenho das organizações de saúde?	Oygarden et al (2020);Secinaro et al (2022)
QF10	De que forma pode a liderança no contexto organizacional ter um papel inspirador na transformação digital ?	Albrecht et al (2020);Oygarden et al (2020)